

APES Ch 20 Outline: Pest Management

20-1 Pesticides: Types and Uses

- A. *Predators, parasites, and disease organisms found in nature control populations of most pest species as part of the earth's free ecological services.***
1. Worldwide, only about 100 species of plants, animals (mostly insects), fungi, and microbes cause about 90% of the damage to the crops we grow.
 2. In natural ecosystems, natural enemies (organisms) control populations of about 98% of potential pest species.
 3. Clearing forests and grasslands and spreading pesticides upsets the checks and balances of natural populations.
- B. *To help control pest organisms, we have developed a variety of pesticides or biocides.***
1. Common biocides include insecticides, herbicides, fungicides, and rodenticides. These biocides actually kill more than their intended target organisms.
 2. Plants have produced chemicals to ward off, deceive, or poison herbivores for millions of years, and this is a co-evolutionary process.
 3. People used sulfur, arsenic, lead, and mercury to kill insects on crops, but abandoned this practice in the 1920s when people were also poisoned.
 4. The first generation natural insecticides were nicotine sulfate, pyrethrum, and rotenone.
- C. *Chemists have developed hundreds of chemicals for use on pests.***
1. In 1939, Paul Muller discovered DDT was a potent insecticide. It was the first of the second-generation pesticides.
 2. Since 1970, chemists have returned to natural repellents and have developed pesticides based on a variety of natural chemicals found in the neem tree.
 3. A new natural herbicide was discovered in 2003 in the knapweed. It should soon be on the market.
- D. *We have greatly increased our use of a variety of increasingly toxic synthetic pesticides.***
1. Pesticide use has increased 50-fold and their toxicity has increased by 10-fold.
 2. About one-fourth of pesticide use is for non-agricultural uses in the U.S.
 3. Children playing on lawns where pesticides have been used are particularly vulnerable to them. Health scientists warn early exposure may lead to learning disabilities, behavioral problems, some forms of cancer, and other chronic diseases.
 4. People working in the flower industry in South American countries are exposed to large doses of fungicides, insecticides, and herbicides.
 5. Pesticides may be broad-spectrum (effective against many species) or selective or narrow spectrum agents.
 6. Pesticides vary in their length of persistence.
 7. As early as 1962, Rachel Carson warned against relying on synthetic organic chemicals to kill pests.

20-2 The Case for Pesticides

- A. *Modern pesticides save lives, increase food supplies, increase farmer's profits, work fast, and are safe if used properly.***
1. Some important benefits of modern chemicals
 - a. They save lives (an estimated 7 million).
 - b. They increase food supplies (about 55% of the world's potential food supply is lost to pests).
 - c. They increase profits for farmers.
 - d. They work faster and better than alternatives.
 - e. When used properly, their health risks are very low compared to their benefits.
 2. Newer pesticides are safer and more effective than many older pesticides.
 3. Botanicals and microbotanicals are the basis for a number of new pesticides.
 4. Many new pesticides are used at much lower rates per unit area than older products.
 5. Genetically engineered crops could also reduce the use of toxic insecticides.
- B. *Scientists work to develop more effective and safer pesticides, while pests continue to co-evolve and find ways to combat these pesticides.***

20-3 The Case Against Pesticides

A. *Insects can rapidly become genetically resistant to widely used pesticides.*

1. The main problem with synthetic pesticides is that it accelerates the development of genetic resistance to these chemicals by pest organisms.
2. Several hundred organisms have developed genetic resistance to pesticides since 1945.
3. This has led to a reemergence of a number of diseases, especially in the tropics.
4. Framers may also be on the pesticide treadmill where it takes more pesticide for less effective treatment of pest organisms.

B. *Pesticides may kill natural enemies of pest species, create new pest species, linger in the environment, and harm wildlife and people.*

1. Most pesticides kill beneficial as well as target pest species.
2. Pests that were once minor have become very destructive.
3. Of the pesticides applied by spraying, more than 95% end up in the air, surface water, groundwater, sediments, food, and nontarget organisms.
4. Some pesticides harm wildlife such as honeybees needed for pollination of crops. In addition, they kill more than 67 million birds and 6–14 million fish each year.
5. Some pesticides threaten human health. At least 3 million agricultural workers in developing countries and at least 300,000 in the U.S. are seriously poisoned each year.
6. Premature death from cancers has been attributed to pesticide use.
7. Certain diseases have been linked to pesticide exposure, such as childhood leukemia, Parkinson's disease, immune system disorders, and prostate and breast cancers.

C. *A slightly higher percentage of the U.S. food supply is lost to pests today than in the 1940s.*

1. David Pimentel, an insect ecologist, has evaluated data and come to three major conclusions.
2. Synthetic pesticide use has increased 33-fold since 1942, and about 37% of the U.S. food supply is lost to pests compared to 31% in the 1940s.
3. The estimated environmental, health, and social costs of pesticide use have been estimated at \$4–10 billion/year all the way up to \$100–200 billion/year.
4. Alternative pest management practices could halve the use of chemical pesticides on 40 major U.S. crops without reducing yields.

20-4 Pesticide Regulation

A. *A federal law regulates pesticide use in the U.S., but it can be improved.*

1. The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) was established by Congress in 1947 and amended in 1972. It requires EPA approval for use of all commercial pesticides. EPA sets a tolerance level specifying the amount of residue that can remain on the crop at consumption.
2. The EPA banned or severely restricted 56 active pesticide ingredients between 1972 and 2004.
3. There is still controversy over the ban of DDT.
4. The 1996 Food Quality Protection Act (FQPA) increased public protection from pesticides.
5. Banned or severely restricted chemicals are still manufactured and exported to other countries.
6. According to literature reviewed by the EPA, about 165 of the active ingredients approved for use in U.S. pesticide products are known carcinogens, but only 43 of these have been banned by the EPA or discontinued voluntarily by manufacturers.
7. A study of Missouri children showed a statistically significant correlation between childhood brain cancer and the use of household chemicals.
8. The National Academy of Sciences states that federal laws regulating pesticides are inadequate and poorly enforced.
9. The pesticide industry disputes the harmful effects of pesticides on human health.
10. The U.S. laws could be improved, but most other countries have not made as much progress as the U.S. has in regulating pesticides.

B. DDT has been banned in developed countries since 1972, and there is controversy over its use in some developing countries to combat malaria.

1. DDT was cheap and effective as a broad-spectrum pesticide.
2. In 1962, Rachel Carson published *Silent Spring*, which warned of the dangers of these broad-spectrum, persistent pesticides.
3. The EPA was established in 1970, and FIFRA was amended to give the EPA control over registration and regulation of pesticides in the U.S.
4. The EPA banned the use of DDT for several reasons.
 - a. It kills many beneficial insects as well as its target species.
 - b. It is persistent and remains in the environment for up to 15 years and can be biologically magnified in food webs.
 - c. It reduced populations of birds and other species, especially those feeding at higher trophic levels.
 - d. Preliminary evidence suggested it could cause cancer in humans.
 - e. It was becoming less effective due to increasing pest resistance.
5. The DDT controversy continues even today.
6. Scientists say that we can't separate harm to the environment from harm to people.
7. Since 1975, there has been growing evidence that very low levels of chlorine-containing pesticides may disrupt the human immune, endocrine, and nervous systems.
8. Organophosphates replaced the chlorinated hydrocarbon pesticides, and these chemicals were hundreds of times more toxic to humans than DDT.
9. The EPA has since banned many organophosphates and carbamates, the next generation of pesticides.
10. DDT is still used in several developing countries to kill disease-carrying insects.
11. In 2000, delegates from 122 countries agreed on a global prevention treaty to control, reduce, phase out, and destroy stockpiles of 12 persistent organic pollutants (POPs).
12. DDT use is still allowed in 25 countries to combat malaria.

20-5 Alternatives to Conventional Chemical Pesticides

A. The primary goal of pest control should be to reduce crop damage to economically tolerable levels.

1. The economic threshold is the point at which the economic losses caused by pest damage outweigh the cost of applying a pesticide.
2. Farmers may not want to monitor crop fields and will either do insurance spraying or will purchase pest loss insurance.
3. Cosmetic spraying is another source of increased pesticide use. This is done to insure blemish free fruits and vegetables.

B. A mix of cultivation practices and biological and ecological alternatives to conventional chemical pesticides can help control pests.

1. Cultivation practices to decrease losses include rotation of types of crops planted each year.
2. Timing of planting can be done to either starve the pests or be eaten by predators.
3. Polyculture is another alternative, the use of plant diversity.
4. Cutting the grass no lower than 3 inches will help to keep out weed species.
5. Genetic engineering can speed up the development of pest- and disease-resistant crop strains.
6. Increase the use of biological pest control; use natural predators to help regulate pest organisms.
7. Biological control focuses on selected target species, is nontoxic, and minimizes genetic resistance. It can save large amounts of money.
8. Disadvantages are that it is often slower acting and more difficult to apply, and the controls may become pests themselves.
9. Insect birth control is another possible strategy where the life cycle of the insect is interrupted so that they can't reproduce. Problems include high cost, difficulty in knowing mating time, behavior of each target insect, and the large number of sterile males required to prevent pest resurgence.
10. Pheromones have been used to lure pest insects into traps or to lure natural predators to crop fields.
11. Another method is to use hormones that disrupt the normal insect life cycle and prevent them from reaching maturity. The disadvantages are that they take weeks to kill an insect, are often ineffective if the infestation is large, and must be applied at the right time in the life cycle.
12. Hot water sprayed on crops has worked well on cotton, alfalfa, and potato fields and citrus groves.
13. Exposure of food to high-energy gamma radiation extends the shelf life of foods and kills insects, parasitic worms, and harmful bacteria.
14. The long-term health effects of eating radiated food are unknown.

- C. ***Integrated pest management uses a mixture of cultivation, biological methods, and small amounts of selected chemical pesticides as a last resort.***
1. The overall aim of integrated pest management (IPM) is to reduce crop damage to an economically tolerable level. Fields are carefully monitored for damage.
 2. The Indonesian government banned 57 of the 66 pesticides used on rice. Within 5 years, pesticide use dropped 65%, and rice production rose by 15%. A well-designed IPM program can reduce pesticide use and pest control costs while increasing crop yields.
 3. IPM is an important form of pollution prevention that reduces risks to wildlife and human health.
- D. ***Government subsidies for conventional pesticides, opposition of manufacturers, and lack of experts to advise farmers are reasons farmers have not all adopted IPM.***
1. Disadvantages include higher initial costs, lack of expert knowledge regarding the pests, and slower action than conventional pesticides.
 2. If the U.S. shifted to ecologically based pest management, within 5–19 years it could cut U.S. pesticide use in half.
 3. Scientists are urging the USDA to use three strategies to promote IPM.
 - a. Add 2% sales tax on pesticides, and use the revenue to fund IPM research and education.
 - b. Set up a federally supported IPM demonstration project on at least one farm in every county.
 - c. Train USDA field personnel in IPM to help farmers use this alternative
 4. Several UN agencies and the World Bank are establishing an IPM facility.