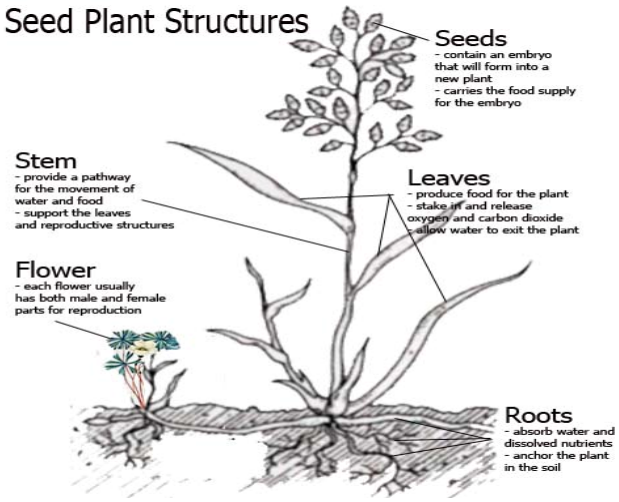
1.0 Understanding structures and life processes of plants helps us to interpret their needs.

1.1 The Body of Seed Plants

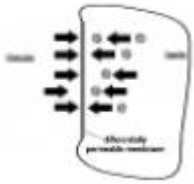
Seed plants are the largest group of plants in the world.
Each seed plant structure has specific functions.



1.2 Plant Processes

- ***A Process For Moving Water Up From The Roots***

A combination of different processes moves the water from the roots to other parts of the plant, and also allows substances in and out of the cells.



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**.

Capillary action – where the water particles are attracted to each other and to the sides of the tubes, and the pushing and pulling action of diffusion and osmosis (moving water through the xylem tissue in the stem) moves water from the roots up to the very top of the plant. The loss of water through evaporation is called transpiration.
Active Transport is another process that enables a plant to get nutrients regardless of the difference in concentration. It does however require energy to move these substances in and out of the plant.

- ***A Process to Make Food***

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.

- ***A Process to Use Food***

Cellular Respiration is a gas exchange 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 word equation for cellular respiration is:

Sugar + Oxygen → Carbon Dioxide + Water + Energy

1.3 Reproduction of Seed Plants

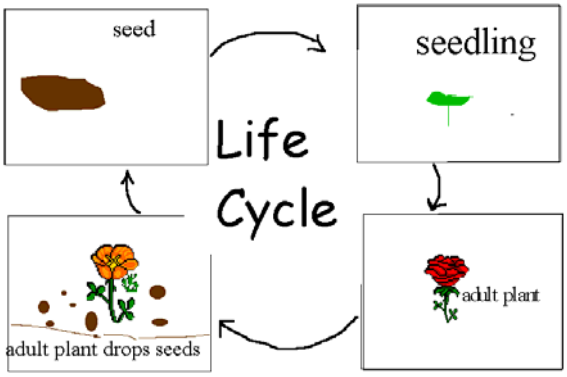
A **life cycle** is the stages that a living thing goes through from one generation to the next.
Plants reproduce in their lifecycle in two very different ways.
Sexual reproduction involves the production of seeds and fruits from specialized cells of two plants.

The Life Cycle of Seed Plants

The Seed Stage

Seed Parts include the living plant (embryo) , the food supply (cotyledon), and the seed coat.

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.



When a 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.

The Seedling Stage

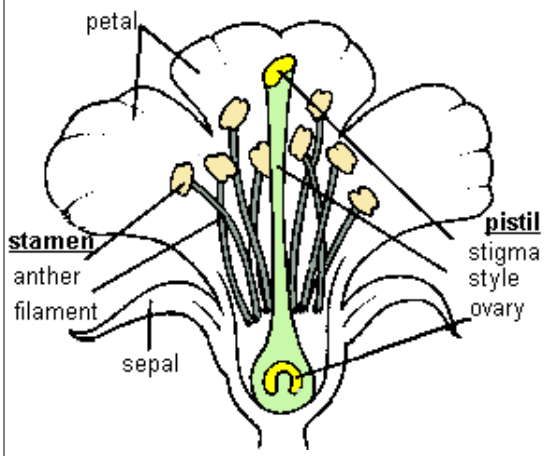
Very fast growth, producing their own food by photosynthesis

The Adult Stage

A plant is an adult when it produces reproductive structures, either cones or seeds

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

Identify the Flower Parts



Flower part	Function
petal	brightly colored parts of the flower to attact 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

Pollination can occur by self-pollination or cross-pollination.
Pollination occurs after a pollen grain lands on the stigma of the flower, above the ovary. The pollen grain produces a pollen tube that grows down from the stigma to the ovule. Through this tube, cells transfer from the pollen grain to the ovule. The ovule then grows into a seed.
Pollination (good visual description at: http://www.botany.uwc.ac.za/ecotree/flowers/pollination.htm)

Pollinators

Dispersal is the transportation of seeds away from the parent plant.
It can happen in various ways, including: wind, waterways (rivers, streams, etc.), bird droppings , animal fur, and fire. 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).

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.

Cones

The cone is the part of the tree that has a series of woody scales, and come in various shapes and sizes. Both male and female cones are produced by cone-bearing trees. 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.

Reproduction Without Seeds

Asexual, or **vegetative reproduction**, occurs when a 'parent' plant grows new plants from its roots, stems, or leaves. Plants that reproduce by vegetative reproduction are genetically identical to the parent that produces it. Some plants reproduce from stems:

Strawberry **Runners** **layering** (runners)

Gladioli **Corm** **fragmentation** (buds and root systems)

Cattails Horizontal **Rhizome**s

Cacti **Flattened Stems**

Plants can also reproduce from their roots and are called **suckers**.

Technology to Reproduce Plants

Asexual reproductive technologies include:
cuttings – small pieces of a plant that usually have part of the stem and a few leaves.
grafting – one stem cutting that is attached to the stem of another plant, eventually growing together.

1.4 Plant Structures Are Adapted to Their Environment

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. 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.

The Stem One function of the stem is to transport water and nutrients between the leaves and the roots. 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 Still another function is to store food for the plant. The food produced in the leaves is stored in 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.

1.5 Plant Needs and Growing Conditions

All plants need the right amount of light, water, nutrients and space in order to grow and survive.

- ***Plants Need Different Amounts of Light*** (fern – marigold)
- ***Plants Need Different Amounts of Water*** (cactus – rice)
- ***Plants Need Different Nutrients*** (beans – wheat)
- ***Plants Need Different Amounts of Space*** (buttercups – redwoods)

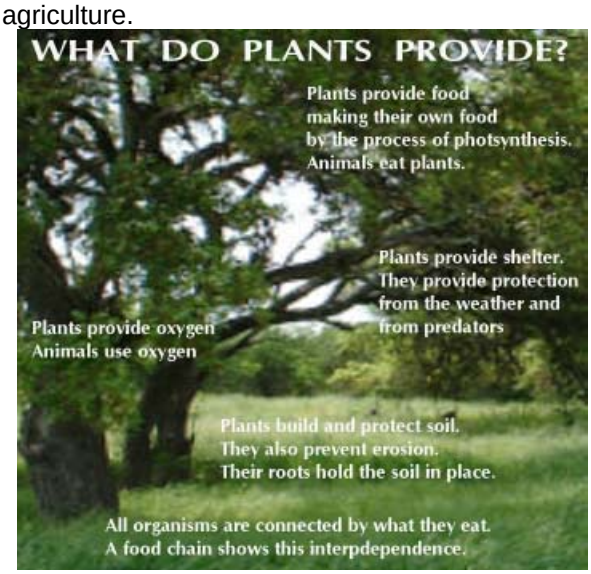
ROOT CROPS
Generally grow in a short period of time, usually survive when there is little moisture and can be stored for long periods of time

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 growing conditions can be controlled. There are obvious advantages, but there are also disadvantages. A wide range of warm-season crops, including seedless cucumbers, tomatoes, lettuce, peppers, house plants, and cut flowers are grown in greenhouses. Growing healthy plants requires knowing the best conditions for the plant you are growing, at each stage in its life cycle.

2.0 Plants play an essential role in the environment and in meeting human needs

2.1 The Role of Plants in the Environment

Plants are necessary for all life on Earth. Plants provide many things for the sustainability of life on our planet. Vegetation in Canada is classified into 4 main categories: forest, tundra, barren and agriculture.

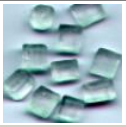


As a critical part of the ecosystem, plants provide **oxygen** for organisms to survive. They are able to **reduce the problem of pollution**, by using carbon dioxide. Plants are also the basis of most food webs as **producers of food** for herbivores and ultimately carnivores. Plants also provide **shelter**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

2.2 We Use Plants in Many Ways

Plants For Food

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

Cocoa	Canola	Seaweed	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	other products from seeweed include: ice cream, chocolate milk, yogurt, whipped cream, pies, jellies and candies	roots are shredded, heated in running water and the concentrated clear liquid crystallizes to produce sugar similar to sugar cane
	It is used to make margarine, shortening, baked goods, potato chips and french fries	seeweed products are often used to thicken food (alginate, agar, carrageenan)	
			

People use plants for things other than food.

Plants for Fibre

Plants also provide fibre, which is the tissue of plants from the stem, leaves, seeds or roots.
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 - 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 strans to intelock 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.
- Hemp - 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.
- Flax - 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 klinoleum 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
- tea (made from white spruce and hemlock) to prevent scurvy
- white willow bark - is used to ease pain
- kinnikinick (buffalo berry) was used to treat kidney problems
- opium poppy's 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 needed to grow the plants and a lot of the energy is lost when it is converted to fuel.

We must make sure that our living resources survive and thrive, in order to have them in the future.

2.3 Managing Living Resources

Living resources are living things that can be used for human needs. Managing living resources involves maintaining healthy populations of all living things that make up those resources.

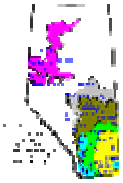
Because we grow more than we consume, Canada exports the excess to other countries around the world. Canada is also a leader in forestry and agricultural research science. Changing practices in using the living resources the land provides has resulted in certain stresses on these resources. This has led to the need to become better mangers of the resources we have and need. 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 living resources healthy in the long term.

Agriculture in Alberta

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

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.



Click on Map to see full view

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

Forestry in Alberta

Canada has about 10% of the world's forests. Alberta tree species most valued for lumber and paper include: **Lodgepole Pine, White Spruce, Black Spruce, Aspen, Tamarack (Larch) and White Birch**. 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.

Agencies that mange forests resources establish methods and regulations that foresters must follow when a forest is to be harvested. These regulations provide the rules for harvesting. Foresters explore a potential tree cutting area thoroughly before any work begins. They map the area indicating which species of trees are 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). 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 (shredded) 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, they must be removed by thinning or pruning. 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).

3.0 Soil is an important resource that human activity can protect or degrade.

3.1 What is Soil?

Soil Contains Minerals and Organic Matter

Organic Matter (decaying or decayed living things) and **minerals** (broken down rock) are what makes up soil particles. Soil that contains a partly decayed organic matter is called **humus**. Soil is a natural resource, like water and minerals. 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)

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)

Characteristics of Different Types of Soil

Sandy	*Clay*	*Loam*
Runs between your fingers	Feels slippery when wet	Feels crumbly
Few lumps	Dry clay is very hard	Soft and feathery
When moistened and squeezed, it will not stay together	When moistened and squeezed, it will stay together forming a tight ball	When moistened and squeezed, it will stay together forming a loose ball
Light brown	Color is determined by the minerals it contains	Dark brown or black
Mostly minerals	Mostly minerals, little humus	Balance between mineral particles and organic matter
Little food for plants	Fine texture	Lots of nutrients for plants
Dries quickly	Small pore size	Absorbs water very well

Different Plants For Different Soils

Even though loam soil appears to be the best type of soil for all plants, not all plants grow well in it. Plants are adapted to different soils.

3.2 Our Practices Can Improve or Degrade Soil

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**.

Fertilizer Use

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. 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 are:

- 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. Urea and ammonia are both used as sources of nitrogen.
- 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.

Irrigation

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.

Clearing The Land

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. Production practices have, over time, sometimes damaged large areas of soil throughout the Prairie Provinces. 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** (salty soil) and can have the same effect as a drought. Two factors lead to increased salinization: not enough vegetation or 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. 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, like the **Noble blade and drill** that replaced traditional plows. **Shelterbelts** (rows of trees), **Modification of waterways**, and **Crop rotation** (forage crops to add more organic matter - manure from livestock). This involves planting a different crop in a particular field every year. The plants from the different crops use the nutrients the other crops don't need.
Forestry can also have an impact on soils. Removal of trees from a particular area 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.

4.0 The ways that plants are grown and used are related to human needs, technology, and the environment.

4.1 Modifying Environments to increase Yields

Scientists and growers have developed technologies that increase the *yield* of plants. **Yield** is the amount of useful plant part per plant. Plants are sometimes grown in artificial environments, in which the growing conditions can be controlled.

Greenhouses are one example of an artificial environment.
A hydroponics system is another type of artificial soil environment. **Hydroponics** is a technique for growing plants, without soil in a water solution. (This occurs in greenhouses in Canada)

4.2 New Plant Varieties Are Developed by Selective Breeding

We Grow Particular Varieties Of Plants

A species is a group of organisms with similar traits that can reproduce with each other. A variety is a subset of a species. A variety has particular traits, or special characteristics that distinguish it from other varieties. New varieties are developed with those traits (grow in colder climates, tolerate salty soil, resist disease, fight off insect infestation) we want or need in the plant we are growing.

Apple Varieties
There are over 7500 varieties of apples grown in the world - of which 2500 are grown in North America

Varieties Are Developed By Selective Breeding

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

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.)

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**.

New Varieties Can Cause New Problems

Some may require more fertilizer, or special treatment of pesticides, which can increase the costs to the grower, and possibly cause harm to the environment.

Canola (an oilseed crop) 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. But, they might cross pollinate with 'wild' mustard to make 'super weeds'.

4.3 Controlling Weeds and Pests

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. In natural systems, organisms have parasites, predators, or competing plants that help to keep their numbers in check. There are many different kinds of pests.
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)

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).

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).

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. 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.

There are various ways that pests can be controlled:

- Natural enemies - often referred to as **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.
- 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 (chemicals that kill selected plants)
    - Pesticides – Insecticides (chemicals that kill selected insects)
    - Fungicides (chemicals that kill off diseases and fungus growing on the plant)

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.

4.4 Consequences of Environmental Management

Unintended consequences result when we don't know or don't think about all of the factors in a particular situation that we are trying to manage in the environment.

Some Practices Have Unintended Consequences For The Environment

Environmental management is balancing the needs of humans with the needs of the environment. When technologies are used to maintain the balance in the environment, all of the effects must be studied, not just the intended effects.

Forestry – roads bring in people and equipment and also destroy habitat, disrupt wildlife migration patterns, and make it easier for predators to capture their prey (in the open). Human recreational use will disrupt particular species of wildlife, by moving away, in order to avoid the noise and presence of humans.

Monoculture

In farm management, each field often support only one type of plant. This is called a **monoculture**. Although this may be good for the farmer (harvesting and overall lower cost), It can also give certain pests a huge supply of their favorite food – resulting in an increased population and ultimately more pesticide used to control this increase. Monoculture also lowers the **biodiversity** of the environment, because only one habitat is available.

There are alternatives to using 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. 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)

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

Sustainable Management

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** (so it will continue for a long time).

Sustainable ways of producing plants (like **crop rotation**) can also have some consequences other than just helping the environment:

- Breaks insect and disease cycle
- Improves soil structure
- Controls problem weeds
- Improves yield by as much as 15%
- Prevents the continued depletion of nutrients in the soil
- Makes economic sense
- Maintains a secure work environment for the grower and the workers