



What Are Biological Pests?

- Biological pests are organisms that reduce the availability, quality, or value of resources useful to humans



What Are Pesticides?

- Chemicals that kill pests



Pests and Pesticides

- Biological Pests – organisms such as insects or fungi that compete with humans to consume agricultural crops.
- Pesticides are chemicals that kill biological pests.
 - Biocides kill a wide variety of living organisms
 - Herbicides kill plants
 - Insecticides kill insects
 - Fungicides kill fungi
- Synthetically produced pesticides are the most common method of controlling pests in modern agricultural production.

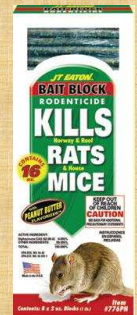
The "Perfect" Pesticide

Narrow-spectrum pesticides

- Target only intended pest
- Biodegradable
- Fungicide, Rodenticide

Broad-spectrum pesticides

- Kill wide range of organisms
- Persistent
- Chlorinated Hydrocarbons, Organophosphates, Carbamates

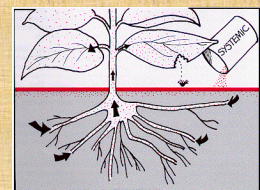


Use of Pest Controls is Not New

- The ancient Sumerians used sulfur to kill insects and mites over 5000 years ago.
- The ancient Chinese used mercury and arsenic to control pests.
- Greeks and Romans used oil, sulfur, ash, lime and other natural materials to protect their livestock and crops from pests.
- Crop rotation, burning of fields and use of biological controls have also been used by a variety of ancient cultures.

Contact & Systemic Herbicides

- **Contact:** work immediately upon spraying: taken in through tissue
 - Ex: Atrazine,
- **Systemic:** enter through roots, up vascular system
 - Ex: Glyphosate "Roundup"



First Generation Pesticides

- Highly **toxic, persistent, non specific natural compounds** like:
 - *Sulfur, Mercury, Lead*
 - *Botanical Chemicals – nicotene, rotenone.*
- **Second Generation Pesticides**
- Created **synthetically** specifically to kill pests – DDT, Dieldrin.
- Persistent, Biomagnify

Types of Pesticides?

- **Herbicide** = kills plant pests
- **Insecticide** = kills insects
- **Fungicide** = kills fungi
- **Nematocide** = kills nematodes
- **Rodenticide** = kills rodents



Chlorinated Hydrocarbons

- Synthetic organic insecticides
 - *DDT, Aldrin, Paradichlorobenzene (Mothballs)*
- Block nerve signal transmission
- Fast acting, highly toxic to sensitive organisms
- Persist in soil for 15 yrs, stored in fatty acids of animals



Organophosphates

- Phosphate containing compounds that are toxic to mammals, birds, and fish
- More toxic than chlorinated hydrocarbons.
- Came from nerve gas research in WWII
 - *Malathion,*
 - Affects nervous system
- **Degrades rapidly** & is widely used by high-input farms.



Benefits of Pesticides

- Control of mosquitoes minimizing malaria.
- Protects Crops from weeds, insects, pathogens.
- Farmers save \$3-\$5 for every \$1 spent on pesticides.

Pros and Cons of Modern Pesticides

- The era of synthetic organic pesticides began in 1939 with DDT.
- DDT was inexpensive, stable, easily applied, highly effective
- By the 1960s, evidence showed DDT was concentrating through food chains.
- Carnivorous birds such as eagles suffered egg shell thinning leading to an inability to reproduce.
- In 1962, Rachel Carson warned of the dangers of pesticide overuse
- DDT was banned in the US by the late 1960s
- It is still used in developing countries.

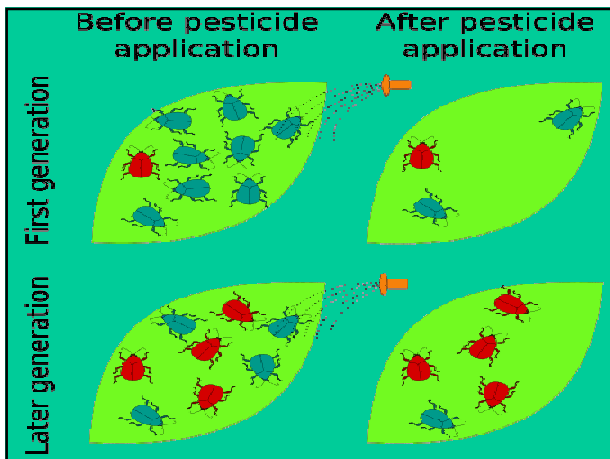
Pros and Cons of Modern Pesticides

- Since the development of DDT, many new synthetic pesticides have been developed.
- Like DDT, many of them have proven to have unintended consequences on non-target species.
- The EPA estimates total pesticide use in the U.S. amounts to about 5.3 billion pounds annually.
 - Roughly 80% of all conventional pesticides applied in the U.S. are used in agriculture or food storage and shipping.
 - Home and garden use account for about 14% of US pesticide use annually.

Pesticide Treadmill

- **Frequency of application increases while effectiveness decreases**
- **US crop production loss of 37% per year is unchanged since pesticides were first introduced.**

In Peru: 1950's use of DDT increased cotton crop yields, but boll weevils quickly became resistant, and became a bigger problem than ever



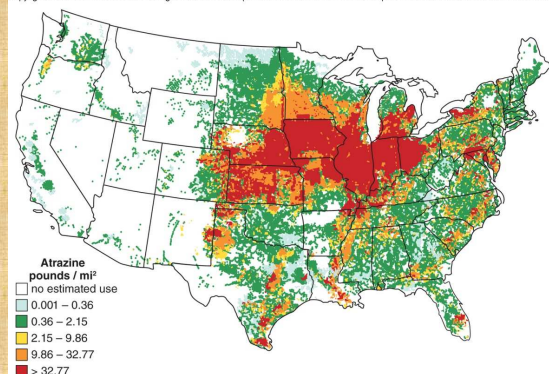
Pesticide Types

- Organophosphates – most abundantly used synthetic pesticides.
 - Roundup-most commonly used organophosphate herbicide
 - Genetically modified Roundup resistant crops have been produced
 - Other organophosphates are used as insecticides and inhibit cholinesterase, an enzyme necessary for nervous system function.
 - Quickly degrade and do not persist.
 - Dangerous to workers and can be lethal

Pesticide Types

- Chlorinated Hydrocarbons - fast acting and highly toxic to sensitive organisms
 - Atrazine, Para dichlorobenzene (mothballs) and DDT are examples.
 - Persistent and concentrate in food chains
- Fumigants-small molecules (e.g., carbon tetrachloride) which are delivered as a gas to penetrate soil or other materials.
 - Used in fungus control on strawberries or to prevent insect/rodent damage to stored grains.
 - Extremely dangerous to workers and restricted or banned in some areas.

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Pesticide Types

- Inorganic Pesticides-compounds of toxic elements such as mercury or arsenic.
 - Highly toxic, indestructible and persistent.
 - Generally act as nerve toxins.
- Natural Organic Pesticides-generally extracted from plants and include such pesticides as nicotine or pyrethrums.
 - Toxic to insects and may prevent wood decay

Pesticide Types

- Microbial Agents and Biological Controls- living organisms or toxins derived from them that are used in place of pesticides
 - Bacteria such as *Bacillus thuringiensis* kill beetles and caterpillars.
 - Parasitic wasps such as *Trichogramma* kill moth caterpillars and eggs.
 - Ladybugs are used to control aphids

Environmental Effects of Pesticides

- Widespread use of pesticides brings a number of environmental and health risks.
- Non-Target Species
 - Broadly sprayed pesticides might not reach intended target and instead kill beneficial organisms (e.g., honey bees)
- Pest Resurgence
 - A few resistant pests survive the pesticide and survive to repopulate the area with more resistant pests.
 - Resistant pests require finding new pesticides

Persistent Organic Pollutants

- Persistent Organic Pollutants (POPs) –are chlorinated hydrocarbons like DDT that are stable, soluble in fats and toxic.
 - They can travel far from the point of dispersal.
 - Stored in fat and tend to bioaccumulate
 - High levels have been detected in predators at the upper levels of food chains such as polar bears and eagles
 - POPs accumulate in polar regions by the “grasshopper effect”; they evaporate from warm regions and condense in cold regions.

Environmental Persistence and Mobility

- Many POPs were banned globally in 2001 when 127 countries signed a treaty.
 - Use of these chemicals was previously banned or restricted in developed countries, but U.S. companies continued to sell POPs in underdeveloped countries where regulations were lax.
 - Many pesticides then returned to U.S. in agricultural products.
- Since the treaty banning POPs, other pesticides have taken their place

Human Health Problems

- WHO estimates 25 million people suffer pesticide poisoning, and 20,000 die each year.
 - At least 2/3 of these result from occupational hazards in developing countries.
 - Chronic, or long-term health effects are difficult to conclusively document, but effects may include:
 - Cancer, birth defects, neurological problems, Immune system problems
- A USDA study shows 73% of conventionally grown foods in the US contain residue of at least one pesticide.

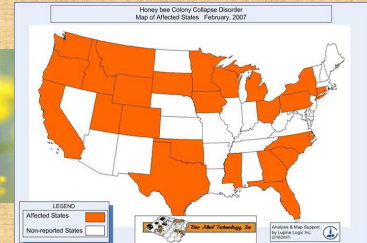
Protection from the Health Hazards of Pesticide Usage

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Effects on Non-target Species

- **Colony Collapse Disorder**
- **30-90% of bee colonies found dead**
- **Pesticides are a likely cause**

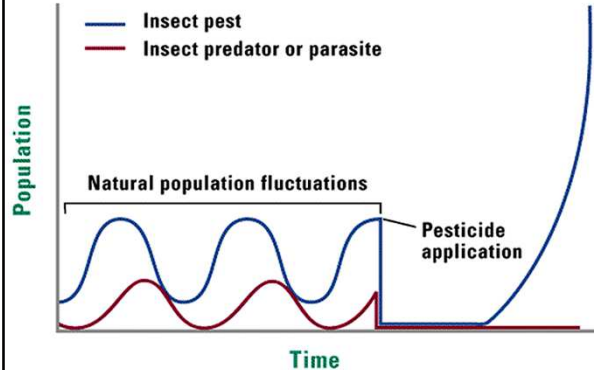


Effects on Non-target Species

- **Beneficial predator species killed**



Natural population fluctuations



Effects on Non-target Species

- **Train mishap**
- 7 tankers derailed and fell off the river trestle. One landed in the river.
- 19,000 gallons of the pesticide metam sodium dumped into Sacramento river
- The spill had entered the lake and formed a plume 18 feet thick, one hundred yards wide and three quarters of a mile long, lying 18 to 36 feet below the surface.
- Of the ten thousand disinfectants and pesticides registered for use in California, only 2,000 have been given the designation "hazardous" by the EPA, and metam sodium wasn't one of those.



Organic and Sustainable Agriculture

- Numerous studies have shown organic, sustainable agriculture is more eco-friendly and leaves soil healthier than intensive, chemical-based mono-culture cropping.
 - Currently, less than 1% of all American farmland is organic but market is growing.
 - Organic food must be produced without the use of hormones, antibiotics, pesticides, synthetic fertilizers or genetic modification.
 - Animals must be raised on organic feed, given access to the outdoors, given no steroids or growth hormones and given antibiotics only to treat disease.

Organic and Sustainable Agriculture

- Critics are disappointed by limited scope of the definition of organic. They hope to include:
 - Growing food in harmony with nature
 - Food distribution based on co-ops, farmer's markets, and local production
 - Food should be simple, wholesome, nutritious. At present, processed ingredients are allowed in organic food.
- Some doubt whether organic growers can produce enough to feed everyone.

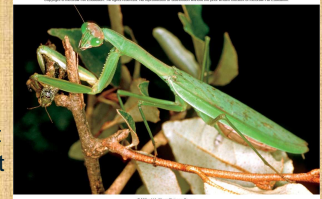


Careful Management Can Reduce Pests

- Behavioral Changes
 - Crop Rotation
 - Mechanical Cultivation
 - Flooding Fields
 - Habitat Diversification
 - Adjusting Planting Times
 - Plant Mixed Polycultures
 - Tillage at the Right Time

Biological Controls

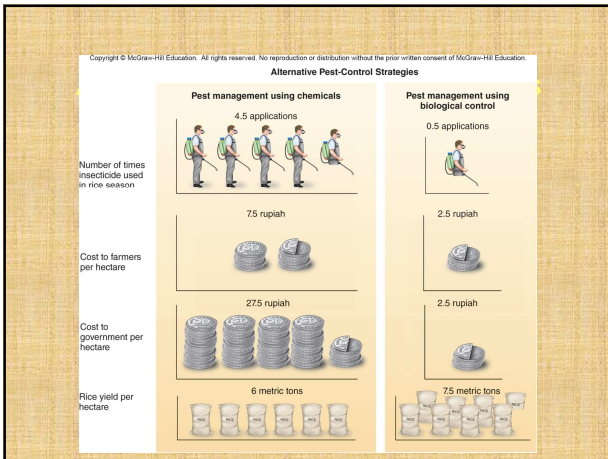
- Predators or pathogens
- Insects that eat weeds
- Plants like the neem tree that make their own pesticides
- Bioengineering
- Hormones that disrupt development or attract insects to traps



IPM Uses a Combination of Techniques

- Integrated Pest Management -is a flexible, ecologically based strategy that is applied at specific times against specific pests.
 - Some use of pesticides takes place, but the time, type and method of application are controlled.
 - Trap crops - small areas are planted before the main crop. These plants mature first and attract the insects, and the trap crop is then destroyed along with the pests.
- IPM is being used successfully all over the





Environmental Estrogens

- **Alligators in Florida lakes**
 - 90% of eggs laid were infertile
 - Only 1/2 of hatchlings survived
 - Males had shrunken penises, low testosterone levels
- Due to **DDE** - byproduct of DDT

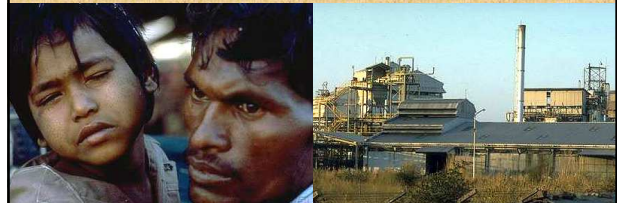


Human Health Effects

- Studies on farm works have uncovered a link between pesticides and certain types of cancers and immune system disorders
- Due to low level, long term exposure
- Non-hodgkin's lymphoma, muscle tumors, leukemia



Dec. 3 Bhopal India - At the Union Carbide pesticide plant, water got into a tank of **Temik** (a carbamate) causing an explosive reaction. People awoke coughing, gasping for air and rubbing their burning



- 40 tons of pesticides were released into the air.
- Causing respiratory distress, blindness, birth defects, reproductive failures
- 8,000 killed directly over 500,000 injured



Alternatives to Pesticides

Using Cultivation Methods to Control Pests

Alternating Agricultural Practices

Rotation of crops so that pests do not have stable habitat

Strip cropping which allows pest predator's habitat year round



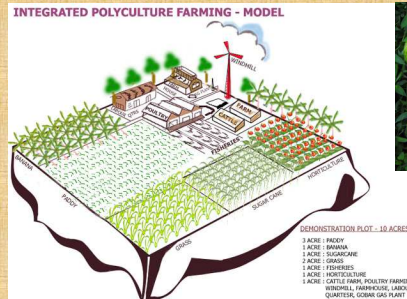
Developing Resistant Crops

- Selective breeding of varieties that have natural pest defenses



Behavioral Changes

- Polyculture instead of monoculture
- Accepting food that isn't perfect



Biological controls – Solution or bigger problem?

- Cane Toad –
 - introduced to Australia and Hawaii to control the native can beetle.
 - Completely ineffective in controlling can beetle.
 - Toads produce a toxic venom.
- Biological control species are implicated in the extinction of 100 insect species worldwide



- Integrated Pest Management uses a combination of techniques (natural predators, monitoring, pesticides) applied at different times
- Goal is not eradication
- There is acceptable crop damage

WHAT IS IPM?

Farmers use Integrated Pest Management (IPM) strategies to prevent crop damage from insect, weed, and disease pests.

IPM PRACTICES INCLUDE:



WHY SHOULD YOU CARE?

Because IPM practices help farmers:

- conserve our environment
- produce quality crops
- maintain farm profitability

ROCKWELL COOPERATIVE EXTENSION

NORTHEAST CENTER FOR RURAL DEVELOPMENT

Federal Insecticide, Fungicide, & Rodenticide Act (FIFRA)

- Passed to regulate effectiveness
- 1972 - EPA given control over pesticides, banned most chlorinated hydrocarbons
- Aldrin, dieldrin banned after 80% of all meats & fruits were found w/residues



Atrazine – A Contact Herbicide

- Legal in US, banned in Europe (2004) due to groundwater contamination
- Suspected Endocrine disruptor and Teratogen. Demasculizes frogs.

