Pesticides and Biomagnification

Pests

To maximize growth of the desired crop, we try to eliminate organisms that we consider pests.

Pests

For example, weeds are plant pests, mosquitoes are insect pests, and mice are rodent pests.

Pests

The term pest is used only in reference to human wishes. There are no pests in nature.

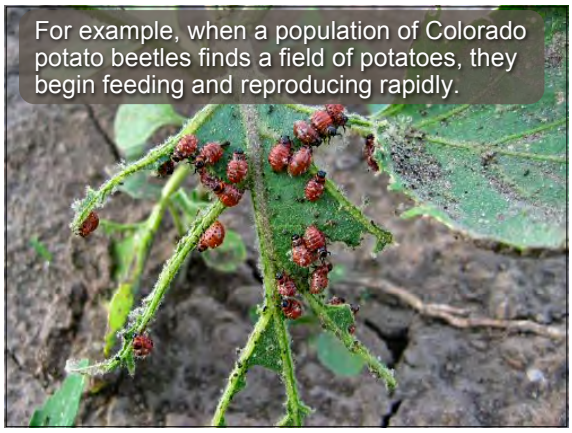
All organisms are simply producers and consumers within food webs.

By controlling pests, crops grow in the near-absence of their natural consumers and competitors.

Insects are also considered serious pests in the forestry industry.

When farmers plant a monoculture, they often create the ideal environment for pests.

For example, when a population of Colorado potato beetles finds a field of potatoes, they begin feeding and reproducing rapidly.



Uncontrolled, the population could skyrocket and devastate the entire crop.

Pesticides

One of the most common ways to control or eliminate pests is to use poisons that kill pests - pesticides.

Pesticides

There are many different kinds of pesticides…

Herbicides are used to kill plants…

Pesticides

Other pesticides include insecticides, rodenticides and fungicides.

Humans even use molluscicides and piscicides to kill snails and fish, respectively.

Once applied, pesticides vary greatly in how long they persist or remain active in the environment.

Some long-lived pesticides persist for many years. Other pesticides are short-lived, lasting only a matter of days before they degrade.

Characteristics of Pesticides

In general, pesticides obtained from natural sources are less persistent than synthetic pesticides.

However, modern synthetic pesticides are less persistent than those developed 30 or more years ago.

Characteristics of Pesticides

Pesticides vary widely in the number of species they are able to control.

Broad-spectrum pesticides are toxic to a range of species, whereas narrow-spectrum pesticides are toxic to a limited number of species.

Characteristics of Pesticides

For example, DDT (dichlorodiphenyltrichloro ethane), a once widely used insecticide, is toxic to most insect species.

Characteristics of Pesticides

Bt, a modern pesticide derived from bacteria (*Bacillus thuringiensis*) is highly toxic only to caterpillars, beetle larvae and fly larvae. It is not toxic to most beneficial insects.

How Pesticides Work

Pesticides work by causing physical or biological harm to the pest organism.

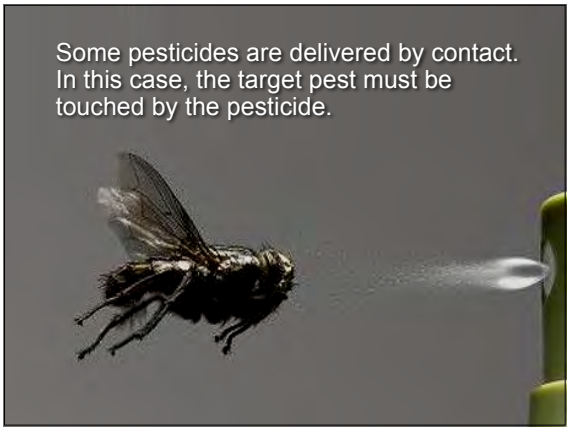
How Pesticides Work

Diatomaceous earth, for example, is composed of the fossilized remains of a type of algae called diatoms.

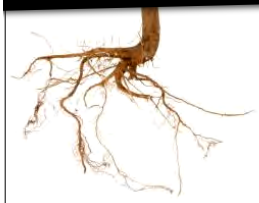
This abrasive powder scratches the waxy outer coating of small organisms, such as insects, causing them to dehydrate.

Other pesticides may interfere with biological processes, such as photosynthesis, or cause damage to vital organs.

Some pesticides are delivered by contact. In this case, the target pest must be touched by the pesticide.



How Pesticides Work



Alternatively, some pesticides are indirectly applied. For example, herbicides can be sprayed on the soil and taken up through the roots of the weed.

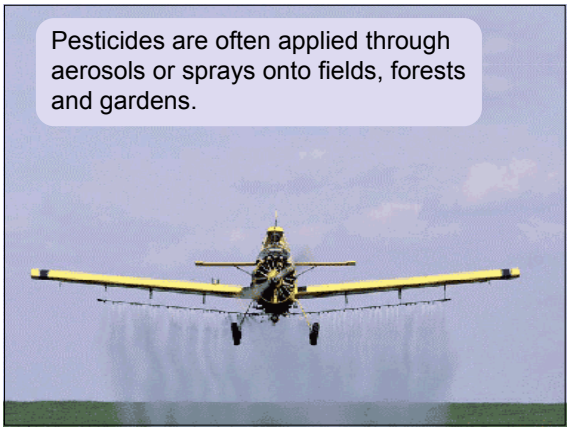
Insecticides can be sprayed on a plant and later consumed by an insect.

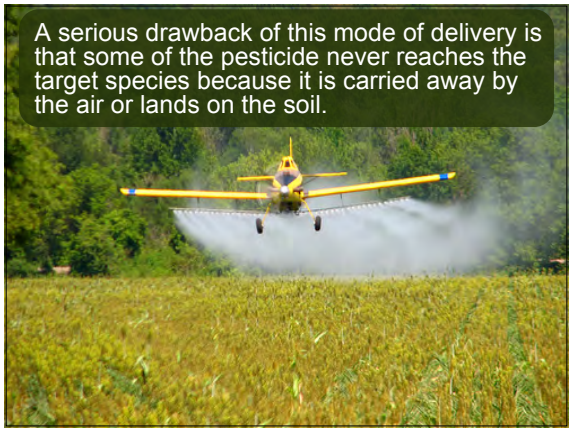
Issues With Pesticides

Pesticides have helped farmers reduce crop damage from pests and increase food production.

Issues With Pesticides

While such benefits can result in more food and better health for some, pesticide use has a number of environmental costs.



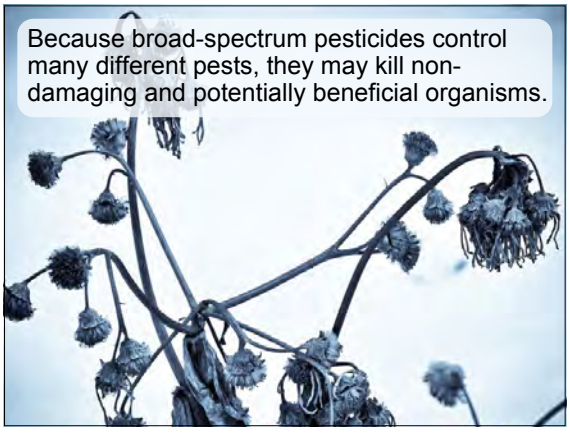


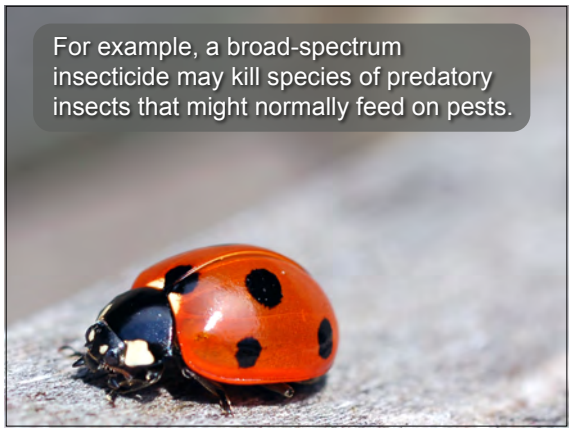
Issues With Pesticides

These pesticides then become potential sources of pollution to the soil, air and water.

Non-Target Species

Pesticides may also harm non-target species - species they were not intended to kill.





Non-Target Species

When natural pest controls are killed (i.e. predatory insects) farmers must replace them by using more pesticides.

Non-Target Species

Improper use of pesticides can also kill non-target species. For example, spraying an insecticide at the wrong time of year may kill honeybees, which are essential for pollinating fruit crops.

Non-Target Species

As a result, less fruit will be produced.

One of the most serious side effects of pesticide use is their tendency to accumulate in individual organisms.

Biomagnification

This happens because some pesticides are not broken down or eliminated with other body wastes.

If an individual continues to eat food contaminated with pesticide, it will accumulate in the body.

Biomagnification

If the pesticide is long-lived, then the concentration of pesticide in the individuals will increase to levels much higher than in the environment.

Biomagnification

Pesticides that bioaccumulate do so because they cannot be easily excreted from the body.

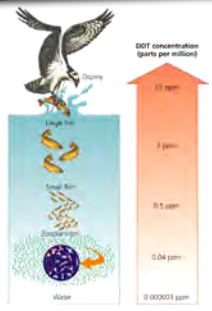
This is because they are not soluble in water, but are soluble in fats and oils.

This process is called bioaccumulation.

Biomagnification

All individuals are part of a food chain. As a result, toxins stored in the fats and oils of an organism at one trophic level are passed on to the organisms at the next trophic level.

Biomagnification

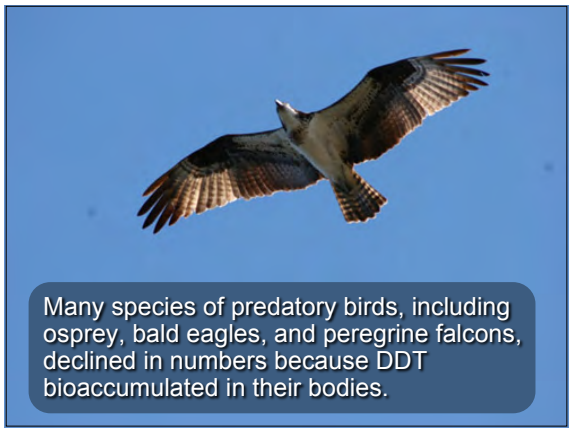


The higher up the food chain, the more concentrated the pesticides become.

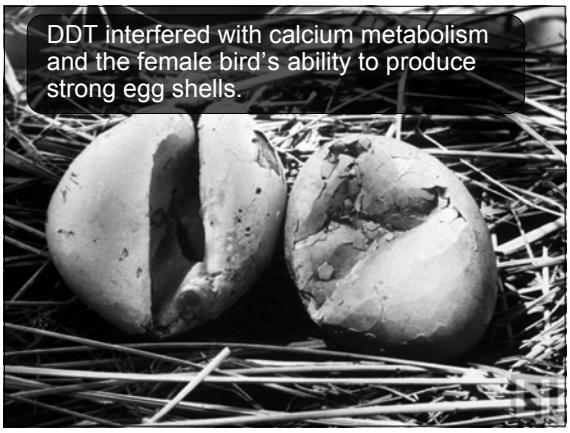
This process is called biomagnification (or bioamplification)

Biomagnification

If a pesticide biomagnifies in a food chain, it may reach toxic concentrations.



Many species of predatory birds, including osprey, bald eagles, and peregrine falcons, declined in numbers because DDT bioaccumulated in their bodies.



DDT interfered with calcium metabolism and the female bird's ability to produce strong egg shells.

Biomagnification

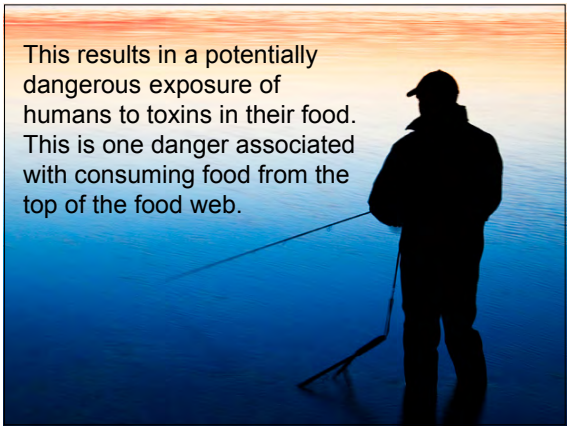
Other fat-soluble toxins, such as mercury and polychlorinated biphenyls (PCBs) also bioamplify in the food web.

Arctic ecosystems are particularly vulnerable to biomagnification of toxic substances.

Biomagnification

Many long-lived top consumers such as whales, polar bears, walrus, and fish live in the arctic.

In addition, Inuit that live in these environments rely on these same species as their traditional food supply.



This results in a potentially dangerous exposure of humans to toxins in their food. This is one danger associated with consuming food from the top of the food web.

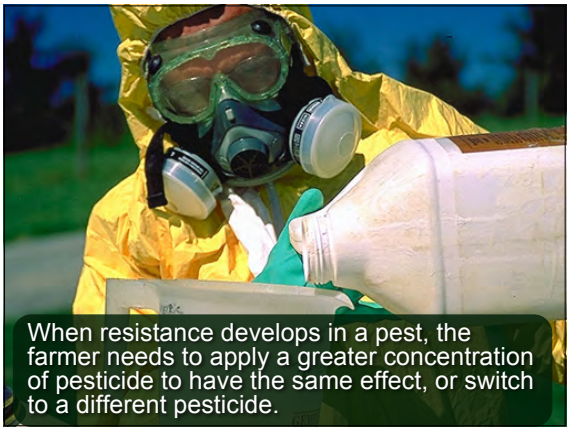
Pesticide Resistance

When pesticides are used for long periods of time, some pest species may become resistant to the pesticide.

Pesticide Resistance

This means that the pesticide is no longer able to control the pest.

Individuals that exhibit the greatest resistance are more likely to survive an application of pesticide than those with little or no resistance.



Reducing Pesticide Dependence

There is little doubt that pesticides have dramatically increased global food production.

By reducing competition and other pests, crops grow faster and have higher yields.

Reducing Pesticide Dependence

However, the benefits of using pesticides must be weighed against the risks of pollution, harm to non-target species, biomagnification and pesticide-resistance.

Reducing Pesticide Dependence

One alternative type of agriculture, organic farming, uses no synthetic pesticides or fertilizers.

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Reducing Pesticide Dependence

However, these losses may be offset by the higher price growers get for their organic products as well as savings from not purchasing synthetic chemicals.

Reducing Pesticide Dependence

Organic farmers rely on a range of ecologically sustainable techniques:

1. Biological control
   - predatory insects, mites and disease-causing micro-organisms feed on and infect prey species
   - e.g. parasitic wasps, ladybugs

2. Altered timing
   – better timing of planting and harvesting can avoid peak pest populations

Reducing Pesticide Dependence

3. Crop rotation & mixed planting
   – when farmers do not grow monocultures in the same location year after year, pest populations do not have the same opportunities to establish and prosper

4. Baiting pest
   – pheromone baits can be used to confuse some mating insects

While organic farming minimizes environmental impacts, it could result in lower crop yields. This may not be acceptable.

Reducing Pesticide Dependence

In such cases, an intermediate approach called integrated pest management (IPM) is often employed.

IPM takes advantage of all types of management methods. The goal is to maximize efficiency and minimize costs and harm to the environment.

Reducing Pesticide Dependence

IPM farmers use many of the techniques employed by organic farmers, but use synthetic pesticides and fertilizers when necessary.