

## Ch. 21 - Protecting Food Resources: Pesticides and Pest Control

### **Types of Pesticides and Their Uses**

Pests: Any species that competes with us for food, invades lawns and gardens, destroys wood in houses, spreads disease, or is a nuisance.

Pesticides (Biocides): Chemicals developed to kill organisms that we consider undesirable.

1. Insecticides - Insect-killers
2. Herbicides - Weed-killers
3. Fungicides – Fungus-killers
4. Nematocides – Roundworm-killers
5. Rodenticides – Rat- and Mouse-killers

### **The First Generation of Pesticides:**

1. Sulfur – used as an insecticide since 500 BC
2. Nicotine sulfate – extracted from tobacco leaves in the 1600s
3. Pyrethrum – obtained from the heads of chrysanthemum flowers
4. Rotenone – from the root of the derris plant

### **The Second Generation of Pesticides:**

About 2.5 million tons of pesticides are used yearly, worldwide. In the United States, about 630 different biologically active (pest-killing) ingredients and 1,820 inert (inactive) ingredients are mixed to make 25,000 different pesticide products.

1. DDT – 1939, Entomologist Paul Mueller discovered that DDT (dichlorodiphenyltrichloroethane) was a potent insecticide. It soon became the world's most-used pesticide.
2. Broad-spectrum agents – toxic to many species
3. Selective-spectrum agents – effective against a narrowly defined group of organisms.

Persistence – the length of time in which pesticides remain deadly in the environment.

## **The Case For Pesticides:**

1. Pesticides save human lives: Since 1945 DDT and other insecticides have probably prevented the premature deaths of at least 7 million people from insect-transmitted diseases.
2. Pesticides increase food supplies and lower food costs: About 55% of the world's potential human food supply is lost to pests before or after harvest. Without pesticides, these losses would be worse, and could cause the prices of food in the U.S. to rise nearly 50%.
3. Pesticides increase profits for farmers. Overall, for every dollar spent on pesticides, there is an increase in U.S. crop yields worth approximately two dollars.
4. Pesticides work faster and better than alternatives: Pesticides can control most pests quickly and at a reasonable cost.
5. The benefits overpower the health risks: Safer and more effective pesticides are being developed.

## **The Case Against Pesticides:**

1. Genetic resistance – Insects can develop immunities to pesticides in just a few years.
2. Broad-spectrum insecticides kill good organisms – This includes killing natural predators and parasites that may have been maintaining the population of a pest species at a reasonable level.
3. Unexpected outcome – Wiping out natural predators can also unleash new pests whose populations the predators had previously held in check, causing other unexpected effects.

**The Pesticide Treadmill:** A situation where farmers are forced to pay more for a pest control program that often becomes less effective as genetic resistance develops.

Although the use of synthetic pesticides has increased 33-fold since 1942, it is estimated that more of the U.S. food supply is lost to pests today than in the 1940s.

The estimated environmental, health, and social costs of pesticide use in the United States range from \$4 billion to \$10 billion per year.

Alternative pest control practices could halve the use of chemical pesticides on 40 major U.S. crops without reducing crop yields.

A 50% cut in U.S. pesticide use would cause retail prices to rise by only about 0.2% but would raise average income for farmers about 9%.

## **Where Do Pesticides Go?**

### **Environmental Effects:**

Less than 2% of the insecticides applied to crops by aerial spraying or by ground spraying actually reach the targeted pests.

Some pesticides can harm wildlife. DDT had harmful effects in the environment when it biologically magnified in food webs. This resulted in certain birds being listed on the endangered species list in the U.S. because of fatal effects. Each year 20% of honeybee colonies in the U.S. are wiped out by pesticides, while another 15% are damaged, costing farmers over \$200 million annually.

### **Human Health:**

An estimated 25 million agricultural workers in developing countries are seriously poisoned by pesticides each year. 220,000 deaths result.

In developed countries an estimated 300,000 farm workers suffer from pesticide-related illnesses yearly. 250,000 Americans get sick each year from home misuse of pesticides.

Approximately 13% of vegetables and fruits consumed in the United States may contain illegal pesticides and levels of approved pesticides above their legally allowed limits.

At least 75% of the active ingredients approved for use in U.S. pesticide products cause cancer in test animals.

## **Pesticide Regulation in The United States:**

All commercial pesticides must be approved by the EPA for general or restricted use

When a pesticide is legally approved for use on fruits or vegetables, the EPA sets a tolerance level, which specifies the amount of toxic pesticide residue that can legally remain on the crop when the consumer eats it.

According to a National Academy of Sciences study, federal laws regulating the use of pesticides in the United States are inadequate and poorly enforced by the EPA, FDA, and USDA.

Exposure to pesticide residues in food causes 4,000-20,000 cases of cancer per year in the United States.

A 1993 study of pesticide safety by the U.S. National Academy of Sciences urged the government to do the following things:

- Make human health the primary consideration for setting limits of pesticide levels allowed in food.

- Collect more and better data on exposure to pesticides for different groups, including farm workers, adults, and children.

- Develop new and better test procedures for evaluating the toxicity of pesticides, especially for children.

- Consider cumulative exposures of all pesticides in food and water, especially for children, instead of basing regulations on exposure to a single pesticide.

## **The 1996 Food Quality Protection Act:**

- Requires new standards for pesticide tolerance levels in foods, based on a reasonable certainty of no harm to human health.

- Requires manufacturers to demonstrate that the active ingredients in their pesticide products are safe for infants and children.

- Allows the EPA to apply an additional 10-fold safety factor to pesticide tolerance levels to protect infants and children.

Requires the EPA to consider exposure to more than one pesticide when setting pesticide tolerance levels.

Requires the EPA to develop rules for a program to screen all active and inactive ingredients for their estrogenic and endocrine effects by 1999.

## **Solutions:**

### **How Can Cultivation Practices Control Pests:**

Crop rotation

Planting rows of hedges or trees around fields to hinder insect invasions.

Adjusting planting times so that major insect pests either starve or get eaten by their natural predators.

Planting trap crops to lure pests away from the main crop.

### **How Can Genetically Resistant Plants Help Lower Pest Losses:**

Plants and animals that are genetically resistant to certain pests insects, fungi, and diseases can be developed.

We can use genetic engineering to build pest resistance into crops and thus reduce the need for pesticides.

**Using Natural Enemies to Help Control Pests:** Biological control using predators, parasites, and pathogens to regulate pests populations.

### **Using Biopesticides to Control Pests**

**Insect Birth Control, Sex Attractants, and Hormones:** Males of some insect pest species can be raised in the laboratory, sterilized by radiation or chemicals, and then released into an infested area to mate unsuccessfully with fertile wild animals.

**Hot Water:** The 'Aqua Heat' Machine sprays boiling water on crops to kill weeds and insects.

**Radiation:** Exposing certain foods after harvest to gamma rays emitted by radioactive isotopes will extend food shelf life and kill harmful insects, parasitic worms, and bacteria.

**Integrated Pest Management (IPM):** In this approach, each crop and its pests are evaluated as parts of an ecological system. Then a control program is developed that includes a mix of cultivation and biological and chemical methods applied in proper sequence with the proper timing.

The overall goal is not to eliminate pest populations, but reduce crop damage to an economically tolerable level.

IPM requires expert knowledge about each pest situation, and is much slower acting than conventional pesticides.

Although long-term costs are typically lower than the costs of using conventional pesticides, initial costs may be higher.

Scientists urge the USDA to promote IPM in the U.S. by:

- i) Adding a 2% sales tax on pesticides and using revenue to fund IPM research and education.
- ii) Setting up a federally supported IPM demonstration project on at least one farm in every county.
- iii) Training USDA field personnel and county farm agents in IPM so that they can help farmers use this alternative.
- iv) Providing federal and state subsidies to farmers who use IPM.
- v) Gradually phasing out subsidies to farmers who depend almost entirely on pesticides, once effective IPM methods have been developed for major pest species.