Science Focus 7 - Unit 2

Teaching Notes

Prepared for Teachers by Edquest Resources 2002

Topic 1 - People and Plants

People use plants for things other than food. Plants also provide fibre, which is the tissue of plants from the stem, leaves, seeds or roots. The subtopics will outline how plants frovide food and fibre for human needs.

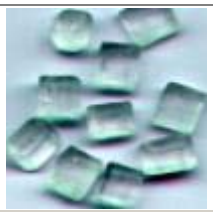
Plants in the Environment

As a critical part of the ecosystem, plants provide oxygen for organisms to survive. They are able to reduce the problem of pollution, by using carbon dioxide. Plants are also the basis of most food webs as producers of food for herbivores and ultimately carnivores. Plants also provide shelter for animals, clean and filter water and help prevent soil erosion.

Plants for Food

Nearly 75% of the world's food supply is based on seven major crops: wheat, rice, maize (corn), potatoes, barley, cassava and sorghum.

From Plant to Final Product (p. 93)

Cocoa	Canola	Seeweed	Sugar
Chocolate is made from the fruit of the cocoa tree	78% of vegetable oil production is from canola	contains iodine and is used in soup broths and sushi	half of the world's sugar comes from sugar beets, located in the sugar beets' roots
			
Cocoa beans are roasted, shelled and then crushed. Cocoa butter and cocoa powder are separated. Cocoa powder is then mixed with milk to make chocolate.	Canola is pressed from the canola seeds and used as salad oil and frying oil It is used to make margarine, shortening, baked goods, potato chips and french fries	other products from seeweed include: ice cream, chocolate milk, yogurt, whipped cream, pies, jellies and candies seeweed products are often used to thicken food (alginate, agar, carrageenan)	roots are shredded, heated in running water and the concentrated clear liquid crystallizes to produce sugar similar to sugar cane
			

Plants for Fibre

Plants provide fibres for clothing, paper and shelter. The aboriginal people from the west coast wove cloth from the bark of the western red cedar tree. Much of our clothing today comes from synthetic (manufactured) material, such as polyester and nylon. Natural fibres also provide resources for cloth:

Cotton	Hemp	Flax
- is a natural fibre that absorbs moisture and then allows it to evaporate easily, making it the world's most important non-edible plant. The cotton fibres come from the plant's seeds. The silky fibres are strong, flexible and have a gradual spiral that causes the strands to interlock when twisted, making them ideal for spinning into thread. The second layer of fibers are shorter and are 'fuzzy' - they are used to make cotton batting, rayon and various types of plastic and paper.	- early makers of jeans used hemp, which is the oldest cultivated fibre plant in the world. Other products included the Bible, sails and ropes. Hemp has a less negative effect on the environment, because it uses less land area than trees, can be harvested in a year, lasts longer than paper, can be recycled up to seven times, chokes out weeds naturally and is not prone to insect pests.	- is a food and fibre crop. The flax fibres, which are smooth and straight, are taken from the stem of the plant are are two to three times stronger than cotton fibres. Flax fibre is used for making linen paper, linseed oil - which is used as a drying oil in paints and varnish - and in products such as linoleum and printing inks.

Plants for Medicine

An apple a day keeps the doctor away! Many medicines (over 7000) contain ingredients made from plants. Herbal remedies are a common example of how plants are used to prevent illness. Plant medicines include: tea (made from ginger root) - is used to soothe an upset stomach; white willow bark - is used to ease pain; opium poppy seed pod - thick milky fluid provides a powerful pain medication – morphine; codeine is also found in the poppy - it is used in cough medicines; quinine - which comes from the cinchona tree - is used to prevent malaria.

Plants for Transportation and Construction

Rubber is one of the most important plant products that people use. Natural rubber comes from the Brazilian rubber tree. Synthetic rubber is made from coal and oil by-products - but natural rubber is also an important ingredient.
Canoes were carved from trees by Aboriginal people. Lubricants are provided from coconut and castor bean oils. The construction industry in North America uses wood (softwood lumber from British Columbia) as a building material.

Plants for Fuel

Wood or coal (which is a fossil fuel) are used to heat homes. Sugar can be turned into ethanol and wood can provide methanol (wood alcohol). Fuel from plants is economical, but not energy efficient, because a large amount of energy is need to grow the plants and a lot of the energy is lost when it is converted to fuel.
Human Needs and Plant Needs

Our task is to make sure that plants survive and thrive in order to have this important resource in the future.

Topic 1 Review p. 103

Topic 2 - Structure and Adaptations

Plants have particular habitats, each with its own set of environmental characteristics, including light, temperature water and soil conditions. The structure of a plant helps it to adapt to these conditions.

Roots

There is much more to a plant than what you are able to see above the surface of the soil. In fact, up to one third of the plant can be beneath the soil. Types of Roots

Roots perform several functions:

- **they absorb water and minerals from the soil**
- **they support and anchor the plant so it cannot be relocated easily**
- **they store food to help the plant survive during times of scarcity**

The most prominent part of the root in many plants is the taproot, with many smaller roots coming out from it, like branches on a tree. These smaller roots are covered in root hairs. The smaller roots and root hairs absorb water and nutrients from the soil.

Other plants have fibrous roots, which is a shallow system of similar-sized roots that can quickly soak up moisture.

Roots are often especially adapted to a plant's habitat.

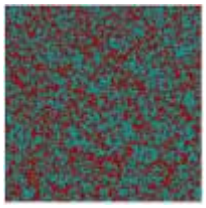
Moss campion is an example of how a plant grows its taproot system throughout the early years of the plant's life, so that it can have a well established taproot system before the upper part of the plant matures (it can take up to 25 years for the plant to bloom).

The duckweed on the other hand has tiny roots on the underside of the leaf and are surrounded entirely by water.

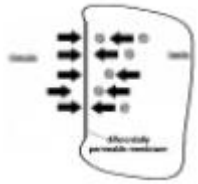
ROOT CROPS

Generally grow in a short period of time, usually survive when there is little moisture and can be stored for long periods of time

Diffusion and Osmosis (p. 107)



Diffusion is the tendancy of particles in a gas or liquid to become evenly distributed by moving from areas of greater concentration to areas of lesser concentration. The particles continue to spread out until they are evenly distributed within the enclosed area.



Osmosis is a particular type of diffusion in which only some of the particles are allowed to pass through a barrier. This barrier is called a differentially permeable membrane. Osmosis is the diffusion of water through a differentially permeable membrane.

Stems

One function of the stem is to transport water and nutrients between the leaves and the roots.

Support
Another function of the stem is to support the leaves and to ensure that the leaves receive adequate light. To achieve this most stems grow above the ground

Food Storage
Another function of the stem is to store food for the plant. The food produced in the leaves is stored ion the stem - like potatoes, which have swollen underground stems called tubers (the starch they store is used by the plant to grow). Some plants store food as sugar as well - the sugar cane is a good example.

Different Types of Stems

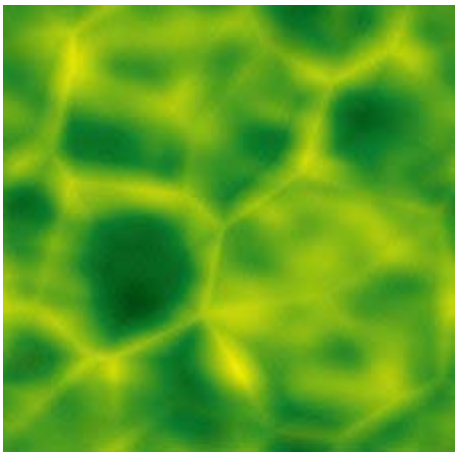
Strawberry Runners

Gladioli Corm

Cattails Horizontal Rhizomes

Cacti Fattened Stems

Leaves



A pigment called chlorophyll makes the leaves green. The energy of the sun is trapped in the leaves and changed into a kind of chemical energy. Carbon dioxide and water are used by the leaves in the process called photosynthesis, to make sugar and give off oxygen. Plants also need oxygen - at night when photosynthesis does not happen, respiration does. Respiration is a process by which plants release carbon dioxide and let oxygen into their cells. Water enters and leaves the cells in the leaves through the guard cells. When they absorb water they swell, opening the stoma (which lets in carbon dioxide and lets out water vapor). The loss of water through evaporation is called transpiration.

Moving Water in Plants

The pushing and pulling action of osmosis (pushing water up from the roots) and transpiration (pulling the water up the xylem tissue from the roots) moves water up to the very top of the plant.

Topic 2 Review p. 114

Topic 3 - Plant Reproduction and Breeding

Selective breeding means that people choose specific plants with particular characteristics and encourage these plants to reproduce.

Apple Varieties
Did You Know (p.116)
There are over 7500 varieties of apples grown in the world - of which 2500 are grown in North America

Plants are also bred for …

- **their ability to withstand certain environmental conditions (hardiness)**
- **how much food they produce (yield)**
- **their resistance to disease.**
- **their appearance (sweetheart cherries - Summerland Research Station, B.C.)**

New Genes?

Canola was developed using selective breeding and originated from a plant called **rapeseed.** It was developed to produce seeds that created a good-tasting oil. Canola crops are now more resistant to diseases, drought and even certain chemicals.

Scientists can change plants by going inside an individual plant cell and modify some of its material, by removing parts of the cell that control particular characteristics. This genetic material (genes of the plant) can then be combined with genetic material from another plant to create a new plant - having characteristics from both plants. This process (biotechnology) is called genetic modification, or genetic engineering.

Types of Plant Reproduction

Plants can reproduce in two very different ways. Sexual reproduction involves the production of seeds and fruits from specialized cells of two plants. Asexual, or vegetative reproduction, occurs when a 'parent' plant grows new plants from its roots, stems, or leaves.
Traditional types of vegetative reproduction include:

- **cuttings**
- **layering** (runners)
- **grafting**
- **fragmentation** (buds and root systems)
- **Seed Plant Reproduction (p. 93)**

In vegetative reproduction, plants produce new plants identical to themselves. In sexual reproduction - *reproduction using seeds* - the new plants are slightly different from their parents.

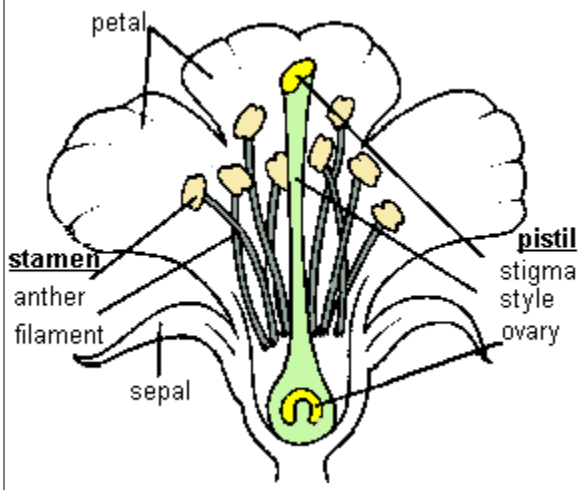
Cones

The cone is the part of the tree that has a series of woody scales, and come in various shapes and sizes. Cone-bearing trees produce both male and female cones. Female cones contain ovules (eggs) - the small bumps at the end of a scale in a cone. Pollen grains (containing sperm) develop on the smaller male cone. Wind carries the pollen grains to the female cones. Although most of the pollen grains never reach the female cones, those that do get caught in the sticky fluid near the ovule. A pollen tube grows to the ovule and sperm is able to fertilize the egg. The process of pollination is complete. Female cones of pine trees mature, open, and release their seeds during the fall or winter months. (This whole process takes at least two years) The seeds can then be dispersed by various methods and when they get covered they can eventually sprout and become new pine trees.

Flowers

Flowers use color, scent, nectar to attract animals, so that the pollination process can begin.
Flowering Plant Reproduction
Flower Structure - A Web Quest

Parts of a Flower

Identify the Flower Parts	Flower part	Function
	**petal**	brightly colored parts of the flower to attract insects and birds
	sepal	green, protect the flower before it opens (underneath after it opens)
	stamen (male reproductive organ)	
	anther	where pollen is produced and stored
	pollen grains	cases containing male reproductive cells
	filament	stalk that supports the anther
	pistil (female reproductive organ)	
	stigma	sticky 'lip' of the pistil that captures pollen grains
	style	stalk that supports the stigma
	ovary	swollen base of the pistil containing ovules
	ovules	sacs containing female reproductive cells

Pollination (good visual description at: http://www.botany.uwc.ac.za/ecotree/flowers/pollination.htm)

Pollination can occur by self-pollination or cross-pollination.

The bee spreads pollen over more crops than any other insect. Artificial pollination can also be used to breed different varieties of plants for specific purposes (usually to produce a better yield, or one that is more resistant to environmental conditions - such as cold winters) It is not just exposure to cold temperatures that kills seeds, but prolonged exposure to cold temperatures.

From Seed to Fruit

Once a plant is pollinated, a seed is formed. Seed Parts include the living plant (embryo) and the food supply (cotyledon). The length of time a seed is able to stay alive varies according to the conditions it experiences. The longest-lasting seed was frozen for over 10,000 years before it sprouted and even flowered (p.125).

Fruit

A fruit is the growing ovary of the plant that swells and protects the developing seeds of a plant, until they are ripe. Not all fruits can be eaten though - a cotton boll is a fruit. (uses for non-edible fruits)

Seed Dispersal

Dispersal is the transportation of seeds away from the parent plant.
It can happen in various ways (see pictures on p. 127), including:

- **wind**
- **waterways (rivers, streams, etc.)**
- **bird droppings**
- **animal fur**
- **fire**

Spreading and Harvesting Seeds in the Field

Farmers use machines to disperse seeds. Once they have grown into the crop, they are harvested in two steps. A swather cuts the plants and lays them in rows (the stubble - what is left of the plant after being cut - prevents the plant from touching the soil, so the seeds can ripen). A combine then separates the grain from the rest of the plant. (The grain seeds are collected and the straw is baled, or spread evenly over the field).

Germination

When the seed is able to come in contact and get covered by the soil, it remains inactive until the right conditions are present for it to germinate. Germination is the development of a seed into a new plant. (Figure 2.39 p. 128 - Germination of a bean seed) .

Topic 1 Review p. 130

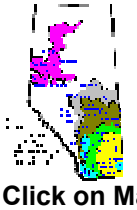
Wrap-Up (Topics 1-3) p. 131

Topic 4 - Meeting the Need for Food and Fibre

Because we grow more than we consume, Canada exports the excess to other countries around the world. Canada is also a leader in forestry and agricultural research science. Scientists, farmers and foresters are working together, developing practices that will reduce the negative effects that sometimes occur when we harvest plants for food and fibre. Sustainability (an ecological balance) is essential if we are to keep our natural resources healthy in the long term.

Agriculture in Alberta

Agriculture is important, but relatively new as an industry in Alberta. The vast natural resources in Alberta attracted many settlers who cultivated the grasslands to grow crops and harvested trees for construction, manufacturing and fuel. Nearly all of the grassland in the prairie provinces was converted to cropland, thus destroying the natural vegetation and native plant species that had been around for a thousand years.
This map shows the ecoregions of Alberta where parkland, grassland and forests in Alberta have been cultivated to grow crops
(*Of the 60 million hectares of land in Alberta, over 20 million is now farmland.*)



Click on Map to see full view

Who's Who in Crop Country?

Alberta crops are worth almost $3 Billion. The food industry is second only to oil and gas in terms of earnings.

Wheat	Oats	Canola	Barley
Wheat is used to make food. The seeds are ground to make bread, pasta and many other processed foods.	Oats are grown to feed livestock.	Oil is pressed out of the canola seeds and is used to make margarine, cooking oil and salad dressing. Leftover 'meal' is used to feed poultry and livestock, because it is high in protein.	Is fed to livestock and is used for making malt flavouring (used in many foods).
Legumes	**Potatoes**	**Alfalfa**	**Specialty Crops**
High in protein - legume crops, such as field peas, faba (or fava) beans and lentils are grown in the Parkland and Peace River Regions	The cool climate is ideal for growing potatoes. Half of the potatoes grown in Alberta are processed into frozen french fries and potato chips. Many potatoes are sold to other farmers as seed potatoes.	This crop is grown for its leaves and stems. They are known as hay crops or forage crops and are fed to livestock. It has a very strong and deep taproot system.	Sunflowers Beans, field corn, sugar beets, lentils, safflower and spices (grown in Southern Alberta)

Math Note: ***A hectare of land is equal to 10,000 square meters of land.***

Growing Under Glass

The yield from crops that are grown outdoors is highly dependent on the environmental conditions, climate and soil types. In a greenhouse all of the growinging conditions can be controlled. There are obvious advantages, but there are also disadvantages. Make a list of those you are able to find out about and report your findings to the class to complete the chart.

Advantages	Disadvantages
higher yield	cost

A wide range of warm-season crops, including seedless cucumbers, tomatoes, lettuce, peppers, house plants, and cut flowers grown in greenhouses

Farming Practices

To be economically sustainable, farmers need to make more money with their crops than they spend to grow their crops. They are able to do this by using very large machinery that can cover large parcels of land as they seed and harvest their crops. They also need to add fertilizer to the soil to increase the yield and irrigate to provide the need moisture for growth of the crop. Most farmers only grow one type of crop in one particular area - this is known as monoculture.

Farming Then and Now

Farming practices changed from using human and animal power in the early 1900's to total mechanization by the 1950's to modern computerized controls in the present. Comparison chart on p. 141.

Farming Activity	Technology of the Early 1900's	Technology of Today
loosen the soil	oxen or horse-drawn cultivator	cultivator machines
add nutrients	manure used as fertilizer	chemical fertilizers
fungi (disease) control	few controls for fungi	chemical fungi control
spreading seed evenly	seeds spread by hand	air seeders and seed drills
pest and weed control	people, including children, pulled weeds by hand	sprayed with chemicals
cutting of grain	scythe used to cut crops	swathers used to cut hay
threshing of grain	grain picked by hand (tossed in the air and caught in a basket - wind carried the straw away)	combines used to harvest grain and separate seeds and hay
taking crop to market	horse-drawn carts	large tractor trailer trucks
prepare land for another season	horse-drawn plough	modern plough

Saving Soil Moisture

Irrigation is a technique that farmers use to make sure that moisture gets into the soil for crop growth. It is often a problem in grassland areas, where the moisture evaporated quickly. Irrigation systems (using natural waterways and irrigation canals) can often be the life or death of a crop and must be maintained, to ensure an adequate supply of water is available when it is needed.

Fibre Plants and the Forestry Industry

Canada has about 10% of the world's forests. From these forests come lumber and pulp and paper products. Natural forests have many different kinds of trees, shrubs, and smaller plants. There are many animals that make their homes in, around and under these plants. A natural ecosystem has a higher diversity, or variety, of plants and animals than a field of wheat or a stand of trees. The species within this ecosystem are all interdependent. Forestry practices can increase the diversity of forest species by careful cutting to let in more light and air.

Who's Who in Fibre-Space?

Alberta tree species most valued for lumber and paper include:

- **Lodgepole Pine**
- **White Spruce**
- **Black Spruce**
- **Aspen**
- **White Birch**
- **Tamarack (Larch)**

Graphs on p. 145 show the tree species harvested in Canada and the percentage value of forest products.

Harvesting Trees

Foresters explore a potential tree cutting area thoroughly before any work begins. They map the area indicating which trees to be cut and what special features should be noted. They also decide how to cut the trees, either clear cut (removing all the trees)- or, selective harvesting (removing only selected trees). See Figure 2.49 p. 146

Reforestation

Foresters attempt to improve the conditions (light, temperature, water and nutrients) within the forest. Leftover branches (from the logging operations) must be disposed of. They are chopped (shred**ded) spread out over the forest floor and some smaller piles are burned. Replanting is always done by hand. When the trees begin to grow again, if too many of a particular kind compete,** thinning or pruning must remove them**. Fertilizer is dropped from a helicopter to improve the level of nutrients for the young trees. Forest fires are a natural development of forests, but foresters try to ensure that they burn in a controlled fashion (as much as possible).**

Global Problems

Erosion is a worldwide problem. Frequent and long-lasting droughts have resulted in desertification - a process in which desert has taken over much of the agricultural land.

Topic 4 Review p. 148

Topic 5 - Sustaining the Soil

Healthy soil is critical in natural ecosystems and sustains our need to grow plants for food and fibre. Soil gives plants a place to sink their roots and anchor themselves. Soil is also a community with billions of organisms.

How Do Soils Develop?

Five factors determine how soils develop:

- **Parent material (mineral matter - rock, soil clay)**
- **Climate (determines the kinds of plants, how fast they grow and decompose)**
- **Vegetation (determines the amount and type of organic matter in the soil)**
- **Landscape (helps to prevent erosion)**
- **Time (all these process happen over long periods of time)**

Soil: A Lively Community

Healthy soil contains soil-dwellers and decomposers. The decomposers break down plant and animal tissue, forming humus, which helps roots grow by trapping water and air.

The four main types of decomposers are:

- **Bacteria**
- **Fungi (including moulds and mushrooms) - make nutrients available to plants**
- **Microscopic actinomycetes (a special type of bacteria)**
- **Earthworms (eat soil, grind, digest and mix it - their tunnels provide air and the mucus helps stick soil particles together)**

All You Can Eat

Plants require 6 basic nutrients from the soil in order to grow healthy.
These nutrients are: nitrogen (N), phosphorus (P), potassium (K), sulphur (S), calcium (Ca), and magnesium (Mg).

Typical nutrients in fertilizers:

- **The first number in a fertilizer formula is the amount of nitrogen in the fertilizer ... Nitrogen … which is used by plants for producing leaf growth and greener leaves.**
- **The second number is the phosphorus amount of ... Phosphorus … which is used by plants to increase fruit development and to produce a strong root system.**
- **The third number is the amount of ... Potassium (potash) … which is used by plants for flower color and size. It is also helps to strengthen the plant.**

Challenges and Solutions

Production practices have over time, sometimes damaged large areas of soil throughout the Prairie Provinces.

Salinization: Salty Soil

The white crusty ring around a body of water is salt, which has run off the land into the water. This condition is called salinization and can have the same effect as a drought.

Two factors lead to increased salinization:

- **not enough vegetation**
- **too much water (irrigation)**

This problem can be corrected by replanting the areas where there is very little vegetation, so the plants can use up the water that falls before it runs off as excess or seeps into the soil dissolving the mineral salt in the soil and getting into the groundwater.

Organic Matter and Erosion

Loss of organic matter is a very serious problem and can lead to soil erosion. If the soil has lost this organic matter (which has been built up over many years) the plants may not grow very well, because of the lack of sufficient nutrients in the soil. Ploughing and cultivating the soil too much and the practice of regular summer fallow (cultivating the land to control weeds - by not planting a crop) exposes the soil surface to sunlight and higher temperatures, encouraging bacteria to decompose organic matter at a rapid rate and exposes it to sun and wind - thus increasing topsoil erosion.

Saving the Soil

Soil erosion can be solved, by planting a cover of vegetation on the surface, to slow the flow of water runoff (giving it more time to absorb more water). This vegetation also helps to anchor the soil particles from the wind. Zero Tillage is one way to accomplish this and it also helps control the growth of weeds. Special farming equipment is also used (seed drills), Shelterbelts (rows of trees), Modification of waterways, and Crop rotation (forage crops to add more organic matter - manure from livestock)

Hydroponic Technology

Hydroponics is a technique for growing plants, without soil in a water solution. (This occurs in greenhouses in Canada)

Saving Soil in Forests

Forestry can also have an impact on soils. Removal of trees from a particular areas can lead to erosion by wind and water. Cut areas often are littered with debris, which has been left to lower erosion (and add organic matter to the soil) and replanting programs are started after the trees have been harvested. Vegetation near waterways is usually left undisturbed.

Topic 5 Review p. 162

Topic 6 - Pests and Pest Control

What is a Pest?

A pest is any organism that is causing plants to produce less than they otherwise would. When organisms are part of a natural ecosystem, or are beneficial to people, then they are not pests. There are many different kinds of pests.

The Pest Problem

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

Pests which cause the most problems are:

- **Insects (are consumers, because they eat some or all of the plant)**
- **Fungi (cause infections which can destroy all or part of the plant)**
- **Weeds (Common Weeds) (are thieves, because they steal moisture, nutrients, light and space from the plant crop)**

Dandelion: Profile of a Champion Competitor

Dandelions are successful weed pests because they have:
Powerful roots (long taproot)
Broad Leaves (shade other plants close by)
Super seeds (easily carried by the wind)
… And they are very adaptable, because they grow well in any kind of soil and often survive because they are hardy and can easily be missed by the lawn mower (because of their short flower stalks).
(See profile on p. 165)

Canola and its Pests (Ref. 'WANTED' p. 166) Invasive Plants of Canada

- **Canada Thistle**
- **Wild Oats**
- **Blackleg Fungus**
- **Sclerotina**
- **Fusarium Fungus**
- **Bertha Army Worm**
- **Lygus Bug**
- **Diamond-backed Moths**
- **Flea Beetles**
- **Aphids**
- **Cinchbugs (insect species bios)**

Introduced Species

Each food and fibre crop has its own unique set of pest weeds, insects and fungi.

Sometimes exotic pests are introduced from other countries by accidental exposure to the crop (or sometimes intended). These types of pests can often become serious problems, because they may not have any natural predators, or environmental controls. Quack grass, thistles and chickweed are examples of some exotic weed pests. Dandelions were introduced to North America, from Europe, to be used as a salad vegetable. Naturals controls were not present and , as a result, dandelions thrived and over populated the country (coast to coast).

The European bark-boring beetle was introduced fro the Netherlands in a shipment of logs. Unfortunately, it also brought with it a fungus, called Dutch Elm Disease, that has almost entirely wiped out the native elm trees of North America.

Controlling Pests

There are various ways that pests can be controlled:

- **Natural enemies**
- **Large pests can be chased, or scared away**
- **Smaller pests can be picked off the crop by hand**
- **Machines (like cultivators and ploughs) can be used to uproot pesky weeds**
- **Different crops are grown each year (crop rotation)**
- **Regular summer fallow (controlled pests, but led to soil damage)**
- **Chemical controls (herbicides, insecticides and fungicides)**

Concerns with Chemical Controls

Long term problems were created with the extensive use of pesticides.

- **Bioaccumulation - Pollutants move from level to level in the food chain. Bioaccumulation is a primary concern with the use of chemical pesticides, because as the chemicals move from level to level they accumulate in the organism. Organisms at the top of the food chain are the most adversely affected.**

- **Soil Residue - Some of the chemicals used as pesticides wash off the plants and leave residue in the soil and water. If the chemical is not easily decomposed they remain in the soil and can be poisonous.**

- **Harming Non-Target Organisms - Pesticides are often be toxic to organisms they were never intended to harm (like earthworms who can be exposed to pesticides from soil residue and ladybird beetles who eat aphids can be killed by the pesticide used to control the aphids)**

- **Resistant Species - As pesticide use increases, pests can (over time) develop a resistance to the toxic effects of the chemicals being used.**

Alternatives to Pesticides

Organic Food Production

Organic food is food that has been grown without the use of chemical fertilizers and chemical pesticides. Manure and compost is used to add nutrients to the soil. Pests are controlled by crop rotation, tilling, mulching, companion planting and removal of insects by hand.

Other techniques used to discourage the need for chemicals are

- **using good quality seeds**
- **removing weeds before their seeds mature**
- **cutting weeds along property lines**
- **cleaning equipment to reduce transfer**
- **planting a variety of crops (instead of monocultures) - increasing diversity**

Organic Farming can be more expensive, but the quality is much better, the environment is less harmed and there is a higher level of safety fro the farmer (without using chemicals)

Biological Control

Using a pest's natural predators (enemies) to keep it's numbers under control is an effective technique, provided the species used to control the pest has its own predators to control its numbers.

Producers and Consumers - Partners in Sustainability

Producers, such as farmers and foresters must make very careful economically feasible decisions about what to produce and the practices they use to produce it. Consumers must be more conscious of interdependence, and environmental impact factors, which must be taken into account, besides the cost, to ensure that the food and fibre industry is sustainable.

Topic 6 Review p. 174

Wrap-Up (Topics 4-6) p. 175

Unit Review pgs. 180 - 183