



Overview of Chapter 22

- What is a Pesticide?
- Benefits and Problems With Pesticides
- Risks of Pesticides to Human Health
- Alternatives to Pesticides
- Laws Controlling Pesticides Use
- The Manufacture and Use of Banned Pesticides

Pests and natural insect predators

- The enemies of our enemies are our friends
 - ▣ Wasps and natural predators of insect pests
- Pesticides kill all insects
- Need to balance positives and negatives of pesticide use



© Nigel Cattlin/Alamy

What is a Pesticide

- Pest – any organism that interferes with human welfare or activities
- Insecticide, Fungicide, Herbicide, Rodenticide
- Broad spectrum pesticide
 - ▣ A pesticide that kills a variety of organisms, not just the targeted organisms
 - ▣ Ideal pesticide would be narrow spectrum (species specific)

What is a Pesticide

- First generation of pesticides were:
 - ▣ Inorganic compounds
 - Lead, mercury, arsenic
 - Persist in environment
 - ▣ Botanicals - plant derived pesticides
 - Plants produce compounds to protect themselves from predators
 - Nicotine, pyrethrin, rotenone, juglans
 - May be less persistent in environment



©Robert E. Ford/Terraphotographics

What is a Pesticide

- Second generation pesticide
 - ▣ Synthetic poison
 - ▣ Ex: DDT
- 20,000 pesticides currently exist



© Bettmann/CORBIS

Applying DDT in 1945

Major Groups of Insecticides

- Chlorinated Hydrocarbons
 - ▣ Organic compound containing chlorine
 - ▣ Slow to degrade and persist in the environment
 - ▣ Banned or largely restricted
- Organophosphates
 - ▣ Organic compounds that contain phosphorus
 - ▣ Most poisonous insecticide
 - ▣ Do not persist as long as chlorinated hydrocarbons
- Carbamates
 - ▣ Broad spectrum; derived from carbamic acid
 - ▣ Generally nontoxic to mammals

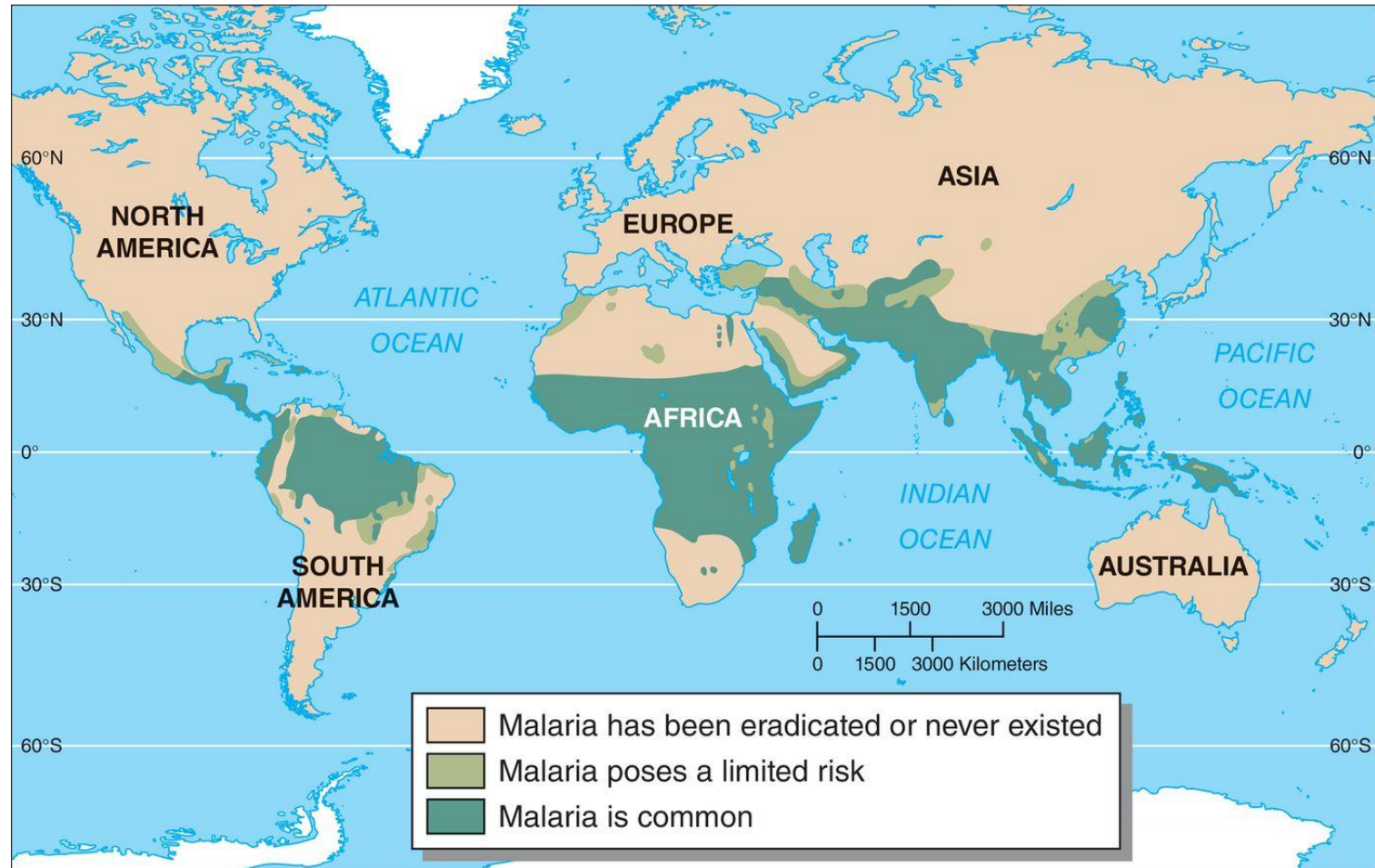
Major Kinds of Herbicides

- Herbicides
 - ▣ Kill or inhibit the growth of unwanted vegetation
- Can be classified to the type of plant they kill
 - ▣ Selective herbicides - kill only certain kinds of plants
 - Broad-leaf herbicides
 - Grass herbicides
 - ▣ Non selective herbicides - kill all vegetation
- Glyphosphate – Round up
 - ▣ Nonselective, low toxicity to mammals
 - ▣ Highly toxic to amphibians – Round up ready crops

Benefits of Pesticides

- Disease control
 - Fleas, lice and mosquitoes carry disease
 - Malaria - mosquito born
 - In 2009, 250 million people suffered from malaria, leading to over 800,000 deaths- few drugs available
 - Focus is on killing mosquitoes - DDT
 - Ex: Sri Lanka
 - DDT was used to control mosquitoes from 1950–1964
 - Nearly zero malaria deaths
 - 1968 - there were 1 million malaria cases
 - DDT use resumed, but in fewer broad applications

Locations of Malaria



Benefits of Pesticides

- Crop Protection
 - Pests eat and destroy 1/3 of world's crops
 - Farmers save \$3 to \$5 for every \$1 they invest in pesticides
- Pests focus on crops because they are monocultures
- Pesticides reduce crop loss to weeds, insects and plant pathogens
- Only 200 species of insects have ability to cause large economic impact on crops

Problems with Pesticides

- Evolution of Genetic Resistance
 - Pest populations are evolving resistance to pesticides
 - 520 pests have developed genetic resistance
 - 17 species are resistant to all pesticides farmers are permitted to use

Pesticide Resistance

- Pesticide Treadmill
 - ▣ Cost of applying pesticide increases
 - Must apply MORE or STRONGER pesticides
 - ▣ Effectiveness continues to decrease
- Resistance Management
 - ▣ Strategies for managing genetic resistance in order to maximize the period in which a pesticide is useful
 - Strategy depends on the species



© Nigel Cattin / Alamy

Problems with Pesticides

- Imbalances the Ecosystem
 - Spraying to kill insects can affect birds, rabbits, etc.
 - Despite 33-fold increase in pesticides since the 1940s, crop loss has not decreased much

Table 22.1 Percentage of Crops Lost Annually to Pests in the United States

<i>Period</i>	<i>Insects</i>	<i>Diseases</i>	<i>Weeds</i>
2006	13.0	12.5	12.0
1989–1999	13.0	12.0	12.0
1974	13.0	12.0	8.0
1951–1960	12.9	12.2	8.5
1942–1951	7.1	10.5	13.8

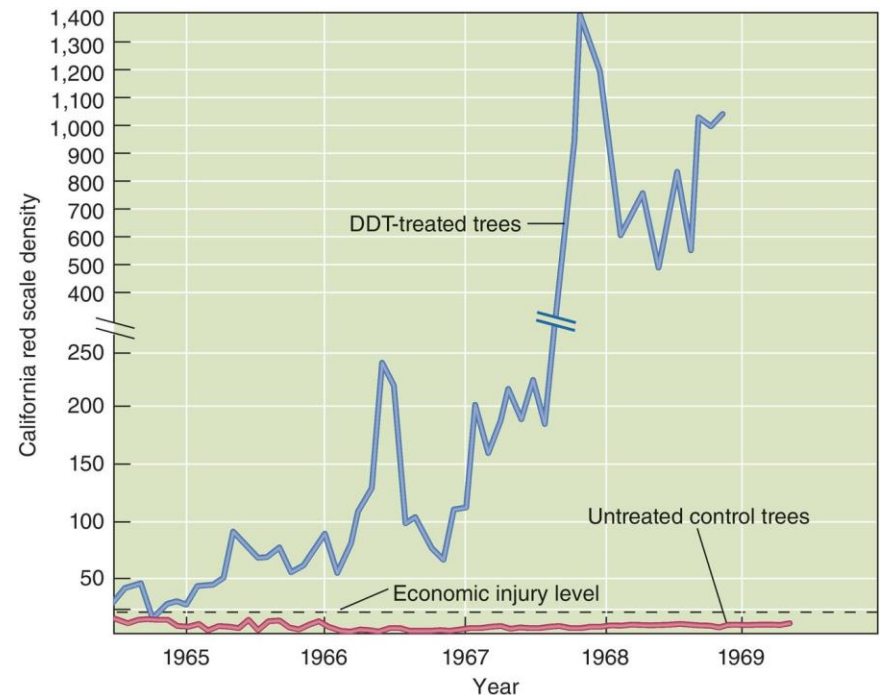
Source: USDA Agricultural Research Service

Problems with Pesticides - Creation of New Pests

- Infestation of red scale insects on lemons after DDT sprayed to control another pest



Nigel Cattlin/Science Source



Problems with Pesticides

- Persistence, Bioaccumulation, and Biological Magnification
 - Bioaccumulation - The buildup of a persistent pesticide or other toxic substance in an organisms body
 - Biological magnification- Increase concentration of toxic chemicals in tissues of organisms at high trophic levels



Dave Watts / Photoshot

Problems with Pesticides - Mobility in the Environment

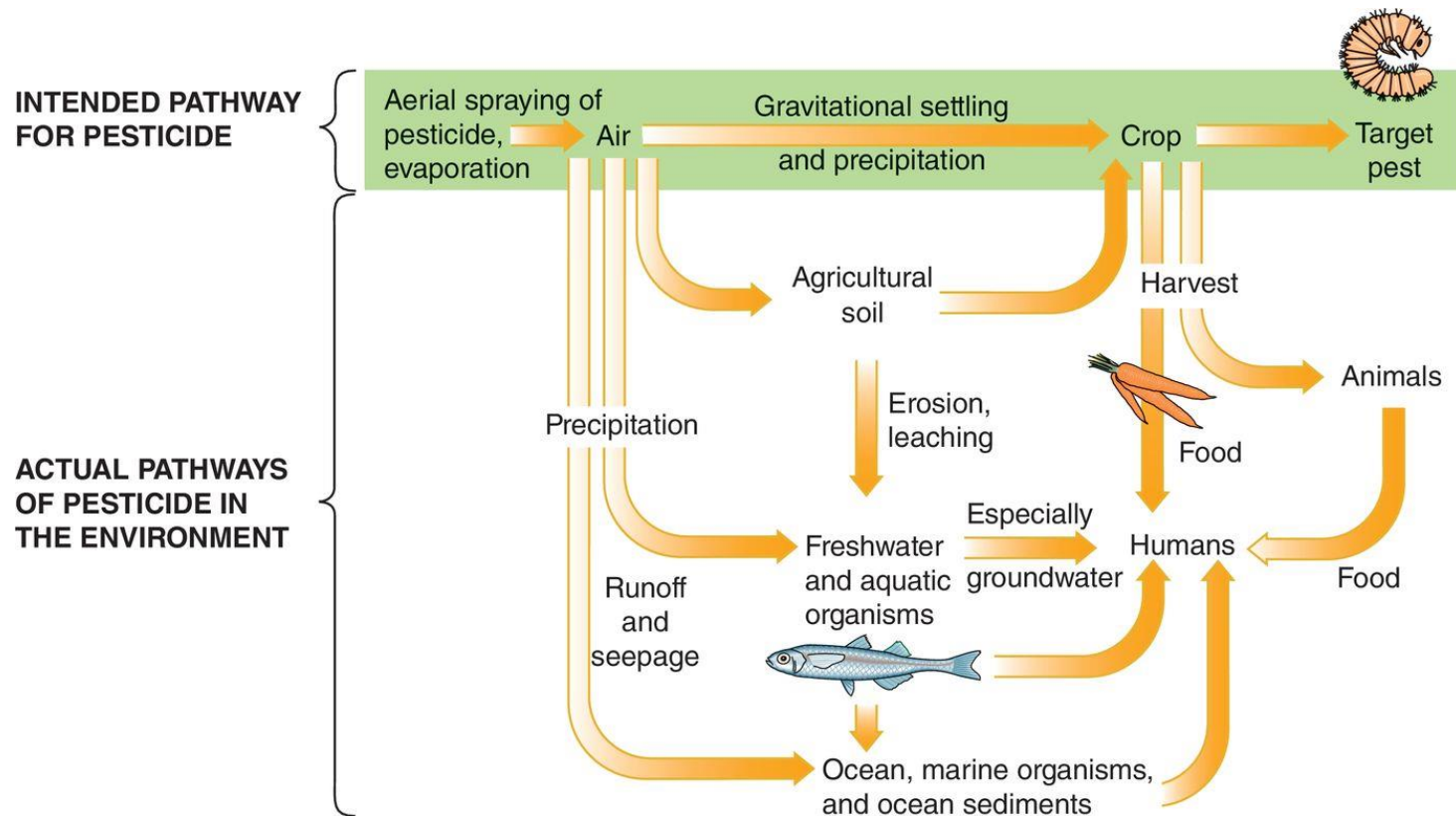
- ▣ Do not stay where they are applied



Lawrence Migdale/Science Source

Problems with Pesticides - Mobility in the Environment

- At least one pesticide found in urban streams above concentration that threatens organisms



Risk of Pesticides to Human Health

- Short-term Effects of Pesticides
 - ▣ Caused by handling food with pesticide residue
 - ▣ Mild: nausea, vomiting, headaches
 - ▣ Severe: damage to nervous system, death
 - ▣ 4 million people poisoned each year; 300,000 die



Lens/Getty Images

Risk of Pesticides to Human Health

- Long-term effects of pesticides (especially for farmworkers and workers in pesticide manufacture companies)
 - ▣ Cancer- lymphoma
 - ▣ Breast cancer
 - ▣ Sterility
 - ▣ Miscarriage
 - ▣ Birth defects
 - ▣ Decreases body's ability to fight infection
 - ▣ Potential connection to Parkinson's disease

Pesticides as Endocrine Disruptors

- Many studies began to link pesticides to reproductive problems in animals (1990s)
- Termed endocrine disruptors
 - ▣ Mimic hormones in humans and other animals produced by endocrine system
- Examples
 - ▣ River otters exposed to certain chemical pollutants had abnormally small penises
 - ▣ Alligators exposed to common herbicide produce eggs inside testes

Pesticides as Endocrine Disrupters

Table 22.2 Some Pesticides That Are Known Endocrine Disrupters*

<i>Pesticide</i>	<i>General Information</i>
Atrazine	Herbicide; still used
Chlordane	Insecticide; banned in United States in 1988
DDT (dichlorodiphenyl-trichloroethane)	Insecticide; banned in United States in 1972
Endosulfan	Insecticide; still used
Kepone	Insecticide; banned in United States in 1977
Methoxychlor	Insecticide; still used

Alternatives to Pesticides

- Using cultivation methods to control pests
 - ▣ Interplant mixtures of plants (alternating rows)
 - ▣ Strip cutting
 - ▣ Proper timing of planting, fertilizing, and irrigating
 - ▣ Crop rotation
- Interplanting results from Kenya
 - ▣ Corn damage 5% when intercropped, 39% in monoculture

Alternatives to Pesticides

- Biological Control
 - ▣ Use of naturally occurring disease organisms, parasites or predators to control pests
 - ▣ ex: *Bacillus thuringiensis* (*Bt*)
 - ▣ Must take care that introduced agent does not attack unintended hosts

National Geographic/Getty Images



Alternatives to Pesticides

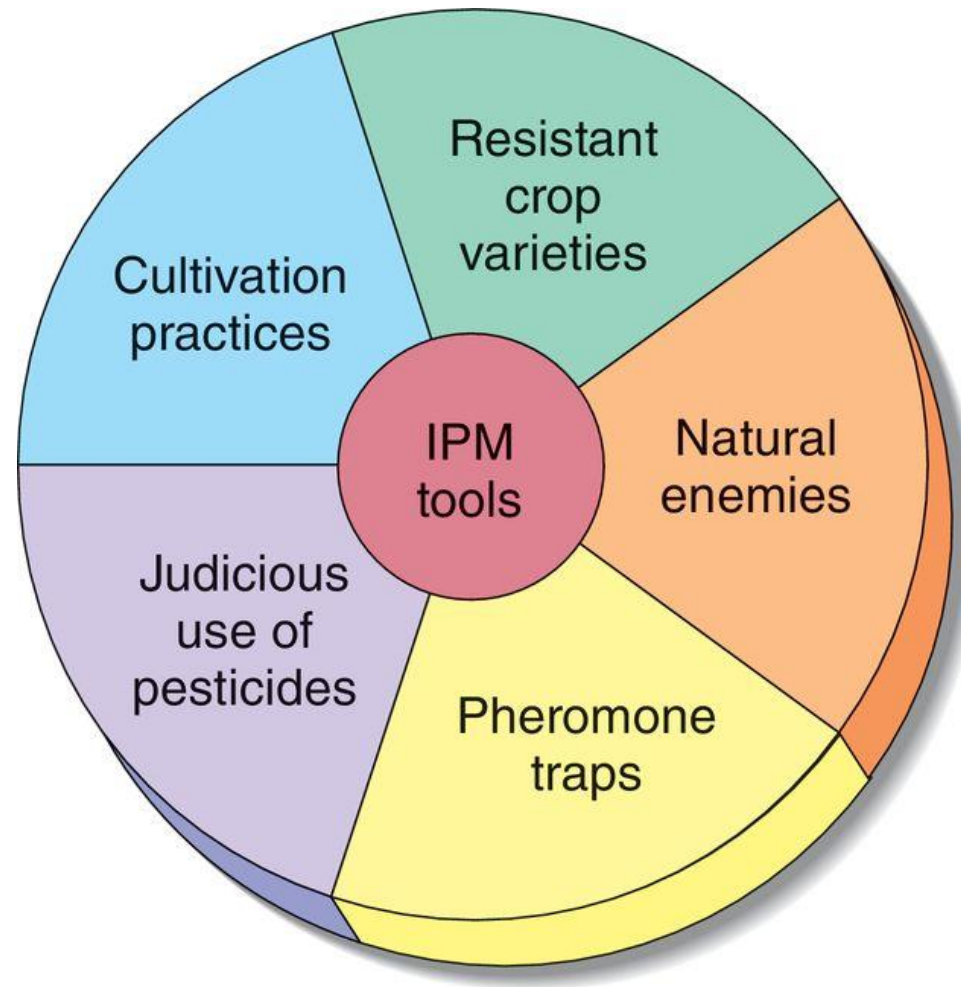
- Pheromones and Hormones
 - By applying insect hormones at wrong time in life cycle, insects can be killed off
- Reproductive Controls
 - Sterile male technique
 - Large #s of males sterilized in lab and released
 - For certain species, males mate many times, females mate once
 - Decreases reproductive potential of pest population
 - Carried out consistently to work
 - Does not work for mosquitos

Alternatives to Pesticides

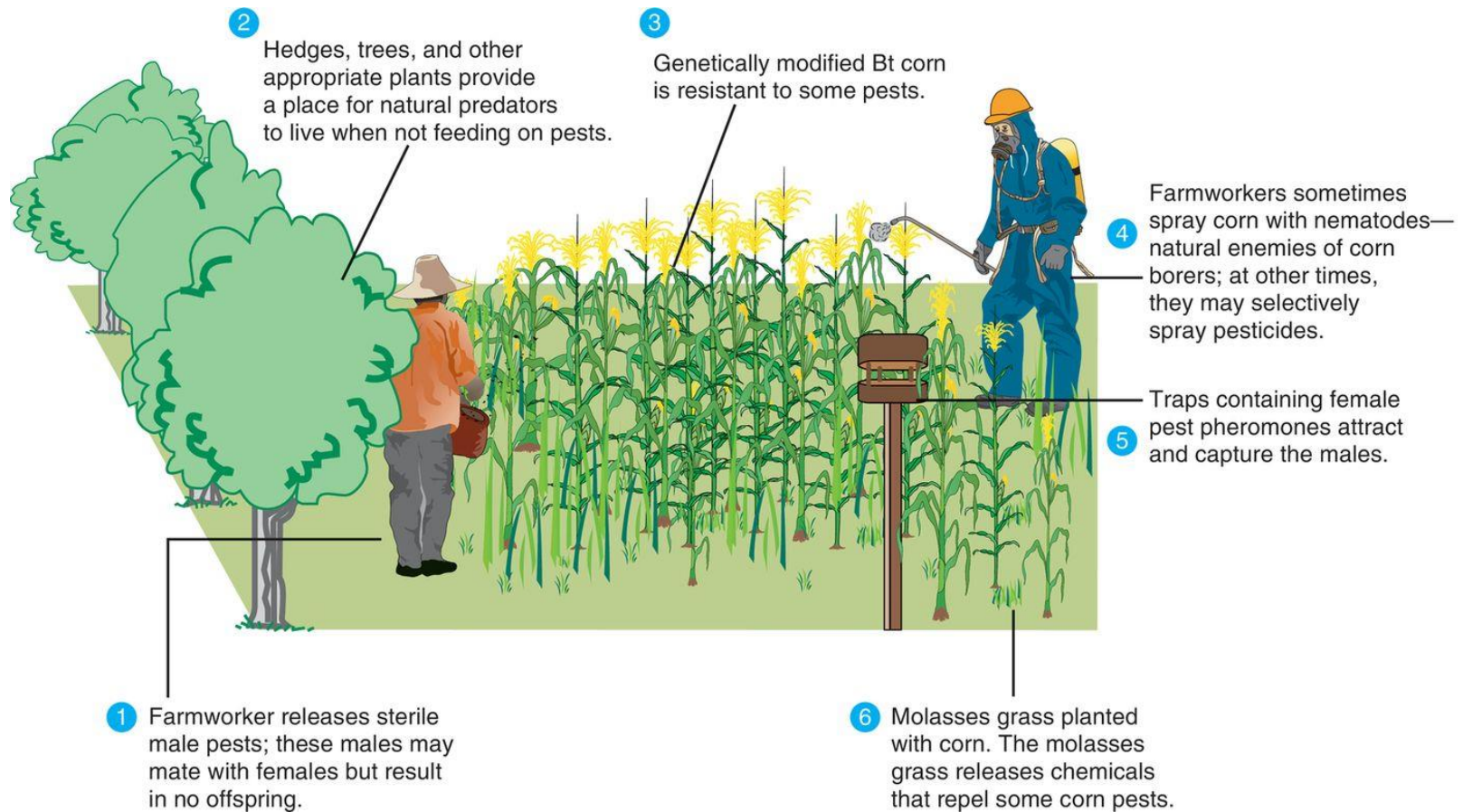
- Genetic Controls
 - Genetically Modified plants (GMOs)
 - *Bt* toxin
 - Potential problem: may affect non-target species
- Quarantine
 - Restriction of the importation of exotic plant and animal material that might harbor pests

Systems Approach- Integrated Pest Management (IPM)

- IPM
 - ▣ Combination of pest control methods that keeps pest population low without economic loss
- Conventional pesticides are used sparingly when other methods fail

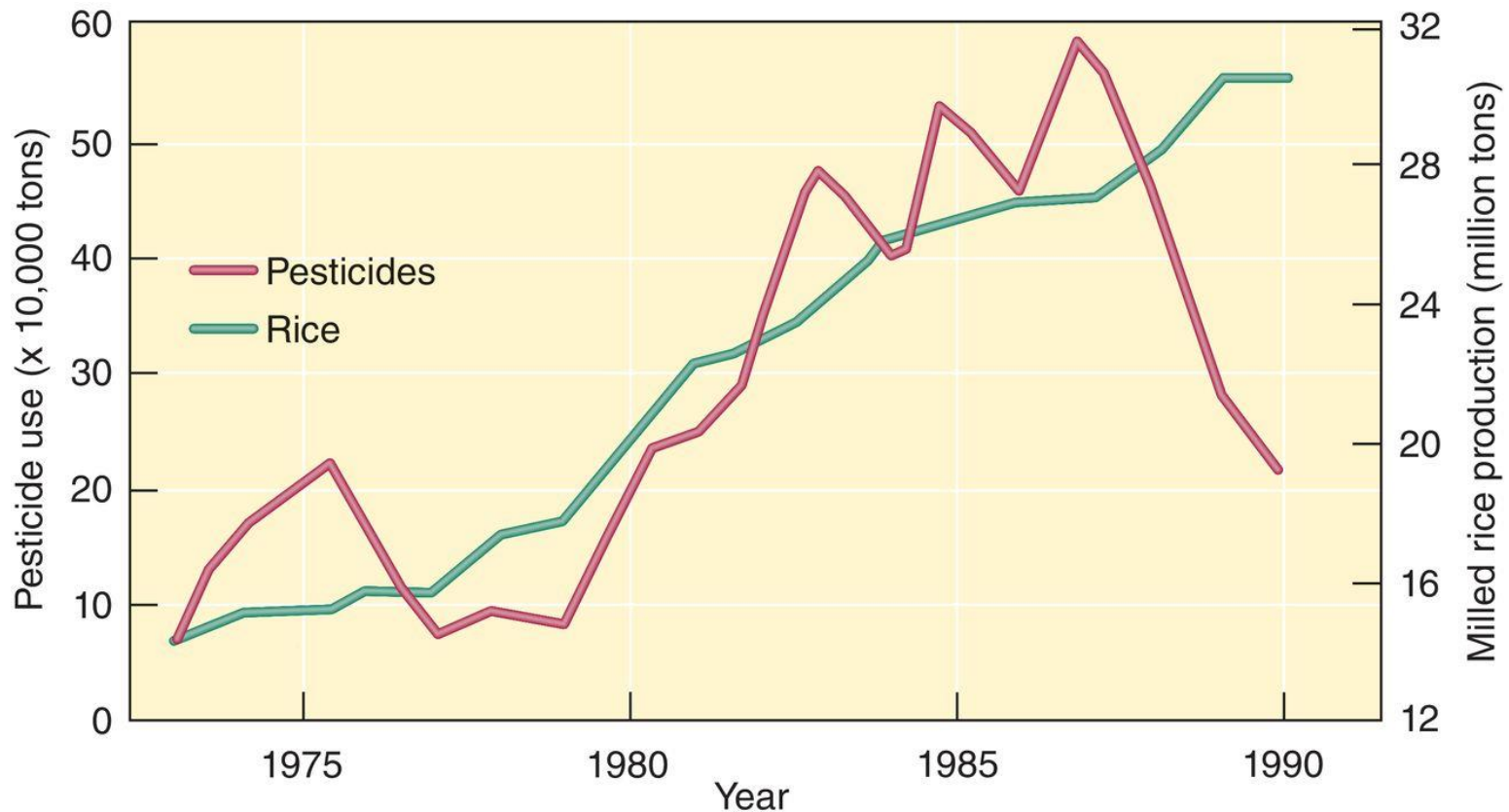


Integrated Pest Management



Systems Approach- Integrated Pest Management (IPM)

□ Rice Production in Indonesia



Alternatives to Pesticides

- Irradiating Food (aka cold pasteurization)
 - ▣ Harvested food is exposed to ionizing radiation, which kills many microorganisms
 - ▣ Predominantly used on meats
 - ▣ Somewhat controversial due to potential for free radicals

Avoiding Pesticide Use at Home

- Alternatives to pesticides work well on small scale gardens
- Best solutions are preventive
- Natural pesticides



Nancy Gift

Laws Controlling Pesticide Use

- Food, Drug, and Cosmetics Act (1938)
- Pesticide Chemicals Amendment (1954)
- Delaney Cause (1958)
- Federal Insecticide, Fungicide, and Rodenticide Act (1947, updated most recently in 2008)
- Food Quality Protection Act (1996)

Manufacture and Use of Banned Pesticides

- Some U.S. companies still make banned or seriously restricted pesticides
 - ▣ Product is exported
- May lead to the importation of food tainted with banned pesticides
 - ▣ 2007 pet food and toothpaste imported from China was contaminated with pesticides
- Global ban of persistent organic pollutants
 - ▣ Stockholm Convention on Persistent Organic Pollutants (2004)

Manufacture and Use of Banned Pesticides - The Dirty Dozen

Table 22.3 Persistent Organic Pollutants: The “Dirty Dozen”

Persistent Organic Pollutants Regulated Under the Stockholm Convention (2014)

Aldrin Pesticide	Hexabromobiphenyl* Industrial chemical
Chlordane Pesticide	Lindane Pesticide
Chlordecone Pesticide	Mirex Pesticide
DDT Pesticide	Pentachlorobenzene Pesticide, Industrial chemical, by-product
Dieldrin Pesticide	Perfluorooctane sulfonic acid Industrial chemical
Endrin Pesticide	Polychlorinated biphenyls Industrial chemical
Endosulfan Pesticide	Polychlorinated dibenzo-p-dioxins By-product
Heptachlor Pesticide	Polychlorinated dibenzofurans By-product
Hexachlorobenzene Pesticide	(Tetra- and penta-)bromodiphenyl ether Industrial chemical
Hexachlorocyclohexane* Pesticide, by-product	Toxaphene Pesticide

* multiple forms regulated