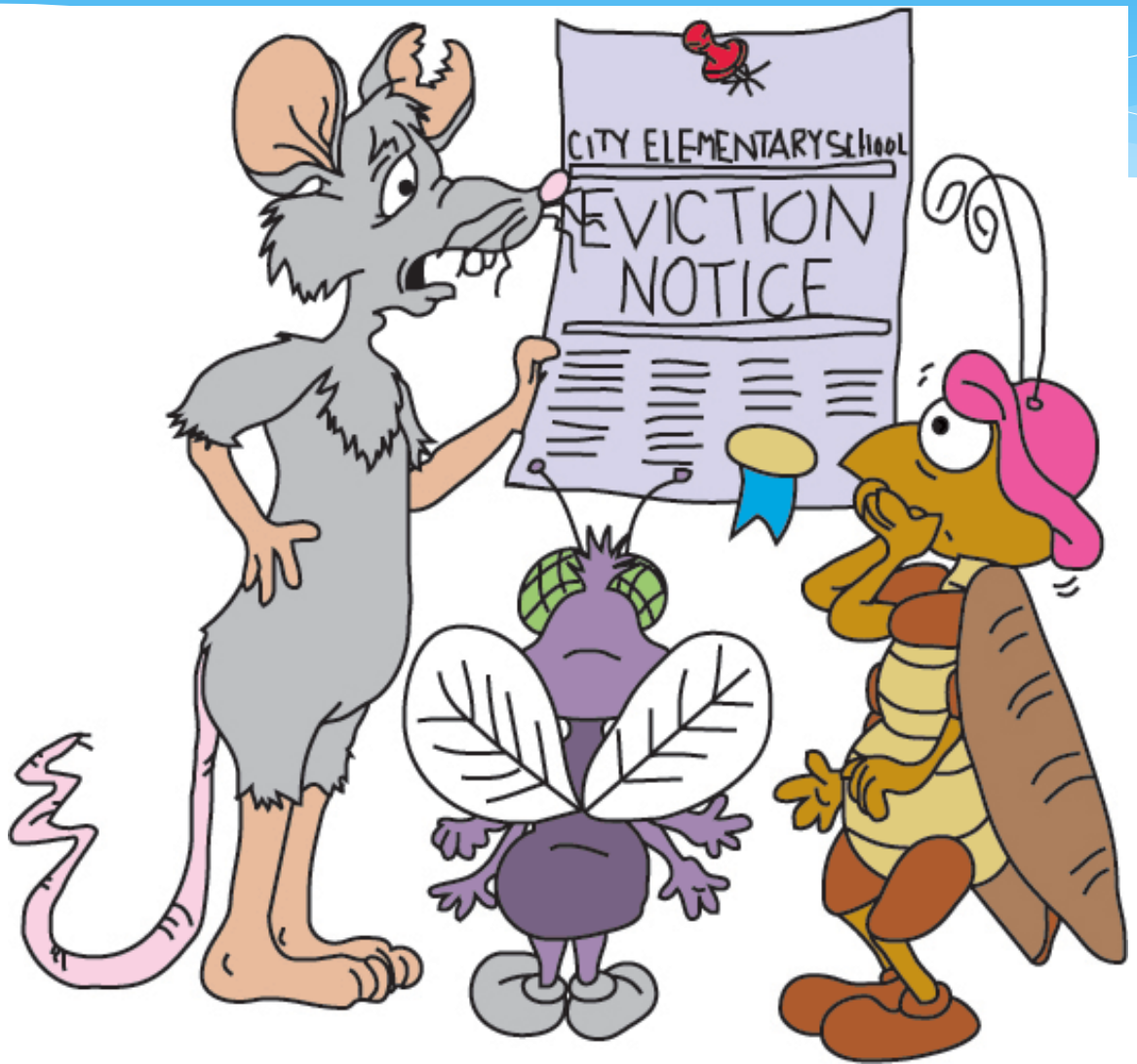
Pesticides



Definitions

*Pesticides

* Any chemical, **natural** or **human-made**, that is designed to kill another organism.

Using that broad definition

There are hundreds of thousands of pesticides in the natural environment.

Biological warfare was invented and perfected in Nature.
It must be kept in mind that for every scary synthetic pesticide man has created, Nature has created something worse.

99.99% Of Pesticides We Eat Are Produced By Plants Themselves at https://www.acsh.org/news/2017/06/13/9999-pesticides-we-eat-are-produced-plants-themselves-11415

What!?

According to Dr. Bruce Ames every plant produces roughly a few dozen toxins, some of which (at a high enough dose) would be toxic to humans.

Cabbage produces at least 49 known pesticides.

Source: Bruce Ames, Margie Profet, Lois Gold. “Dietary pesticides (99.99% all natural).” PNAS 87: 7777-81. Published: October 1990.

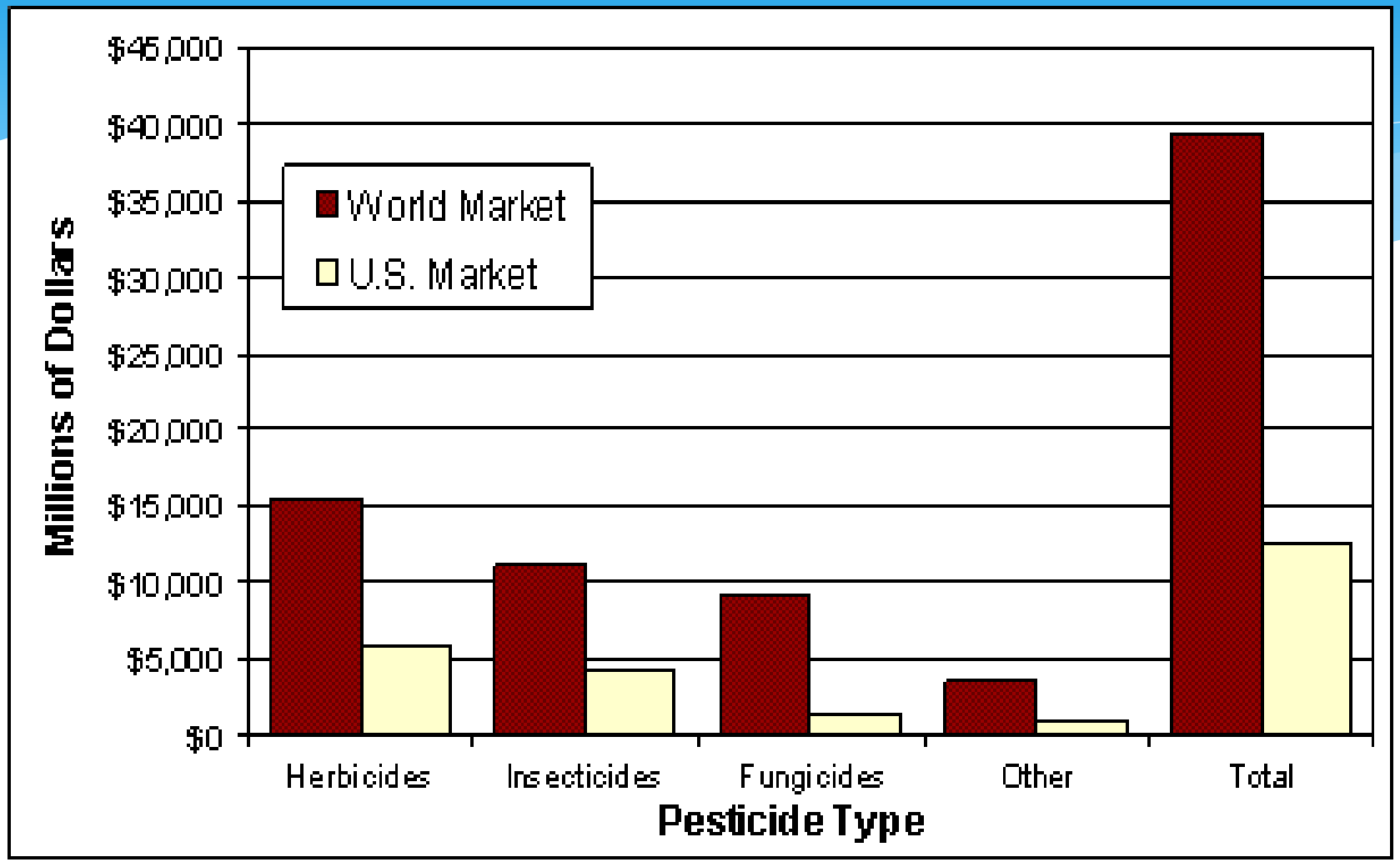
A Bit of Pesticide History

* Before W.W.II pesticides in common use throughout the US were predominantly inorganic materials, such as sulfur, lead, copper, arsenic, boron, mercury, as well as botanical compounds such as nicotine, pyrethrum and rotenone.

World War II Created a New Generation of Pesticides

* During this time DDT insecticide was further **developed by the Swiss**, it changed the nature of pest control worldwide.
* The extraordinary effectiveness of DDT and the related materials that followed it: lindane, dieldrin, chlordane, 2 4-D.

Pesticide Use



EPA World and U.S. Pesticide Expenditures User Level by Pesticide Type, 2007 Estimates

Pesticide Use 2012

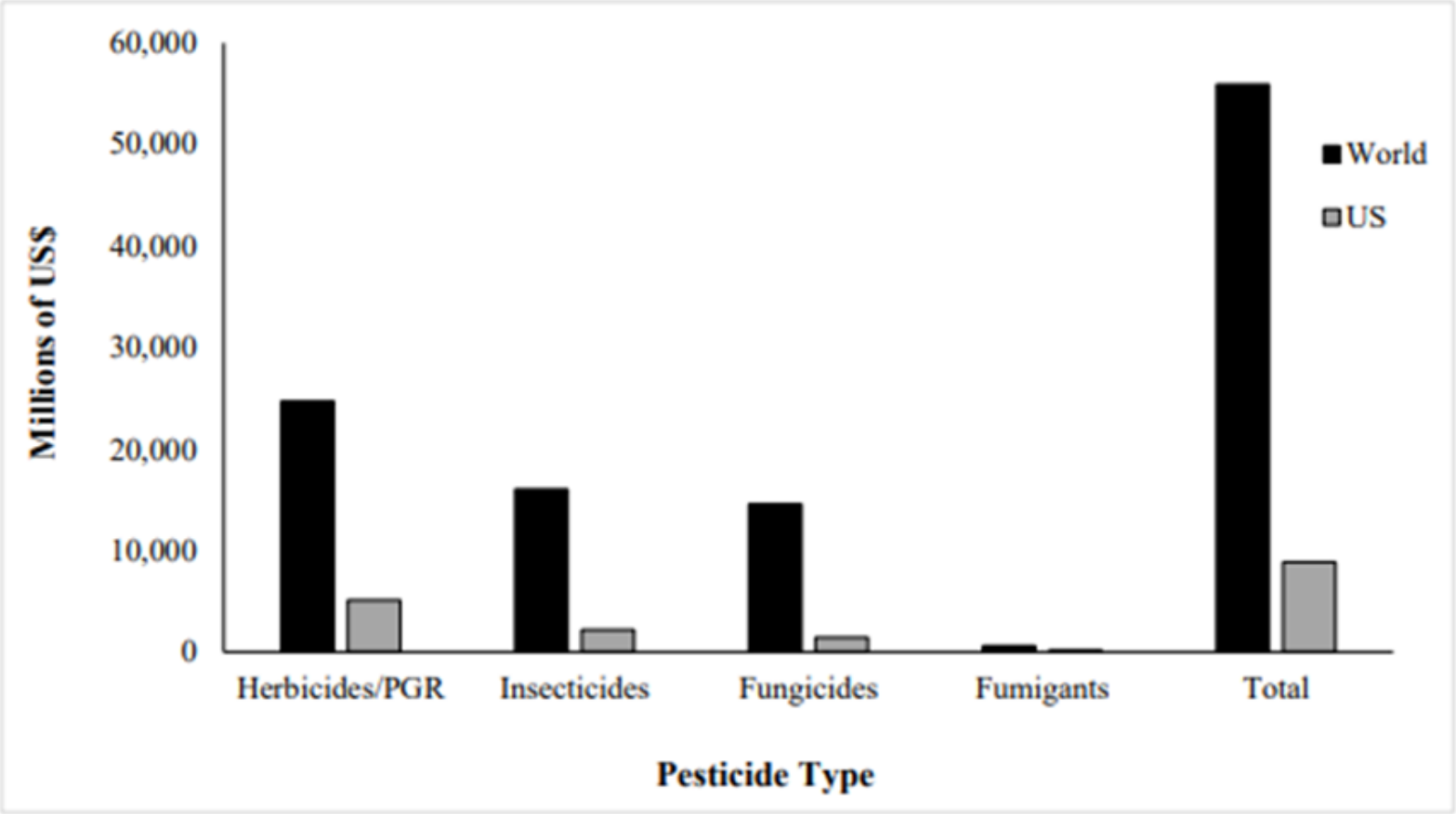


Figure 2.1. World and U.S. Pesticide Expenditures at Producer Level by Pesticide Type, 2012 Estimates

https://www.epa.gov/sites/production/files/2017-01/documents/pesticides-industry-sales-usage-2016_0.pdf

Who is using them.

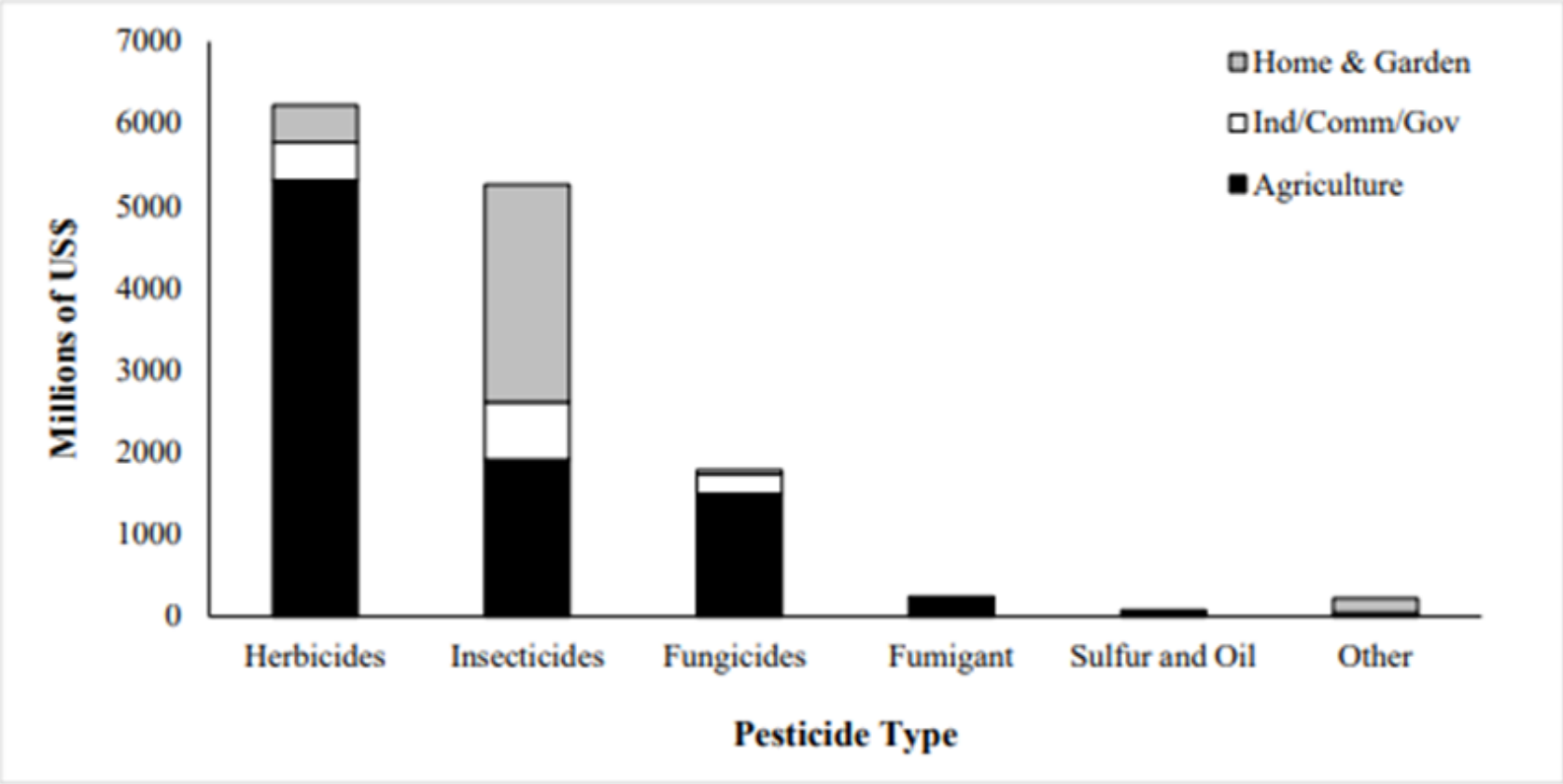


Figure 2.2. User Expenditures on Pesticides in the United States by Pesticide Type and Market Sector, 2012 Estimates

https://www.epa.gov/sites/production/files/2017-01/documents/pesticides-industry-sales-usage-2016_0.pdf

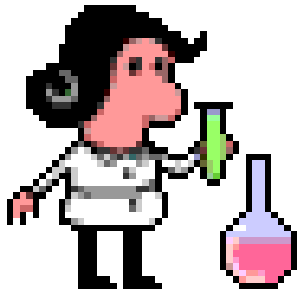
Active Ingredient

* aka Main Ingredient…
* Active ingredient (actual pesticide chemical) may require mixing with one or more chemicals in order to make it satisfactory for use.
* Active pesticide chemicals are frequently in a form, which is not suitable for direct application.

Synergism

* Occurs when one compound enhances the effect of another many times beyond what would be experienced if either were encountered alone. (Like alcohol and drugs).

* In the presence of a synergist, **a little active ingredient can go a long way**.



Synergist-

Piperonyl Butoxide

* derived from sesame seeds, is the most common synergist.
* is a registered pesticide.
* It is used in most products containing pyrethrins.

Inert Ingredients

* By Federal law, the active ingredient must be identified by name on the pesticide product's label together with its percentage by weight.

* All other ingredients in a pesticide product are called "inert ingredients.“ epa

Inert Ingredients

* “Inerts” by law, does not mean non-toxic.

* Often contain more than one inert ingredient.
* Inert ingredients -key roles in the effectiveness of pesticides.

* They can: prevent caking or foaming, extend product shelf-life, or solvents that allow herbicides to penetrate plants.

Inert Ingredients

* Xylenes, found in agricultural insecticides
  Cause eye, skin irritation, headaches, nausea, confusion, tremors and anxiety.
* Methyl paraben, found in head lice products. Regulated as a drug, causes skin sensitivity, digestive and respiratory irritation.

Inert Ingredients

* Dimethyl ether, found in flea products, causes respiratory, skin and eye irritation, depresses the central nervous system.
* Butane, found in household insecticides, exposure causes irritation, nausea, and drowsiness.

Inert Ingredients

* Polyethoxyalted tallowamine (POEA)

Inert ingredient in Round-up.

- It improves the solubility by increasing the penetration of the plants waxy surfaces.

^ U.S. Patent 4,528,023

^ http://www.bio-medicine.org/biology-news/Roundup-AEhighly-lethal-to-amphibians--finds-University-of-Pittsburgh-researcher-824-2/

Sub-Classed Into Groups by Types of Pesticides:

* Acaricide	mites, ticks
* Attractant	insects
* Avicide	birds
* **Bactericide**	bacteria
* Fungicide	fungi
* Herbicides	weeds
* Insecticides	insects

Classified by Function

* **Attractants**, compounds that attract pest to traps or poison, including sex based, and food based. Ants
* **Repellents**, compounds that repel the target pest. Deer.
* **Desiccants**, compounds that kill by adhering to insect cuticle, abrading a hole and drying out the insect, (i.e) diatomaceous earth, silica aerogel.

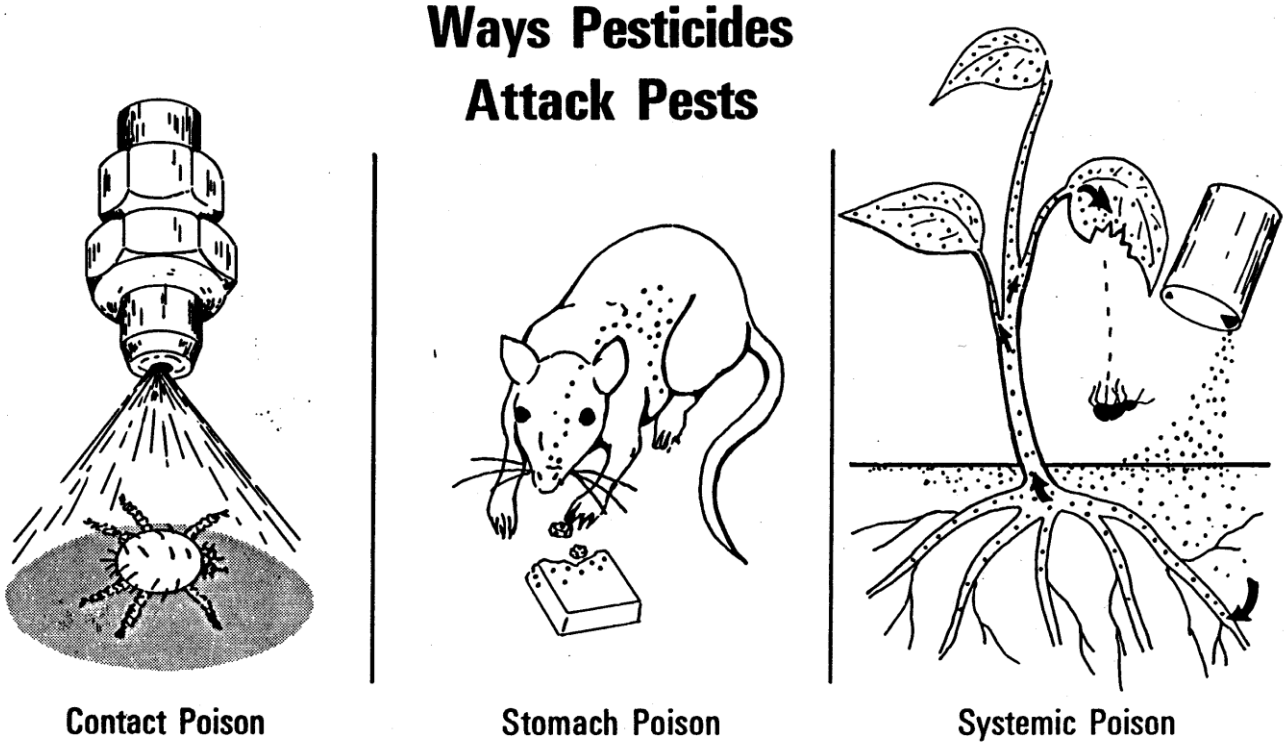
Classified by Function

* Pass through, livestock is fed this passes through in the manure where a target pest eats it. Flies.
* Systemics, absorbed by the plant kills any organism that feeds on that tissue.

Classified by Function cont…

* Growth Regulators
* Contact Poisons
* Stomach Poisons
* Dusts
* Baits
* Aerosols.
* Fumigants.

3 Main Attack Modes



Lethal Dose (LD 50)

* The 50 in this expression refer to the dose of a given substance that kills 50% of the organisms exposed to it in the sites.
* The LD 50 rating is usually expressed in milligrams of poison per kilogram of body weight.
* ex LD 50 rating of 1.0 mg/kg and each individual in a group of 150 lb. men consume approx. 6.8 mg of the pesticide, presumably half the individuals will die immediately.

Lethal Dose (LD 50)

* The higher the rating the less acutely poisonous.
* Bleach has an LD of 150.

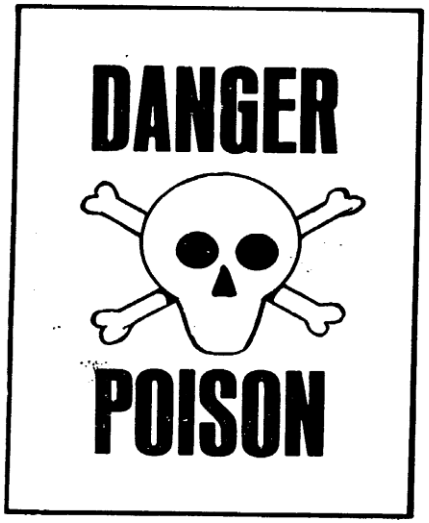
Laundry Bleach, Very toxic, taste to teaspoon.
Rubber Cement, High toxicity, teaspn to tblspn.
Liquid Detergent, Moderate toxicity, oz. to a pint.
Baby Lotion, Low toxicity, pint to a quart.

Warning Labels

* (3) levels of alert or Categories concerning the amount of pesticide to kill a 150-pound person.
* 1 - Category I, **DANGER** (highly hazardous poison) Taste to teaspoon.
* 2- Category II, **WARNING** (moderately hazardous) Teaspoon to a tablespoon.
* 3- Category III and IV, **CAUTION** (slightly hazardous to relatively non hazardous) Ounce to a pint.

Words on the Label

Signal Words



Highly Toxic

WARNING

Moderately Toxic

CAUTION

Slightly Toxic to
Relatively Nontoxic

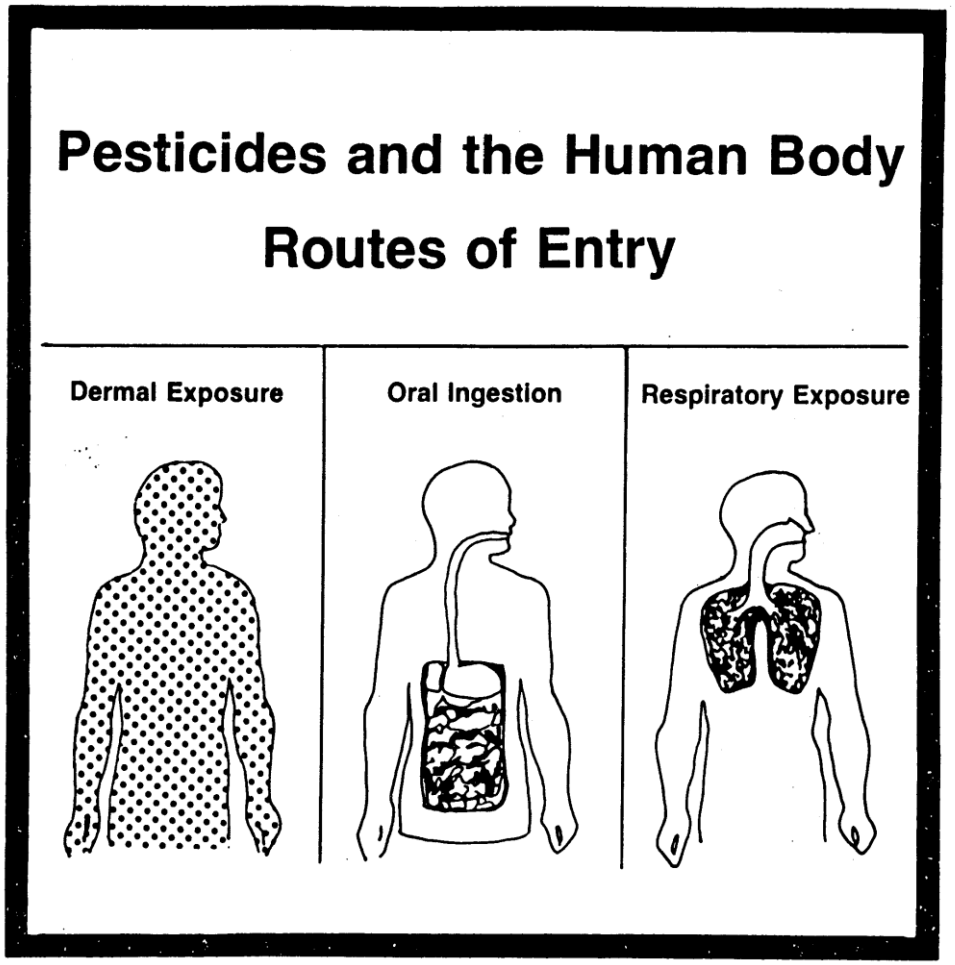
Vocational Agriculture Service - College of Agriculture - University of Illinois at Urbana-Champaign
(Safe Use of Pesticides 14)

The Label is the Law (Federal)

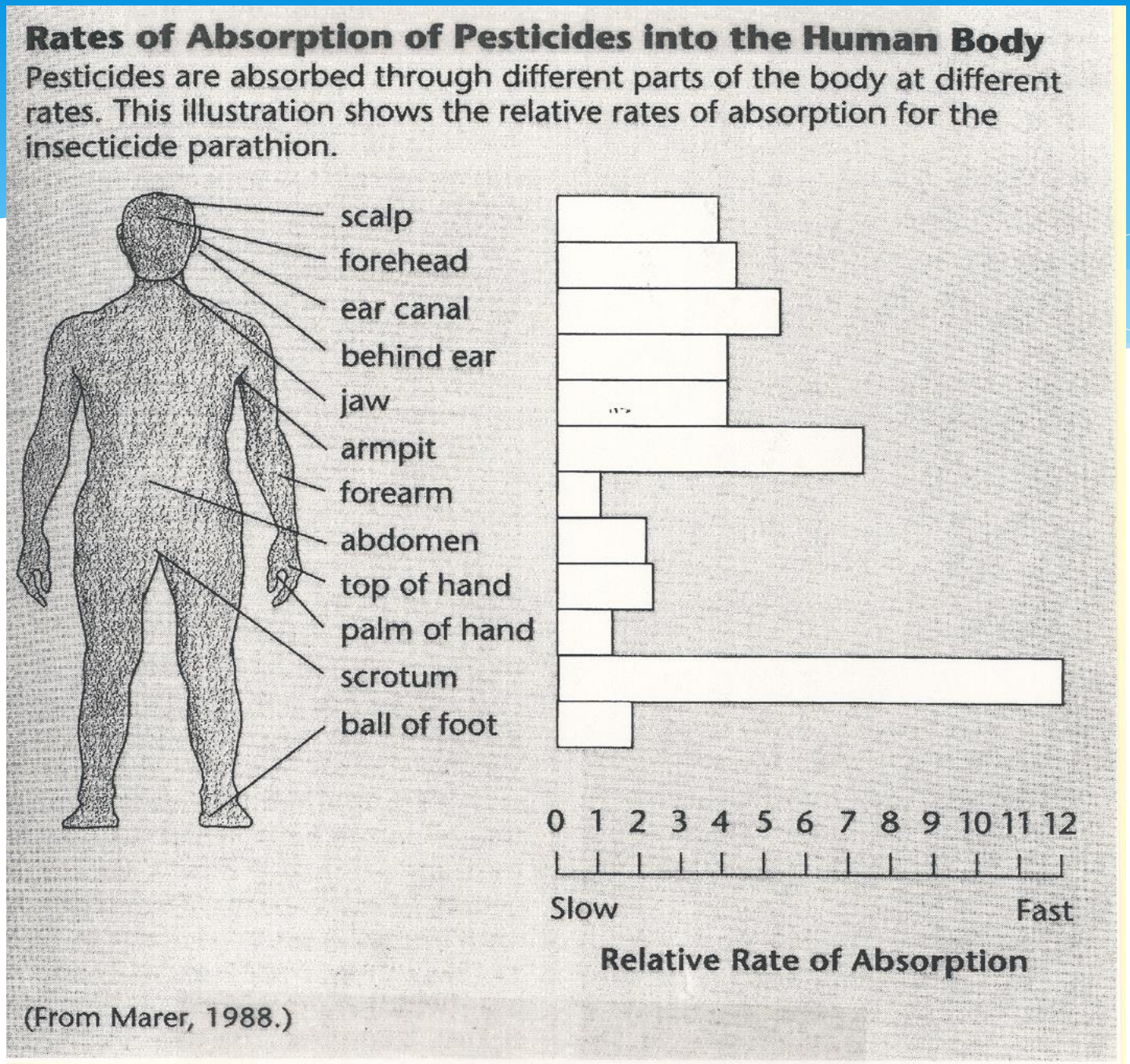
From a Client.

* I used Fertilome systemic drench for tree and shrubs last year on my fruit trees. This year it has a large harvest of fruit. (Peaches)
* I am concerned the fruit is not fit for consumption because it may contain pesticide.
* It would be a shame to let it go to waste but I obviously don't want to eat toxic fruit Please advise. Thank you

Pesticide Entry



Your Skin is a big Sponge.



LD50 of some Insecticides

* Nicotine LD50 50-60 mg/kg
* Sevin LD50 850 mg/kg
* Malathion LD50 885-2,800 mg/kg
* Pyrethrins LD50 1,200 to 1,500 mg/kg
* Neem LD50 13,000 mg/kg

The smaller the number the more harmful.

People Problems

* Neuro-degenerative diseases such as Parkinson's Disease and Alzheimer's Disease have been linked to toxic chemical exposure.

* 99-U.S. Congress, Neurotoxicity: identifying and Controlling Poisons of the Nervous System.

People Problems

* Numerous pesticides are hormone mimics.
* For example: methoxychlor a.k.a. Maralate (a organochlorine pesticide) and vinclozolin (a fungicide) a.k.a Drive, Ornalin.
* A study discovered the process was disrupted to estrogen.
* The results; adult (human) males had low sperm counts and reduced fertility.

* https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/methoxychlor

Some Symptoms

* When chemicals are taken in:
* Some symptoms: apprehension, twitching, tremors, confusion, and convulsions
* Fatigue headache, dizziness, nausea, and mild physical distress to muscular weakness and breathing difficulty.
* Pesticides effect humans and other mammals.
  * Cornell University Ithaca, NY 14853-0901 (607)255-1866

Insecticidal Modes of Action

* Nerve poisons
* Muscle poisons
* Physical toxicants
* Repellants

Nerve Poisons

* Synaptic poisons - act by interrupting normal synaptic transmission of nervous system, causing the nerve to continue to fire which in turns cause tremors and death.

* Axonic poisons - interrupt normal axonic transmission of nervous system. (Pyrethroids and chlorinated hydrocarbons).

Nerve Poisons

* Anti-cholinesterases - organophosphates and carbamates.
*
* Cholinomimetics - nicotine and nicotine sulfates.

Physical Toxicants

* Block metabolic process via physical rather than chemical means.
* Oils are used against aquatic pests to prevent respiration.
* Dormant oils work against scale insects by clogging spiracles.

Repellants

* Does not kill insects.
* Very low toxicity to no toxicity.
* LD 50 levels of 1,800 to 2,700.

Repellants “Deet”

* Developed by scientists at the U.S.D.A.
* Patented by the U.S. Army in 1946.
* Registered for use by the general public in 1957.
* A broad-spectrum repellent effective against mosquitoes, biting flies, chiggers, fleas, and ticks.

Repellants -Deet

* *N*,*N*-diethyl-3-methylbenzamide (**DEET**)

* The most effective and best studied insect repellent currently on the market.
* This substance has a remarkable safety profile after 40+ years of worldwide use.
* But toxic reactions can occur (usually when the product is misused).

Two Main Chemical Groups: Inorganic and Carbon Based.

- ***In-organic pesticides:*** Stable & water-soluble.

  - (Boric acid, borates, chlorates, copper sulfate, silica aerogel, Stomach poisons.
  - Sodium Hypochlorite (bleach) chemically burns the pest, oxidizing the tissue).

Carbon Based (C)

… Compounds, which sometimes also contain hydrogen, oxygen, nitrogen, phosphorus or sulfur, with majority of all modern pesticides.

Types of Carbon Based Pesticides

- Organophosphates
- malathion, methyl parathion, diazinon (now off the market)

- Carbamates; Sevin

- Chlorinated hydrocarbons; (no longer available in the US)
  DDT, chlordane, aldrin, dieldrin

Organophosphate

* By-product of nerve gas and chemical warfare research WWII in Germany.
* **Diazion, Malathion, Orthene,**
* They inactivate the cholinesterase enzymes. Synaptic or Nerve poison.

Organophosphates-Malathion

* More toxic to mammals than Organochlorines.
* Many are systemic.
* For 75% of **Malathion** to break down it takes 1 year.

* The EPA lists organophosphates as “very highly acutely toxic to bees, wildlife, and humans.”

* **Diazion** is highly toxic to birds, and very toxic to aquatic species. Non-persistent. Off the market.

Carbamates (*Sevin*)

* Carbaryl pesticides.
* Inactivate the cholinesterase enzymes.

Chloronicotinyls

* Synthetic version of nicotine, disrupts the nervous system.
* Broad spectrum, long residual, low rate (a little goes a long way) and systemic.
* Modeled after natural nicotine.
* **Imidacloprid** (neonicotinoids).

Imidacloprid neonicotinoids

* It causes a blockage in a type of neuronal pathway (nicotinergic) that is more abundant in insects than in warm-blooded animals

* It is effective on contact and via stomach action.

Imidacloprid neonicotinoids

* However: **Do not** use on flowering plants….
* Neonicotinoids are absorbed into plant tissue and can be present in pollen and nectar, making them toxic to bees.

Pyrethrum

Pyrethrin

Pyrethroid

Permethrin

Pyrethrum and Its Derivatives

* Refers to the dried, powdered flower heads of the plant; *Pyrethrum roseum* = *Chrysanthemum coccineum*.
* One of the most important insecticides ever developed.
* Persist only a few hours.

Pyrethrin

* Disruption of normal transmission of nerve impulses, causing virtually instant paralysis in insects.

* Some insects can detoxify Pyrethrin and recover from the initial knockdown so most pyrethrins are combined with a synergist, which blocks the insects ability to break down the toxin.

Pyrethroids

* Synthetic compounds that resemble pyrethrins in chemical structure but are more toxic to insects.
* May last 10 days or more compared to a few hours for the natural botanicals.

Permethrin

* Synthetic Pyrethroid family.
* First marketed in 1973.
* Used on, nursery stock, cotton corn,
* **home use**.
* Can persist up to 3 days.

Coalition for alternatives to pesticides, Eugene, or., journal of pesticide reform/summer 1998 vol 18. No 2141

Permethrin

* **Toxic to honey bees and other beneficial insects such as; Mayflies, Damselflies, it is highly toxic to fish and aquatic insects.**
* A wide variety of insects have developed resistance to permethrin such as; cockroaches, head lice and tobacco budworm.

What If……

* Rocky Mountain Poison Center 800-332-3076.
* National Pesticide Information Center 800-858-7378.

Pesticide Persistence

* All pesticides break down - eventually into hydrogen, carbon and oxygen.

Short Lived pesticides, Some break down in hours or a few days

Long lived or persistent pesticides, determined by: conditions of temperature, sunlight, air and location.

Resurgence

* When the predators, parasitoids or pathogens *that would naturally control the pest* are temporarily removed or drastically reduced in numbers.

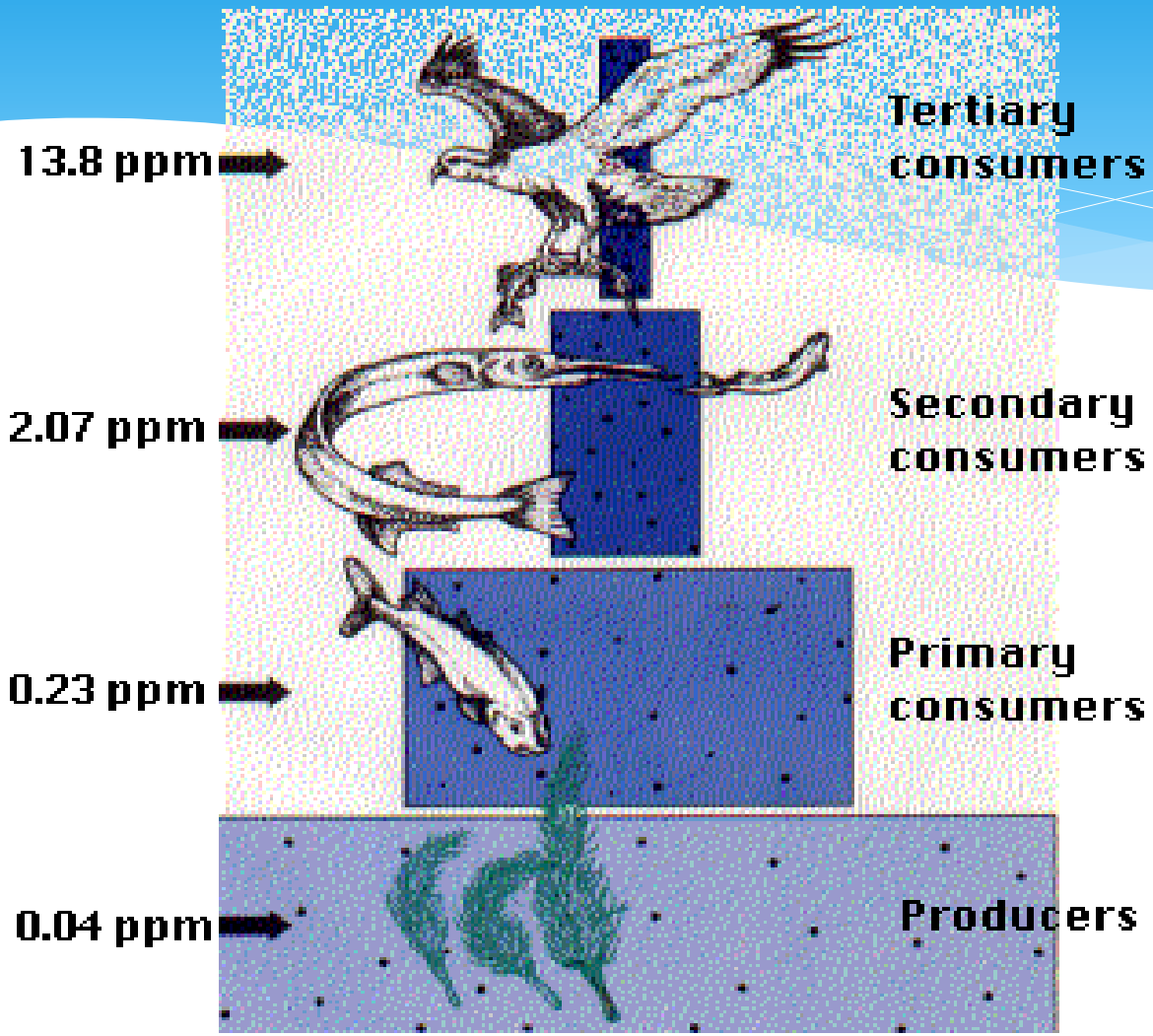
Resurgence

* The remaining pest multiply with fewer restraints, ***the problem can even worsen.***
* *Aphids, spider mites, thrips, whiteflies…..*

Resistance

* **Insects are among the most adaptable organisms on the face of the earth.**
* Managed to survive 400 million years by adjusting to changes in their environment.
* There are over 500 pest species that exhibit some level of resistance to at least one type of insecticide.

Biomagnification



The numbers are representative values of the concentration in the tissues of **DDT** and its derivatives (in parts per million, ppm)

John R. Meyer
Department of Entomology
NC State University

When and How to Apply

* Spot spray when possible.
* Avoid repeat spraying.

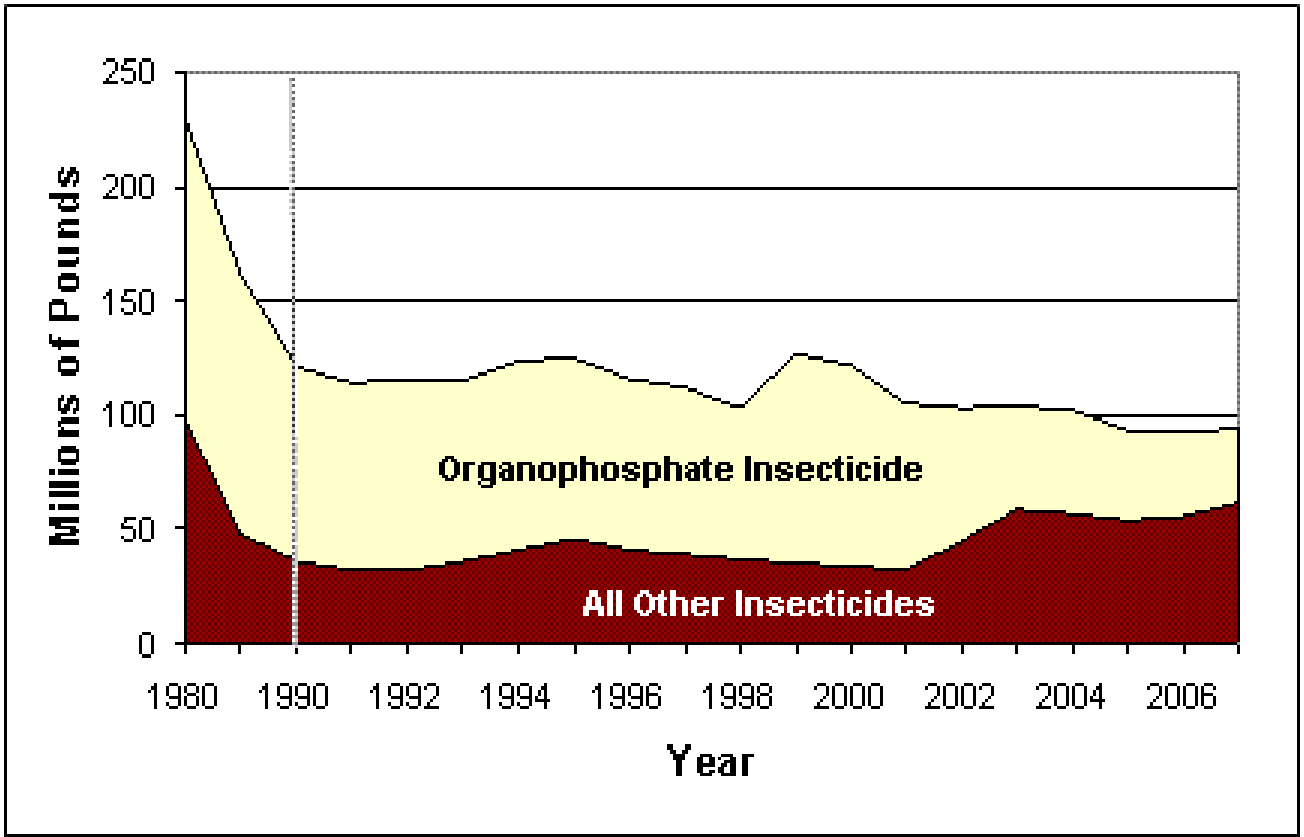
* **<u>Only if there is indication of insects that need to be sprayed.</u>**

What to Protect

* **Soil**.
* **Water**.
* **Air.**
* **Plants.** *Phytotoxicity.*
* **Good Bugs** Honeybees, native bees.
* **You!**

Good News?

* 1-2003 Biotech crops in Iowa alone reduced farmers' reliance on pesticides by nearly 46 million pounds. http://www.ifbf.org/fullarticle
* 2-



PESTICIDES

* Call City of Cheyenne Sanitation Department.

307.637.6440

They take hazardous household waste by appointment every Saturday.

A snail can sleep for three years.

Better Ways to Control Pest

Integrated Pest Management **IPM**

* Id the problem first.
* Start with the least toxic solution first.
* Beneficial insects, water, bio-pesticides.
* Give it some time and Persistence.

Bio-Rational Insecticides

* *Can be Specific* to that insect or more selective to that pest.
* Non-target insects or animals are not affected at all or very little.

Bio Pesticides

* Examples:
* Bacillus thuringiensis,
* spinosad,
* Azadirachtin
* Myco-insecticides (Beauveria bassiana).

Bio-Pesticides

* For example, some bacteria and fungi produce antibiotics to kill other microbes. We don't call these antibiotics "pesticides," but that's exactly what they are. To a bacterial cell, a microbe of a different species is often nothing more than a competitive pest that should die. So, it produces chemicals with the intention of killing it. That's a pesticide.

Bio-Pesticides

* “Plants do the same thing.
* From a plant’s point of view, many insects are nothing more than dangerous, leaf-eating parasites that should die.
* So plants produce insecticides, like caffeine and nicotine, to keep those obnoxious, six-legged vegetarians away. (They also produce pesticides to keep the furry, four-legged vegetarians away, too.)”
* By Alex Berezow — June 13, 2017 **99.99% of Pesticides We Eat Are Produced by Plants Themselves**

Plant-derived pesticides or plant-derived Essential Oils (botanicals).

* These are primarily obtained by steam distillation or by other processes from plant leaves, flowers or seeds.
* Can act as insect growth regulators.
* modes of action, such as anti-feeding, molting and respiration inhibition, growth and cuticle disruption.

Essential Oils for pest control

* Peppermint (or spearmint) – repels ants, spiders, aphids, beetles
* Rosemary – moths, flies, mosquitos, ticks
* Tea Tree – ants, mosquitos, ticks,
* Cinnamon – silverfish, cockroaches, dust mites
* Clove – wasps, ants, cockroaches, aphids
* Lemongrass – gnats, ants, mosquitos, fleas, ticks
* Lavender – mosquitos, fleas, flies, spiders
* Citronella – spiders, gnats, fleas, mosquitos

https://www.recipeswithessentialoils.com/essential-oil-plant-spray/

Diseases formulated as sprays

* Nontoxic to mammals,
* Not systemic. Must be consumed by insect (e.g., caterpillars).
* Various fungi non-persistent (very short).

* Milky spore disease for Japanese beetle grubs. First used in 1948
* Bacillus Thuringiensis v. Kurstaki for worms found on trees & veggies.
* Bt v. Israelensis for mosquito control, black flies and fungus gnats, midges.
* Bt v. San Diego for larvae of Colorado potato beetle, elm leaf beetle.

* Beauveria bassiana (BotaniGard).
* Nosema Locustae a type of protozoa, for grasshopper control.
* Nucleopolyhedrosis virus (NPV) for Gypsy Moth control.

Ants

* Ants can be repelled by: vinegar, cayenne pepper, citric extracts, bone meal, cinnamon, cream of tartar, salt, wheat flour, and perfume.
* You will have to keep trying different repellents to find the one your ants aren't willing to tolerate. Place lines of the selected repellent at points of entry and at various points along their path.
  * EPA

Kaolin Clay

* A non-toxic particle film that places a barrier between the pest and its host plant.
* Sprayed on as a liquid, which evaporates, leaving a protective powdery film on the surfaces of leaves, stems, and fruit.

* Spray was developed by Drs. Michael Glenn and Gary Puterka of the USDA/ARS at Kearneysville, WV

Kaolin Clay

* Tiny particles of the clay attach to the insects when they contact the tree or fruit, agitating and repelling them.
* Even if particles don't attach to their bodies, the insects find the coated plant or fruit unsuitable for feeding and egg-laying.

Kaolin Clay

* Control: leafrollers, leafhoppers.
* Suppression: mites, codling moth, thrips plum curculio, stink bugs, apple maggot.
* Horticultural Benefits: reduced heat stress and fruit drop, reduced sunburn, improved color in certain cultivars.
* **SurroundWP™**

NEEM (Azadirachta indica)

* Principal active ingredient is azadirachtin, more than 25 other active compounds have been isolated.
* **Modes of action**.
* Its various active ingredients act as: repellents, feeding inhibitors, egg-laying deterrents, growth retardants, sterilants and direct toxins.
* These multiple modes of action make it *unlikely* that insects or pathogens will develop resistance.

NEEM (Azadirachta indica)

* Neem-oil extracts show very low toxicity to mammals, The LD-50 is greater than 13,000.
* The active ingredient biodegrades rapidly in sunlight and within a few weeks in the soil.

* Non-selective.

Spinosad

* Is a soil-dwelling bacterium called *Saccharopolyspora spinosa*.
* Spinosad poses less risk than most insecticides to mammals, birds, fish.
* A unique mode of action coupled with a high degree of activity on targeted pests and low toxicity to non-target organisms.

"**Spinosad Battles Crop Pests**" was published in the April 2000 issue of *Agricultural Research* magazine.

Spinosad

* The mode of action: excitation of the insect nervous system, leading to involuntary muscle contractions, prostration with tremors, characterized by cessation of feeding and paralysis of exposed insects **within minutes**.

* No other class of products affects the insect nervous system with the same mode of action.

Diatomaceous Earth or D.E.

* Is mined from the fossilized silica shell remains of diatoms.
* It has both abrasive and sorptive qualities.
* *Mode of Action*: it absorbs the waxy layer on the surface of insect skins, causing the insect to desiccate.
* It also works abrasively to rupture insect cuticles, allowing fluids to leak out.
* DE is virtually nontoxic to mammals.

Garlic Oil

* As an insecticide spray it will also kill the beneficial insects. To be used where natural controls are not present.

Garlic Oil

1 bulb

1 quart of water

Blend in a mixer for 5 minutes

Dilute to one gallon

* Spray on plants or directly on insects, can use as a soil drench.

* Works best: to help control, repel and suppress mosquitoes, aphids, caterpillars, whiteflies, mites some beetles.
* The smellier the garlic the better.

Boron, Boric Acid or Borax

* Works as a stomach poison.
* Slow to work 5 to 10 days.
* LD 3,200.
* Apply as a thin film, insects pick this up on their legs, groom themselves, ingest it.
* 1-2 % solution.
* Ants.

Pesticidal Soaps

* Mode of action:
  * May dissolve the protective covering and dissolve into the membranes around its cells, resulting in dehydration and death.
  * Acts as a suffocate.
* Insects must be present for this to work.
* Do not spray when temps are about 85 degrees.
* Don't spray stressed or wilted plants.

A goldfish has a memory span of three seconds.

Pesticidal Soaps

* **Works on soft body insects** such as: aphids, mealybugs and whiteflies.
* Does not work on most beetles.
* Good for indoor use.
* 2-3 Tablespoons of soap

  1 Gallon of water

  Mix well.

    Can add 2 cups of boiled and strained citrus peel for severe infestations of insects.

Traps

* Coated with a sticky substance usually with an attractant such as a pheromone.
* Good for whiteflies, fungus gnats, aphids, leafminer flies, thrips and apple maggot flies.
  * For apple maggots hang trap in early June and leave until harvest. One per tree.

Miscellaneous

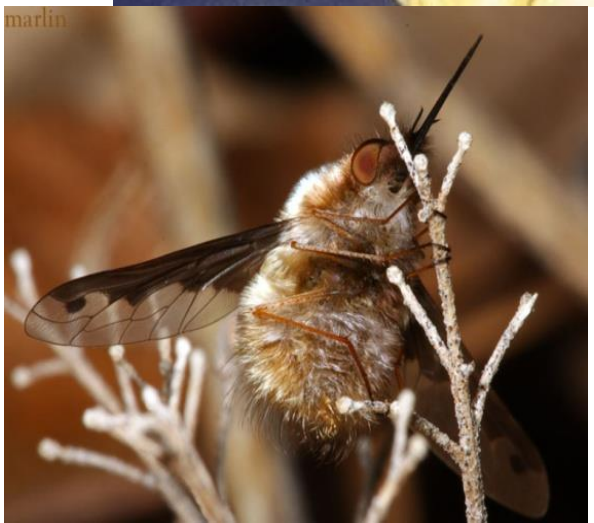
* Hort oils, most are petroleum based, some vegetable based mixtures w/trace amounts of nitrogen and sulfur.
* Suffocating and smothering.

* Canola oil is listed as a bio-pesticide.
* Corn oil is listed as a minimum risk pesticide.

Raspberries..

* Spotted Wing Drosophila, a very small fruit fly.
* Bait stations (traps).
* Erythritol, a natural sugar alcohol.
  * Half pound/gallon H2O sprayed on fruit 75% larvae kill of SWD.
  * Works by possible drying them out.

Beneficial Insects



* Lady Bugs and their larvae.
* Green Lacewings, eggs and larvae.
* Praying Mantids.
* Beneficial Nematodes.
* Trichogramma wasps.
* Encarsia formosa (Whitefly parasite).
* Minute Pirate Bugs.
* Bee Fly

Places to Buy Beneficial Insects

- Arbico, www.arbico.com, 1.800.827.2847.
- M&R Durango Inc., Insectary 970.259.3521, goodbug.com.
- International Tech. Service, 303.661.9546, www.Greenhouseinfo.com.
- Planet Natural, www.planetnatural.com 1.800.289.6656.

Herbicides

* Amino Acid Synthesis Inhibitors.
* Cell Membrane Disruptors.
* Growth Regulators.
* Lipid Synthesis Inhibitors.
* Photosynthetic Inhibitors.
* Seedling Growth Inhibitors.
* Unclassified.

Glyphosate

* Roundup
* Blocks critical respiration enzyme pathways

Cell Membrane Disruptors

* Herbicides in this family are post-emergence contact herbicides.
* Activated by sunlight to form active compounds that disrupt the plant cells causing disintegration of cell membranes and chloroplasts.
* On bright sunny days herbicide injury symptoms can occur in one to two hours.

Growth Regulators

* Herbicide uptake is primarily through the leaves.
* Interfere with numerous biological activities and protein synthesis of plants.
* Move systemically in the plant.
* Injury symptoms are most obvious on newly developing leaves. **2,4-D.**

Seedling Growth Inhibitors

* They are soil-applied herbicides.
* Interferes with the development of seedlings as they emerge from the soil.
* **Corn Gluten Meal,** 20 pounds to 1,000 sq ft. Not a one size fits all.

Vinegar

* Inexpensive and environmentally benign weed killer.
* Canada thistle treated with 5% vinegar showed 100% shoot burn-down but roots were not affected.
* Will kill anything it touches, not selective.
* http://www.barc.usda.gov/anri/sasl/vinegar.html.

Grasshopper Patrol on the look out