An Introduction to Pesticides

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Table of Contents

What is a Pesticide?

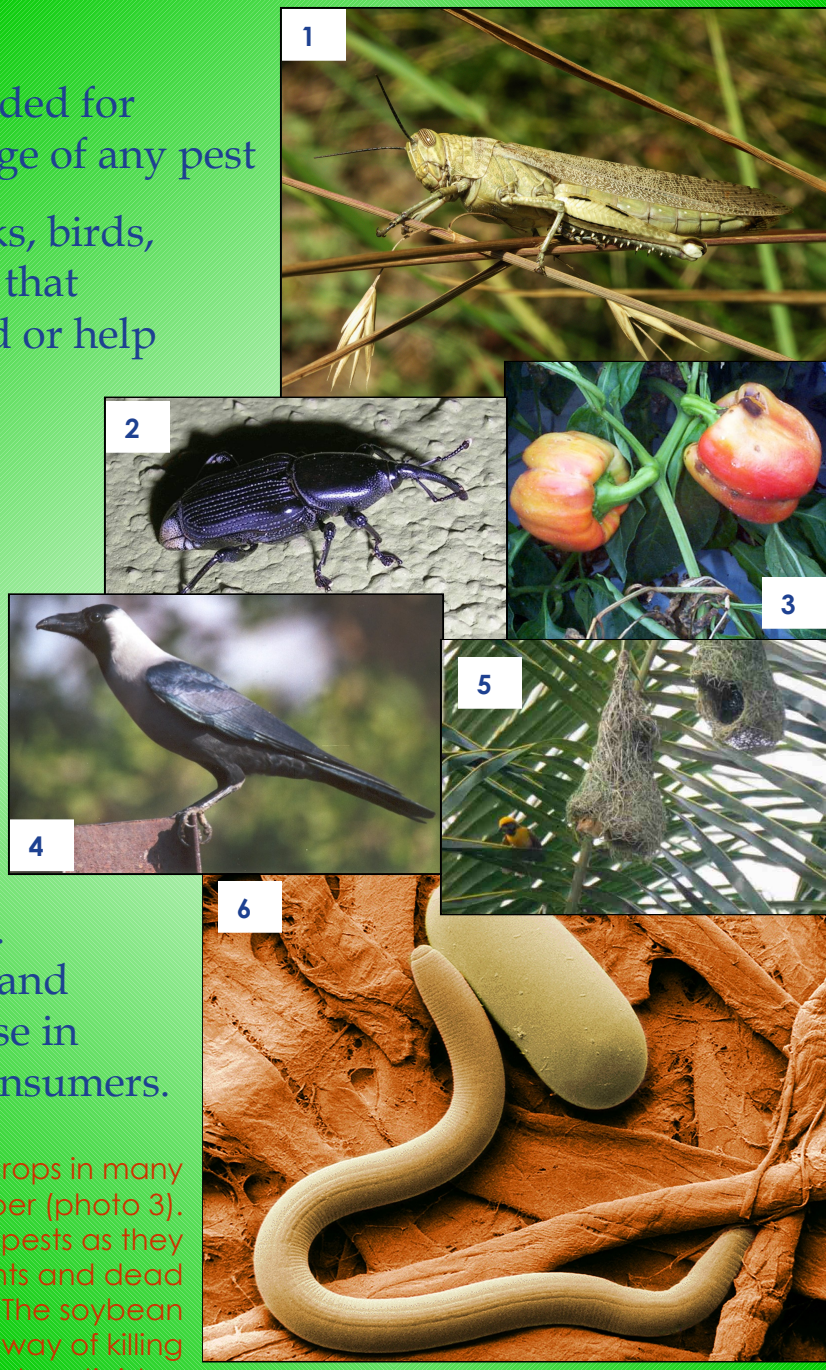
A pesticide is a substance or mixture of substances intended for preventing, destroying, repelling, or lessening the damage of any pest

The pest can be insects, plant pathogens, weeds, mollusks, birds, mammals, fish, nematodes (roundworms) and microbes that compete with humans for food, destroy property, spread or help carry or spread diseases or are seen as a nuisance.

A pesticide may be a

- chemical substance,
- biological agent (such as a virus or bacteria),
- antimicrobial,
- disinfectant or
- device

Many chemical pesticides are poisonous to humans also. Pesticides are used both in farms and within our homes and gardens. In this presentation, we will look at pesticide use in farming and how it affects many entities including us consumers.



Insects such as locusts (1), weevils (2) are common pests and destroy crops in many parts of the world. Virus also attack a variety of plants such as the bell pepper (photo 3). Birds such as the crow (4) and the weaver bird (5) are also considered as pests as they eat some crops. But they also provide benefits by eating insects, rodents and dead animals which may otherwise harm humans or the crops themselves. The soybean nematode (worm) (6) is another type of pests. Currently, the most common way of killing all these pests is through the use of poison – usually chemical pesticides.

Types of Pesticides

Pesticides come in many forms:

Bactericides for the control of bacteria

Fungicides for the control of fungi & oomycetes

Herbicides for the control of weeds

Insecticides for the control of insects - these can be Ovicides (for eggs), Larvicides (for larva or baby insects) or Adulticides (for mature insects)

Miticides for the control of mites

Molluscicides for the control of slugs and snails

Nematicides for the control of nematodes

Rodenticides for the control of rodents

Virucides for the control of viruses

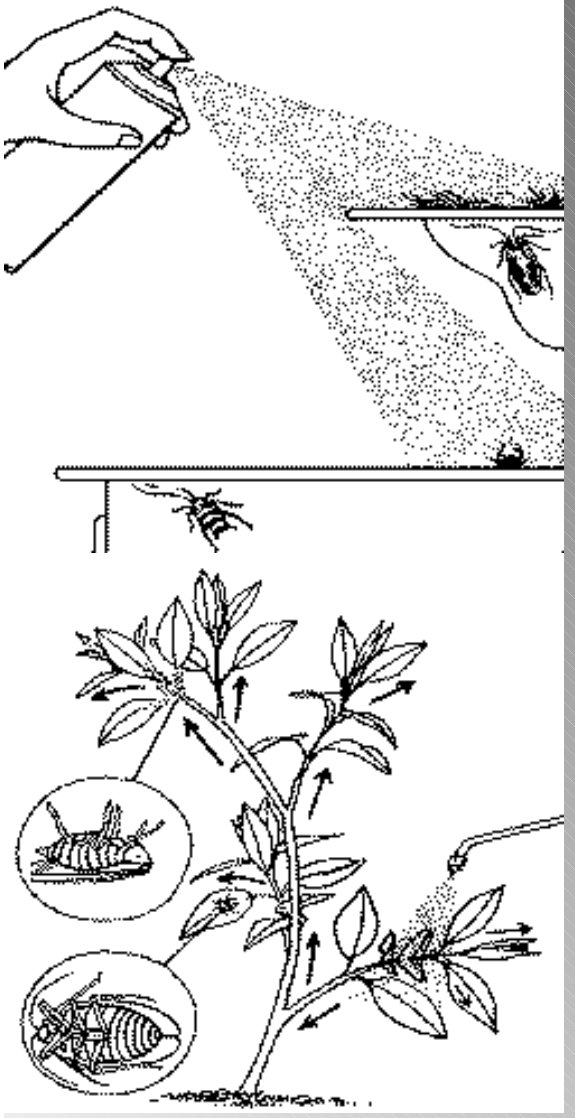
Some pesticides are absorbed by the plants and thus become part of the plants themselves. Such pesticides are called **systemic** pesticides. The poison then appear in all parts of the plants such as leaves and flowers causing many organism that consume parts of the plant to be affected, including humans. Often useful insects such as bees which pollinate plants die from this.

Most pesticides are also harmful to humans. Extreme care has to be taken to prepare them for use. In the top photo, the farmer has covered himself with gloves and a coat to prevent any skin contact. He has also worn a mask to prevent breathing in the fumes. In western countries, farmers often use airplanes (right middle) to spray pesticides. Not only does this prevent any contact between the farmer and the chemicals, but also a large area can be sprayed within a short time. Farmers often rent airplanes for a day or two during farming season. Pesticides such as molluscicides for water based pests may require a different application (right bottom). Different types of pests require different pesticides. Some common ones are shown below.

How Pesticides Work

Some pesticides are **contact** pesticides. To be effective these need to be absorbed through the external body surface or the exposed plant tissue where the pests reside; for example, tetramethrin used in household fly sprays, and bipyridillium herbicides such as paraquat. Contact pesticides have to reach their target directly to be effective.

Other pesticides are **systemic** in action. Systemic pesticides are absorbed by a plant or animal and moved (translocated) from the site of application to another site within the plant or animal where they become effective; for example, insecticides that are absorbed by foliage and translocated throughout the plant where they kill chewing or sucking insects; or nematicides that are applied to the leaves of plants and are transferred to the roots of the plant to kill worms or caterpillars that are attacking the plant's roots. Similarly, blood anticoagulant rodenticides in baits take effect once they have been transferred from the digestive system to the bloodstream of rats or mice.



Pesticides are most effective on eggs, larvae or seedlings. Thus they must also be applied at the right time – early in the life of the pest. Any delay in application would render them ineffective.

How Pesticides Work

Once it reaches the target pest, the chemical may act in different ways:

- **Blocking the cellular processes of target organisms in a purely mechanical way** By this, the pesticide physically prevents a basic cellular function even without any chemical reactions. Example of this would be spray oils that clog the respiratory mechanism of insects, petroleum oils that dissolve protective waxes on some insects and plants, or the bypyridylium herbicides that destroy the membranes of plant cells leading to their desiccation.
- **Destroy or alter the pest's metabolism**. Metabolism is the transfer of energy within the cells of organisms, which is essential for the growth and survival of all living things. There are many inhibitory pesticides in this category, such as by obstructing the respiratory, germination mechanisms. Sometimes, the pesticide will undergo transformation to another harmful chemical during the pest's metabolism and thus affect it. Example of these are rotenone and cyanide which disrupt respiratory functions in animals and sodium monfluoroacetate which gets converted to fluorocitrate inside the cell which is then poisonous to many animals.
- **Disrupt enzyme processes or denature proteins** – a very important part of every living cell. Examples include inorganic copper compounds, dithiocarbamate fungicides, phosphono amino acid herbicides such as glyphosate, and organophosphate insecticides.

Some common Pesticides. White oil blocks the pests pores and causes suffocation. Roundup® and Clearout® are glyphosates.

How do Pesticides Work – Continued

- **Simulate or otherwise interfere with hormones**, which are messenger chemicals that activate needed biological functions such as reproduction, to disrupt these cycles. Examples are the phenoxy herbicides that interfere with plant growth hormones and insect growth regulators that interfere with cuticle formation in insects during moulting.
- **Nervous system disruptors** affect mainly animal groups such as insects, nematodes and rodents. Some are narcotics such as some fumigant pesticides. Others disrupt the movement of nerve impulses, such as the organophosphate, carbamate and pyrethroid pesticides.
- **Disrupt photosynthesis prevent the plant (weeds) from producing or storing energy** and ultimately kill the plant. Examples include the triazine, substituted urea and uracil herbicides.

Weedwhacker™ and Buster™ and common phenoxy-based herbicide used mainly against broad leafed weeds. Anvil™ is a , pyrethriod-based insecticide used to combat mosquitoes. Princep™ is a triazine-based pesticide.

Some pesticides are residual in action and continue to be effective for days, weeks or months after their application. Examples are the triazine herbicides that persist in the soil and kill emerging weeds over the lifetime of a crop and insecticides that remain active for several years as a barrier to termites entering buildings.

Many modern pesticides do not persist for long in the environment. They act quickly and are then degraded to non-toxic substances by chemical or microbial processes. This helps prevent their build-up in crops or other organisms. How quickly a pesticide breaks down depends on its chemical properties, how much is applied and how it is distributed, as well as environmental factors such as temperature, moisture, soil pH and the availability of micro-organisms.

History of Pesticides

Humans have used pesticides for a long time to prevent damage to their crops. Common traditional pesticides include plant and animal derivatives such as neem, chrysanthemums, and rotenone derivates or common chemicals such as sulfur, mercury and arsenic. However, most were either ineffective or toxic to both humans and animals. Thus only a small set of these were used. Traditional farmers used other (non-chemical) means to control pests.

The story of modern synthetic pesticides starts with World War I and the introduction of DDT. During the 19th century, active research into science had yielded several chemicals. Accidental contact with some of these indicated they have some effect on humans. Thus the idea that these chemicals could be used to affect living organisms took shape.

Large-scale use of synthetic chemicals as weapons against humans first occurred in World War I by Germany, Britain, France and other major participants. Chemicals such as Mustard Gas, Cyanides and Chlorine were observed to cause burns, sicknesses and death in soldiers.

World War I is often called "the chemists' war", both for the extensive use of poison gas and the importance of nitrates and advanced high explosives. Their effects evoked interest among people and many scientists started studying them closely. Research into these and similar chemicals was funded by many companies and governments and continued well after the war.

(Bottom Left) A soldier suffering from Mustard gas burns during World War I (1914-1919) is being treated in a hospital. (Bottom Right) Soldiers in a trench use masks to escape from chemical weapons. (Top) A poison gas attack.

History of Pesticides: DDT

DDT had been discovered in 1874 by a German chemist named Zeidler, but did not have any use for it. In 1939, following on the interest in chemicals due to WWI, Paul Müller discovered that DDT was a very effective insecticide. No effect was apparent on humans. It quickly became the most widely-used pesticide in the world. It was used extensively during World War II by soldiers as well as certain civilian populations to control insect typhus and malaria.

A US soldier sprays DDT. The chemical was used as an insecticide to kill mosquitoes and other pests that spread diseases such as malaria.

Over the next twenty years, DDT became the number one insecticide in the world. Farmers started using this in large quantities in their fields. DDT was also used by agencies such as the WHO to reduce or prevent the spread of many killer disease across the world.

By the mid 1950s, it was observed that the mosquitoes and other pests were becoming resistant to DDT. This led to a decrease in its use. Also, in the late 1950s and 1960s, many people started to observe changes in the environment, such as dying fishes and decrease in bird populations, where DDT was being used.

These observations led to a study by Rachel Carson, a NY Times editor, of the effect of DDT and other synthetic chemicals on the environment, particularly water and water-based life in the US. Her conclusions, recorded in a book, *Silent Springs,* showed that DDT caused birds to lay eggs with thin shells as well as reproductive problems and death in birds almost reducing raptors such the Bald Eagle, Osprey and Peregrine Falcon to extinction.

Supported by many scientists, she also documented other side effects of such chemicals such as environmental devastation, immunity development in the pests, development of problems such as cancer in humans etc.

Learn more about DDT at:
http://www.tc.umn.edu/~allch001/1815/pestcide/sim/background.htm

History of Pesticides:

Modern Environmentalism

In her book, Carson explored the subject of environmental connectedness: although a pesticide is aimed at eliminating one organism, its effects are felt throughout the food chain, and what was intended to poison an insect ends up poisoning larger animals and humans. She said the chemical industry spread misinformation on the use of chemicals, particularly DDT, to increase consumption causing their indiscriminate use and thus damage in the environment.

Carson had made it clear she was not advocating the banning or complete withdrawal of helpful pesticides, but was instead encouraging responsible and carefully managed use with an awareness of the chemicals' impact on the entire ecosystem.

(Left) DDT spraying on a public beach as people go about their normal activities. Such spraying was common before the adverse effects of DDT were known. (Right) An advertisement for DDT in the Time magazine. Rachel Carson's work was instrumental in understanding the all-round effects of DDT. Source: http://www.tc.umn.edu/~allch001/1815/pestcide/sim/background.htm

The chemical industry with companies such as Monsanto, Velsicol, American Cyanamid and the US Dept. of Agriculture reacted to these charges with their own. They argued that these chemicals were a much needed weapon against pests and diseases and that much of the the ideas in the book were speculation and aimed at creating unnecessary fear in the readers.

But public sentiment against these had been awakened and the resultant pressure forced the US government to ultimately ban DDT as an insecticide in 1972. DDT was subsequently banned for agricultural use worldwide, but its limited use in disease vector control continues to this day in certain parts of the world. The limited use of DDT has also helped decrease the rate at which pests develop immunity to it, thus making it more effective.

Rachel Carson's struggle was an important moment in the history of environmental campaigns. There is now a strong awareness on the effects of introducing synthetic chemicals in the environment and opposition in the world has eventually created interest in organic farming and other traditional eco-friendly practices.

Pesticide Pollution

It is almost impossible to limit the area of effect of pesticides. Even when it is applied in a very small area, it spreads in the air, is absorbed in the soil or dissolves in the water and eventually reaches a much bigger area. Pesticides also often seep into ground water which we humans consume, poisoning us over time. In addition to these, residual pesticides on the plants are sometimes consumed by animals and even humans leading to very serious illnesses such as cancer and even death.

According to the US Geological Survey, pesticides have been found to pollute virtually every lake, river and stream in the United States. Similar results are expected in any place where pesticide use is widely prevalent.

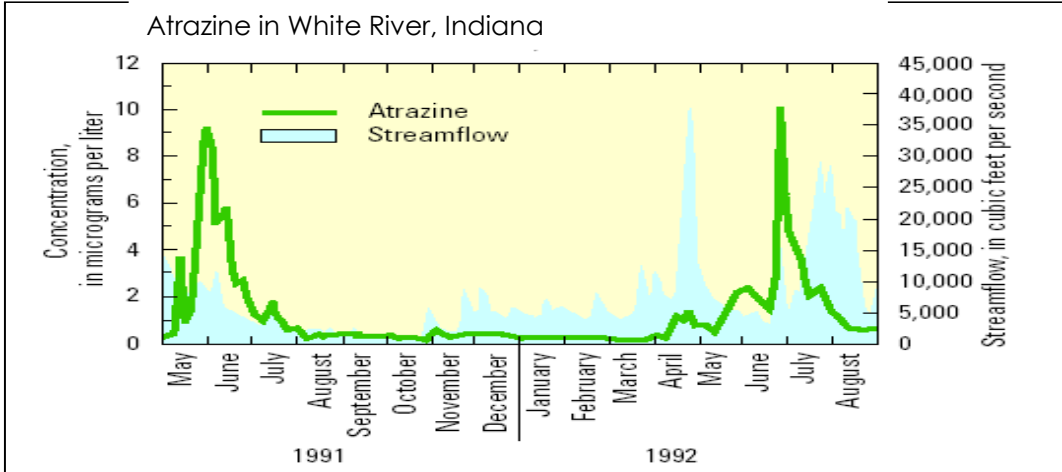
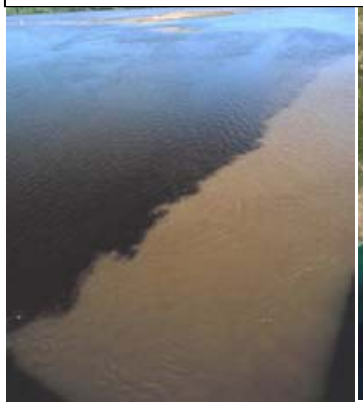


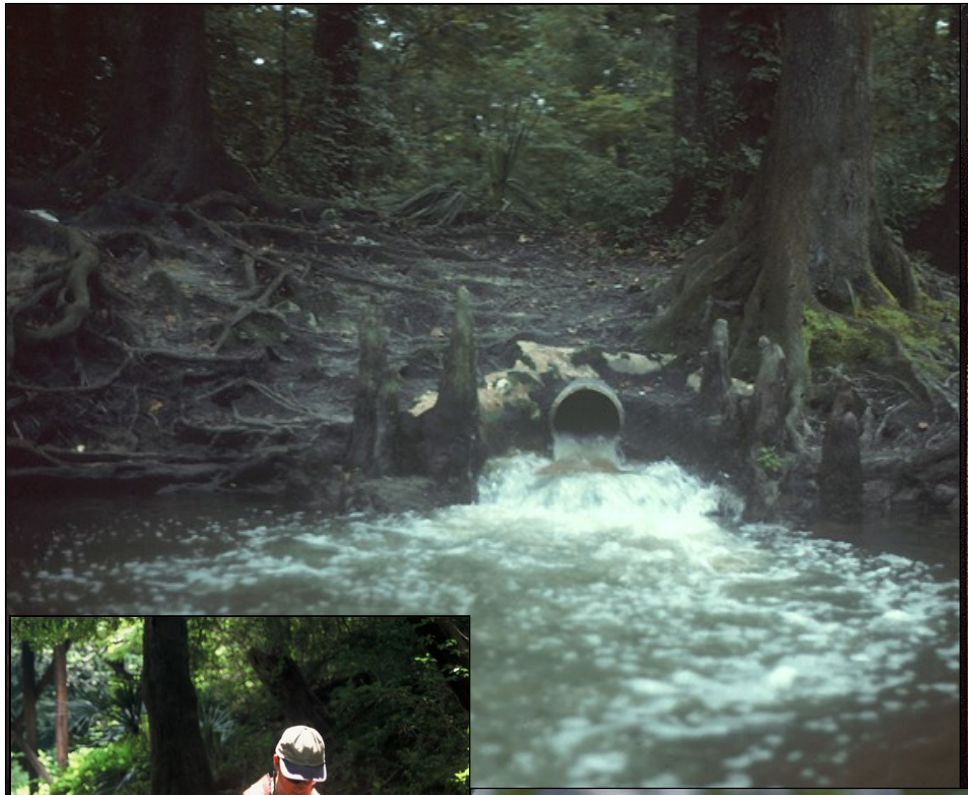
Figure 2–6. Atrazine concentrations in the White River (White River Basin) rose rapidly and peaked during the first runoff events that occurred soon after spring applications of atrazine in May and June. High runoff and streamflow either before or substantially after the high-use period typically did not result in similarly high concentrations (Carter and others, 1995).

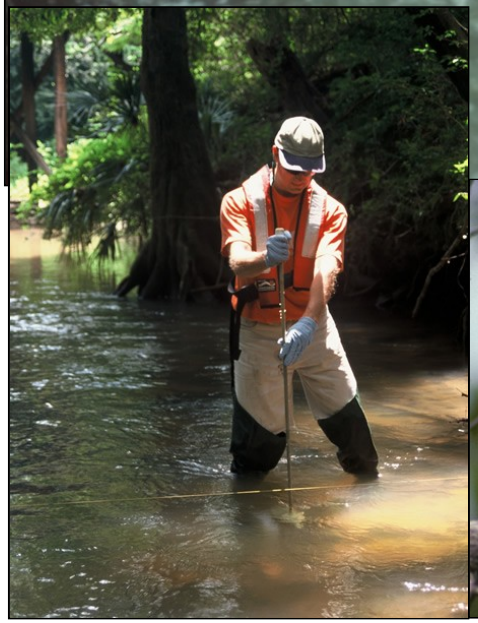


Deadzones are areas of waterbodies where the concentration of red algae and similar organisms have increased due to the presence of nitrates and phosphates from fertilizer and pesticide runoff. Due to the depletion of oxygen in these areas, marine life such as fish and mollusks die out or migrate leaving the area barren. The photo above (left) shows the Mississippi river dead zone while the satellite image on the right is the Gulf of Mexico dead zone spanning the coastlines of several states.

Pesticide Pollution Through Water

Most pesticides do not breakdown in a short time. They stay on the plant or end up in soil. During rains, these residual pesticide wash into rivers and ponds like the photo (below left). The first casualty of these remnant pesticides are water life such as fish (below), water based micro organisms such as algae, insects and plants. Being at the bottom of the food chain, these are very important to other life forms. Other Insects, animals and birds consume these and thus the poison spreads along the food chain. Fish eating birds such as ospreys (below middle) and bald eagles (below right) are among the first bigger species to be affected by pesticide presence in water. A regular study of chemicals in water sources (below far left)is the first step at eliminating this poisoning.





Effect of Pesticides on Environment

Central to the effect of pesticides on environment is the concept of biodiversity. Biodiversity is the variation of life forms within a given ecosystem, biome or for the entire Earth. Biodiversity is often used as a measure of the health of biological systems. The more the number of organisms living in balance in an environment, the healthier that environment is. This is important to humans too as we depend on nature to provide us food, water and everything else. The application of pesticides has a significant effect on biodiversity.

A diverse environment sustains many types of life-forms all of which are interdependent. These may range from microbes to insects such as ants, beetles and wasps to birds to large animals such as the elephant and predators such as foxes, wolves, wild dogs, lions, tigers and bears. Such a system has the ability to maintain its balance so that no one species becomes dominant. What we consider to be a pest may also be beneficial to us by consuming and controlling other pests. Or they may be sustaining a species that feeds on that and other similar pests. Eliminating even one of them can cause significant changes and may result in many others also becoming extinct in that environment.

Pesticides & Environment

Most pesticides also do not distinguish between pests and other similar incidental life-forms. It kills them all. Many of these insects, animals and birds feed on what humans look upon as pests. Also, by consuming pests killed by use of pesticides, they ingest the same poisonous chemicals causing them to suffer. This is ironic as these species are often helpful to humans by consuming and limiting the pests. **It is estimated that for every target animal poisoned, 100-300 non-target animals die**.

At a lower level, pesticides kill soil microbes and other organisms that take part in nitrogen fixing and other important natural cycles. These affect the ability of soil to regenerate itself and remain viable for plant and animal life.

Insects, soil and water-based life forms are often the first non-targeted casualties of pesticide usage. Frogs and fish have permeable skins that absorbs any impurities in surrounding water including pesticides. On land, insects such as bees and butterflies suffer the same fate as they consume pesticide-laden plants and flowers. At a second level, birds such as owls, pelicans and many raptors and carrion eaters (eagles, vultures) which eat either the poisoned fish or any pest will ingest the same poison.

Environment devastated by pesticides may take years to recover. In some cases, it may never recover at all!

Pesticides & Environment – Examples

Roundup Herbicide Kills More Than Weeds: Frog Species are Rapidly Dying Off

DEBORAH K. RICH / San Francisco Chronicle 23jul2005

[In an experiment] Relyea [assistant professor of aquatic ecology, toxicology, evolution and behavior at the University of Pittsburgh] found that the [common] insecticides reduced the diversity and number of insects. Interestingly, he found that very low doses of the insecticides increased the survival of tadpoles, probably because of the high mortality of the dragonflies, beetles and hemipterans, all tadpole predators. Perhaps most surprisingly, Relyea discovered that Roundup, designed to kill plants, exterminated two frog species, and nearly exterminated a third, reducing tadpole "richness" by 70 percent. Many of the deaths occurred in the first 24 hours after the addition of the Roundup.

Relyea found the same results using Roundup in subsequent tests. "Collectively, the available data indicate that, contrary to conventional wisdom, current application rates of Roundup can be highly lethal to many species of amphibians," writes Relyea in his paper "The Impact of Insecticides and Herbicides on the Biodiversity and Productivity of Aquatic Communities." The federal National Science Foundation funded Relyea's research.

http://www.mindfully.org/Pesticide/2005/Roundup-Kills-Amphibians23j
htm

King Cotton, Meet Rachel Carson

By SAM HOWE VERHOVEK

NY Times: Published: January 28, 1996

The idea was to get rid of the historical nemesis of King Cotton: the boll weevil. But angry cotton farmers in the Rio Grande Valley of Texas forged an unusual anti-government rebellion last week by saying no.

The eradication program, based on intensive aerial spraying with the insecticide malathion, is intended to vanquish the pest in this country by the turn of the century, and has already all but killed it off in much of the Southeast. But in South Texas, many farmers have found unwelcome side effects.

They blame the spraying for killing a lot of spiders, wasps and other insects they consider beneficial, as well as the weevil; this, they say, spurred an outbreak of another cotton-destroying pest, the beet armyworm, that caused one of their worst crop harvests this century.

"This thing isn't a boll-weevil eradication program," said one leader of the [insecticide] recall drive. "It's a cotton-farmer eradication program." SAM HOWE VERHOVEK

Pesticides Spell Doom for bird life in Wayanad

By R Madhavan Nair/(Appeared in THE HINDU, dated 01 April 2003)

Many bird species that once livened up Wayanad's landscape with their brightly coloured presence and tuneful cries are headed for extinction. … the threat to birds seems to have risen to 'an alarming level-due to indiscriminate use of pesticides, habitat destruction, habitat fragmentation and high levels of deforestation.

The invasion of banana and arecanut into paddy fields and `the shift in agriculture practices torn subsistence cropping to cash cropping and intensive application of chemical fertilizers and pesticides have caused irreparable damage to Wayanad's fragile eco-system and has caused unfavourable living conditions for birds.

Pesticides disrupt farmland bird food chains

December 17, 2001 - Preliminary results are emerging from important new work on the indirect effects of agricultural pesticides on farmland birds in Britain. At the British Ecological Society`s Winter Meeting, at the University of Warwick on 18–20 December 2001, Tony Morris of the Royal Society for the Protection of Birds (RSPB) will present early evidence from a DEFRA funded project aimed at understanding the role of indirect effects from pesticides in the declining populations of a number of farmland bird species. The results of the work, which was instigated by DEFRA`s Pesticide Safety Directorate, will be important in ensuring that indirect effects are properly considered before agricultural pesticides are approved.

Morris says: "Results from the RSPB research indicate that pesticide, especially insecticide, spraying in spring and summer reduces the abundance of key insects, which are an important part of farmland birds` diets.“

http://www.brightsurf
.com/news/headlines/16427/Pesticides_disrupt_farmland_bird_food_chains.html

Immunity to Pesticides

A very important issue is the evolving immunity of pests to pesticides. Evolution is a fundamental natural phenomenon that occurs all the time. Natural selection and other laws of evolution help species survive changes in their environment. Constant application of pesticides falls in the category of changes in environment. Over time pests, targeted by these pesticides, evolve to be able to survive their presence in their environment. When this happens, the pesticide becomes ineffective. A different (and usually stronger) variety of pesticide is needed to be as effective. The rate at which immunity develops is dependent on the amount of exposure to the pesticide – the higher the exposure, the faster immunity develops.

Usually pests are more aggressive and the first to evolve to adopt to newer environments. Other passive species are not as quick to adopt and continue to be affected by the pesticides well after it has become ineffective to the pests. Thus the pesticides not only become ineffective, but they also continue to harm the environment.

Farmers respond to this situation by applying increasing amounts of the same pesticide, thereby compounding the problem and depleting the soil. The cost of these pesticides being very high, an overuse of these turns ruinous for farmers over time.

The slow poisoning of Punjab

Damaged soil, ill-effects from pesticides, and falling water tables are the legacy of practices that were once thought great for the state. Ramesh Menon reports.

http://www.indiatogether.org/2004/feb/hlt-poison.htm

All was fine till the cotton crop was introduced. The first few years were good and brought in good returns. But when the American bollworm attack came, the crop got destroyed. Panic stricken, the farmers guided by pesticide dealers, started pumping in huge amounts of pesticide. Initally, the pests died, but later on, year after year, the pest started developing immunity to pesticide sprays and continued to attack the cotton crop and destroy it. The pests developed immunity fast as pesticide was often adulterated. The body mechanism of the pest fought against the excessive spraying.

Says Lal Singh, a cotton farmer in Bhatinda: “Before 1990, we had no problems. We used to earn well and so eat well and lived well. But after the pests came, we saw hell. We had to spray throughout the year and sometimes as many as 35 times. As the pesticide was very expensive, we had to take loans.”

This corn fields in Vermont was devastated by the overuse of fertilizers and pesticides, which left it unable to retain nutrients or moisture.

Carina Sorensen / The McGill Daily

http://www.mcgilld

Pesticides and GM crops

Genetic modification (GM) is a development that has gained importance in recent times. The ability to identify specific gene sequences and change them provide certain advantages in controlling the behavior of species to our advantage.

One such application of GM is in developing plants or crops immune to herbicides that would otherwise kill a natural occurring specimen. This makes it possible to apply very large quantities of that chemical as a pesticide causing other species around that plant to die. Such plants fall under the category of genetically modified organisms.

While this appears a sound development on the surface, there are several hidden dangers in this approach. Of relevance to us here is the danger of overuse of the herbicide. As we have seen, this eventually leads to them not only becoming ineffective, but also poisons the environment and altering it for the worse. An overuse of these GM plants with the gene sequences can easily transfer to surrounding weeds making the pesticide ineffective. Furthermore, the newly resistant pests and now immune to naturally occurring pesticides and microbial predators making them "super" pests! Thus farmers who rely on these naturally occurring pests will suffer.

Zero-till farmers air Roundup Ready concerns

By Ian Bell, Brandon bureau [shortened]

Western Producer, Friday Dec 7

http://www.producer.com/articles/20011206/news/20011206news08.html

In Chris Dzisiak's opinion, one year of gain from growing a herbicide-tolerant canola translates into three years of pain.

In 2000, volunteer canola appeared in the 156 acre field where Roundup Ready canola had been planted the year before. The field was planted to wheat in 2000. […] he said his problems with the volunteer canola became more acute this year when he planted the same field to flax. A preseed burnoff failed to control the [remaining] herbicide-tolerant [canola] plants. **Dzisiak killed the volunteer canola [with high dosage of herbicides], but his flax crop suffered because of the high rate of herbicide, he told a gathering of minimum and zero till farmers in Brandon last week. The stunted flax grew slowly over the next two weeks, allowing wild oats and volunteer wheat to flourish. The result, according to Dzisiak, was a yield loss of three bushels an acre in his flax crop.**

He estimates he lost $4,500 this year because of the yield loss, the extra herbicide costs to control the volunteer canola, and the excess dockage in his flax due to the wheat volunteers and wild oats. He expects problems with the herbicide-tolerant canola again

GM crops need more pesticide

A new study has revealed that pesticide use has increased by a massive 73 million pounds (33,112 metric tonnes) since US farmers started to grow GM crops commercially in 1996.

These crops are genetically modified to be resistant to a particular pesticide, allowing it to be used indiscriminately to kill pests. But many farmers then have to spray greater quantities of herbicide on their GM crops, as weed species adapt to GM and become harder to control. In some cases, the weeds are even developing a genetic resistance to the herbicide.

http://www.greenpeace.org.uk/gm/gm-crops-need-more-pesticide

Effects of Pesticides on Farmers

Pesticides are, by design, poisonous to at least some organisms. They attack mechanisms by which organisms live. Thus, it is no surprise that exposure to pesticides is not good for humans.

All pesticides affect humans to some extent. This extent is what differentiates pesticides from one another. Some may have negligible effects while others a large impact. In the US and elsewhere, pesticides are thus classified according to its toxicity and attack mechanism.

Effects of pesticides on farmers may range from short-lived to chronic, minor to serious and sometimes fatal ailments. The most common reason for this is lack of information about the pesticide or unavailability of it to the farmer. In many cases, farmers do not practice safe application methods leading to skin contact, inhalation and even ingestion. Overuse of pesticides compounds this issue as farmers are exposed to several times the safe limits.

Acute pesticide poisoning among cut-flower farmers

http://www.thefreelibrary.com/Acute+pesticide+poisoning+among+cut-flower+f

The study reported here was conducted among cut-flower farmers in La Trinidad {Philippines]. This municipality grows cut flowers such as roses, chrysanthemums, angel's breath, and anthurium, accounting for a 50-billion-peso industry. The heavy use of pesticides has, however, posed a risk to the health of the farmers (Lu, 2005). The first and second phases of the study showed that 19 percent of respondents reported an illness associated with pesticides, and 32 percent were symptomatic. The illness of the farmers was associated with certain risk factors, such as farm use of pesticides for the past 12 months, exposure to pesticides during application, and inhalation of pesticide vapors and mists (p = .05). Other risk factors included re-entering recently sprayed farms, wiping sweat off the face with a contaminated piece of fabric, and spills on bodies during application of pesticides (p = .05). Symptoms included eye pain, dizziness, and respiratory problems. (Boiko et al., 2005).

Pesticides in children/Environmental Science & Technology

August 23, 2006: When researchers from the Wake Forest University School of Medicine studied pesticide levels in immigrant farmworkers, they were surprised to find very high concentrations in their children. The scientists are now calling for better education for farmworkers to protect their children from exposure (Am. J. Ind. Med. 2006; doi 10.1002/ajim.20354).

http://pubs.acs.org/subscribe/journals/esthag-

Pesticide Poisoning in a Farmer: The case of Jerry Vann

A Farmer's Life Dream Ends in Disaster (in his own words)

The following is taken from "Pesticides and You", Fall 1997.

Jerry Vann: "I am a 58 year old farmer who is dying due to the chemicals used to grow cheaper food for our tables".

Mr. Vann farmed about 3000 acres in the state of Missouri, USA growing cotton, wheat, milo and other crops from the early 1960s. In the 1970s, owing to a lack of farm help, he along with many farmers took to mechanized chemical farming. This helped him farm large tracts with far less labor.

To help such farmers, chemical companies devised several pesticides and fertilizers. In the short run, these were very helpful to farmers. While the effects of these on humans were not well studied, companies and the government agency (EPA) both offered several general precautionary advice to farmers handling these chemicals. These advice, though sound, were always not practical and could not be followed all the time and thus there were some incidental contacts with the chemicals from time to time.

"In about 1992, a new chemical came on the market that would kill the most feared weed on the farm, the Morning Glory. This new chemical was used with another chemical under the cotton seed. We were told it would keep the herbicide from killing the cotton."

"The chemical that you out under the cotton was an organophosphate, which was a very dangerous chemical. After studying this new technology, I decided to use it in liquid form. We fixed our tractor and planter to do this. Because it is so windy here in the spring, I didn't want to use the powder. The liquid really worked good and was really accurate with the ration we wanted to put out."

"When planting cotton, it is very important to plant the right depth. Not thinking, I was digging in the ground behind the planter to make sure I was planting the right depth, I was digging in killer chemicals."

Shortly after that, Mr. Vann started experiencing tiredness and burning in his feet. Local doctors were unable to find out the exact cause with certainty. Finally, a specialist diagnosed his ailment as peripheral neuropathy – an illness where the nerves in his extremities die – and there was not cure for it.

Mr. Vann was unable to farm anymore and the bank took possession of his farm. He could not even be anywhere near a place where pesticides were being used. He moved out and was last heard of taking seeking a cheaper cure to his ailment.

Many farmers do not use protective equipment and come into contact with pesticides. Usually temporary farm hands such as those employed during planting or harvesting seasons are most affected. In the photo above, lettuce pickers come in direct contact with the pesticide laden plant and soil. They also breath in remnant pesticides in the air. All these lead to ailments.

Alternatives to Pesticides

Mr. Vann's case is not an isolated incident. In many cases, farmers and farming communities exposed to pesticides have come down with serious and chronic ailments. In many communities, pesticide spraying season is now considered a dangerous time to be outside! Some have even advised closures of schools that function near the farms!

Incidents such as Jerry Vann's and others have prompted serious concern among farmers around the world. Many farmers have now switched to Integrated Pest Management (IPM) methods or organic farming that minimizes or altogether avoids the use of these toxic chemicals in their farmlands.

Integrated Pest Management (IPM) is an effective and environmentally sensitive approach to pest management that relies on a combination of common-sense practices. IPM programs use current, comprehensive information on the life cycles of pests and their interaction with the environment. This information, in combination with available pest control methods, is used to manage pest damage by the most economical means, and with the least possible hazard to people, property, and the environment.

Organic farming goes even further, with no chemical inputs to the farm. All fertilizers and pesticides have a natural or organic basis.

Breaking News: Pesticide Contamination in Lindsay Residents' Bodies

May 16th, 2007: http://www.pesticidereform.org/article.php?id=297

Tired of seeing their children become ill during times of peak pesticide spraying, a group of concerned residents of Lindsay, Tulare County tested the air they breathe and their own bodies for the presence of the commonly used, highly toxic pesticide chlorpyrifos.

Over 91% of the people tested had above average levels of breakdown products of the pesticide chlorpyrifos in their urine, and most of the women had amounts above the level calculated from U.S. Environmental Protection Agency data to be safe for pregnant and nursing women.

IS INTEGRATED PEST MANAGEMENT (IPM) PROFITABLE?

Over the past four years[1990-93], 35 growers increased their profits by $191 per acre on 1,867 acres of sweet corn by reducing their culls from 14% pre-program to 3% after their IPM training. That's a total savings of $357,000 or $10,200 per grower, and means that the average grower (53+ acres) could save an additional $10,200 per year if he continued to utilize IPM after his initial training.

Savings from reduced pesticide use, reduced machine hours, and reduced labor from spraying and culling more than offset the costs of scouting and trapping equipment.

http://www.hort.uconn.edu/ipm/veg/htms/ipmprofit.htm

"Even a moderately fertile area like that of Chengalpattu (Tamilnadu) our paddy production in a substantial area of its lands around 1760-70 amounted to some 5-6 tons per hectare, which equals the production of paddy per hectare in present day Japan - the current world high." – *Indian historian Dharampal on the effectiveness of traditional agriculture methods.*

The Bhopal Gas Tragedy: Pesticides in our midst

The worst industrial disaster in the history of the world is related to pesticide production. This occurred in Bhopal, India on the early hours of Dec. 3, 1984.

In this incident, Methyl Isocyanide (MIC) – an ingredient in the production of the insecticide Carbaryl – produced and stored in the Union Carbide plant, escaped into the atmosphere killing more than 3,000 people within a few hours. Several thousands have developed serious ailments over the years stemming from exposure to the chemical just that one night. The insecticide, Carbyl, itself is a highly toxic chemical and carcinogen (cancer causing agent) to humans and many insects including several beneficial ones such as honey bees.

The tragedy occurred due to lack of adequate safeguards in the storing the chemical and lack of adequate warning to the public. It highlights, among others, the need for proper protection and education to the public on the presence and use of such toxic chemicals in their midst.

(Top) Survivors of the tragedy lineup outside the factory awaiting treatment. Pesticides such as Lindane (middle) and Sevin (bottom) are still being stored in unsafe manner in the now abandoned the factory. Photo source: Maude Dorr, www.bhopal.org

Pesticides and Consumers

This is of importance to all of us, in that we are all consumers at some level. Many of the foods we eat are grown using synthetic fertilizers and chemicals.

The primary concern to consumers is the presence of pesticides in the food. Pesticide residue occur in food if the sprayed crops have not been cleaned fully after harvesting. Or if systemic pesticides have been used, they may be present in the harvested crop. While some of these may not be harmful to consumers especially in small quantities, it is important to know what we are eating.

Government agencies normally prescribe safe limits for common pesticides and check for them against the limits. This method has not proven effective several times. There are many reasons:

- The agencies may not have enough resources to check all the food articles. Usually only a small sample is checked and even these are not rigorously scrutinized. Often, the agency relies on data from the grower.
- The limits are prescribed based on past studies. For many newer pesticides, independent studies on long-term effects are not available. Agencies also rely on studies conducted by the manufacturers which may be inadequate or even biased.
- As pests develop immunity, newer stronger variety of pesticides are needed. Agencies often have to balance the bad side effects of the pesticides with the good ones.
- Public policies are ultimately shaped by public opinion. If the public (consumer) is not aware of the side effects of the pesticides, framing a balanced policy is not possible. In many cases the public is unaware of the effects of pesticides and have the chance to listen to only one side of the story.

EPA restricts 2 pesticides, but denies any food safety threat

http://www.cnn.com/NATURE/9908/02/pesticide.risk.02/

"When the government announces these chemicals are unsafe on food they're ... announcing, in effect, that the farm groups and chemical companies who have said there is no problem were wrong," Ken Cook of the Environmental Working Group told CNN.

But Allan Jennings, the director of the Agriculture Department's Office of Pest Management Policy, insists this year's crop of apples and produce that have been sprayed with the chemicals are safe.

Farm groups say no sound scientific basis exists for restricting the two pesticides. They fear the public will react by shunning this year's crops.

"(The EPA is) simply acting on a political deadline and for a political reason rather than a reason based on sound science," Sharp told CNN.

How Have Pesticides Been Regulated in the Past?

http://www.childenvironment.org/factsheets/pesticides_in_food.htm

From 1958 to 1996, the Environmental Protection Agency (EPA) regulated pesticide use according to the Delaney Clause of the Food, Drug and Cosmetic Act. This clause prohibited carcinogenic pesticide residues in food. But, by the late 1980s, several factors prompted the reevaluation of how to estimate and manage pesticide risks. In 1987, a National Academy of Sciences (NAS) report revealed that the EPA consistently neglected to enforce the Delaney Clause.1 At the same time, concern arose over the tolerances established by the EPA. Tolerances-the maximum quantities of pesticide residues allowable on food-were determined based on average exposure of the entire population. They therefore did not account for variability in exposure patterns, nor health risks related to geography, ethnicity, and age.

Pesticides in Food

Food Product	Total Different Pesticides Found	Total # of Pesticides in 37 Samples	Average # of Pesticides Per Sample	Average Parts Per Billion Per 100gm Serving (3.5 oz.)
Apple	27	193	5.2	22,190
Butter	17	218	5.9	26,170
Carrots	12	64	1.7	2,230
Celery	22	194	5.2	8,030
Collard greens	39	211	5.7	32,030
Cucumber	33	191	5.2	6,950
Egg - Soft boiled	9	20	0.5	200
Grapes	32	152	4.1	20,590
Green peppers	28	199	5.4	31,330
Hamburger	22	216	5.8	1,820
Lettuce	20	97	2.9	3,920
Raisins	21	76	2.1	2,680
Spinach - boiled	36	245	6.6	36,480
Strawberries	29	204	5.5	84,950

Source: Pesticides In Common Foods - FDA Study

http://www.cfsan.fda.gov/~acrobat/tds1byfd.pdf

Fruits are some of the foods containing most pesticide residue.

http://www.guardian

Pesticides in Food

http://www.nofany.org/hottopics/pesticidesinfood.html

An analysis made by the Environmental Working Group of more than 110,000 government-tested food samples and detailed government data on children's food consumption found that multiple pesticides known or suspected to cause brain and nervous system damage, cancer, or hormone interference are common in foods many children consume.

• More than a quarter of a million U.S. children aged 1–5 ingest a combination of 20 different pesticides every day. More than 1 million preschoolers eat at least 15 pesticides on a given day. Overall, 20 million children aged 5 and under eat an average of 8 pesticides every day.

• Some 610,000 children aged 1–5 consume a dose of neurotoxic organophosphate insecticides that the government deems unsafe. More than half of these unsafe exposures are from one pesticide—methyl parathion.

• Preschoolers' eating habits are even more dramatically different from those of adults than previous data indicated. When weight is taken into account, kids aged 1–5 consume 30 times more apple juice, 21 times more grape juice, and 7 times more orange juice than the average person in the population.

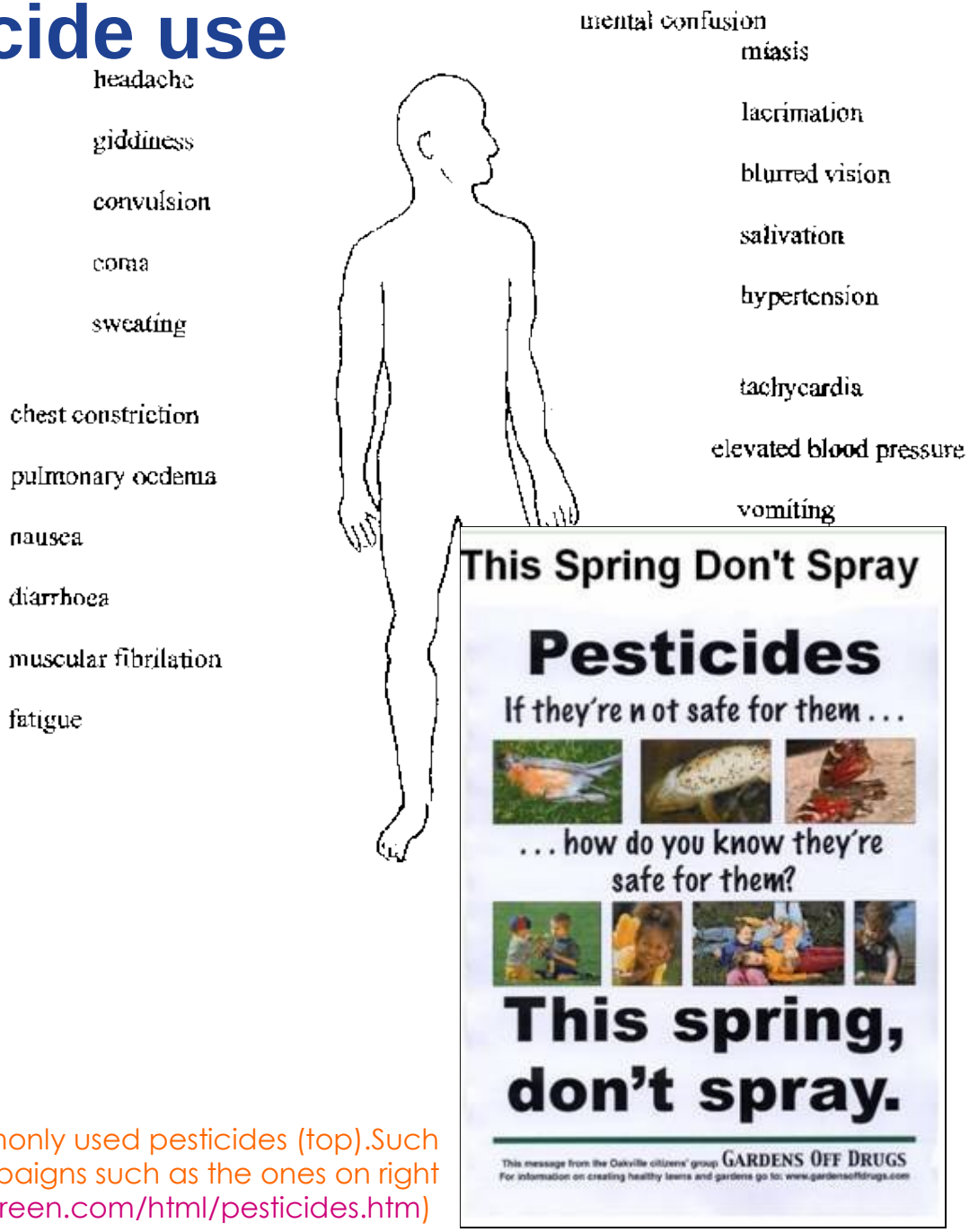
• Ten years after the Alar scare, apples are still loaded with pesticides. The average apple has residues of four pesticides after it is washed and cored. Some have residues of as many as ten. More than half of the children exposed to an unsafe dose of organophosphate insecticides get it from apples, apple sauce, or apple juice.

Learn more on pesticide use

Clearly, the use of pesticides requires a careful long-term study of both the benefits and ill-effects. As we learn more about pesticides and their effects on the environment, users and consumers, it is apparent that at the very least, their use needs to be limited. Such a limit is also useful in maintaining their effectiveness to the target pests.

To complement this, a better understanding of how nature works and maintains a balance between different species is needed. Such an understanding also helps us preserve biodiversity upon which all species including human societies depend for survival.

As farmers and the public learn more about this, newer and more nature-friendly techniques such as organic farming and IPM have evolved. A basic understanding of pesticides and other chemicals used in our food production is also necessary for the general public since they are the ultimate arbiters of public policy.



List of symptoms caused by poisoning with commonly used pesticides (top).Such information has led to several awareness campaigns such as the ones on right (source: http://www.oakvillegreen.com/html/pesticides.htm)

Useful information sources

Pesticide Classification:
http://www.epa.gov/pesticides/about/types.htm

Integrated Pest Management: http://www.epa.gov
/pesticides/factsheets/ipm.htm

Pesticides and farmers: http://www.epa.gov
/pesticides/about/ag_faq.htm

PAN intro to pesticide: http://docs.pesticideinfo
.org/Docs/ref_general1.html

Residual pesticide levels:
http://www.sustainablefood.com/guide/residues.html

Pesticide side effects:
http://pmep.cce.cornell.edu/facts-slides-self/facts/ger