

Pests and Poisons

When walking through a natural ecosystem, have you ever noticed the incredible biodiversity? Your experience would have been much different walking through an agricultural ecosystem (Figure 1). Nothing is more unnatural about agroecosystems than the low biodiversity they support. This is not surprising given that their purpose is large-scale food production. Devoting land to food production has dramatic ecological implications. In addition to habitat loss, it alters food webs as well as water and biogeochemical cycles.



Figure 1 (a) Natural prairie has many types of grasses and other flowering plants. (b) Vegetable crops, such as these potatoes, are usually planted as monocultures.

READING TIP

Use Sticky Notes

Use sticky notes while reading to record your questions beside the part of the text you do not understand. After reading the text, you can check to see if information in the tables, photos, and captions in the rest of the section answered these questions.

How does growing crops alter relationships within food webs? In natural ecosystems, organisms are part of complex food webs where producers and consumers coexist. Producers support the entire community of hundreds or thousands of consumer species. In agroecosystems, these relationships are almost entirely absent. Table 1 compares the food web of a natural ecosystem with that of a typical crop, the potato.

Table 1 Comparison of the Food Web in a Natural Grassland with That of a Potato Field

	Natural grassland	Potato field
producers	50 to 100 species of wildflowers and other plants coexist	Monoculture of potato plants. The few other plant species that occur are considered weeds.
herbivores	Numerous species of herbivorous insects, rodents, sparrows, and so on	A few species such as the Colorado potato beetle and the flea beetle. Both are considered pests.
carnivores	Numerous species of carnivorous insects, spiders, snakes, foxes, hawks, and so on	Very few carnivores, if any
food web	Complex web with hundreds of species	Food web effectively eliminated, leaving a single producer with some pest species

Pests

In agroecosystems, thousands or millions of individuals of a single crop species are planted in a monoculture. Then, to maximize growth of the desired crop, we try to eliminate organisms that we consider pests.

Pests are organisms that might compete with or damage crop species. Agricultural pests are plants and animals that reduce crop yields. Weeds are plant pests, mosquitoes are insect pests, and mice are rodent 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. Farmers are not the only people interested in controlling pests. Insects are considered serious pests in the forestry industry. The spruce budworm, the gypsy moth, and the Asian long-horned beetle are just a few examples of tree-infesting species (Figure 2).

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, or **pesticides** (Figure 3). There are many different kinds of pesticides. Herbicides are used to kill plants. Other pesticides include insecticides, rodenticides, and fungicides. Humans even use molluscicides and piscicides to kill snails and fish, respectively.



Figure 3 Pesticides are toxic, and protective equipment must be worn when they are applied.

Characteristics of Pesticides

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. 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.

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

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

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



Figure 2 Caterpillars of the gypsy moth

pesticide a substance used to kill a pest

DID YOU KNOW?

Livestock and the Drugstore

Although not usually referred to as pesticides, antibiotics are commonly used in agriculture to kill micro-organisms. Antibiotics are also used as a preventive medicine to improve the health of livestock. This large-scale use can lead to micro-organisms becoming resistant to these antibiotics. This is a concern because the same micro-organisms have the potential to infect humans and would then be resistant to the same antibiotics when used for treatment.

broad-spectrum pesticide a pesticide that is effective against many types of pest

narrow-spectrum pesticide a pesticide that is effective against only a few types of pest

Ask Inferential Questions

Often a text does not supply all the information about a topic. This means you might have to ask an inferential question. You might ask why insects are considered agricultural pests. The text does not say how insects harm plants. Your own experience is that insects eat plants and cause damage. By combining what the text does not say with what you already know, you end up asking an inferential question.

How Do Pesticides Work?

Pesticides work by causing physical or biological harm to the pest organism. 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. Alternatively, some pesticides are indirectly applied. For example, herbicides can be sprayed on the soil and taken up through the roots of the weed. Or insecticides can be sprayed on a plant and later consumed by an insect.

Table 2 provides an overview of some pesticides. In the next section, you will consider the ecological consequences of pesticide use.

Table 2 Characteristics of Some Pesticides

Pesticide	Origin/source	Use	Important characteristics
DDT	synthetic	broad-spectrum insecticide	<ul style="list-style-type: none"> one of the first widely used synthetic pesticides highly persistent in food chains causing die-off of many predatory birds widely banned in 1970s but still used in some countries to kill mosquitoes that transmit malaria
rotenone	natural toxin extracted from plant roots	insecticide and piscicide	<ul style="list-style-type: none"> highly toxic to many aquatic organisms, including fish approved for use by some organic farmers
glyphosate	synthetic	broad-spectrum herbicide	<ul style="list-style-type: none"> widely used herbicide very low persistence
Bt	a protein obtained from the bacteria <i>Bacillus thuringiensis</i>	narrow-spectrum insecticide	<ul style="list-style-type: none"> highly toxic to moth and butterfly caterpillars safer than most pesticides

IN SUMMARY

- Agroecosystems are often based on a single plant species and the elimination of natural food webs.
- Synthetic pesticides tend to persist longer than natural pesticides.
- Monocultures create ideal conditions for certain pests, which are often controlled using pesticides.
- Pesticides may have a physical effect or disrupt biological processes.
- Pesticides are used to control weeds, insects, rodents, fungi, and other types of pest organisms.

CHECK YOUR LEARNING

1. What is the most unusual characteristic of food webs in agroecosystems? K/U
2. Define the term *pest*.
3. List five different types of pesticides. K/U
4. Explain what is meant by “broad-spectrum” and “narrow-spectrum” pesticides. K/U
5. Do you think pesticides that come from natural sources are better than synthetic pesticides? Explain your reasoning. C
6. Explain why the term *pest* is not used in reference to natural ecosystems. K/U
7. Why are populations of pests likely to be much larger in agroecosystems than they would be in natural ecosystems? Explain your reasoning. K/U
8. Insecticides and herbicides are the most commonly used pesticides. Brainstorm some of the characteristics that make insects and weeds such serious competitors. T/I