

Modifying Environments to increase Crop 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.

New Plant Varieties Are Developed by Selective Breeding

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.



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

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)
- yield - how much food they produce
- resistance to disease.
- appearance

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 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'.



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. Natural controls were not present and, as a result, dandelions thrived and overpopulated 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 fiber 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 from 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 its 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 can be 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.

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. 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