

Pesticides & Pest Control

Chapter 20

Rachael Carson

- In 1962 wrote “ Silent Spring”
- This book warned against the use of synthetic chemicals to kill insects and other pests.

Pests

- Any species that competes with use for food, invades lawns and gardens, destroy wood in houses, spreads disease or are simply a nuisance.
- In natural ecosystems 50% - 90% of these species are controlled by predators, parasites and disease - natural enemies
- Monocultures need to be protected however

What are pesticides?

- Also called **biocides**
- Chemicals to kill organisms we consider undesirable.



Types of pesticides

- Insecticides - insects
- Herbicides - weeds
- Fungicides - fungus
- Nematocides - nematodes
- Rodenticides - rats & mice
- Plants have always produced natural chemicals to ward off or poison pests. Herbivores develop resistance through natural selection & then plants develop new defences.
- This is coevolution.

First generation pesticides

- Before 500 BC sulfur was used as an insecticide.
- As, Pb, Hg by 1400's were used as insecticides on crops.
- Poisoning of humans in 1920's led to ceasing of these metals.-traces can still be found in the soil
- 1960's nicotine sulfate from tobacco used as an insecticide.

- Two other natural pesticides - pyrethrum from chrysanthemums and rotenone from tropical forest legumes were used.
- These are called **First Generation Pesticides** and were mainly natural substances

Second Generation Pesticides

- 1939 - Paul Mueller - **DDT** - first second generation pesticide
- Since 1945 hundreds of synthetic organic chemicals have been developed.
- 2.3 million metric tons/year use worldwide of pesticides. About 75% in developing countries.

Why use pesticides?

- Save human lives - DDT, etc have prevented deaths of 7 million people from insect transmitted diseases such as malaria, etc.
- Increase food supplies and lower food costs- About 55 % of world's potential human food supplies are lost to pests either before or after harvest. No use would cause increase in food prices.

- Increase profits for farmers
- Work faster than alternatives
 - They control most pests
 - Have a long shelf life
 - Are easily shipped and applied
 - Are safe when handles properly

- **When properly used**, health risks are insignificant compared with benefits
- Newer pesticides are safer and more effective than many older ones
- Many new ones can be used at very low rates per unit area as compared to older products.

The ideal pesticide would:

- Kill only the target pest
 - Harm no other species
 - Disappear or break down in harmless substances after being used - not be **persistant**.
 - Not cause genetic resistance in target organisms
 - Be more cost effective than doing nothing.
- So far no pesticide meets all of these criteria



Why not use pesticides?

- **Genetic resistance** - insects breed rapidly and in 5-10 years they can develop immunity - directional natural selection
 - Then come back stronger than before -
RESURGENCE
- **Broad spectrum pesticides** kill natural predators and parasites that may have been keeping the population in check
 - This can unleash new pests which the predators kept in check
- **Narrow spectrum pesticides** - kill only the target species.

- Currently 100 of the 300 most destructive pests in the United States were secondary pests that became major pests after widespread use of insecticides

What is the pesticide treadmill?

- Genetic resistance develops therefore:
 - More frequent application of pesticide
 - Larger does of pesticide are applied
 - Switch to new chemicals to keep the resistant species under control
- **PAY MORE AND MORE FOR A PEST CONTROL PROGRAM THAT IS LESS AND LESS EFFECTIVE.**

WHAT IS THE GENETIC TREADMILL?

- Some think that increasing dependence on genetically altered crops may cause a genetic treadmill similar to the pesticide treadmill.



Pesticides do not stay put

- Aerial spraying on crops or ground spraying often does not reach the target species
- Pesticides end up in the air, surface and groundwater, bottom sediments, food, and nontarget organisms
- What could be done?
 - Use ground sprayers that suck up & recover pesticide
 - Covering booms to keep pesticides from drifting
 - Lay ropelike wicks on ground to deliver pesticides directly to the weeds
 - Some crops are genetically altered to release small amounts of pesticide directly to peses

How do pesticides harm wildlife?

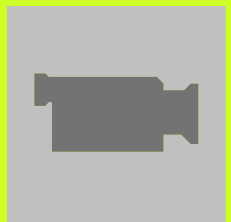
- DDT - biomagnified - made eggshells so fragile that fish eating birds almost became extinct
- Also pesticides wipe out honeybee hives
 - Kill other birds
 - Kill fish when they get into the water
 - Harm many of the endangered and threatened species in the US.

Are they a threat to human health?

- Chlorinated hydrocarbons - very persistent pesticides have been banned in US
- Organophosphates much less persistent but are highly toxic to humans & animals
- Main part of the population affected in developed & developing countries are farm workers
- See text p 514 for other examples

Pesticides may cause:

- Genetic mutations
- Birth defects
- Nervous system disorders - especially behavioral disorders
- Effects on immune & endocrine system disorders



Pesticide regulations

- FIFRA - Federal Insecticide, Fungicide, Rodenticide Act - 1947
 - All commercial pesticides must be approved by the EPA for general or restricted use
 - Pesticide companies must evaluate for toxicity to animals
 - EPA reviews this data before approving the pesticide
 - Sets a **tolerance level** - specifying the amount of toxic pesticide residue that can remain on the crop when the consumer eats it.

Circle of Poison

- US can make and sell pesticides that are banned in our country to other countries - mainly developing countries
- Residues of these banned pesticides come back into our country on fruits and vegetables.
- Also on the wind

Primary goal of pest control

- To reduce crop damage to an economically tolerable level.
- **Economic threshold** - the point where the economic losses caused by pest damage outweighs the cost of applying a pesticide.
- Hard to determine when economic threshold has been reached
- Many farmers do: cosmetic spraying - appearance & insurance spraying - to be on the safe side.

Other ways to control pests



Cultivation practices

- Crop rotation
- Planting hedges or trees around fields to hinder insect invasions & provide habitats for predators
- Adjust planting times so pests either starve or are eaten by predators
- Grow crops in areas where pests don't exist
- Switch from monoculture to polyculture
- Use plastic to keep weeds from sprouting
- Use vacuum machines to remove pests

Genetic engineering

- Goal: to develop pest and disease resistant crop strains
 - There is much controversy over whether the increasing use of genetically modified plants and foods outweigh their projected disadvantages.

Using natural enemies:

- **Biological pest control** - use predators, parasites & pathogens to control pests
 - Parasitic wasps etc
- Focuses on: target species
- Nontoxic to other species
- Self perpetuating
- Minimizes genetic resistance
- Bad - can take years of research
 - Cannot be always mass produced
 - Can be slower acting
 - Must be protected from sprayed pesticides

Biopesticides

- Synthetic pyrethroids
- Bt - *Bacillus thuringiensis* toxin - a registered pesticide which is a soil bacterium. Used by organic farmers as a nonchemical pesticide.
- Some plants are developing genetic resistance to Bt toxins.
- Bt toxins have been put in genetically altered crops such as corn, potatoes, and soybeans.

Birth control

- Male insects have been raised in the lab
 - Steralized by radiation or chemicals
 - Released to mate with fertile wild females
- Males are steralized rather than females because females mate only once while males mate several times.
- Has been used to eliminate screwworm fly
 - Mediterranean fruit fly
 - Tsetse fly (sleeping sickness)
- Expensive, must know mating times, need many males, need to release males continually

Pheromones & juvenile hormones

- **Pheromones** - sexual attractants that lure pests into traps or attract their natural predators
 - Attract only one species, work in small amounts, don't cause genetic resistance, & are not harmful to non-target species.
- **Juvenile & molting hormones** -disrupt the insect's normal life cycle.

Hot water & Ionizing radiation

- Spraying boiling water can kill weeds and insects
 - Works well on cotton, alfalfa, potatoes, & citrus groves
- Irradiation of foods can kill insects, parasitic larvae, and bacteria
 - Does not harm the food

Integrated Pest Management

IPM

- Educate the farmers to evaluate each crop and develop control programs
- Use **cultivation methods, biological methods, & chemical methods**
 - Apply in proper sequence and with the proper timing
- Can work but it is expensive and slower acting than just using pesticides.