1. Introduction

Toxicology "the science of poisons" may be regarded as the oldest science in the world. Man has shown an interest in poisons and poisoning since the Egyptian civilization well over 5000 years ago. Menes, the first of the Pharaohs, is reported to have cultivated and studied poisons and medicinal plants and to have made a collection of all types of poison.

However, in the past 60 years, toxicology has expanded from the study of the negative effects of chemicals to the evaluation of their safety. Environmental toxicology is a rapidly developing field concerned with the harmful effects of chemical, physical and biological agents on living organisms, including fish, plants, animals and humans**.** The environmental toxicologist draws on a variety of scientific disciplines to describe, measure, explain and predict the severity and frequency of adverse effects on living organisms due to environmental pollutant exposure. Environmental toxicology is truly an interdisciplinary science.

Today, progress in science and technology has led to the creation of a large number of new chemicals. As a result, our modern society is dependent on chemicals, which are used in the form of pharmaceutical products, food, food additives, and household items, and also in agriculture and industry. It is estimated that:

in 1977: 4,000,000 chemicals were available
by 1985 the number increased to 7,000,000
in 1994 it reached 13,000,000 chemicals.

Currently, approximately 70,000 chemicals are in common use with 1,000 new chemicals launched into the market each year.

In 2002, the National Cancer Institute, USA, reported that from approximately 70,000 chemicals in common use, only 4000-8000 have been tested for carcinogenicity. Between 800-900 compounds are known to be carcinogenic, and between 1600-2800 compounds are possibly carcinogenic. With the increase in the production and use of chemical compounds, man has become more exposed to the deleterious effects of some of them either directly or indirectly through the pollution of our natural environment**.**

For environmental pollution, both regulatory agencies and the general public are more concerned with the long-term effects after receiving small amounts of chemicals through food ingested, through the air we breathe and through other contacts, since it will take a period of even 10-20-30 years to see the end results.

Every year hundreds of millions of tons of toxic pollutants are produced and released into the environment. Most air pollution comes from one human activity: burning fossil fuels—natural gas, coal, and oil—to power industrial processes and motor vehicles. Among the harmful chemical compounds this burning puts into the atmosphere are carbon dioxide, carbon monoxide, nitrogen oxides, sulfur dioxide, and tiny solid particles—including lead from gasoline additives—called particulates.

Air pollution, addition of harmful substances to the atmosphere, has brought about damage to the environment, human health, and quality of life. Air pollution makes people sick. It causes breathing problems and promotes cancer. Air pollutants also harm plants, animals, and the ecosystems in which they live.

Toxic water pollutants enter the food chain, water system and eventually our bodies. Industrial pollutants that run into streams, rivers, or lakes can have serious effects on wildlife, plants, and humans. Sewage, industrial wastes, and agricultural chemicals such as fertilizers and pesticides are the main causes of water pollution.

Heavy metals become more concentrated as animals feed on plants and are consumed in turn by other animals. When they reach high levels in the body, heavy metals can be immediately poisonous, or can result in long-term health problems.

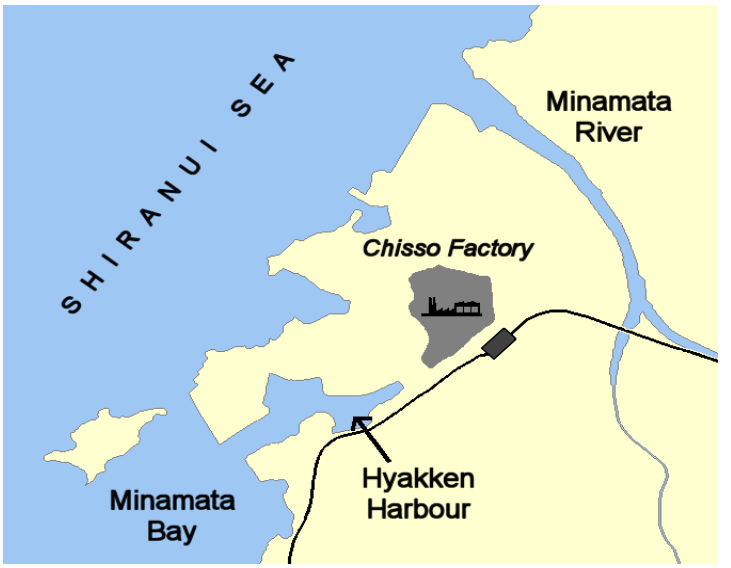
In developing nations, more than 95 percent of urban sewage is discharged untreated into rivers and bays, creating a major human health hazard.

Fish and shellfish harvested from polluted waters may be unsafe to eat. People who ingest polluted water can become ill, and, with prolonged exposure, may develop cancers or bear children with birth defects.

The Minamata Bay incidence of mercury poisoning in Japan is a classic example. Minamata disease was first discovered in Minamata city in Kumamoto prefecture, Japan in 1956. It was caused by the release of methyl mercury in the industrial wastewater from the Chisso Corporation's chemical factory. This highly toxic chemical bioaccumulated in shellfish and fish in Minamata Bay, which when eaten by the local populace resulted in mercury poisoning.

The Kumamoto University Research Group was formed on August 24, 1956. Researchers from the School of Medicine began visiting Minamata regularly and admitted patients to the university hospital for detailed examinations.

Minamata map illustrating Chisso Factory effluent route



The disease developed without any prior warning, with patients complaining of a loss of sensation and numbness in their hands and feet. They became unable to grasp small objects or fasten buttons. They could not run or walk without stumbling, their voices changed in pitch and many patients complained of difficulties seeing, hearing and swallowing. In general these symptoms deteriorated and were followed by severe convulsions, coma and eventually death.

Researchers from Kumamoto University found that the victims, often members of the same family, were clustered in fishing hamlets along the shore of Minamata Bay. The staple food of victims was invariably fish and shellfish from Minamata Bay.

The cats in the local area, who tended to eat scraps from the family table, had died with symptoms similar to those now discovered in humans. On November 4 the research group announced its initial findings: “Minamata disease is rather considered to be poisoning by a heavy metal... presumably it enters the human body mainly through fish and shellfish…”

Minamata disease, sometimes referred to as Chisso-Minamata disease, is a neurological syndrome caused by severe mercury poisoning. Symptoms include Ataxia, numbness in the hands and feet, general muscle weakness, narrowing of the field of vision and damage to hearing and speech. In extreme cases, insanity, paralysis, coma and death follow within weeks of the onset of symptoms. A congenital form of the disease can also affect fetuses in the womb. While cat, dog, pig and human deaths continued over more than 30 years.

Minamata disease patient Tomoko's hand **taken by W. Eugene Smith in 1971.**

Minamata disease, sometimes referred to as 30,000 times more methyl mercury than the normal level, was found in the dead bodies of fishermen at Minamata.

. On 21 October 1959 Chisso was ordered by the Ministry of International Trade and Industry to switch back its wastewater drainage from the Minamata River to Hyakken Harbour and to speed up the installation of wastewater treatment systems at the factory. Chisso installed a Cyclator purification system on 19 December 1959, and opened it with a special ceremony. Chisso's president Kiichi Yoshioka drank a glass of water supposedly treated through the Cyclator to demonstrate that it was safe.

In 1970, the Water Pollution Control Law was enacted, which enforced control of discharge of effluent in all water areas in Japan, in relation to toxic substances, for example, mercury and cadmium. Furthermore, conversion of the production method was advised against caustic soda plants that might discharge mercury other than Chisso and Showa Denko plants.

Because methylmercury remained a considerable concentration in bottom sediment of the related water areas even after the discharge of the methylmercury compound was stopped, in order to remove this bottom sediment, from 1974 to 1990, Kumamoto Prefecture carried out the project for dealing with about 1,500,000 cubic meters of bottom sediment of Minamata Bay that contained mercury more than the removal standard (25 ppm of total mercury) by means of dredging and landfill, and for making 58ha. landfill, at a total cost 48 billion yen (of this total, the responsible company bore 30.5 billion yen).

In 1976, Niigata Prefecture carried out dredging river bottom sediment that contained mercury more than the removal standard around the drainage outlets of Showa Denko plant by the burden of the responsible company. The governor of Kumamoto Prefecture declared the mercury levels in fish and shellfish from Minamata Bay safe for consumption on July 29, 1997.

As of March 2001, 2,265 victims had been officially recognised (1,784 of whom had died) and over 10,000 had received financial compensation from Chisso. By 2004, Chisso Corporation had paid $86 million in compensation.

2. Environmental pollutants and health effects

2.1. Environmental pollutants

Environmental pollutants are the contaminants of earth's environment that interfere with human health, the quality of life, or the natural functioning of *ecosystems* (living organisms and their physical surroundings). All types of pollution – air, water and soil pollution – have an impact on the living environment.

2.2. Health effects of environmental pollutants

(a)Routes of entry. There are three primary routes of entry into the body: ingestion, skin or eye absorption, and inhalation.

Ingestion:- This means taking a material into the body by mouth (swallowing). Ingestion of toxic materials may occur as a result of eating in a contaminated work area.

Absorption- Substances that contact the eye and the skin may be either absorbed into the body or cause local effects. For the majority of organic compounds, the contribution from skin absorption to the total exposure should **not** be neglected.

Inhalation- This means taking a material into the body by breathing it in. In the lungs, very tiny blood vessels are in constant contact with the air we breathe in. As a result, airborne contaminants can be easily absorbed through this tissue. In the occupational environment, this is generally the most important route of entry.

(b) Health Effects: Chronic vs Acute. Once a toxic substance has contacted the body it may have either **acute (*immediate*)** or **chronic (*long term*) effects.** *Example*: Spilling acid on your hand will cause ***immediate harm***, i.e. a burn to the skin. Exposure to asbestos or tobacco smoke may result in lung cancer after as much as twenty years **(*this is a long term effect*).**

Exposure: Chronic vs Acute. Exposure can be classified as chronic or acute. **In chronic exposures,** the dose is delivered at some frequency (*daily or weekly usually*) over a period of time. **In acute exposures**, the dose is delivered in a single event and absorption is rapid. Usually, a chronic exposure occurs at low concentration and acute exposure at high concentration.

Some materials may only cause harm if given acutely, not having any effect in the long term. Other materials may not exhibit an effect in the short term, but may cause problems after prolonged exposure.

2.3. Physiological classification of toxic chemicals

This classification identifies toxic chemicals on the basis of biologic action.

Irritants - refer to some sort of aggravation of whatever tissue the material comes in contact with. *e.g. ammonia, nitrogen dioxide.*

Asphyxiants - exert their effects through a depletion of oxygen to the tissues *e.g.* - **simple asphyxiants** - *carbon dioxide, nitrogen, methane ,hydrogen.*

Chemical asphyxiants - *carbon monoxide, hydrogen cyanide, hydrogen sulphide.*

Narcotics or Anaesthetics - the main toxic action is the depressant effect upon the Central Nervous System. *e.g. - many organics, chloroform, xylene.*

Systemic poisons - the main toxic action includes the production of internal damage.

e.g. Hepatotoxic agents - *toxic effects produce liver damage*.

eg. carbon tetrachloride.

e.g. Nephrotoxic agents - toxic effects produce kidney damage

eg. some halogenated hydrocarbons

Carcinogens - agents/compounds that will induce cancer in humans.

e.g. benzene, arsenic, inorganic salts of chromium, nickel, beryllium.

Mutagens - agents that affect the cells of the exposed people in such a way that it may cause cancer in the exposed individual or an undesirable mutation to occur in some later generation.

e.g. radiation, variety of chemical agents that alter the genetic message.

Teratogens - Agents or compounds that a pregnant woman takes into her body that generate defects in the fetus.

e.g. Thalidomide, possibly steroids

Sensitizers- Agents that may cause allergic or allergic-like responses to occur. After an initial exposure to a substance an individual may become sensitized to that substance. Subsequent exposures to the same substance, often at a much lower concentration than before, produce an allergic response. This response may be a skin rash (*dermatitis*) or an asthmatic-like attack, depending on the route of exposure.

e.g. cutting oils, isocyanates in polyurethane foam operations and paint spraying operations, some laboratory solvents.

3. Effects of air pollutants

3.1. Sources of air pollution

Air pollution is the introduction of chemicals, particulate matter, or biological materials that cause harm or discomfort to humans or other living organisms, or damages the natural environment into the atmosphere Sources of air pollution refer to the various locations, activities or factors which are responsible for the releasing of pollutants in the atmosphere. These sources can be classified into two major categories which are:

(a)Anthropogenic sources (human activity) mostly related to burning different kinds of fuel

"Stationary Sources" include smoke stacks of **power plants**, manufacturing facilities (factories) and waste incinerators, as well as furnaces and other types of fuel-burning heating devices

"Mobile Sources" include **motor vehicles**, marine vessels, aircraft and the effect of sound etc.

Chemicals, dust and controlled burning practices in agriculture and forestry management. Controlled or prescribed burning is a technique sometimes used in forest management, farming, prairie restoration or greenhouse gas abatement. Fire is a natural part of both forest and grassland ecology and controlled fire can be a tool for foresters. Controlled burning stimulates the germination of some desirable forest trees, thus renewing the forest.

Fumes from paint, hair spray, varnish, aerosol sprays and other solvents

Waste deposition in landfills, which generate methane. Methane is not toxic; however, it is highly flammable and may form explosive mixtures with air. Methane is also an asphyxiant and may displace oxygen in an enclosed space. Asphyxia or suffocation may result if the oxygen concentration is reduced to below 19.5% by displacement

Military, such as nuclear weapons, toxic gases, germ warfare and rocketry

(b) Natural sources

Dust from natural sources, usually large areas of land with little or no vegetation.

Methane, emitted by the digestion of food by animals, for example cattle.

Radon gas from radioactive decay within the earth's crust. Radon is a colorless, odorless, naturally occurring, radioactive noble gas that is formed from the decay of radium. It is considered to be a health hazard. Radon gas from natural sources can accumulate in buildings, especially in confined areas such as the basement and it is the second most frequent cause of lung cancer, after cigarette smoking.

Smoke and **carbon monoxide** from **wildfires.**

Volcanic activity, which produce sulfur, chlorine, and ash particulates.

3.2. Classification of air pollutants

Air pollutants can be classified as either primary or secondary. Usually, primary pollutants are substances directly emitted from a process, such as ash from a volcanic eruption, the carbon monoxide gas from a motor vehicle exhaust or sulfur dioxide released from factories.

Secondary pollutants are not emitted directly. Rather, they form in the air when primary pollutants react or interact. An important example of a secondary pollutant is ground level ozone — one of the many secondary pollutants that make up photochemical smog.

(a) Major primary pollutants produced by human activity include:

Sulfur oxides (SO_x) - especially sulfur dioxide, a chemical compound with the formula SO_2. SO_2 is produced by volcanoes and in various industrial processes. Since coal and petroleum often contain sulfur compounds, their combustion generates sulfur dioxide. Further oxidation of SO_2, usually in the presence of a catalyst such as NO_2, forms H_2SO_4, and thus acid rain. This is one of the causes for concern over the environmental impact of the use of these fuels as power sources.

Nitrogen oxides (NO_x) - especially nitrogen dioxide is emitted from high temperature combustion. Can be seen as the brown haze dome above or plume downwind of cities. Nitrogen dioxide is the chemical compound with the formula NO_2. It is one of the several nitrogen oxides. This reddish-brown toxic gas has a characteristic sharp, biting odor. NO_2 is one of the most prominent air pollutants.

Carbon monoxide - is a colourless, odourless, non-irritating but very poisonous gas. It is a product of incomplete combustion of fuel such as natural gas, coal or wood. Vehicular exhaust is a major source of carbon monoxide.

Carbon dioxide (CO_2) - a greenhouse gas emitted from combustion but is also a gas vital to living organisms. It is a natural gas in the atmosphere.

Volatile organic compounds - VOCs are an important outdoor air pollutant. In this field they are often divided into separate categories of methane (CH_4) and non-methane

(NMVOCs). Methane is an extremely efficient greenhouse gas which contributes to enhanced global warming. Other hydrocarbon VOCs are also significant greenhouse gases via their role in creating ozone and in prolonging the life of methane in the atmosphere, although the effect varies depending on local air quality. Within the NMVOCs, the aromatic compounds benzene, toluene and xylene are suspected carcinogens and may lead to leukemia through prolonged exposure. 1,3-butadiene is another dangerous compound which is often associated with industrial uses.

Particulate matter - Particulates, alternatively referred to as particulate matter (PM) or fine particles, are tiny particles of solid or liquid suspended in a gas. In contrast, aerosol refers to particles and the gas together. Sources of particulate matter can be manmade or natural. Some particulates occur naturally, originating from volcanoes, dust storms, forest and grassland fires, living vegetation, and sea spray. Human activities, such as the burning of fossil fuels in vehicles, power plants and various industrial processes also generate significant amounts of aerosols. Averaged over the globe, anthropogenic aerosols—those made by human activities—currently account for about 10 percent of the total amount of aerosols in our atmosphere. Increased levels of fine particles in the air are linked to health hazards such as heart disease, altered lung function and lung cancer.

Persistent free radicals connected to airborne fine particles could cause cardiopulmonary disease.

Toxic metals, such as lead, cadmium and copper.

Chlorofluorocarbons (CFCs) - harmful to the ozone layer emitted from products currently banned from use.

Ammonia (NH_3) - emitted from agricultural processes. Ammonia is a compound with the formula NH_3. It is normally encountered as a gas with a characteristic pungent odor. Ammonia contributes significantly to the nutritional needs of terrestrial organisms by serving as a precursor to foodstuffs and

fertilizers. Ammonia, either directly or indirectly, is also a building block for the synthesis of many pharmaceuticals. Although in wide use, ammonia is both caustic and hazardous.

Odors — such as from garbage, sewage, and industrial processes

Radioactive pollutants - produced by nuclear explosions, war explosives, and natural processes such as the radioactive decay of radon.

(b) Major secondary pollutants include:

Particulate matter formed from gaseous primary pollutants and compounds in photochemical smog. Smog is a kind of air pollution; the word "smog" is a portmanteau of smoke and fog. Classic smog results from large amounts of coal burning in an area caused by a mixture of smoke and sulfur dioxide. Modern smog does not usually come from coal but from vehicular and industrial emissions that are acted on in the atmosphere by sunlight to form secondary pollutants that also combine with the primary emissions to form photochemical smog.

Ground level ozone (O_3) formed from NO_x and VOCs. Ozone (O_3) is a key constituent of the troposphere (it is also an important constituent of certain regions of the stratosphere commonly known as the Ozone layer). Photochemical and chemical reactions involving it drive many of the chemical processes that occur in the atmosphere by day and by night. At abnormally high concentrations brought about by human activities (largely the combustion of fossil fuel), it is a pollutant, and a constituent of smog.

Peroxyacetyl nitrate (PAN) - similarly formed from NO_x and VOCs.

(c) Minor air pollutants include:

Persistent organic pollutants (POPs) are organic compounds that are resistant to environmental degradation through chemical, biological, and photolytic processes. Because of this, they have been observed to persist in the environment, to be capable of long-range transport, bioaccumulate in human and animal tissue, biomagnify in food chains, and to have potential significant impacts on human health and the environment.

3.3. How people are exposed to air toxics

People are exposed to toxic air pollutants in many ways that can pose health risks by:

(a)**Breathing contaminated air**.

(b)**Eating contaminated food products**, such as fish from contaminated waters; meat, milk, or eggs from animals that fed on contaminated plants; and fruits and vegetables grown in contaminated soil on which air toxics have been deposited.

- Drinking water contaminated by toxic air pollutants.
- Ingesting contaminated soil. Young children are especially vulnerable because they often ingest soil from their hands or from objects they place in their mouths.

-Touching (making skin contact with) contaminated soil, dust, or water (for example, during recreational use of contaminated water bodies).

Once toxic air pollutants enter the body, some persistent toxic air pollutants accumulate in body tissues. Predators typically accumulate even greater pollutant concentrations than their contaminated prey. As a result, people and other animals at the top of the food chain who eat contaminated fish or meat are exposed to concentrations that are much higher than the concentrations in the water, air, or soil.

3.4. How air pollution can hurt human health

Air pollution can affect our health in many ways with both *short-term* and *long-term* effects. Different groups of individuals are affected by air pollution in different ways. Some individuals are much more sensitive to pollutants than are others. Young children and elderly people often suffer more from the effects of air pollution. People with health problems such as asthma, heart and lung disease may also suffer more when the air is polluted. The extent to which an individual is harmed by air pollution usually depends on the total exposure to the damaging chemicals, i.e., the *duration of exposure* and the *concentration of the chemicals* must be taken into account.

Examples of short-term effects include irritation to the eyes, nose and throat, and upper respiratory infections such as bronchitis and pneumonia. Other symptoms can include headaches, nausea, and allergic reactions. Short-term air pollution can aggravate the medical conditions of individuals with asthma and emphysema.

Long-term health effects can include chronic respiratory disease, lung cancer, heart disease, and even damage to the brain, nerves, liver, or kidneys. Continual exposure to air pollution affects the lungs of growing children and may aggravate or complicate medical conditions in the elderly.

3.5 Health impact of specific air pollutants

Tobacco smoke. Tobacco smoke generates a wide range of harmful chemicals and is a major cause of ill health, as it is known to cause cancer, not only to the smoker but affecting passive smokers too. It is well-known that smoking affects the passive smoker (the person who is in the vicinity of a smoker and is not himself/herself a smoker) ranging from burning sensation in the eyes or nose, and throat irritation, to cancer, bronchitis, severe asthma, and a decrease in lung function.

Biological pollutants. These are mostly allergens that can cause asthma, hay fever, and other allergic diseases.

Volatile organic compounds. Volatile compounds can cause irritation of the eye, nose and throat. In severe cases there may be headaches, nausea, and loss of coordination. In the longer run, some of them are suspected to cause damage to the liver and other parts of the body.

Formaldehyde. Exposure causes irritation to the eyes, nose and may cause allergies in some people**.**

Mercury. The main hazard arises from inhalation of mercury vapour. The most serious effects of chronic mercury poisoning are produced on the nervous system, on behaviour and on the kidney.

Cadmium. Cadmium is used in some alloys.
Cadmium oxide fumes cause lung irritation and influenza-like symptoms. The main effects of chronic cadmium poisoning are directed against the kidneys and the lungs**.**

Lead. Prolonged exposure can cause damage to the nervous system, digestive problems, and in some cases cause cancer. It is especially hazardous to small children.

Chromium. Chromium is used for the production of alloy with nickel. It is also used for chromium plating. The skin is the organ chiefly affected by chrome**.** The nasal mucosa may become ulcerated. The cartilaginous part of the nasal septum may become perforated.

Dioxins. Dioxins are produced as a by-product of chlorine, such as: dry cleaning, combustion of gasoline, bleaching of paper, most name brand home cleaning products and air fresheners. Dioxins are hormone disrupters and one of the most potent carcinogens ever tested.

Toluene. It is found in paints, resins and glues, as a solvent for rubber Acute poisoning causes euphoria, headache and coma. Chronic poisoning may cause possibly cerebellar degeneration and dementia.

Asbestos. Asbestos fibers are so small that they can't be seen. It was once used widely as insulation. Disturbing asbestos can cause fibers to float in the air and easy to inhale and become lodged in the lungs. Over time, they can build up in the lungs, causing scarring and inflammation. This can eventually affect breathing and lead to diseases, such as: Asbestosis, (scarring of lungs that makes it hard to breathe) and Lung cancer.

Radon. A radioactive gas that can accumulate inside the house, originates from the rocks and soil under the house and its level is dominated by the outdoor air and also to some extent the other gases being emitted indoors**.** Exposure to this gas increases the risk of lung cancer.

Ozone. Exposure to this gas makes our eyes itch, burn, and water and it has also been associated with increase in respiratory disorders such as asthma. It lowers our resistance to colds and pneumonia.

Oxides of nitrogen. This gas can make children susceptible to respiratory diseases in winter.

Carbon monoxide. CO (carbon monoxide) combines with haemoglobin to lessen the amount of oxygen that enters our blood through our lungs. The binding with other haeme proteins causes changes in the function of the affected organs such as the brain and the cardiovascular system, and also the developing foetus. It can impair our concentration, slow our reflexes, and make us confused and sleepy.

Sulphur dioxide. SO_2 (sulphur dioxide) in the air is caused by the rise in combustion of fossil fuels. It can oxidize and form sulphuric acid mist. SO_2 in the air leads to diseases of the lung and other lung disorders such as wheezing and shortness of breath. Long-term effects are more difficult to ascertain as SO^2 exposure is often combined with that of SPM.

SPM (suspended particulate matter). Suspended matter consists of dust, fumes, mist and smoke. The main chemical component of SPM that is of major concern is lead, others being nickel, arsenic, and those present in diesel exhaust. These particles when breathed in, lodge in our lung tissues and cause

lung damage and respiratory problems**.** The importance of SPM as a major pollutant needs special emphasis as a) it affects more people globally than any other pollutant on a continuing basis; b) there is more monitoring data available on this than any other pollutant; and c) more epidemiological evidence has been collected on the exposure to this than to any other pollutant.

3.6. Incidences of air pollution around the world

The World Health Organization states that 2.4 million people die each year from causes directly attributable to air pollution, with 1.5 million of these deaths attributable to indoor air pollution. "Epidemiological studies suggest that more than 500,000 Americans die each year from cardiopulmonary disease linked to breathing fine particle air pollution. . ." A study by the University of Birmingham has shown a strong correlation between pneumonia related deaths and air pollution from motor vehicles. Worldwide more deaths per year are linked to air pollution than to automobile accidents. Direct causes of air pollution related deaths include aggravated asthma, bronchitis, emphysema, lung and heart diseases, and respiratory allergies**.** The US EPA estimates that a proposed set of changes in diesel engine technology (Tier 2) could result in 12,000 fewer premature mortalities, 15,000 fewer **heart attacks,** 6,000 fewer emergency room visits by children with **asthma**, and 8,900 fewer respiratory-related hospital admissions each year in the United States.

The worst short term civilian pollution crisis in India was the 1984 Bhopal Disaster. Leaked industrial vapors from the Union Carbide factory, belonging to Union Carbide, Inc., U.S.A., killed more than 2,000 people outright and injured anywhere from 150,000 to 600,000 others, some 6,000 of whom would later die from their injuries.

The United Kingdom suffered its worst air pollution event when the December 4 Great Smog of 1952 formed over London. In six days more than 4,000 died, and 8,000 more died within the following months.

An accidental leak of anthrax spores from a biological warfare laboratory in the former USSR in 1979 near Sverdlovsk is believed to have been the cause of hundreds of civilian deaths.

The worst single incident of air pollution to occur in the United States of America occurred in Donora, Pennsylvania in late October, 1948, when 20 people died and over 7,000 were injured.

3.7. How you can help reduce air pollution

The small things you do every day can help reduce air pollution and hence improve the protection of the environment as well as human health. Here are some tips on what you can do, on a day-to-day basis, to help prevent air pollution:

(a) Drive less. About half of the air pollution comes from cars and trucks. Two important ways to reduce air pollution are to drive less -- even a little less -- and to drive smart. Taking fewer trips in your car or truck helps cut air pollution. Driving less doesn't mean you have to stay home. Try combining driving with alternative modes of transportation:

- Carpool.
- Walk or ride a bicycle.
- Shop by phone or mail.
- Ride public transport.
- Telecommute**.**

(b) Choose air-friendly products. Many products you use in your home, in the yard, or at the office are made with smog-forming chemicals that escape into the air. Here are a few ways to put a lid on products that pollute*:*

- Select products that are water-based or have low amounts of volatile organic compounds (VOCs).
- Use water-based paints. Look for paints labeled "zero- VOC."
- Paint with a brush, not a sprayer.
- Store solvents in air-tight containers.
- Start your barbecue briquettes with an electric probe or use a propane or natural gas barbecue**.**

(c) Save Energy. Saving energy helps reduce air pollution. Whenever you burn fossil fuel, you pollute the air. Use less gasoline, natural gas, and electricity (power plants burn fossil fuels to generate electricity):

- Turn off the lights when you leave a room.
- Don't leave your electronic devices - TV sets, computers, DVD's - on stand-by mode. Switch them off completely and you will save about 10 % of your electricity bill.
- Replace energy hungry incandescent lights with energy-saving light bulbs
- Use a thermostat that automatically turns off the air conditioner or heater when you don't need them.
- Use a fan instead of air conditioning.
- Heat small meals in a microwave oven.
- Dry your clothes on a clothesline.

(d) Waste not. It takes energy to make and sell the products we use. Here are ways to cut energy use, reduce air pollution, and save money.

- Choose recycled products.
- Reuse paper bags.
- Shop with a reusable canvas bag instead of using plastic bags.

(e) Watch out for the small stuff. When you breathe, very small particles -- such as dust, soot, and acid droplets -- can slip past your lung's natural defense system. These particles get stuck deep in your lungs and may cause problems -- more asthma attacks, bronchitis and other lung diseases, decreased resistance to infections, and even premature death for the elderly or sick. Here are a few things you can do to reduce particulate matter pollution and protect yourself:

- Don't use your wood stove or fireplace on days with unhealthy air.
- Avoid using leaf blowers and other types of equipment that raise a lot of dust. Use a rake or broom instead.
- Drive slowly on unpaved roads.
- Avoid vigorous physical activity on days with unhealthy air.

(f) Know the inside story. Air pollution is a problem indoors and out. Most people spend at least 80 percent of their lives indoors. Here are some ways you can reduce pollution in your home, office or school:

. - Don't smoke. Send smokers outside.
- Products such as cleaning agents, paints, and glues often contain harmful chemicals. Use them outdoors or with plenty of ventilation indoors.
- Use safer products, such as baking soda instead of harsher chemical cleaners.
- Don't heat your home with a gas cooking stove.
- Have your gas appliances and heater regularly inspected and maintained.
- Clean frequently to remove dust and molds.

4. Effects of water pollutants

4.1. Sources of water pollution

Man-made situations are typically the causes of water pollution.

(a) Industry

There are three main ways that industries contribute to water pollution. They pollute by disposing of waste directly into waterways, emitting toxic gases that cause acid rain and changing the temperature of water with their disposals into waterways.

Direct disposal of waste into natural waterways causes waste to build up within the water. A pungent odor is the result. Additionally, this waste decreases the amount of oxygen in water, causing the death of aquatic animals or other organisms.

The emission of toxic fumes into the air causes acid rain. When acid rain falls, it contaminates local natural waterways including streams, rivers and lakes. This causes the death of many aquatic animals. Other animals drinking the water may become ill and die, too.

Thermal pollution occurs when water used to cool hot machinery is released into waterways and the temperature of the water is drastically increased. This temperature change may cause aquatic life to die and numbers to be reduced. Additionally, such a temperature increase decreases the amount of oxygen in water, increasing the risk of death to organisms.

(b) Agriculture

It's common for farmers to use fertilizers and other chemicals on their crops to help them grow. However, these chemicals and nutrients added to the soil can seep into the underground water supplies. Additionally, when it rains, these chemicals join the run-off water and flow into streams, rivers and lakes, thus polluting them. Even just the sediments of dirt, without any chemicals, are pollutants in that they cause the waterways to become cloudy and muddy.

(c) Homes

Households are a leading cause of water pollution by the trash they create. Even if taken to landfills, often this trash finds its way to natural waterways. Human waste, disposed of typically by sewers, pollute water. Any time a septic system is not installed properly or bursts beneath the ground, the underground water supply may be polluted. Oils and anti-freeze leaked from vehicles also cause pollution of underground water supply.

4.2. Health impacts of water pollutants

It is a generally accepted fact that the developed countries suffer from problems of chemical discharge into the water sources mainly **groundwater**, while developing countries face problems of agricultural run-off in water sources. Polluted water like **chemicals in drinking water** causes problem to health and leads to **water-borne diseases** which can be prevented by taking measures even at the household level.

(a) Groundwater and its contamination

Ground water can be contaminated through various sources and some of these are mentioned below.

Pesticides. Run-off from farms, backyards, and golf courses contain pesticides such as DDT that in turn contaminate the water. Leachate from landfill sites is another major contaminating source. Its effects on the ecosystems and health are endocrine and reproductive damage in wildlife. Groundwater is susceptible to contamination, as pesticides are mobile in the soil. It is a matter of concern as these chemicals are persistent in the soil and water.

The organophosphates and the carbonates present in pesticides affect and damage the nervous system and can cause cancer. Some of the pesticides contain carcinogens that exceed recommended levels. They contain chlorides that cause reproductive and endocrinal damage**.**

Sewage. Untreated or inadequately treated municipal sewage is a major source of groundwater and surface water pollution in the developing countries. The organic material that is discharged with municipal waste into the watercourses uses substantial oxygen for biological degradation thereby upsetting the ecological balance of rivers and lakes. Sewage also carries microbial pathogens that are the cause of the spread of disease.

Nutrients. Domestic waste water, agricultural run-off, and industrial effluents contain phosphorus and nitrogen, fertilizer run-off, manure from livestock operations, which increase the level of nutrients in water bodies and can cause eutrophication in the lakes and rivers and continue on to the coastal areas. The nitrates come mainly from the fertilizer that is added to the fields. Excessive use of fertilizers cause nitrate contamination of groundwater, with the result that nitrate levels in drinking water is far above the safety levels recommended. Good agricultural practices can help in reducing the amount of nitrates in the soil and thereby lower its content in the water.

Synthetic organics. Many of the 100 000 synthetic compounds in use today are found in the aquatic environment and accumulate in the food chain. POPs or Persistent organic pollutants, represent the most harmful element for the ecosystem and for human health, for example, industrial chemicals and agricultural pesticides. These chemicals can accumulate in fish and cause serious damage to human health. Where pesticides are used on a large-scale, groundwater gets contaminated and this leads to the chemical contamination of drinking water.

Petrochemicals. Petrochemicals contaminate the groundwater from underground petroleum storage tanks. Benzene and other petrochemicals can cause cancer even at low exposure levels.

Chlorinated solvents. Metal and plastic effluents, fabric cleaning, electronic and aircraft manufacturing are often discharged and contaminate groundwater. These are linked to reproduction disorders and to some cancers.

(b) Chemicals in drinking water

Chemicals in water can be both naturally occurring or introduced by human interference and can have serious health effects.

Fluoride. Fluoride in the water is essential for protection against dental caries and weakening of the bones, but higher levels can have an adverse effect on health. Excess fluorides can cause yellowing of the teeth and damage to the spinal cord and other crippling diseases.

Arsenic. Arsenic occurs naturally or is possibly aggravated by over powering aquifers and by phosphorus from fertilizers.

Arsenic poisoning through water can cause liver and nervous system damage, vascular diseases and also skin cancer High concentrations of arsenic in water can have an adverse effect on health. A few years back, high concentrations of this element was found in drinking water in six districts in West Bengal. A majority of people in the area was found suffering from arsenic skin lesions

Lead. Pipes, fittings, solder, and the service connections of some household plumbing systems contain lead that contaminates the drinking water source. Lead is hazardous to health as it accumulates in the body and affects the central nervous system. Children and pregnant women are most at risk.

Nitrates. Drinking water that gets contaminated with nitrates can prove fatal especially to infants that drink formula milk as it restricts the amount of oxygen that reaches the brain causing the 'blue baby' syndrome**.** It is also linked to digestive tract cancers. It causes algae to bloom resulting in eutrophication in surface water.

Other heavy metals. These contaminants come from mining waste and tailings, landfills, or hazardous waste dumps. Heavy metals cause damage to the nervous system and the kidney, and other metabolic disruptions.

(c) Recreational use of water.

Untreated sewage, industrial effluents, and agricultural waste are often discharged into the water bodies such as lakes, coastal areas and rivers endangering their use for recreational purposes such as swimming and canoeing.

4.3. Diseases caused by water pollutants

The following conditions all have potential causes of specific types of pollution. If an area has both a high occurrence of the condition and the water contains high levels of any of the chemicals or minerals associated with it then pollution or other contamination may be an underlying culprit.

Cancer

Arsenic
Barium
Lead
Manganese
Tetrachloroethylene (Dry Cleaning Solvent)
Copper
Zinc
Chlorine
Selenium
Chromium
Beryllium
Nickel
Radon
Radium

Kidney Damage & Organ Failure

Arsenic
Barium
Lead
Manganese
Tetrachloroethylene (Dry Cleaning Solvent)
Selenium
Chromium
Beryllium
Nickel

Nervous Damage

Arsenic
Barium
Lead
Manganese
Copper
Zinc
Chlorine
Selenium

Tooth Decay

Lead
Nickel
Heavy Metals

Skin Irritation

Lead
Nickel
Heavy Metals

Infection

Animal Feces

Birth Defects and Fertility Problems (Male and Female)

Pesticides

Susceptibility to H1N1 (Swine Flu)

Arsenic

4.4. How to reduce water pollution

(a) Reduce the amount of runoff that comes from your property. Reducing runoff pollution actually has two components: improving the quality of runoff and reducing the quantity..

(b) Maintain your vehicle. You can see the stains from leaky cars all over any parking lot. The chemicals--motor oil, transmission fluid, and antifreeze--almost always get washed directly into the nearest river or body of water. Have your vehicle regularly serviced and immediately repair any leaks you notice..

(c) Minimize your use of fertilizers, pesticides, and herbicides. The chemicals you spray or spread on your home, lawn, or garden don't stay there. Multiply these small amounts by thousands of households, and the effects on watersheds and aquatic life can be catastrophic. Take an integrated pest management (IPM) approach to controlling undesirable organisms, and you often won't have to use toxic chemicals at all. If you do need to use these chemicals, use only as much as you need; target their application, and don't apply them right before rainfall is expected.

(d) Properly store and dispose of chemicals. Many household chemicals and automotive products are extremely toxic both to humans and to other organisms. Protect water quality by making sure these chemicals are stored in tightly sealed containers and that they aren't exposed to extreme temperatures. Clean up spills carefully, rather than leaving them on the ground or washing them into the street.

(e) Clean up pet waste. Pet waste contains harmful bacteria and other pollutants. While a good rain storm may wash your dog or cat's poop away, promptly pick up after your pet, and seal the waste in a plastic bag before throwing it in the trash.

(f) Contain and/or compost yard waste. Yard waste that sits around can easily wash into storm drains when it rains. Even if the waste doesn't contain chemicals such as herbicides and pesticides, the introduction of large quantities of sticks, leaves, and grass clippings can overwhelm waterways with unhealthy quantities of nutrients.

(g) Pick up litter and properly dispose of trash. Litter isn't just unsightly; it can also contribute to water pollution. Just about every material--from paper to cigarette butts to aluminum cans and old appliances--contains chemicals that can leach out into the environment. Everybody knows that littering is a no-no, but it's important to understand that trash or junk sitting in your yard can be just as harmful as trash illegally dumped by the side of the road.

(h) Maintain your septic system. If you have a septic system, have it regularly inspected and maintained. Overloaded or improperly functioning septic systems can spew raw sewage directly into bodies of water or can contaminate groundwater. Most septic systems should be pumped every 2-3 years.

5. Effects of Soil Pollutants

People across the globe have been facing a number of health problems caused by the pollution of land, water and air. Talking about soil pollution, it has some of the most devastating effects on both nature and living beings. Soil pollution is characterized by the contamination of earth's surface, where humans and other creatures live. One of the major causes of soil pollution is human activities.

5. 1. Sources of soil pollution

(a) Increase in urbanization. Construction uses up forestland. More constructions means increase in demand for raw materials like timber. This leads to the exploitation and destruction of forests. There is more demand for water. Reservoirs are built leading to the loss of land.

(b) Increase in agricultural land. As the human population grew there was a greater demand for food. This caused more land allocated to agriculture. Forests were cut down for this purpose.

(c) Domestic waste. Every single day, tons and tons of domestic waste is dumped ranging from huge pieces of rubbish such as unused refrigerator to fish bones. If all these wastes are not disposed of properly, the damage they can do to the environment and humankind can be devastating. While waste collected from homes, offices and industries may be recycled or burnt in incinerators, a large amount of rubbish is neither burnt nor recycled but is left in certain areas marked as dumping grounds. We throw away more things today and there is an increase in the quantity of solid waste. This has given rise to problems as new dumping grounds have to be found.

(d) Agricultural activities. Besides domestic waste, pesticides and herbicides used by farmers to increase crop yields also pollute the land when they are washed into the soil.

(e) Industrial activities. Industrial activities also are a contributing factor to land pollution. For example, in open cast mining, huge holes are dug in the ground and these form dangerously deep mining pools. Heaps of mining waste are left behind and these waste often contain several poisonous substances that will contaminate the soil.

5.2. Harmful effects of soil pollution

Tonnes and tonnes of domestic wastes are dumped every day. Since people do not follow proper methods for the disposal of such wastes, it leaves the places looking dirty and makes them unhealthy.

Soil pollution indirectly affects the respiratory system of human beings. Breathing in polluted dust or particle can result in a number of health problems related to the respiratory system. Skin problems are often diagnosed as being due to land pollution. It is said that the improper disposal of household wastes leads to allergic reactions on the skin.

Soil pollution has been found as one of the leading causes of birth defects. Pregnant women living in unhealthy and dirty environment can incur breathing problems and a number of diseases, which may affect the health of the baby as well.

Soil pollution has serious effect on wildlife. Flora, which provides food and shelter to wildlife, are destroyed. Soil pollution often disrupts the balance of nature, causing human fatalities.

5.3. Major soil pollutants and their effect on human Health

No	Metal	Source	Effects
1	Arsenic	Occur naturally	Chronic poisoning leads to a loss of appetite and weight, diarrhea, alternating with constipation, gastro intestinal disturbances, peripheral neuritis, conjunctivitis and sometimes skin cancer
2	Cadmium	Mining, metallurgy chemical Industry	leads to chronic poisoning and affects the proximal tubules of the kidney, causing formation of kidney stones
3	Lead	Lead smelters storage battery	lead poisoning can lead to severe mental retardation or death
4	Mercury	Industrial wastes	methyl mercury compounds are much more toxic than other forms of mercury, causes neurological problems and damages renal glomeruli and tubules
5	Cyanides	Wastes from heat trearment of metals,	rapid death may follow due to exposure to cyanide as a result of inhibition of cellular respiration

5.4. Control of soil pollution

The following steps have been suggested to control soil pollution.

(a)Reducing chemical fertilizer and pesticide use. Applying bio-fertilizers and manures can reduce chemical fertilizer and pesticide use. Biological methods of pest control can also reduce the use of pesticides and thereby minimize soil pollution.

(b)Reusing of materials. Materials such as glass containers, plastic bag, paper, cloth etc. can be reused at domestic levels rather than being disposed, reducing solid waste pollution.

(c)Recycling and recovery of materials. This is a reasonable solution for reducing soil pollution. Materials such as paper, some kinds of plastics and glass can be, and are being recycled. This decreases the volume of reuse and helps in the conservation of natural resources. For example, recovery of on tonne of paper can save 17 trees.

(d)Reforesting. Control of land loss and soil erosion can be attempted through restoring forest and grass cover to check wastelands, soil erosion and flood. Crop rotation or mixed cropping can improve the fertility of the land**.**

(e)Solid waste treatment. Proper methods should be adopted for management of solid waste disposal. Industrial wastes can be treated physically, chemically and biologically until they are less hazardous.. Acid and alkaline wastes should be first neutralized; the insoluble material if biodegradable should be allowed to degrade under controlled conditions before being disposed.

(f) Storage of hazardous waste. New areas for storage of hazardous waste should be investigated such as deep well injection and more secure landfills. Burying the waste in locations situated away from residential areas is the simplest and most widely used technique of solid waste management.

6. Effect of pesticides on plant, beneficial soil microorganisms, insects, spider, fish, birds and amphibians

6.1. Types of pesticides

Pesticides are chemicals used to eliminate or control a variety of agricultural pests that can damage crops and livestock and reduce farm productivity. The most commonly applied pesticides are insecticides (to kill insects), herbicides (to kill weeds), rodenticides (to kill rodents), and fungicides (to control fungi, mold, and mildew). Of these pesticide classes, herbicides (weed killers) are the most widely used.

6.2. Pesticides harm the environment

The contribution of pesticides to stabilization of agricultural production, improvement of crop quality, and saving in labor cannot be overestimated. However, occurrence of accidental poisoning in birds and mammals including man or damage to aquatic animals as a result of use of pesticides has come to constitute an important problem.

Pesticides are found as common contaminants in soil, air, and water, and on non-target vegetation in our urban landscapes. Once there, they can harm plants and animals ranging from beneficial soil microorganisms and insects, non-target plants, fish, birds, and other wildlife. Animals may be poisoned by pesticide residues that remain on food after spraying, for example when wild animals enter sprayed fields or nearby areas shortly after spraying.

Widespread application of pesticides can eliminate food sources that certain types of animals need, causing the animals to relocate, change their diet, or starve. Poisoning from pesticides can travel up the **food chain;** for example, birds can be harmed when they eat insects and worms that have consumed pesticides. Some pesticides can **bioaccumulate**, or build up to toxic levels in the bodies of organisms that consume them over time, a phenomenon that impacts species high on the food chain especially hard.

(a) Plants

Nitrogen fixation, which is required for the growth of higher plants, is hindered by pesticides in soil. The insecticides DDT, methyl parathion, and especially pentachlorophenol have been shown to interfere with legume-rhizobium chemical signaling. Reduction of this symbiotic chemical signaling results in reduced nitrogen fixation and thus reduced crop yields. Root nodule formation in these plants saves the world economy $10 billion in synthetic nitrogen fertilizer every year.

Pesticides can kill bees and are strongly implicated in pollinator decline, the loss of species that pollinate plants, including through the mechanism of Colony Collapse Disorder, in which worker bees from a beehive or Western honey bee colony abruptly disappear. Application of pesticides to crops that are in bloom can kill honeybees, which act as pollinators. The USDA and USFWS estimate that US farmers lose at least $200 million a year from reduced crop pollination because pesticides applied to fields eliminate about a fifth of honeybee colonies in the US and harm an additional 15%.

(b) Beneficial soil microorganisms

One spoonful of healthy soil has millions of tiny organisms including fungi, bacteria, and a host of others. These microorganisms play a key role in helping plants utilize soil nutrients needed to grow and thrive. Microorganisms also help soil store water and nutrients, regulate water flow, and filter pollutants. The heavy treatment of soil with pesticides can cause populations of beneficial soil microorganisms to decline.

According to soil scientist Dr. Elaine Ingham, "If we lose both bacteria and fungi, then the soil degrades. Overuse of chemical fertilizers and pesticides have effects on the soil organisms that are similar to human overuse of antibiotics. Indiscriminate use of chemicals might work for a few years, but after awhile, there aren't enough beneficial soil organisms to hold onto the nutrients." For example, plants depend on a variety of soil microorganisms to transform atmospheric nitrogen into nitrates that plants can use. Common landscape herbicides disrupt this process: triclopyr inhibits soil bacteria that transform ammonia into nitrite; glyphosate reduces the growth and activity of both free-living nitrogen-fixing bacteria in soil and those that live in nodules on plant roots; and 2,4-D reduces nitrogen fixation by the bacteria that live on the roots of bean plants, reduces the growth and activity of nitrogen-fixing blue-green algae, and inhibits the transformation by soil bacteria of ammonia into nitrates.

Mycorrhizal fungi grow with the roots of many plants and aid in nutrient uptake. These fungi can also be damaged by herbicides in the soil. One study found that oryzalin and trifluralin both inhibited the growth of certain species of

mycorrhizal fungi. Roundup has been shown to be toxic to mycorrhizal fungi in laboratory studies, and some damaging effects were seen at concentrations lower than those found in soil following typical applications. Triclopyr was also found to be toxic to several species of mycorrhizal fungi, and oxadiazon reduced the number of mycorrhizal fungal spores.

\ **(c) Insects and spiders**

In addition to killing insect "pests," insecticides obviously have the potential to harm non-target insects such as beneficial natural predators and pollinators. Less obviously, weed-killers can also **be harmful to beneficial insects.** One study found that exposure to freshly dried Roundup (glyphosate) killed over 50 percent of three species of beneficial insects: a parasitoid wasp, a lacewing and a ladybug. Over 80 percent of a fourth species, a predatory beetle was killed. Moderate doses of the herbicide 2,4-D severely impaired honeybee brood production. The herbicide oxadiazon is also **toxic to bees,** which are pollinators. Herbicides may **hurt insects or spiders** indirectly as well, such as when they destroy the foliage that these animals need for food and shelter. For example, spider and carabid beetle populations declined when 2,4-D applications destroyed their natural habitat.

(d) Fish

When pesticides contaminate water they can be **harmful to the fish** that live there. Insecticides can be particularly toxic to fish. Chlorpyrifos, a common contaminant of urban streams, is very highly toxic to fish, and has caused fish deaths in waterways near treated fields or buildings. Diazinon, also commonly found in urban streams, is acutely toxic to many species of fish, including salmon. Herbicides can also be toxic to fish. According to the EPA, studies show that trifluralin, an active ingredient in

the weed-killer Snapshot, "is highly to very highly toxic to both cold and warmwater fish."

Oryzalin, the active ingredient of Surflan, also is 'highly toxic' to fish. The weed-killers Ronstar and Roundup are also acutely toxic to fish. The toxicity of Roundup is likely due to the high toxicity of one of the inert ingredients of the product. In addition to direct acute toxicity, some herbicides may produce sublethal effects on fish that lessen their chances for survival and threaten the population as a whole. Glyphosate or glyphosate-containing products can cause sublethal effects such as erratic swimming and labored breathing which increase the fish's chance of being eaten. 2,4-D herbicides caused physiological stress responses in sockeye salmon, and reduced the food gathering abilities of rainbow trout.

Fish and other aquatic biota may be harmed by pesticide-contaminated water. Pesticide surface runoff into rivers and streams can be highly lethal to aquatic life, sometimes killing all the fish in a particular stream.

Application of herbicides to bodies of water can cause fish kills when the dead plants rot and use up the water's oxygen, suffocating the fish. Some herbicides, such as copper sulfite, that are applied to water to kill plants are toxic to fish and other water animals at concentrations similar to those used to kill the plants. Repeated exposure to sublethal doses of some pesticides can cause physiological and behavioral changes in fish that reduce populations, such as abandonment of nests and broods, decreased immunity to disease, and increased failure to avoid predators. Application of herbicides to bodies of water can kill off plants on which fish depend for their habitat.

Pesticides can accumulate in bodies of water to levels that kill off zooplankton, the main source of food for young fish. Pesticides can kill off the insects on which some fish feed, causing the fish to travel farther in search of food and exposing them to greater risk from predators.

(e) Marine or freshwater animals

Marine or freshwater animals are endangered by pesticide contamination. 2,4- D containing products have been shown to be harmful to **newts**, **frogs, crabs, shellfis**h, and other **aquatic species.** The weed-killer trifluralin is moderately to highly toxic to **aquatic invertebrates**, and highly toxic to estuarine and marine organisms like **shrimp and mussels.** Diuron is also highly toxic to aquatic invertebrates. Since herbicides are designed to kill plants, it makes sense that herbicide contamination of water could have devastating effects on aquatic plants. In one study, oxadiazon was found to severely reduce **algae** growth. Algae is a staple organism in the food chain of aquatic ecosystems. Studies looking at the impacts of the herbicides atrazine and alachlor on algae and **diatoms** in streams showed that even at fairly low levels, the chemicals damaged cells, blocked photosynthesis, and stunted growth in varying ways.

Another important class of organisms is the cyanobacteria. Cyanobacteria live in aquatic environments as well as soil, and play a crucial role in nitrogen fixation, helping plants convert atmospheric nitrogen into nitrate compounds that the plant can use. Trifluralin was found to inhibit the growth of two common cyanobacteria at all levels of application.

(f) Birds

The insecticide diazinon is notorious for causing bird kills. Over 50 incidents involving the deaths of up to 1000 birds have been documented in every region of the U.S. Diazinon is so lethal to birds that the EPA estimates that between 15 and 80 minutes of grazing on diazinon treated turf is enough to kill a bird. Non-target birds may also be killed if they ingest poisoned grains set out as bait for pigeons and rodents. Avitrol, a commonly used pigeon bait, poses a large potential for ingestion by non target grain feeding birds. It can be lethal to small seed-eating birds.

Rodifacoum, a common rodenticide, is highly toxic to birds. It also poses a secondary poisoning hazard to birds that may feed on poisoned rodents. Herbicides can also be toxic to birds. Although trifluralin was considered "practically nontoxic to birds" in studies of acute toxicity, birds exposed multiple times to the herbicide experienced diminished reproductive success in the form of cracked eggs. Exposure of eggs to 2,4-D reduced successful hatching of chicken eggs, and caused feminization or sterility in pheasant chicks. Herbicides can also adversely effect birds by destroying their habitat. Glyphosate treatment in clear cuts caused dramatic decreases in the populations of birds that had lived there.

Bald eagles are common examples of nontarget organisms that are impacted by pesticide use. Rachel Carson's landmark book **Silent Spring** dealt with the of loss of bird species due to bioaccumulation of pesticides in their tissues. There is evidence that birds are continuing to be harmed by pesticide use.

In the farmland of Britain, populations of ten different species of birds have declined by 10 million breeding individuals between 1979 and 1999, a phenomenon thought to have resulted

from loss of plant and invertebrate species on which the birds feed. Throughout Europe, 116 species of birds are now threatened. Reductions in bird populations have been found to be associated with times and areas in which pesticides are used. In another example, some types of fungicides used in peanut farming are only slightly toxic to birds and mammals, but may kill off earthworms, which can in turn reduce populations of the birds and mammals that feed on them.

Some pesticides come in granular form, and birds and other wildlife may eat the granules, mistaking them for grains of food. A few granules of a pesticide is enough to kill a small bird.

The herbicide paraquat, when sprayed onto bird eggs, causes growth abnormalities in embryos and reduces the number of chicks that hatch successfully, but most herbicides do not directly cause much harm to birds. Herbicides can also adversely effect birds by destroying their habitat. Glyphosate treatment in clear cuts caused dramatic decreases in the populations of birds that had lived there.

(g) Amphibians

In the past several decades, decline in amphibian populations has been occurring all over the world, for unexplained reasons which are thought to be varied but of which pesticides may be a part.

Mixtures of multiple pesticides appear to have a cumulative toxic effect on frogs. Tadpoles from ponds with multiple pesticides present in the water take longer to metamorphose into frogs and are smaller when they do, decreasing their ability to catch prey and avoid predators.

A Canadian study showed that exposing tadpoles to endosulfan, an organochloride pesticide at levels that are likely to be found in habitats near fields sprayed with the chemical kills the tadpoles and causes behavioral and growth abnormalities.

The herbicide atrazine has been shown to turn male frogs into hermaphrodites, decreasing their ability to reproduce**.**

6.3. Bio magnification

Due to bioaccumulative characters, pesticide pass through the food chain web. While passing through the organisms, the concentration of pollutants gets increased. This is called bio magnification. For e.g., 0.5 ppm DDT in grass get magnified to 2 ppm in sheep. It may be magnified to 10 ppm in human beings who eat such polluted mutton.

Some organochlorine pesticides cause health hazard like impotence, cancerous tumors beyond a threshold limit of accumulation**.**

7. Effects of pesticides on human health

7.1. How pesticides enter our bodies

Pesticides can enter the human body through inhalation of aerosols, dust and vapor that contain pesticides; through oral exposure by consuming food and water; and through dermal exposure by direct contact of pesticides with skin. Pesticides are sprayed onto food, especially fruits and vegetables, they secrete into soils and groundwater which can end up in drinking water, and pesticide spray can drift and pollute the air.

7.2. Effects on human health

The effects of pesticides on human health are more harmful based on the toxicity of the chemical and the length and magnitude of exposure. Farm workers and their families experience the greatest exposure to agricultural pesticides through direct contact with the chemicals. But every human contains a percentage of pesticides found in fat samples in their body**.** Children are most susceptible and sensitive to pesticides due to their small size and underdevelopment. The chemicals can bioaccumulate in the body over time.

Exposure to pesticides can range from mild skin irritation to birth defects, tumors, genetic changes, blood and nerve disorders, endocrine disruption, and even coma or death. Pesticides can be dangerous to consumers, workers and close bystanders during manufacture, transport, or during and after use.

(a) Farmers and workers. The World Health Organization and the UN Environment Programme estimate that each year, 3

million workers in agriculture in the developing world experience severe poisoning from pesticides, about 18,000 of whom die. According to one study, as many as 25 million workers in developing countries may suffer mild pesticide poisoning yearly. There have been many studies of farmers intended to determine health effects of occupational pesticide exposure. Associations between non-Hodgkin lymphoma, leukemia, prostate cancer, multiple myeloma, and soft tissues sarcoma have been reported in studies, with less associations found for other cancers.

Organophosphate pesticides have increased in use, because they are less damaging to the environment and they are less persistent than organochlorine pesticides. These are associated with acute health problems for workers that handle the chemicals, such as abdominal pain, dizziness, headaches, nausea, vomiting, as well as skin and eye problems. Additionally, many studies have indicated that pesticide exposure is associated with long-term health problems such as respiratory problems, memory disorders, dermatologic conditions, cancer, depression, neurological deficits, miscarriages, and birth defects.

Summaries of peer-reviewed research have examined the link between pesticide exposure and neurologic outcomes and **cancer**, perhaps the two most significant things resulting in organophosphate-exposed workers.

According to researchers from the National Institutes of Health (NIH), licensed pesticide applicators who used chlorinated pesticides on more than 100 days in their lifetime were at greater risk of diabetes. One study found that associations between specific pesticides and incident diabetes ranged from a 20 percent to a 200 percent increase in risk. New cases of diabetes were reported by 3.4 percent of those in the lowest pesticide use category compared with 4.6 percent of those in the highest

category. Risks were greater when users of specific pesticides were compared with applicators who never applied that chemical.

(b) Consumer There are concerns that pesticides used to control pests on food crops are dangerous to people who consume those foods. These concerns are one reason for the organic food movement. Many food crops, including fruits and vegetables, contain pesticide residues after being washed or peeled. Chemicals that are no longer used but that are resistant to breakdown for long periods may remain in soil and water and thus in food.

A study published by the United States National Research Council in 1993 determined that for infants and children, the major source of exposure to pesticides is through diet. A study in 2006 measured the levels of organophosphorus pesticide exposure in 23 school children before and after replacing their diet with organic food (food grown without synthetic pesticides). In this study it was found that levels of organophosphorus pesticide exposure dropped dramatically and immediately when the children switched to an organic diet.

(c)The public. Exposure routes other than consuming food that contains residues, in particular pesticide drift, are potentially significant to the general public.

The Bhopal disaster occurred when a pesticide plant released 40 tons of methyl isocyanate (MIC) gas, a chemical intermediate in the synthesis of some carbamate pesticides. The disaster immediately killed nearly 3,000 people and ultimately caused at least 15,000 deaths.

In China, an estimated half million people are poisoned by pesticides each year, 500 of whom die.

Children have been found to be especially susceptible to the harmful effects of pesticides. A number of research studies have found higher instances of brain cancer, leukemia and birth defects in children with early exposure to pesticides, according to the Natural Resources Defense Council. Often used for ridding school buildings of rodents, insects, pests, etc., pesticides only work temporarily and must be re-applied. The poisons found in pesticides are not selectively harmful to just pests and in everyday school environments children (and faculty) are exposed to high levels of pesticides and cleaning materials.

Peer-reviewed studies now suggest neurotoxic effects on developing animals from organophosphate pesticides at legally tolerable levels, including fewer nerve cells, lower birth weights, and lower cognitive scores. Some scientists think that exposure to pesticides in the uterus may have negative effects on a fetus that may manifest as problems such as growth and behavioral disorders or reduced resistance to pesticide toxicity later in life.

A new study conducted by the Harvard School of Public Health in Boston, has discovered a 70% increase in the risk of developing Parkinson's disease for people exposed to even low levels of pesticides.

A 2008 study from Duke University found that the Parkinson's patients were 61 percent more likely to report direct pesticide application than were healthy relatives. Both insecticides and herbicides significantly increased the risk of Parkinson's disease.

One study found that use of pesticides may be behind the finding that the rate of birth defects such as missing or very small eyes is twice as high in rural areas as in urban areas. In the

United States, increase in birth defects is associated with conceiving in the same period of the year when agrichemicals are in elevated concentrations in surface water.

Pyrethrins, insecticides commonly used in common bug killers, can cause a potentially deadly condition if breathed in.

7.3. Diseases caused by hazardous Pesticides

(a) Asthma. Researchers found an association between asthma and use of pesticides by male farmers. Although this study involved adults, it raises concerns about children's exposures to pesticides used in the home or residues brought home on parents' clothes or equipment**.**

(b) Birth Defects. The commonly used pesticide, chlorpyrifos caused severe birth defects in four children exposed in uteri. Chlorpyrifos is used widely as an agricultural chemical, but is also the most common pesticide used indoors to kill termites, fleas, roaches and in pest control strips. A study in Minnesota found significantly higher rates of birth defects in children born to pesticide applicators and in regions of the state where chlorophenoxy herbicides and fungicides are widely used.

In California, mothers living and working in agricultural areas with high pesticide use had a higher risk for giving birth to children with limb reduction defects.

A study of pregnant women in Iowa and Michigan found that women exposed to multiple pesticides had an increased risk of giving birth to a child with cleft palate.

Researchers found higher rates of numerous birth defects in children born to Norwegian farmers exposed to pesticides, including hormone effects like hypospadia and undescended testicles.

(c) Neurological Effects. Pesticides can be potent neurotoxins. When people are exposed to neurotoxins they may feel dizzy, lightheaded, confused and may have reduced coordination and ability to think. These are the short-term effects, while long term exposure can result in reduced IQ and learning disability, associated with permanent brain damage. In spite of wide reporting of adverse symptoms, until recently, few studies could link permanent brain damage to such exposures. There is new evidence that prolonged exposure to pesticides in areas where they are used routinely may cause permanent brain damage to children who live in these areas.

Dr. Elizabeth Guillette studied the brain function of 4-5 year old children living in the Yaqui Valley area of Sonora, Mexico. Although the children share similar genetic backgrounds, they had very different patterns of exposure to pesticides. Dr. Guillette compared children living in the Valley, where large quantities of agricultural pesticides are used, to children living in the foothills where pesticides are used infrequently. In 1990, high levels of multiple pesticides were found in breast milk and cord blood of newborns from the valley. The children living in the valley, with high levels of pesticide exposure had less stamina, poorer eye-hand coordination, poorer memory and were less skilled in drawing figures.

(d) Cancer. National trends indicate that rates of childhood cancer have been increasing. Researchers at MDH concluded that these increases were also evident in Minnesota. Between 1973

and 1991, all cancers combined increased an average of 1% per year and brain cancer increased 2% per year. Specifically:

- Incidence of acute lymphocytic leukemia (ALL) rose 27.4% between 1973 and 1990, from 2.8 cases per 100,000 children to 3.5 cases per 100,000 children.
- From 1973 to 1994, incidence of childhood brain cancer increased 39.6%.
- In teens aged 15-19 between 1973 and 1995, cancer incidence rose for the following: non-Hodgkin's lymphoma 128%, testicular cancer 65%, ovarian cancer 78% and all cancers combined 24%.

(e) Hormone Disruption. While some substances cause physical birth defects, others can cause subtle hormonal effects on the developing fetus or affect a child's functional capacities. Hormone disruptors have been linked to many health problems including reproductive cancers. The drug DES, which was given to pregnant women to prevent miscarriage between 1941-1971, worked as an endocrine disrupting chemical on the developing fetus. Decades later, many of these DES exposed daughters developed cervical cancer. Twenty-four pesticides still on the market, including 2,4-D, lindane and atrazine, are known endocrine-disrupters. Aside from increases in reproductive cancers, increasing rates of the following conditions are reported. Animal studies link many of these conditions with prenatal exposure to hormone disrupting substances.

- **Endometriosis**, a disease in which the uterine tissue grows outside the uterus, and a common cause of infertility was virtually unheard of twenty years ago. It now affects 5.5 million women in the U.S. and Canada, about 10-20% of women of childbearing age.

-**Hypospadias**, a condition in which the urethra is near the base of the penis, not the end as it should be, has doubled in the last 10 years.

-**Undescended testicles**, which is linked with later risk of testicular cancer, is increasing. Researchers reported a doubling in cases between 1962 and 1982 in England and Wales.

-**Precocious puberty in girls** is now common. A study of 17,077 girls in the US found that the onset of puberty for white girls was 6-12 months earlier than expected and African-American girls experienced puberty 12-28 months earlier than whites.

-**Reduced sperm counts** are documented. Between 1938 and 1990, sperm counts dropped 1.5% each year for American men and 3.1% per year for European men. There was no decrease in men from non-western countries. Low sperm count is a marker for testicular cancer.

-**Fertility Problems** are becoming more common and now affect more than two million couples in the U.S.

8. Pesticide toxicity research in Myanmar

As paddy is the most important crop in Myanmar for local consumption as well as for export, it is needless to say that utilization of pesticides to control pest affecting paddy is very effective measure in rice production. Fish production is intimately connected with paddy cultivation. Agricultural land being under flood, raining months favor extensive feeding growing grounds for the annual brood of fish. Rice fields offer additional water areas for fry, fingering and fish production.

Famers raise fish in rice fields for food and as a source of extra income. The fish harvested from rice fields are as important as the rice harvest in some region for they give the farmers more income and the village community much needed protein, vitamin- and calcium-rich food. Fish are not only the main source of protein for human consumption but also fish in paddy fields result in an increase yield of paddy sometimes as much as 15 per cent. This was due to the fact that fish eat large quantities of worms, insect larvae, algae and weeds which are directly injurious to paddy. The excreta of fish also serve as additional fertilizer in the field. The raising of fish in rice fields has rapidly developed in Myanmar.

Incidences of fish mortality has been reported since 1967 from various parts of the country which appears to be associated with the insecticidal treatment of agricultural crops. The usual sites of damage are the margin of lake and stream adjacent to treated areas, major water diversion channels through agricultural lands. Without question, the world cannot be supplied with the food it needs without large scale irrigation. But irrigation can be a major cause of water pollution. Rice requires constantly flowing water so that insecticides treatment on paddy fields inevitably results in diversion of some toxicants from the treated areas.

Heavy rainfall following the insecticidal treatment wash down the toxicant into the nearby lakes, ponds and streams. Large scale or repeated application of insecticides may let considerable contamination to a great distance down the stream. For example, in Phaukkaung townshjp, not only 300 viss of fish in Khotegyi pond were intoxicated but also it was reported that many fish along the nearby stream were also affected (The Bota-htaung Daily, 16 October, 1967).

Therefore, the excessive use of insecticides may, unless care is taken, cause an unacceptable fish mortality with consequent reduction in protein supplies for the population. The avoidance of risk to fish is especially important in areas where inland fisheries or fish cultivation make a valuable contribution to the country diet. However, many pesticides have been extensively used without proper testing as their possible effects on fish. The long term residual toxicity of some pesticide gives particular significance as possible water pollutants.

It is necessary here to substantiate that population number of fish can surely be reduced by normal insect control practice and that the reduction of fish can effect a large area. People in Myanmar are often applying insecticides quite indiscriminately and such careless use is a serious problem. Ironically it is making the less harmful insecticide even more harmful. The use of insecticide inevitably involves a risk of damage to other creatures than the pests at which the insecticide is aimed. If the insecticides are to be used without endangering fisheries, it is essential to measure their toxicity to fish.

From these considerations, research works have been under taken by the author since 1973 to determine the tolerance of some commercially important fresh water fish to different pesticides to help the farmers to maintain the pest control within limit safe for fisheries.

8.1. Study on the Insecticidal pollution of water by using fish as bio-indicator

The author, in his research work on the **"Insecticidal pollution of water by using fish as bio-indicator**" in 1976, found that *Clarias batrachus* (Nga khu) were killed within 24 hours when placed in water containing as little as 0.0004 parts per million of Endrin 19.5% EC. Experimental results showed that Endrin 19.5% EC, DDT 25%EC, DDT 75% WDP and Lindane L-20 were highly toxic to fish at the normal application rates .They should not be applied in natural or irrigation water in which fish are an important 'Crop".

Dimecron 50% EC and Diazinon 40% EC are not toxic when used in paddy fields. They can be used practically without any special precaution.

Lindane WDP 26, DDT 5% Dust , Elsan 50% EC and Malathion 90% EC are morderately toxic to fish and will not constitute hazard to fish unless an abnormally large amount of them contaminate the waters (Kyaw Myint Oo, 1976).

Among the test fish, *Clarias batrachus* (Nga-khu) was the most sensitive fish species to most of the insecticides tested. The species intermediate in sensitivity were *Channa punctata* (Nga panaw) and *Heteropneustes fossilis* (Nga gyi). The most resistant species of fish was represented *by Anabas testudineus* (Nga byema) (Table 1).

Table 1(A). Acute toxicity of 10 different modern insecticides to four species of fish (Kyaw Myint Oo, 1976)

No	Insecticides	Fish Species	48hTLm(ppm)
1	Endrin 19.5%EC	*Cl.batrachus* *H.fossilis* *A.testudineus* *Ch.punctata*	0.0004 0.0036 0.0094 0.0074
2	DDT 25%EC	*Cl.batrachus* *H.fossilis* *A.testudineus* *Ch.punctata*	0.048 0.050 0.059 0.054
3	DDT 75% WDP	*Cl.batrachus* *H.fossilis* *A.testudineus* *Ch.punctata*	0.583 0.196 0.316 0.245
4	DDT 5% Dust	*Cl.batrachus* *H.fossilis* *A.testudineus* *Ch.punctata*	1.293 1.443 1.516 1.320
5	Lindane L-20	*Cl.batrachus* *H.fossilis* *A.testudineus* *Ch.punctata*	0.045 0.096 0.205 0.092

Table 1(B). Acute toxicity of 10 different modern insecticides to four species of fish (Kyaw Myint Oo , 1976)

No	Insecticides	Fish Species	48 h TLm(ppm)
6	Lindane WDP26	*Cl.batrachus*	0.14
		H.fossilis	0.22
		A.testudineus	0.27
		Ch.punctata	0.14
7	Malathion 90% EC	*Cl.batrachus*	4.20
		H.fossilis	34.00
		A.testudineus	3.20
		Ch.punctata	2.80
8	Elsan 50%EC	*Cl.batrachus*	0.14
		H.fossilis	3.48
		A.testudineus	0.63
		Ch.punctata	0.50
9	Diazinon 40% EC	*Cl.batrachus*	6.53
		H.fossilis	4.40
		A.testudineus	5.80
		Ch.punctata	5.46
10	Dimecron 50% EC	*Cl.batrachus*	77.33
		H.fossilis	206.66
		A.testudineus	221.66
		Ch.punctata	62.66

8.2. Residual Toxicity of different insecticides to *Channa punctata* (Nga panaw)

Average half-lives for chlorinated hydrocarbons in loam soil were 10 months for Aldrin, 25 months for DDT, and10 months for Lindane (National Academy of Science, 1969). Mitchell (1972) stated that organic phosphorus compounds degraded within 7 to 84 days. Johnson (1963) noted a 73 per cent reduction in trout populations following DDT spraying with delayed mortality over a six-month observation period. Therefore, it is also needed to estimate the residual toxicity of different insecticide to fish, so that insecticide of long term residual toxicity can be replaced with insecticide of short term residual toxicity to fish.

The author, in his study on the **" Residual Toxicity of some insecticides to Fish"** in 1991, observed that Kitazin 48% EC remained toxic to the test fish only for 2.4 days.In contrast, DDT 25% EC was degraded very slowly and residual toxicity on fish was 45 days (Table 2). The residual toxicity periods for Lindane L- 20 and Endrin 19.5% EC were 34 days and 28 days respectively.DDT 25% EC, Lindane L-20 and Endrin 19.5% EC were persistent in the water owing to its resistance to biochemical degradation and had long term residual toxicity. They should be replaced with insecticides of short term residual toxicity: Kitazin 48% EC,Elsan 50% EC,Padan 50% EC, EPN 45% EC, Diazinon 40% EC, Sumithion 50% EC and Furadan 3-G
(Kyaw Myint Oo, 1991).

Table 2. Residual toxicity of 10 different insecticides to *Channa punctata (Nga panaw)*
(Kyaw Myint Oo, 1991)

No	Insecticide	Residual toxicity (days)
1	Kitazin 48%EC	2.4
2	Elsan 50% EC	4.8
3	Padan 50% EC	5.6
4	EPN 45% EC	7.0
5	Diazinon 40% EC	8.8
6	Sumithion 50% EC	10.0
7	Furadan 3-G	11.6
8	Endrin 19.5% EC	28.0
9	Lindane L-20	34.0
10	DDT 25% EC	45.0

8.3. Relative Toxicity of 10 Pesticides to *Cyprinus carpio* (Shwe war nga gyin) at different exposure periods

Twenty four, 48- and 96-hour Median Tolerance Limit (TLm) values of *Cyprinus carpio* (Shwe war nga gyin) to 10 pesticides at different exposure periods were reported as parts per million. In most experiments, TLm values decreased with time; the 96-h TLm value was significantly lower than the 24-h TLm's. In some tests, exposure beyond 24-h or 48-h did not have a pronounced effect on toxicity; the toxicity at 96-h was identical to that at 24 – h and sometimes, to that at 48-h (Table 3).

It can be anticipated that fish can survive high concentration of pesticide for a short period of time and toxicity increases with

time. The experimental results indicated that different formulations of the same pesticide compound gave different toxicity to fish (Kyaw Myint Oo, 1994).

The order of toxicity for different pesticide to ***Cyprinus carpio*** indicated that taking the 96-h TLm value of least toxic pesticide, Topsin 70% WP as a basis of 1, EPN 40%EC was 125.92 times more toxic to *Cyprinus carpio* than Topsin 70% WP, Padan 50%EC 56.67 times,Brestan 10% WP 41.96 times, Furadan 3 G 25.76 times, Elsan 50%EC 23.61 times, Sumithion 50% EC 10.0 times, Kitazin 48%EC 7.34 times, Diazinon 40% EC 6.53 times, and Kitazin 17 G 2.43 times(Table 4).

Table 3. Median Tolerance Limit (TLm) Values of *Cyprinus carpio* (Shwe war nga gyin) to 10 pesticides at different exposure periods (Kyaw Myint Oo, 1994)

No	Pesticide	24-hour (pm)	48-hour (ppm)	96-hour (ppm)	Mean TLm Values (ppm)
1	EPN 40%EC	0.27	0.27	0.27	0.27
2	Padan 50%EC	1.51	0.8	0.6	0.97
3	Brestan 10% WP	2.43	1.45	0.81	1.56
4	Furadan 3 G	1.91	1.42	1.32	1.55
5	Elsan 50%EC	1.44	1.44	1.44	1.44
6	Sumithion 50% EC	3.40	3.40	3.40	3.40
7	Kitazin 48%EC	5.83	5.32	4.63	5.26
8	Diazinon 40%EC	5.20	5.20	5.20	5.20
9	Kitazin 17 G	18.00	16.0	14.0	16.00
10	Topsin 70%WP	48.00	39.0	34.0	40.33

Table 4. Relative toxicity of different pesticides to *Cyprinus carpio* (Shwe war nga gyin) at 96 hour of exposure. (Kyaw Myint Oo, 1994)

No	Pesticide	Potency ratio related to Topsin	95% Confidence Interval
1	EPN 40%EC	125.92	86.24 – 183.84
2	Padan 50%EC	56.67	44.62 – 71.97
3	Brestan 10% WP	41.96	33.58 – 52.47
4	Furadan 3 G	25.76	16.10 – 40.97
5	Elsan 50%EC	23.61	17.36 - 32.11
6	Sumithion 50% EC	10.00	6.86 – 14.60
7	Kitazin 48%EC	7.34	5.78 – 9.32
8	Diazinon 40%EC	6.53	4.87 – 8.75
9	Kitazin 17 G	2.43	1.59 – 3.69
10	Topsin 70%WP	1.00	-

8.4. Rapid detection of pesticides in water by using fish bioassays

In Myanmar it can be stated that with increased use of pesticides, the open lakes, rivers and streams will undoubtedly become contaminated with these pesticides. In controlling water pollution it is often necessary to know the toxicity of substances. Chemical examination of toxic substances alone usually does not

yield sufficient information. Therefore, the toxicity of pollutants to local fish in their natural waters must be detected and evaluated directly through bioassay tests under appropriate experimental conditions.

Static bioassays were conducted in accordance with the methods outlined by Lennon and Walker (1964) and American Public Health Association *et al.* (2000) with some modifications being necessary for our facilities and specialized objectives by using *Cyprinus carpio* (Shwe war nga gyin) as bio indicator. Ten different modern pesticides employed in this study were EPN 40 % EC, Padan 50% SP, Furadan 3G, Elsan 50 EC, Brestan 10 % WP, Sumithion 50 EC, Kitazin 48% EC, Diazinon 40 EC, Kitazin 17 G and Topsin 70 % WP.

The number of fish surviving at 1, 3, 6, 9, 12, 24, 48, 72, and 96 hour at each level of pesticidal concentration were observed and recorded. The Median Tolerance Limit (TLm) was calculated at each exposure time from a concentration-response curve plotted on logarithmic probability paper. The TLm values for each pesticide at different exposure time were plotted on log-log scale. This represented a standard curve for each pesticide under a particular set of conditions. Median Tolerance Limit (TLm) and exposure time relationships, expressed as equation, $C^n T = K$ were calculated, where C is TLm value, T is exposure time, and n and K are constants (Warren, 1971).

The level of unknown concentration of certain pesticide can be determined from the standard curve when the exposure time is known, provided that the stage of development of fish, the temperature conditions, and the test media were similar (Kyaw Myint Oo, 1994). Such a linear relationship would persist with indefinite extension of exposure time and reduction of lethal concentrations, we then might also have some confidence in

estimating with the aid of equation C^n T = K, the lowest concentration that would be lethal with the normal life span of the organism (Table 5). Such extrapolation, which must usually be far beyond available data, is ill-advised.

Table 5. The values of exponent *n* and the product *K* from the equation C^n T = K (Kyaw Myint Oo, 1994)

N0	Pesticides	n	K
1	EPN 40 % EC	3.37	0.19
2	Padan 50% SP	1.03	28.35
3	Furadan 3G,	2.61	90.25
4	Elsan 50 EC	2.50	112.36
5	Brestan 10 % WP	1.19	112.58
6	Sumithion 50 EC	5.56	27825.59
7	Kitazin 48% EC	4.42	78686.10
8	Diazinon 40 EC	3.33	5960.63
9	Kitazin 17 G	3.19	291131.40
10	Topsin 70 % WP	7.27	$2x10^{13}$

8.5. Recovery of insecticide-affected *Clarias batrachus* (Nga khu) after being transferred into clear water

Occurrence of accidental damage to fish as a result of use of insecticide has come to constitute an important problem. It was also reported that most toxic insecticides cause repellent effects in fish, which may therefore try to swim to clear water, away from the areas of high concentration and irritancy. Large scale treatments of insecticides may give fish little chance of successfully vacating contaminated areas and thus increase the risk. The purpose of this study is to find whether fish which have

completely lost equilibrium due to the intoxication of insecticides would recover or not when they are exposed to the clear water.

The results of the recovery tests indicated that fish being affected by exposure to Endrin 19.5% Ec, DDT 25% EC and Lindane L-20 could not recover even though they were exposed to clear water. These insecticides are extremely toxic to fish (Kyaw Myint Oo, 1995). On the other hand, exposure to DDT 75% WDP, Lindane WDP 26 and Elsan 50% EC resulted in some test fish making a complete recovery; 38% of test fish recovered in the case of DDT 75% WDP, 83% in case of Lindane WDP 26 and 92 % in case of Elsan 50 % EC (Table 6).

Table 6. Recovery of *Clarias batrachus* (Nga khu) exposed to six highly toxic insecticides after being transferred into clear water (Kyaw Myint Oo, 1995)

No	Insecticide	Number of fish used	Time required to kill all fish if not transferred into clear water (hours)	Percentage recovery after being transferred into clear water
1	Endrin 19.5% EC	24	1	0
2	DDT 25% EC	24	7	0
3	Lindane L-20	24	12	0
4	DDT 75%WDP	24	24	38
5	Lindane WDP26	24	26	83
6	Elsan 50% EC	24	8	92

8.6. Half-lives of biological activity of some pesticides in water

The biological activity of a pesticide is its killing power, and the activity generally decreases as a pesticide is deactivated biologically and chemically with time. The half-life of a pesticide's biological activity is the time taken for that activity to be reduced by half. The purpose of this study was to estimate persistence or half-lives of biological activity of some pesticides in water, so that pesticides that decrease in activity over a short time can be used in rice-fish culture.

Bioassays were conducted in the laboratory according to the methods outlined by Lennon and Walker (1964) and American Public Health Association, American Water Work Association, and Water Pollution Control Federation (2000) with some modifications to suit our facilities and objectives. *Labeo rohita* was selected as the test fish, ranging from 4.8 cm to 6.8 cm in total length. Ten different pesticides employed in this study were Sumithion 50% EC, Padan 50% SP, EPN 45% EC, Diazinon 40% EC, Diazinon10 G, Kitazin 48% EC, Furadan 3G, Kitazin 17 G, Elsan 50% EC and Dimecron 50% EC.

In this research work, the half-lives of biological activity for ten different pesticides on *Labeo rohita* (Nga myitchin) in soft water ranged from 4.6 days to 11.8 days (Table 7). The data from this study , indicate that granular forms of pesticides are more persistent than emulsifiable pesticides. Applying the test pesticides seven to twelve days before fish are introduced into a rice field would be sufficient for degradation of pesticides and result in no fish mortality (Kyaw Myint Oo, 2001). By using this method, the half-life of biological activity of a toxicant can be determined for various environmental parameters such pH and temperature.

Table 7. Half-lives of biological activity of different pesticides on *Labeo rohita* (Nga myitchin) at pH7.5 and 27° C (Kyaw Myint Oo, 2001)

No	Pesticide	Half-life of biological activity (days)
1	Sumithion 50% EC	4.6
2	Padan 50% SP	5.4
3	EPN 45% EC	6.2
4	Diazinon 40% EC	6.5
5	Diazinon 10 G	7.0
6	Kitazin 48% EC	7.6
7	Furadan 3G	8.5
8	Kitazin 17 G	9.4
9	Elsan 50% EC	10.8
10	Dimecron 50% EC	11.8

8.7. Acute toxicity of 23 modern pesticides to *Cyprinus carpio* (Shwe war nga gyin)

Bioassays were conducted according to the methods outlined by Nishiuchi (1974) and American Public Health Association, American Water Work Association, and Water Pollution Control Federation (2000) by using *Cyprinus carpio* as bio-indicator. The aquarium water had pH values of 7.0 – 7.4; dissolved oxygen, 7.2 – 7.8; CO_2, 1.6 – 2.2 ppm; total alkalinity, 32 – 44 ppm; total hardness, 38 – 47 ppm; and water temperature 24 – 27°C. Test pesticides were graded as low toxicity, medium toxicity and high toxicity by using the methods of Moa et al (1985) and Liu (1986).

The 48-h TLm values of *Cyprinus carpio* to 23 different pesticides and fish toxicity grades were listed in Table 7. Thiodan 35 EC was the most toxic pesticide to *Cyprinus carpio* and 48-h TLM values was 0.0027 ppm. Dimecron 50 EC was leasr toxic and 48-h TLm value was 97.0. According to their calculated toxicity grades, Thiodan 35 EC and Cypermethrin 10 EC were highly toxic to *Cyprinus carpio.* Hence, rice field used for raising of fish should not be applied with those pesticides (Kyaw Myint Oo, 2003).

Pesticides of medium toxicity would not constitute a hazard unless an abnormally large amount of them contaminate the water. They should not be applied more than the recommended application rates because an excessive amount of them would contaminate water and might constitute hazard to fish.

As Kitazin 17 G, Topsin 70 WP and Dimecron 50 EC were graded as low toxicity pesticides, it is considered that they were not toxic to fish and can be used practically without any special precaution (Table 8).

Table 8(A). The 48-hour Median Tolerance Limit (48-h TLm) values of *Cyprinus carpio* (Shwe war nga gyin) to different pesticides and fish toxicity grades (Kyaw Myint Oo, 2003)

No	Pesticides	Used Category	48-h TLm (ppm)	Fish Toxicity Grades
1	Thiodan 35 EC	Insecticide	0.0027	High
2	Cypermethrin 10 EC	Insecticide	0.0032	High
3	Decis 2.5 EC	Insecticide	0.01	High
4	K-Obiol 2 DP	Insecticide	0.04	High
5	K-Othrine 2.5 EC	Insecticide	0.06	High
6	Daconil 75 WP	Fungicide	0.09	High
7	Malathion 50 EC	Insecticide	0.1	High
8	K-Othrine5 WP	Insecticide	0.27	High
9	Padan 50 SP	Insecticide	0.42	High
10	Homai 80 WP	Fungicide	0.6	High

Table 8(B). The 48-hour Median Tolerance Limit (48-h TLm) values of *Cyprinus carpio* (Shwe war nga gyin) to different pesticides and fish toxicity grades (Kyaw Myint Oo, 2003)

No	Pesticide	Used Category	48-h TLm (ppm)	Fish Toxicity Grades
11	Padan 4 G	Insecticide	0.8	High
12	Furadan 3 G	Insecticide	1.3	Medium
13	Elsan 50 EC	Insecticide	2.2	Medium
14	Sumithion 50EC	Insecticide	3.0	Medium
15	Diazinon 40EC	Insecticide	3.4	Medium
16	Parashoot M45	Insecticide	3.6	Medium
17	Diazinon 10 G	Insecticide	3.8	Medium
18	Kitazin 48% EC	Fungicide	4.5	Medium
19	Labilite 70WP	Fungicide	5.8	Medium
20	Herbit 20 EC	Herbicide	7.5	Medium
21	Kitazin 17 G	Fungicide	15.0	Low
22	Topsin 70WP	Fungicide	36.0	Low
23	Dimecron 50 EC	Insecticide	97.0	Low

8.8. Acute Toxicity of some modern pesticides to *Cyprinus carpio* (Shwe war nga gyin) and acute effect on Gills

(a)Acute toxicity of some modern pesticides to *Cyprinus carpio* (Shwe war ngagyin)

Rice fields are usually stocked with 5-10 cm fingerlings, two weeks after rice transplant. If the pesticides are to be used without endangering fisheries the first essential is to measure the acute toxicity to fish. Acute toxicity is considered to be direct and rapid damage to the fish by the fastest acting mechanism of poisoning, fatal unless the fish escape the toxic environment at an early stage. Mortality from acute toxicity usually occurs within 96 hours (Prague 1969).

Histological effect of pesticides remains largely undefined and most of the recent work is inconclusive. Lemke and Mount (1963) found that gills are common site of damage. The purpose of this study is to determine the acute toxicity of six modern pesticides to *Cyprinus carpio* (Shwewar Ngagyin) and investigate the acute effect of different pesticides on the histology of gill of *Cyprinus carpio*.

In all acute toxicity bioassay experiments, it was found that Padan 50 % SP was highly toxic to *Cyprinus carpio*. The order of toxicity to *Cyprinus carpio* for different pesticides indicated that Kitazin 17 G was the least toxic pesticide (Kyaw Myint Oo, 2005). On the assumption that all spray or granules emitted, fell evenly into the rice field water, the standard application rates for Padan 50% EC, Furadan 3G, Elsan 50% EC, Sumithion 50% EC, Diazinon 10G and Kitazin 17G would give the expected maximum concentrations of 0.6 ppm, 1.09 ppm, 1.9 ppm, 1.9

ppm, 2.42 ppm and 2.56 ppm respectively at the depth of 5 cm (Table 9).

Safety indexes of different pesticides for *Cyprinus carpio* were computed and their values were also listed in Table 9. According to their calculated safety indexes, all the tested pesticides are moderately toxic to *Cyprinus carpio* and categorized as rank B. Rank B-pesticides would not constitute a hazard to fish unless an abnormally large amount of them contaminate rice field water.

Table 9. Standard application rates, expected maximum concentrations in rice field water at depth of 5 cm, 96-h TLm (ppm) for *Cyprinus carpio* and safety Indexes of different pesticide (Kyaw Myint Oo, 2005)

No	Pesticides	Standard Application rates per acre	Expected maximum concen-tration (ppm) in ricefield water at depth of 5 cm	96–hours TLm (ppm)	Safety Index
1	Padan 50% SP	250 g	0.6	0.65	0.92
2	Furadan 3G	676 g	1.09	1.42	0.76
3	Elsan 50%EC	800ml	1.9	1.52	1.25
4	Sumithion 50% EC	800ml	1.9	2.82	0.67
5	Diazinon 10G	20 kg	2.42	3.62	0.66
6	Kitazin 17 G	9 kg	2.56	14.00	0.18

(b)Acute effect of pesticides on gills of *Cyprinus carpio*

Expected maximum concentrations in rice field water at the depth of 5 cm where the pesticides were applied at the standard application rates acutely effect othe gills of *Cyprinus carpio* and cause significant gill histopathological changes (Kyaw Myint Oo, 2005). The swelling of secondary lamellae are found in gill filament of *Cyprinus carpio* exposed to 1.9 ppm Sumithion 50% EC for 96 hours. Many adjacent secondary lamellae touch each other (Figure 1).

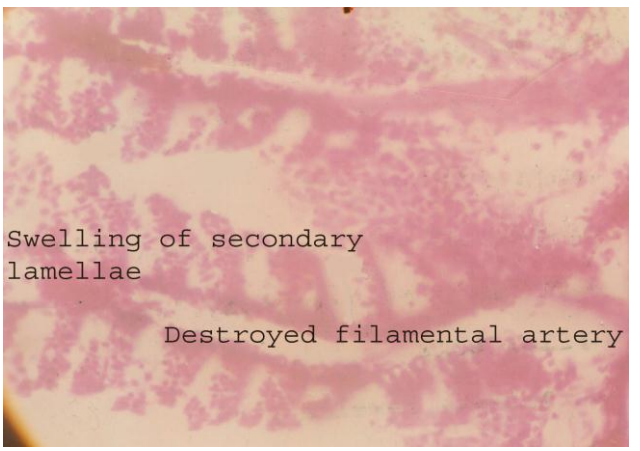


Figure 1. Abnormal gill filament and lamella of *Cyprinus carpio* exposed to 1.9 ppm Sumithion 50% EC for 96 hours (L.S. H&E; X 600)(Kyaw Myint Oo, 2005)

The more obvious destruction occurred in gill exposed to Padan 50% SP where secondary lamella were swollen and distorted. Blood capillaries burst out from the lamella (Figure 2).

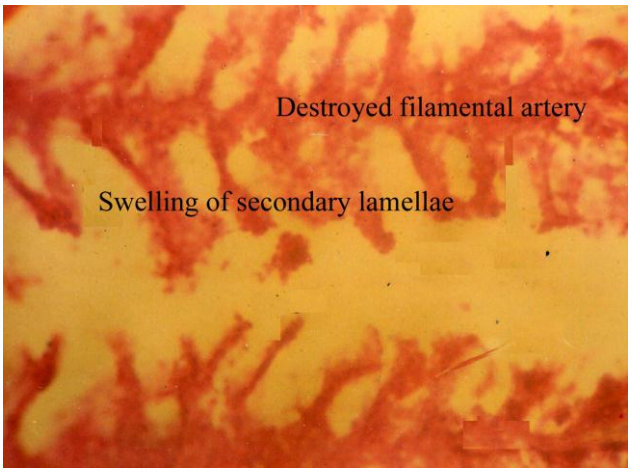


Figure 2. Abnormal gill filament and lamella of *Cyprinus carpio* exposed to 0.6 ppm Padan 50% SP for 96 hours (L.S. H&E; X 600)(Kyaw Myint Oo, 2005)

Gills exposed to Diazinon 10G , filamental artery become enlarged (Figure 3). In the gills exposed to granular formation of pesticides, Diazinin 10G, precipitated masses occluded the capillaries of the gill lamellae (Figure 3). Since gills are delicate respiratory organs they may be assumed as the most susceptible organs to the pesticides. External irritants like pesticides are the most frequent causes of the significant gill pathological changes. In this research work, enlargement of the secondary lamellae are the distinguishable portion with swollen or distortion parts. Blood capillaries burst out from the lamellae when the pesticides are highly toxic(Kyaw Myint Oo, 2005).

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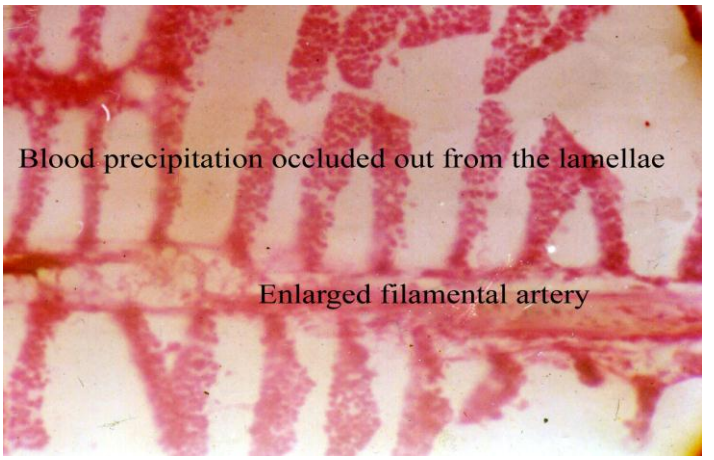


Figure 3. Abnormal gill filament and lamellae of *Cyprinus carpio* exposed to 2.42 ppm Diazinon 10 G for 96 hours (L.S. H&E; X 600)(Kyaw Myint Oo, 2005)

Complete necrosis and sloughing of epithelium lining in the secondary lamellae occurs. The proliferated changes of secondary lamellae were apparent. These changes may be considered as the results of either hyperplasia or hypertrophy or both. This may form a respiratory exchange obstruction, which was probably the main cause of death.

8.9. Safe use of some modern insecticides in rice-fish culture

The raising of fish in rice fields has rapidly developed in Myanmar. Kan-mil Li (1988) reported that fish culture in rice fields increase rice production approximately 4-15 % and help in pest control. Insecticides are indispensable for modern farming and insecticides use is one of the major constraints to rice-fish culture. While insecticides use has steadily increase in Myanmar, there has been a trend towards the development and use of the insecticides less toxic to fish. Increased pesticide use in most

Asian countries has been reported to have caused the decline in rice-fish culture (Cagauan and Arce 1992). Rice fields are usually stocked with 5-10 cm fingerling, two weeks after rice transplant. If the insecticides are used without endangering fisheries, it is essential to measure their toxicity to fish. The present study was, therefore, undertaken to estimate the tolerance of six species of fish to eight different modern insecticides and to help farmers to maintain insect pest control efficiently within limits safe for fishes.

Clarias batrachus (Nga khu*), Anabas testudineus* (Nga-byema), *Channa punctata* (Nga-panaw), *Oreochromis mossambicus* (Talapia), *Cyprinus carpio* (Shwe war ngagyin)and *Labeo rohita* (Nga myitchin) were selected as test fish, ranging from 7 to 10 cm in total length. Eight different insecticides were studied: Cypermethrin 10 EC, Sumithion 50 EC, Diazinon 40 EC, Diazinon 10 G, Elsan 50 EC, Malathion 50 EC, Padan 50 SP and Furadan 3G.

Based on those results of 96-h TLm values and Safety Indexes of eight different modern insecticides to six species of fish shown in Table 10, test pesticides can be categorized for their relative safety for use in ricefield culture with the fish species listed in Table 11.

In this study, among the eight test insecticides there was no A-insecticides which were relatively safe to use in rice fish culture. The B-insecticides are less safe and considerable care must be taken if they are used on a large scale. Those insecticides should never be applied at more than the recommended rates (Kyaw Myint Oo, 2006).

The C-insecticides are highly toxic and unsafe to use (Table 11). The C-insecticides should not be used in rice fields stocked with fish. If those insecticides are necessary to use for pest control, it is important that before applying such insecticides, water in rice fields must be drained. Fish may be driven to the fish sump with a dike built around it to prevent entry of water from the ricefield. When the toxicity of the insecticides has been totally drained, fish are to be returned to the rice fields. Extreme care should be taken so that those insecticides do not contaminate trenches and sump. Water depth of the rice fields may be increased to prevent fish from being poisoned.

The B-insecticides of medium toxicity (Table 11) would not constitute a hazard unless an abnormally large amount of them contaminate the water. They should not be applied more than the recommended application rates as an excessive amount of them would contaminate water and might constitute a hazard to fish.

Repeated application of those insecticides would prolong the exposure period to fish and might also produce delay morality to fish. In such cases, fish sumps need to be provided as hiding places for fish during the application of such insecticides and water from treated field should be held back from flowing into adjacent sump for at least one week or preferably for two weeks.

Careless use of these insecticides may result in considerable pollution of water and cause fish mortality. The data from this research work may also useful for safe use of pesticide in any other types of rice-fish culture.

Table 10(A). Acute toxicity and safety indexes of eight different modern insecticides to six species of fish (Kyaw Myint Oo, 2006)

No	Insecticide	Fish species	96-hour TLm (ppm)	Safety Index
1	Cypermethrin 10EC	*Cl.batrachus*	0.0072	52.78
		A.testudineus	0.0096	39.57
		Ch.punctata	0.0087	43.68
		O.mossambicus	0.0057	66.67
		C.carpio	0.0042	90.48
		L.rohita	0.0063	12.70
2	Sumithion50EC	*Cl.batrachus*	6.63	0.29
		A.testudineus	5.58	0.33
		Ch.punctata	4.8	0.39
		O.mossambicus	1.6	1.18
		C.carpio	3.2	0.59
		L.rohita	3.8	0.50
3	Diazinon 40EC	*Cl.batrachus*	6.2	0.31
		A.testudineus	5.6	0.34
		Ch.punctata	4.8	0.40
		O.mossambicus	1.7	1.12
		C.carpio	3.8	0.50
		L.rohita	0.8	2.35

Table 10(B). Acute toxicity and Safety Indexes of eight different modern insecticides to six species of fish (Kyaw Myint Oo, 2006)

No	Insecticide	Fish species	96-hour TLm (ppm)	Safety Index
4	Diazinon 10G	*Cl.batrachus*	7.8	0.31
		A.testudineus	4.8	0.50
		Ch.punctata	5.8	0.42
		O.mossambicus	3.6	0.67
		C.carpio	3.4	0.71
		L.rohita	3.2	0.76
5	Elsan 50EC	*Cl.batrachus*	0.06	31.67
		A.testudineus	0.48	3.96
		Ch.punctata	0.08	23.75
		O.mossambicus	0.02	95.00
		C.carpio	1.72	1.10
		L.rohita	0.62	3.06
6	Malathion 50 EC	*Cl.batrachus*	3.2	0.59
		A.testudineus	3.6	0.53
		Ch.punctata	2.4	0.79
		O.mossambicus	0.08	23.75
		C.carpio	0.2	9.50
		L.rohita	0.4	4.75
7	Padan 50 SP	*Cl.batrachus*	3.6	0.17
		A.testudineus	2.7	0.22
		Ch.punctata	1.8	0.33
		O.mossambicus	0.8	0.75
		C.carpio	0.5	1.20
		L.rohita	0.6	1.00
8	Furadan 3G	*Cl.batrachus*	3.6	0.30
		A.testudineus	2.8	0.38
		Ch.punctata	0.7	15.57
		O.mossambicus	0.5	2.18
		C.carpio	1.2	0.91
		L.rohita	0.4	2.72

Table 11. Relative safety of insecticides for various fish species used in rice-fish culture, for flood water depth of 5 cm after transplanting (Kyaw Myint Oo, 2006)

No	Fish Species	A (relatively safe)	B (less safe)	C (unsafe)
1	*Clarias batrachus*	none	2,3,4,6,7	1,5
2	*Anabas testudineus*	none	2,3,4,6,7,8	1,5
3	*Channa puntata*	none	2,3,4,6,7	1,5,8
4	*Oreochromis mossambicus*	none	2,3,4,7,8	1,5,6
5	*Cyprinus carpio*	none	2,3,4,5,7,8	1,6
6	*Labeo rohita*	none	2,3,4,5,6,7,8	1

1-Cypermethrin10EC 2-Sumithion50EC
3-Diazinon50EC 4-Diazinin 10G
5-Elsan 50 EC 6-Malathion 50EC
7-Padan 50SP 8-Furadan 10G

8.10. Acute Toxicity of some modern pesticides to egg, fry and fingerling of *Labeo rohita* (Nga myitchin*)*

Among the test pesticides, Cypermethrin 10 EC was the most toxic pesticide to all egg, fry and fingerling and Dimecron 50 EC was least toxic. According to their calculated toxicity grades, Cypermethrin 10 EC, Decis 2.5 EC, K-Othrine 2.5 EC, Malathion 50 EC, Homai 80 WP, Elsan 50 EC and Padan 50 SP were highly toxic to egg, fry and fingerling of *Labeo rohita* (Table 12).

Hence, rice fields used for raising fry and fingerling of *Labeo rohia* should not be applied with those pesticides. Furadan 3 G and Kitazin 48 EC are moderately toxic to egg and highly toxic to fry and fingerling. Sumithion 50 EC, Herbit 20 EC, Diazinon40 EC, Diazinon 10 G and Kitazin 17 G have medium toxicity to fingerling of *Labeo rohita*. Topsin 70 WP and Dimecron 50 EC have low toxicity to fingerling of *Labeo rohita*. Most of the pesticides employed in this study have high toxicity to the fry of *Labeo rohita* with the exception of Kitazin 17 G, Topsin 70 WP and Dimecron 50 EC (Kyaw Myint Oo, 2007).

Therefore, it is important to choose the proper kind of pesticides for rice-fish culture, control its dosage, apply at suitable time with appropriate methods and prevent the pesticides from mixing with paddy water. Prevention of fish poisoning during pesticide application was much needed.

Table 12. The 48-hour TLm values for egg, fry and fingerling of *Labeo rohita* (Nga myitchin) (Kyaw Myint Oo, 2007)

No	Pesticide	Used Category	egg	fry	fingerling
1	Cypermethrin 10EC	Insecticide	0.0014	0.0004	0.0028
2	Decis 2.5 EC	Insecticide	0.018	0.002	0.008
3	K-Othrine 2.5EC	Insecticide	0.037	0.0005	0.04
4	Malathion 50 EC	Insecticide	0.12	0.014	0.08
5	Homai 80WP	Fungicide	0.15	0.027	0.2
6	Elsan 50 EC	Insecticide	0.29	0.037	0.54
7	Padan 50 SP	Insecticide	0.54	0.28	0.5
8	Furadan 3G	Insecticide	1.14	0.13	0.7
9	Kitazin 48EC	Fungicide	1.8	0.45	2.4
10	Sumithion 50EC	Insecticide	0.22	0.06	3.5
11	Hervit 20EC	Herbicide	2.9	0.62	3.7
12	Diazinon 40EC	Insecticide	2.7	0.49	4.8
13	Diazinon 10G	Insecticide	3.2	0.88	5.2
14	Kitazin 17G	Fungicide	3.8	1.95	5.5
15	Topsin 70WP	Fungicide	8.6	2.4	12.0
16	Dimecron 50EC	Insecticide	24.6	6.4	32.0

Table 13. Relative potency ratios of different pesticides among egg, fry and fingerling of *Labeo rohita* (Nga myitchin) at 48-hour exposure (Kyaw Myint Oo, 2007)

No	Pesticides	Fry	Egg	Fingerling
1	Sumithion 50EC	1	3.7	58.3
2	Elsan 50 EC	1	7.8	10.8
3	Diazinon 40EC	1	5.5	9.8
4	K-Othrine 2.5EC	1	7.4	8.0
5	Homai 80WP	1	5.5	7.4
6	Cypermethrin 10EC	1	3.5	7.0
7	Hervit 20 EC	1	4.7	5.9
8	Diazinon 10G	1	3.6	5.9
9	Malathion 50 EC	1	8.6	5.7
10	Furadan 3G	1	8.8	5.4
11	Kitazin 48 EC	1	4.0	5.8
12	Dimecron 50 EC	1	3.8	5.0
13	Topsin 70 WP	1	34.6	5.0
14	Decis 2.5 EC	1	9.0	4.0
15	Kitazin 17G	1	1.9	2.8
16	Padan 50 SP	1	1.9	1.8

The experimental results also revealed that egg of *Labeo rohita* were more resistant to all test pesticides than the fry and fry were more sensitive to all pesticides than the fingerling (Table 13). For instance, potency ratios based on the 48-hour TLm values among egg, fry and fingerling showed that taking 48-hour TLm value of Sumithion EC for fry as basis of 1, the egg of *Labeo rohita* was 3.7 times more resistant than the fry and

fingerling was 58.3 times more resistant than the fry (Kyaw Myint Oo, 2007).

Mount (1962), in acute toxicity tests, reported 96-hour TLm values ranging from 0.27 ppb Endrin to fish 30 mm standard length to 0.47 ppb for 60 mm fish (guppies and bluntnose minnows). Studies on the size of fish had been demonstrated that rainbow trout weighing 1/3 gram had 24-hour TLm value against DDT that was 1/8 of that trout of the same strain weighing 4 gram (Cope,1965).

8.11. Presenting pesticide toxicity research data to Pesticide Registration Board of the Government of the Union of Myanmar

Since 1993, the author has attended the meetings held by the Pesticide Registration Board of the Government of the Union of Myanmar and presented his pesticide toxicity research data so that the Board could consider in registration of pesticides to be used in Myanmar.

9. Pesticide residues in fish, fruit, vegetable, meat and human

9.1. Pesticide Residues

When a crop is treated with pesticide, a very small amount of pesticide, or indeed what it changes to in their plant (its 'metabolites' or 'degradation product'), can remain in the crop until after it is harvested. This is known as the 'residue'. Pesticide residue may be present in:

- Fresh or tinned fruit and vegetables, or
- Processed food and drink made from the crop (e.g. juice, bread or any other manufactured food or drink),
- Fresh or processed animal products (if the animals have been fed on crop treated with pesticide).

Occasionally, residues may also result from environmental or other 'indirect 'source. Residues of old pesticide, like DDT (banned in the UK for many years) are an example of such environmental contaminants.

The level or amounts of residues present are expressed in milligrams of the chemical in a kilogram of crop/food/commodity (mg/kg). These are very small amounts. 1 mg/kg is the same as 1 part per million (ppm).

9.2. Organochlorine residues in fish from LakeVictoria, Kenya

Eighty-two samples of either nile perch fish fat or muscle were collected from the Kenyan region of Lake Victoria for detection of organochlorine residues. Nine organochlorine residues were detected in the following percentages: α-BHCIHCB-40%; P-BHC/HCB-40%; y-BHC/HCB/lindane-4%; aldrin-9%; dieldrin-1%; p, p'-DDE-73%; p, p'-DDD-9%; o, p'-DDT-170; and p, p'-DDT-11%. All levels of organochlorine residues were below the Extraneous Residue Limit (ERL), apart from just one sample of fish fat which had 4.51 ppm of DDT above ERL (Mitema, 2009).

9.3. Concentrations of pesticide residues in tissues of fish from Kolleru Lake in India

Fish samples were analyzed according to a modified method which is proposed for the gas chromatographic determination for the pesticides. The maximum concentrations of pesticide residues in Kolleru Lake fish on wet weight basis are: 2.5 ug/g for malathion, 76.5 ug/g for endosulfan, 1.98 ug/g for dieldrin , 157.4 ug/g for DDT. These analyses were used to evaluate the baseline data and the pesticide pollution in the lake's ecosystem (Amaranini, 2009).

9.4. Pesticide residues in organisms of Malaysian waters

Organochloride compounds were widely used in rapidly developing countries in South East Asia for agriculture, pest control and for public health purposes. From the study in the Straits of Melacca, pp”-DDE pollution in Mussel tissue from six stations on Penang Island ranged from 3.7 to 17.4 ppb (dry

weight basis) and the concentration of 1.2 to 38 ppb for DDT was also found in tissue of the same species (Table 14).

Table 14. Pesticide residues in organisms of Malaysian waters from 1982 to 2000 (Somchit, 2009)

No	Organism	Location	Concentration
1	***Perna viridis***	**Penang Malaysia**	**3.7 – 17.4 ppb (dryweight basis) pp'-DDE 1.2 – 38 ppb DDT**
2	***Anader granosa***	**Penang, Malaysia**	**0.21 ppb Lindane 0.08ppb Aldrin 0.15 ppb Endrin**
3	**Green Mussel**	**Penang**	**0.38-11.28ppb BHC**

9.5. Residues in fruits and vegetables

Below is a table of 27 fruits and vegetables that were tested by the US. Environmental Working Group for pesticide residue (Table 15). The foods are ranked from worst to best (descending). The table will tell you what percentage of that particular fruit/vegetable had pesticides on it and average amount (in ppm) of all pesticides found on each fruit/vegetable. For example, peaches were the worst. 96.6% of peaches had pesticides on them. Average amount of all pesticides found was 1.134 ppm.

Table 15(A). Residue in fruits and vegetables (US. Environmental Working Group for Pesticide Residue, 2008)

Rank (Worst to best)	Commodity	Combined Score	% of sample tested with detectable pesticides	Average Amount (ppm) of all pesticides found
1	Peaches	100	96.6 %	1.134
2	Apples	96	93.6%	0.894
3	Pepper	86	81.5%	0.138
4	Strawberries	83	92.3%	0.799
5	Cherries	75	91.4%	0.290
6	Pears	65	86.2%	0.586
7	Potatoes	58	81.0%	1.655
8	Carrots	57	81.7%	0.046
9	Green beans	55	67.6%	0.199
10	Cucumbers	52	72.5%	0.057
11	Plums	46	74.0%	0.666
12	Oranges	46	85.1%	0.100
13	Grapes	46	60.5%	0.104
14	Cauliflower	39	84.6%	0.004

Table 15(B). Residue in fruits and vegetables (US. Environmental Working Group for Pesticide Residue , 2008)

Rank (Worst to best)	Commodity	Combined Score	% of Sample with detectable pesticides	Average Amount (ppm) of all pesticides found
15	Mushrooms	37	60.2%	0.158
16	Lemon	31	55.6%	0.188
17	Grapefruit	31	62.9%	0.056
18	Tomatoes	30	46.9%	0.029
19	Sweet Potatoes	30	58.4%	0.198
20	Watermelons	25	38.5%	0.021
21	Papaya	21	23.5%	0.053
22	Cabbage	17	17.9%	0.121
23	Bananas	16	41.7%	0.029
24	Mango	9	7.1%	0.057
25	Pineapples	7	7.1%	0.057
26	Avocado	1	1.4%	0.001
27	Onions	1	0.2%	0.000

9.6. Residues of Cypermethrin and Methamidophos on cauliflower at various intervals after treatment.

The residues of Cypermethrin and Methamidophos on cauliflower at different time intervals after treatment are shown in Table 16. The data showed that the dissipation rate of methamidophos was slower than that of cypermethrin. The residues of both insecticides were detected even on 15th day after treatment, indicating their prolong persistence nature in cauliflower.

Table 16. Residues of Cypermethrin and Methamidophos on cauliflower at various intervals after treatment. (Barkat Ali Khan, 2003)

Days after Treatment	Cypermethrin Residues(mg/kg)	Metamidophos Residues(mg/kg)
0	3.74	4.41
1	1.04	2.55
3	0.73	1.62
5	0.35	1.12
7	0.17	0.83
10	0.10	0.68
15	0.07	0.52

9.7. Levels of organochlorine pesticide residues in meat

Organochlorine pesticide residues (Lindane, Aldrin, Dieldrin, Endosulfan, and DDT) were found in beef samples from Buoho abattoirs in Ghana . The average concentration of lindane in beef fat samples from Buoho was 1.79 µg/kg.

Endosulfan concentration in meat samples from Buoho was 2.28 μg/kg in the fat. The average concentration of DDT in beef fat from Buoho was 403.82 μg (Table 17).

Table 17. Levels of pesticide residues in beef fat from Buoho (ug/kg) (Darco, 2007)

	Lindane	Aldrin	Endo sulfan	Dieldrin	DDT
Mean	**1.79**	**4.11**	**2.28**	**6.01**	**403.82**
SD	**0.38**	**8.19**	**1.74**	**5.14**	**276.88**
Max.	**2.11**	**24.32**	**6.53**	**15.37**	**844.28**
Min.	**1.24**	**0.56**	**0.40**	**2.21**	**37.60**

Although, most of the organochlorine residues detected were below the maximum limits set by the FAO/WHO, bioaccumulation of these residues is likely to pose health problems in higher organisms like human beings.

9.8. Chlorinated pesticide residues in the body fat of people in Iran

Adipose tissues of 170 subjects 4 to 91 years old were taken from autopsy cases from September 1974 through November 1976 and analyzed by gas-liquid chromatography for determination of storage levels of dieldrin, BHC (benzenehexachloride), and DDT and its metabolites in human body fat. The results show relatively moderate exposure to DDT and BHC and relatively light exposure to aldrin/dieldrin. The finding of relatively high DDD concentrations may be due to an

intermediate dechlorination product formed in the conversion of DDT to DDA or some change occurring after death, probably anaerobic metabolism by microorganisms. The concentrations of pesticide residues were slightly higher in females than in males. The body fat of the 60- to 70-year-old group of the general population had higher levels of dieldrin and DDT and its metabolites (Hashemy, 2004).

9.9. Organochlorine pesticide residues in human fat in Great Britain

In order to assess the trend in the body load of organochlorine pesticide residues in Great Britain, between July 1965 and June 1967, samples of fat were taken during routine necropsies on 247 subjects over 3 years old and on 44 stillborn or premature babies and infants below the age of 3. The levels of the three main pesticides, B.H.C., dieldrin, and D.D.T., were lower than those found in an earlier survey carried out in 1963 and 1964. No marked differences were observed in levels throughout Britain, but the levels in man were higher than those in women (Abbott, 1968).

9.10. Organochlorine pesticide residues in human milk of a Hmong hill tribe living in Northern Thailand

In December 1998 whole breast milk samples from 25 Hmong mothers living in the village of Mae Sa Mai, 40 km north of Chiang Mai City, Northern Thailand, were collected and analysed for DDT, heptachlor, HCB and HCH residues. DDT was detected in all samples with a median and maximum level of 209 and 2012 ng of total DDT isomers per millilitre of milk, respectively. The median and highest percentages of p,p'-DDT were 23.2 and 44.7%. In 15 samples heptachlor was detected in the metabolized form of heptachlor-epoxide with a median value of 4.4 ng/ml.

The estimated daily intakes of DDT, heptachlor and heptachlor-epoxide by the infants exceeded up to 20 times the acceptable daily intakes as recommended by the FAO and WHO. In nine samples HCB was detected with a median value of 5.4 ng/ml from which seven of the nine also had the highest values of DDT residues. The gamma-isomer of HCH was only found in one sample with 3.6 ng/ml. The mean sum-DDT residues with 14.96 mg/kg milk fat, as well as the estimated daily intakes by the infants are one of the highest reported in the 1990s. The fact that the mother breast-feeds her first child and that she originally comes from a region where DDT is still in use as a vector control agent, as well as the former use of organochlorine pesticides (OCPs) in agriculture, seem to be the main factors for high DDT and other OCP residues in the mothers' milk (Steutz, 2001).

9.11. Evaluation of organochlorine pesticide residues in human serum from an urban and two rural populations in Portugal

Organochlorine pesticide residues were measured in human serum from an urban and two rural populations in Portugal, in an attempt to evaluate the contamination level of Portuguese population. Serum levels of 12 residues were determined using a validated methodology that included gas chromatography-electron-capture detection. The determination was made as an attempt to point out the differences of contamination between rural and urban populations; and among these, if it could be established a relation with sex and with age of individuals.

*p,p′*DDE, α-hexachlorocyclohexane (HCH), *p,p′*DDD, and β-HCH were the most frequently identified residues. *p,p′*DDE concentrations ranged from undetected to 390.5 μg/l in urban samples, and from undetected to 43.5 μg/l and to 171.2 μg/l in

both rural samples. Maximum α-HCH concentration level was 114.4 μg/l in urban samples, 261.3 and 45.5 μg/l in both rural samples. Mean total DDT levels were always higher than mean total HCH levels. About *p,p′*DDE, in all three populations, the majority of the results above the limit of quantification were found among female sex. The analysis of different age groups showed that younger groups continue to reveal contamination. Comparing obtained results with others from Europe, Asia and America, it was observed that Portugal is between the highest levels of contamination (Susana, 2003).

10. Maximum Residue Limits (MRLs), the United Nations Codex Alimentarius Commission, residue monitoring and food safety

10.1. Maximum Residue Limits (MRLs)

A Maximum Residue Limits (MRLs) for pesticides are established in most countries to safeguard consumer health and to promote Good Agricultural Practice (GAP) in the use of insecticides, fungicides, herbicides and other agricultural compounds.

Maximum residue limit or MRL is the maximum amount of residue legally permitted on food. Once residues are demonstrated to be safe for consumers, MRLs are set by independent scientists, based on rigorous evaluation of each pesticide legally authorized. They act as an indicator of the correct use of pesticides, and ensure compliance with legal requirements for low residues on unprocessed food. MRLs are trading standards used to ensure that imported and exported food is safe to eat. In practice, they allow the free movement of goods within the EU and from the rest of the world.

These MRLs vary from country to country depending on the pesticides available, the crops being treated and the way the pesticides are used. Food exporters must comply with these MRLs as a condition of market access.

10.2. The United Nations Codex Alimentarius Commission

The United Nations Codex Alimentarius Commission has recommended international standards for Maximum Residue Limits (MRLs), for individual pesticides in food. Since 1962, the Codex Alimentarius Commission (CAC) has been responsible for implementing the Joint FAO/WHO Food Standards Programme. The Commission's primary objectives are the protection of the health of consumers, the assurance of fair practices in food trade and the coordination of the work on food standards.

The CAC is an intergovernmental body with a membership of 165 Member governments. In addition, observers from international scientific organizations, food industry, food trade and consumer associations may attend sessions of the Commission and of its subsidiary bodies. An Executive Committee, six Regional Coordinating Committees and a Secretariat assist the Commission in administering its work programme and other activities.

The work of the Codex Alimentarius is divided between two basic types of committees:

Nine general subject matter(s) Committees that deal with general principles, hygiene, veterinary drugs, pesticides, food additives, labelling, methods of analysis, nutrition and import/export inspection and certification systems and

Twelve Commodity Committees which deal with a specific type of food class or group, such as dairy and dairy products, fats and oils, or fish and fish products.

The work of the Committees on hygiene, fish and fishery products, veterinary drugs and import/export inspection and certification systems is of paramount interest to the safety and quality of internationally traded fish and fishery products.

The specific Codex food safety provision include the maximum residue limits for pesticides and veterinary drugs, the maximum level of use of food additives, the maximum levels of contaminants, and food hygiene requirements of Codex standards.

10.3. Safe level of a pesticide residue

In the United States of America**,** Environmental Protection Agency (EPA) evaluates tests done in experimental animals, and on plant, human or animal cells growing in the laboratory to estimate the health risk to humans from exposure to pesticides. EPA determines how much the pesticide is likely to remain in foods that are grown using the recommended guideline for pesticide use. It pays extra attention to foods that are eaten by children in large quantities, such as apple juice and milk.

To estimate the health risk to humans from exposure to pesticides, EPA determines how much of the pesticide is likely to remain in foods. A computer program is specially developed to estimate health risks, called the "Dietary Exposure Evaluation Model." EPA considers the exposure through food, drinking water, and home use of pesticides. EPA will set a tolerance level for food if the combined exposure from different sources is 100 to 1,000 times lower than the maximum residue limit (MRL) that shows no harmful effects in experimental animals.

10.4. Monitoring the residue levels of pesticides in food

In developed country like United States of America, Food and Drug Administration (FDA) monitors the levels of pesticides in raw agricultural produce, fish, dairy products and processed foods. Then Food Safety and Inspection Service (FSIS) of US Department of Agriculture (USDA) is responsible for monitoring pesticide residues in meat and certain egg and poultry products.

Both the FDA and USDA work with state agencies to collect and test for pesticide residues in food from different parts of the country. For imported foods, food samples are collected at the port of entry. If a food is found to have any pesticide residue at, or greater than the tolerance level, federal or state officials can remove the food and destroy it. Any pesticide residue that exceeds tolerance levels, or does not meet EPA regulations is reported as "violative".

10.5. Maximum Residue Limits (MRLs) of some agricultural chemicals and environmental chemical contaminants on fish, mollusk, crustaceans

Maximum Residue Limits (MPL) of some agricultural chemicals and environmental chemical contaminants on fish, mollusk, crustaceans and food are shown in Table 18 to Table 21.

Table 18. Maximum Residue Limits (MRLs)(ppm) of some Agricultural Chemicals on fish in Japan
(Pesticide and food safety in Japan, 2009)

No	Agricultural Chemicals	Perciformes	Salmoniformes	Anguilliformes
1	Aldrin	0.1	0.1	0.1
2	Cypermethrin	0.01	0.03	0.01
3	DDT	3.0	3.0	3.o
4	Endosulfan	0.004	0.004	0.004
5	Endrin	0.005	0.005	0.005
6	Heptachlor	0.05	0.05	0.05
7	Lindane	1.0	1.0	1.0
8	Malathion	0.5	0.5	0.5

1.Perciformes - bonito, horse mackerel, sea bass, sea bream and tuna
2.Salmoniformes –salmon and trout
3. Anguilliformes –eel

Table 19. Environmental chemical contaminants. Maximum Residue Limits (MRLs) in fish, mollusk and crustaceans (US. Food and Drug Administration, 1998)

No	Chemicals	US (ppm)	EU (mg/kg)	Food commodity
1	Arsenic	76-86	-	Mollusks, crustaceans
2	Cadmium	3-4	0.05-1.0	Fish, mollusks
3	Lead	1.5-1.7	0.2-1.0	Fish, mollusks
4	Methyl mercury	1.0	1.0	all fish
5	PCB	2.0	-	all fish
6	DDT	5.0	-	all fish
7	Dieldrin	0.0	-	all fish
8	Dioxin	-	0.000004	all fish

Table 20(A). Analysis of wildcaught fish for trace elements and persistent organic pollutants
(Food Standards, Australia New Zealand, 2005)

No	Fish	Residue	Average concentra-tion	MRLs
1	Eel	Dioxins Cadmium Copper Lead Mercury DDT PCB	0.00000030 0.005 0.343 0.007 0.211 0.015 0.033	No limit No limit No limit 0.5 0.5 1.0 0.5
2	Lobster	Cadmium Copper Lead Mercury	0.010 2.821 0.005 0.048	No limit No limit No limit 0.5
3	Mackerel	Dioxins Cadmium Copper Lead Mercury	0.00000031 0.023 0.685 0.006 0.072	No limit No limit No limit 0.5 0.5

Table 20(B). Analysis of wildcaught fish for trace elements and persistent organic pollutants
(Food Standards, Australia New Zealand, 2005)

No	Fish	Residue	Average concentra-tion	MRL
4	**Prawn**	**Cadmium** **Copper** **Lead** **Mercury**	**0.02** **3.634** **0.009** **0.040**	**No limit** **No limit** **No limit** **0.5**
5	**Trout**	**Dioxins** **Cadmium** **Copper** **Lead** **Mercury**	**0.00000025** **0.006** **2.230** **0.009** **0.126**	**No limit** **No limit** **No limit** **0.5** **0.5**
6	**Tuna**	**Dioxins** **Cadmium** **Copper** **Lead** **Mercury**	**0.00000044** **0.007** **1.515** **0.012** **0.343**	**No limit** **No limit** **No limit** **0.5** **1.0**

Table 21`. Some Maximum Residue Limits (MRLs in mg/kg on onions registered for use in Australia (DAFF, Australian Government, 2010)

No	Pesticide	Australia	EU	Japan	Malaysia	Singapore
1	Diazinon	0.70	0.05	0.05	Not set	0.50
2	Methyl Parathion	Not set	0.02	1.00	Not set	Not set
3	Aldrin	0.1	0.05	1.00	Not set	Not set
4	DDT	1.0	0.05	0.50	Not set	1.00
5	Endosulfan	0.2	0.05	0.20	Not set	0.20
6	Endrin	Not set	0.01	0.01	Not set	Not set
7	HCH	Not set	0.01	Not set	Not set	Not set
8	Heptachlor	0.05	0.01	0.03	Not set	0.05
9	Lindane	2.0	0.01	2.0	Not set	Not set
10	Cypermethrin	0.01	0.10	0.10	Not set	0.10
11	Pyrethrins	1.0	1.0	1.0	Not set	1.0

Not set – denotes that no MRL has been established, refer to details above for each countries default value**.**

10.6. Analysis of environmental chemical residues in products of emerging aquaculture industry in Uganda (December 2008)

A study was conducted to analyse market-regulated heavy metals (lead, mercury and cadmium) and organochlorine pesticides in samples of 38 farmed fish comprising Nile tilapia (*Oreochromis niloticus*) (20 samples) and African catfish

(*Clarias gariepinus*) (18 samples) from ten selected fish farms in Uganda.

- Lead was detected in all the 38 samples (maximum = 1.08 mg kg^{-1} (dry weight)),
-Mercury in 31 out of 38 samples (maximum= 0.35mg kg^{-1} (dry weight)),
-Cadmium in two samples (maximum = 0.03 mg kg^{-1} (dry weight)).
-Pesticides detected were: 4,4'-dichloro-diphenyl-trichloroethane (DDT) and endosulfan sulphate, which were found in one fish sample (both 0.002 mg kg^{-1} (wet weight)).

The levels of contaminants were below the US Food and Drug Administration (USFDA) action levels and European Union maximum residue limits (MRLs), indicating that such fish have the potential for export to Markets (Bagumire, 2008).

10.7. Trade problems arising from differing maximum residue levels for veterinary drug and pesticide residues

An international effort is underway to harmonize the procedures and assumptions used for establishing maximum residue levels (MRLs) for residues of veterinary drugs and pesticides. Apparent conflicts in MRLs may not actually reflect differing safety assessments for the residues but may be due to different safety factors, methods of analysis, consumption factors, etc. Equivalence is an important principle in the U.S. position on agricultural trade.

Countries wishing to export food products to the U.S. must demonstrate that their country's residue control programs are equivalent to the U.S. program. From the U.S. export perspective,

there have been several instances of trade problems resulting from different MRLs. The most significant was the decision by the European Economic Community not to accept U.S. beef if the animals were administered anabolic steroids. Another example involved the Japanese rejection of U.S. pork because of sulfamethazine residues. These examples illustrate the importance of harmonization to future efforts to facilitate free trade and reduce the resource burden on government regulatory bodies (Carnevale, 2008).

11. Home food preparation to reduce exposure to pesticide residues

11.1. Health hazard of pesticide residue on fruit and Vegetable

You need to be aware of the dangers of pesticides and you must minimize your exposure to them. Risks you can face with pesticides are:

- Digestive problems
- Damage to the nervous system
- Carcinogenic risks
- Damage to the hormone systems
- Skin, eye, and lung irritation

11.2. Food preparation to reduce exposure to pesticide residue on fresh fruit and vegetable and meat

To reduce the amounts of pesticide residues in food, consumers can wash, peel, cook and dip their food; **trim the fat from meat;** and eat a variety of foods to avoid repeated exposures to a pesticide typically used on a given crop, however, many pesticides are systemic, which means they penetrate into the fruit and vegetable itself and cannot be washed off. Many pesticides are also by design created to be rain-proof.

The following basic food preparation practices and habits can further reduce your exposure to pesticide residues on fresh fruits and vegetables.

(a)Washing vegetable and fruit. Household washing procedures are normally carried outwithrunningorstanding water at moderate outwithrunningorstanding water at moderate temperatures. You can wash using a very diluted solution of mild dishwashing detergent (1 tsp detergent per gallon, or 4 liters, water).

For grapes, strawberries, green beans, and leafy vegetables, swirl the foods in a dilute solution of dish detergent and water at room temperature for 5 to 10 seconds, then rinse with slightly warm water.

For the other fruits and vegetables, use a soft brush to scrub the food with the solution for about 5 to 10 seconds, then rinse again with slightly warm water.

(b) Peel fruits with higher residue levels. Peeling fruits, especially peaches, pears and apples, will help remove residues. Be sure to keep the peelings out of the compost. The outer leaves of vegetables often contain residues of pesticides applied during the growing season. Therefore, peeling or trimming procedures reduce the residues levels in leafy vegetables. Peeling of root, tuber and bulb vegetables with a knife is common household practice.

Many examples show that most of the residues concentration is located in or on the peel. Peeling may remove more than 50% of the pesticide residues present in the commodity. Thus, removal of the peel achieves almost complete removal of residues, so leaving little in the edible portions. This is especially important for fruits which are not eaten with their peels, such as bananas or citrus fruits. Peeling or trimming of carrot reduced the residues of chlorfenvinphos, primiphos-methyl, quinalphos, triazophos. After application of thiometon on cucumbers, no reduction of residue

levels could be detected in the peeled cucumbers. Some pesticides permeate the skin of the fruit, so this method does not guarantee residual free produce in all cases.

(c) Cooking. Several studies were reported on the dissipation of pesticides in crops during cooking. Residues of organophosphorus pesticides chlorfenvinphos, fenitrpothion, isoxathion, methidathion and prothiophos decreased during the cooking process corresponding to the boiling time. According to their water solubility, some pesticides were translocated from the raw materials into the cooking water.

Don't microwave foods in plastic containers. Chemicals from the plastic container can become absorbed by food during microwaving. Cover with waxed paper or paper towel instead of plastic wrap to keep food from spattering.

(d) Dipping in chemical solution. Sodium chloride solution is largely used to decontaminate the pesticide residues from different fruits and vegetables. There are several studies to prove the efficacy of salt water washing to dislodge the pesticides from crops. In this process, sample of chopped fruits and vegetables is put in a beaker containing 5% sodium chloride solution. After 15 minutes the plant samples are gently rubbed by hand in salt solution and salt water is decanted.

Dipping of green chillies in 2% salt solution for 10 minute followed by water wash prove to be effective, facilitating the removal of 32.56 and 84.21% residues correspondingly at 0 and 5 days after spray of triazophos (700g a.i./ha) while the acephate residues were removed to an extent of 78.95% at zero day. Following same technique it was also observed that 90.56 and 66.93% reduction correspondingly on 0 and 5 days after spraying of cypermethrin in chillies.

Dip treatment of fruits in NaCl solution, HCl, acetic acid, NaOH solution, potassium permanganate removed 50-60% of surface residues of synthetic pyrethroids compared to 40-50% removal by hydrolytic degradation with NaOH.

11.3. Buy organic.

Fruit and vegetable certified as 'Organic' is your best assurance of pesticide-free status. Buying organic, in-season produce from your local market is the best assurance of pesticide-free produce.

12. Effects of toxic household chemicals

12.1. Types of toxic household chemicals

Toxic household chemicals are silent killers. Many household products can harm children, pets and environment if not used and stored correctly. Toxic substances in these products can cause harm if inhaled, swallowed or absorbed through the skin. At high doses a toxic substance might cause birth defects or other serious problems, including drain or death.

These different chemicals give off toxins that enter our body and can make us sick. Some of these chemicals are bleach, pine sol, cleaners, ammonia, glass cleaners, polish, sprays, disinfectants, and many other cleaning products. Some other chemicals are detergents, paints, gasoline, polishes, sprays, and many others. We should be extra careful when using these products.

(a)Toxic household cleaning products include:

- bleach
- dishwashing liquids
- floor waxes and furniture polishes
- laundry detergents
- mildew removers
- oven cleaners
- toilet bowl cleaners

(b) Personal care products

. - deodorant
- hairspray

- nail polish and polish remover
- perfume
- shampoo
- hair dye

(c) Other toxic substances that can be inhaled include:

- farm and garden insecticides and herbicides
- insect repellents
- paint thinner fumes

12.2. The effects of cosmetics and perfumes on your body

Nowadays most of our people are using varieties of cosmetics, makeup things, such as Moisturizers, Lipsticks, Lotions, Face creams, Shampoos, Shaving creams, Deodorants and Hair Dyes. Phthalates, Acrylamine, Formaldehyde and Ethylene Oxide are some chemicals present in the cosmetics and act as allergens. They are the things which cause an allergic reaction in our body.

. Some ingredients of Face creams are causing giddiness, vomiting and lack of sleep. Sometimes, face creams work reversely to some persons and totally spoil the natural previous beauty.

Our total body health is susceptible to be affected by the toilet soap which may cause allergy to us. The allergy of toilet soap may cause lack of sleep and briskless feeling.

Many people are “bothered” by perfumes – developing headaches, sinus problem, and even asthma from exposure. These chemicals go directly into the blood stream when applied to our skin and are also absorbed into skin from your clothing. We also

inhale the chemical fumes, which then go straight to our brains where they can do major harm. Many even have a “narcotic” effect, which is why some people seem “addicted” to their perfumes.

Skin and other allergic reactions pose the biggest risk to hair dye users. Signs of mild reaction may only be irritation of the upper eyelids or rims of the ears, but in more severe reactions, the whole head or body may be involved. A severe form of allergic reaction is anaphylactic shock. When this occurs, the mouth and tongue swell and the airways constrict. Anaphylaxis can be rapidly fatal, and there have been isolated cases of hair dyes causing anaphylactic shock.

12.3. Toxic chemicals affect the health of children

The most pressing health issues for children today are:

-the rise of asthma
-the rise in childhood cancers
-the rise in central nervous system disorders, attention Deficit Disorder (ADD), and other learning disorders as the result of environmental neurotoxins.
- the effects of endocrine disruptors

12.4. Reducing toxics inside your house

Until recently, indoor air pollution has been largely ignored as a source of exposure to toxicity. But studies have shown that levels of harmful chemicals in indoor air may exceed the standard to protect us from harmful chemicals. You can avoid such levels in your home by buying and using products that are free of toxic chemicals whenever possible.

(a) Choosing the products you buy. Whenever possible, buy products that are free of toxic chemicals. When purchasing products, take a minute to carefully read the label. Look for products that appear to disclose all their ingredients. Choose the least-hazardous product to do the job. Before you use a product, carefully read the directions and follow the instructions. Select products (cleaners, shampoos, etc.) made from plant-based materials, such as oils made from citrus, seed, vegetable or pine. By doing so, you are selecting products that are biodegradable and generally less toxic. These products also provide the additional benefit of being made from renewable resources. Ask for plant-based products at your local grocery or retail store.

Choose pump spray containers instead of aerosols. Pressurized aerosol products often produce a finer mist that is more easily inhaled. Aerosols also put unnecessary volatile organic chemicals into your indoor air when you use them.

(b) Bath, beauty and hygiene products. Avoid using antibacterial soaps. Antibacterial agents, while not directly harmful to you, contribute to the growing problem we face when bacteria mutate to strains that are more drug-resistant. Remember, however, that hand washing with any soap is still vital to maintaining good health.

Purchase a mercury-free fever thermometer. Broken mercury fever thermometers can be a source of toxic mercury levels in your home and discarded products containing mercury contribute to higher levels in the environment.

Use eye drops, contact lens solutions, and nasal sprays and drops that are free of thimerosal or other mercury-containing preservatives.

Look for unscented and natural dyes in products to avoid potential allergic reactions.

(c) Keeping your house clean. Baking soda works well to clean sinks, tubs and toilets, and it freshens drains as well. Vegetable oil with a little lemon juice works wonders on wood furniture.

Simmer a mixture of cloves and cinnamon or use vinegar and water as a safe and environmentally friendly air freshener. Consider how you can eliminate odor problems rather than just covering them up.

Use vinegar and water in a pump spray bottle for cleaning mirrors and shining chrome. Vinegar or soap and water with drying rags or a squeegee also work well for cleaning windows.

Use reusable unbleached cotton towels, rags, and non-scratch scrubbing sponges for all-purpose cleaning instead of bleached disposable paper products.

Use dishwasher detergents that are free of chlorine bleach and lowest in phosphates.

Use bathroom cleaners that are free of aerosol propellants and antibacterial agents.

(d) Doing the laundry. Instead of more complicated detergents, try using a combination of washing soda and borax in your machine. These are usually as effective as more complex formulas and are also usually cheaper. Avoid bleach when possible. If whitening is needed, use non-chlorine bleach, which is oxygen based and often highly effective.

13. Negative Side Effects of Genetically Modified Foods

13.1. Introduction

Genetically Modified Foods (GM foods) or Genetically modified organisms (GMOs) are defined as organisms (except for human beings) in which the genetic material has been altered in a way that does not occur naturally by mating and/or natural recombination. GMOs have widespread applications as they are used in biological and medical research, production of pharmaceutical drugs, experimental medicine, and agriculture. The use of gene technology in food production has become interesting due to increased needs of food as well as its improved quality. With the application of gene technology to plants and animals, goals can be achieved more quickly than by traditional selection. Consequently, ethical dilemmas are opened concerning the eventual negative effects of production of genetically modified food. It seems that supplementation of nutraceuticals and wild foods as well as wild lifestyle may be protective, whereas western diet and lifestyle may enhance the expression of genes related to chronic diseases.

The prevalence and mortality due to multifactorial polygenic diseases; hypertension, coronary artery disease (CAD), diabetes and cancer vary depending upon genetic susceptibility and environmental precursors because they have identifiable Mendelian subsets. Rapid changes in diet and lifestyle may influence heritability of the variant phenotypes that are dependent on the nutraceutical or functional food supplementation for their expression.

It is possible to recognize the interaction of specific nutraceuticals, with the genetic code possessed by all nucleated cells. There is evidence that South Asians have an increased

susceptibility to CAD, diabetes mellitus, central obesity and insulin resistance at younger age, which may be due to interaction of gene and nutraceutical environment. The negative consequences can affect the human health and environment.

13.2. Effects of Genetically Modified Foods on Human Health

Recombinant DNA technology faces our society with problems unprecedented not only in the history of science, but of life on Earth. Potentially, it could breed new animal and plant diseases.

13.2.1. Cancer

Growth Hormone (GH) is a protein hormone which, when injected into cows stimulates the pituitary gland in a way that the produces more milk, thus making milk production more profitable for the large dairy corporations. In 1993, FDA approved Monsanto's genetically-modified rBGH, a genetically-altered growth hormone that could be then injected into dairy cows to enhance this feature, and even though scientists warned that this resulted in an increase of IGF-1 (from (70%-1000%). IGF-1 is a very potent chemical hormone that has been linked to a 2 1/2 to 4 times higher risk of human colorectal and breast cancer. Prostate cancer risk is considered equally serious – in the 2,8.to 4 times range. According to Dr. Samuel Epstein of the University of Chicago and Chairman of the Cancer Prevention Coalition, this "induces the malignant transformation of human breast epithelial cells." Canadian studies confirmed such a suspicion and showed active IGF-1 absorption, thyroid cysts and internal organ damage in rats.

13.2.2. Super viruses

Viruses can mix with genes of other viruses and retroviruses such as HIV. This can give rise to more deadly viruses – and at rates higher than previously thought. One study showed that gene mixing occurred in viruses in just 8 weeks (Kleiner, 1997). This kind of scenario applies to the cauliflower mosaic virus CaMV, the most common virus used in genetic engineering – in Round Up ready soy of Monsanto, Bt-maise of Novaris, and GM cotton and canola. It is a kind of "pararetro virus" or what multiplies by making DNA from RNA. It is somewhat similar to Hepatitis B and HIV viruses and can pose immense dangers.

In a Canadian study, a plant was infected with a crippled cucumber mosaic virus that lacked a gene needed for movement between plant cells. Within less than two weeks, the crippled plant found what it needed from neighboring genes – as evidence of gene mixing or horizontal transfer. This is significant because genes that cause diseases are often crippled or engineered to be dormant in order to make the end product "safe." Results of this kind led the US Department of Agriculture to hold a meeting in October of 1997 to discuss the risks and dangers of gene mixing and super viruses, but no regulatory action was taken. A French study also showed the recombination of RNA of two Cucomo viruses, and under conditions of minimal selection and in supposedly virus resistant transgenic plants.

13.2.3. Antibiotic resistance

In recent years health professionals have become alarmed by the increasing number of bacterial strains that are showing resistance to antibiotics. Bacteria develop resistance to antibiotics by creating antibiotic resistance genes through natural mutation. Biotechnologists use antibiotic resistance genes as selectable

markers when inserting new genes into plants. In the early stages of the process scientists do not know if the target plant will incorporate the new gene into its genome. By attaching the desired gene to an antibiotic resistance gene the new GM plant can be tested by growing it in a solution containing the corresponding antibiotic. If the plant survives scientists know that it has taken up the antibiotic resistance gene along with the desired gene. There is concern that bacteria living in the guts of humans and animals could pick up an antibiotic resistance gene from a GM plant before the DNA becomes completely digested.

It is not clear what sort of risk the possibility of conferring antibiotic resistance to bacteria presents. No one has ever observed bacteria incorporating new DNA from the digestive system under controlled laboratory conditions. The two types of antibiotic resistance genes used by biotechnologists are ones that already exist in bacteria in nature so the process would not introduce new antibiotic resistance to bacteria. Never the less it is a concern and the FDA is encouraging biotechnologists to phase out the practice of using antibiotic resistance genes.

13.2.4. Birth Defects and Shorter Life Spans

rBGh in cows causes a rapid increase in birth defects and shorter life spans and the number of calves born with birth defects to dairy cows has increased significantly. Canada and the European Union have taken precautions and banned the use of rBGH in their dairy cows.

In a very recent study by Cornucopia Institute Research the following information was reported: "…The experience of actual GM-fed experimental animals is scary. When GM soy was fed to female rats, most of their babies died within three weeks—compared to a 10% death rate among the control group fed

natural soy. The GM-fed babies were also smaller, and later had problems getting pregnant. When male rats were fed GM soy, their testicles actually changed color—from the normal pink to dark blue. Mice fed GM soy had altered young sperm. Even the embryos of GM fed parent mice had significant changes in their DNA. Mice fed GM corn in an Austrian government study had fewer babies, which were also smaller than normal…"

The American Academy of Environmental Medicine (AAEM) called on 'Physicians to educate their patients, the medical community, and the public to avoid GM (genetically modified) foods when possible and provide educational materials concerning GM foods and health risks.' They called for a moratorium on GM foods, long-term independent studies, and labeling. AAEM's position paper stated, 'Several animal studies indicate serious health risks associated with GM food,' including infertility, immune problems, accelerated aging, insulin regulation, and changes in major organs and the gastrointestinal system. They conclude, 'There is more than a casual association between GM foods and adverse health effects. There is causation,' as defined by recognized scientific criteria. 'The strength of association and consistency between GM foods and disease is confirmed in several animal studies.

13.2.5. Interior Toxins

"Pesticidal foods" have genes that produce a toxic pesticide inside the food's cells. The food is engineered to produce their own built in pesticide in every cell which produces a poison that splits open a bug's stomach and kills them when the bug tries to eat the plant. This represents the first time "cell-interior toxicity" is being sold for human consumption. There is little knowledge of the potential long-term health impacts. However, while some biotech companies claim that the pesticide called Bt has been

approved safe and used by farmers for natural insect control, the Bt-toxin in GM plants is thousands of times more concentrated than the natural bug spray, can not be washed off the plants, and has a properties of allergens. We are now ingesting this interior plant toxin from GM foods.

As individuals ingest more and more genetically modified foods and organisms into their body it has been shown that the bodies toxicity increases which leads to a ton of other potentially serious health problems. There is a definite link between Obesity, Cancer and Toxicity.

13.2.6. Lowered Nutrition

A study in the Journal of Medicinal Food showed that certain GM foods have lower levels of vital nutrients – especially phytoestrogen compounds thought to protect the body from heart disease and cancer. In another study of GM Vicia Faba, a bean in the same family as soy, there was also an increase in estrogen levels, what raises health issues – especially in infant soy formulas. Milk from cows with rBGH contains substantially higher levels of pus, bacteria, and fat. Monsanto's analysis of glyphosate-resistant soya showed the GM-line contained 28% more Kunitz-trypsin inhibitor, a known anti-nutrient and allergen.

13.2.7. Food Allergy

Food Allergy affects approximately 5% of children and 2% of adults in the U.S. and is a significant public health threat. Allergic reactions in humans occur when a normally harmless protein enters the body and stimulates an immune response. If the novel protein in a GM food comes from a source that is known to cause allergies in humans or a source that has never been consumed as human food, the concern that the protein could elicit

an immune response in human increases. Although no allergic reactions to GM food by consumers have been confirmed, in vitro evidence suggesting that some GM products could cause an allergic reaction has motivated biotechnology companies to discontinue their development.

13.3. Effects on Environment

Genetic Engineering is often justified as a human technology, one that feeds more people with better food. Nothing could be further from the truth. With very few exceptions, the whole point of genetic engineering is to increase sales of chemicals and bio-engineered products to dependent farmers.

13.3.1. Soil Sterility and Pollution

In Oregon, scientists found GM bacterium (klebsiella planticola) meant to break down wood chips, corn stalks and lumber wastes to produce ethanol – with the post-process waste to be used as compost – rendered the soil sterile. It killed essential soil nutrients, robbing the soil of nitrogen and killed nitrogen capturing fungi. A similar result was found in 1997 with the GM bacteria Rhizobium melitoli. Professor Guenther Stotzky of New York University conducted research showing the toxins that were lethal to Monarch butterfly are also released by the roots to produce soil pollution. The pollution was found to last up to 8 months with depressed microbial activity. An Oregon study showed that GM soil microbes in the lab killed wheat plants when added to the soil.

13.3.2. Super weeds

It has been shown that genetically modified Bt endotoxin remains in the soil at least 18 months (according to Marc Lappé

and Britt Bailey) and can be transported to wild plants creating super weeds – resistant to butterfly, moth, and beetle pests – potentially disturbing the balance of nature. A study in Denmark and in the UK showed super weeds growing nearby in just one generation. A US study showed the super weed resistant to glufosinate (which differs from glyphosate) to be just as fertile as non-polluted weeds. Another study showed 20 times more genetic leakage with GM plants – or a dramatic increase in the flow of genes to outside species. Also in a UK study by the National Institute of Agricultural Botany, it was confirmed that super weeds could grow nearby in just one generation. Scientists suspect that Monsanto's wheat will hybridize with goat grass, creating an invulnerable super weed. The National Academy of Science's study stated that " concern surrounds the possibility of genes for resisting pests being passed from cultivated plants to their weedy relatives, potentially making the weed problem worse. This could pose a high cost to farmers and threaten the ecosystem."

An experiment in France showed a GM canola plant could transfer genes to wild radishes, what persisted in four generations. Similarly, and according to New Scientists, an Alberta Canada farmer began planting three fields of different GM canola seeds in 1997 and by 1999 produced not one, but three different mutant weeds – respectively resistant to three common herbicides (Monsanto's Roundup, Cyanamid's Pursuit, and Aventis' Liberty). In effect genetic materials migrated to the weeds they were meant to control. Now the Alberta farmer is forced to use a potent 2,4-D what GM crops promised to avoid use of. Finally Stuart Laidlaw reported in the Toronto Star that the Ontario government study indicated herbicide use was on the rise primarily largely due to the introduction of GM crops.

13.3.3. Destruction of Forest Life

GM trees or "super trees" are being developed which can be sprayed from the air to kill literally all of surrounding life, except the GM trees. There is an attempt underway to transform international forestry by introducing multiple species of such trees. The trees themselves are often sterile and flowerless. This is in contrast to rainforests teaming with life, or where a single tree can host thousands of unique species of insects, fungi, mammals and birds in an interconnected ecosphere. This kind of development has been called "death-engineering" rather than "life-" or "bio-engineering." More ominously pollen from such trees, because of their height, has traveled as much as 400 miles or 600 kilometers – roughly 1/5 of the distance across the United States.

13.3.4. Terminator Trees

Monsanto has developed plans with the New Zealand Forest Research Agency to create still more lethal tree plantations. These super deadly trees are non-flowering, herbicide-resistant and with leaves exuding toxic chemicals to kill caterpillars and other surrounding insects – destroying the wholesale ecology of forest life. As George McGavin, curator of entomology Oxford University noted, "If you replace vast tracts of natural forest with flowerless trees, there will be a serious effect on the richness and abundance of insects…If you put insect resistance in the leaves as well you will end up with nothing but booklice and earwigs. We are talking about vast tracts of land covered with plants that do not support animal life as a sterile means to cultivate wood tissue. That is a pretty unattractive vision of the future and I for one want no part of it."

13.3.5. Super pests

Lab tests indicate that common plant pests such as cotton boll worms, will evolve into super pests immune from the Bt sprays used by organic farmers. The recent "stink bug" epidemic in North Carolina and Georgia seems linked to bioengineered plants that the bugs love. Monsanto, on their Farm source website, recommended spraying them with methyl parathion, one of the deadliest chemicals. So much for the notion of Bt cotton getting US farmers off the toxic treadmill. Pests the transgenic cotton was meant to kill – cotton bollworms, pink bollworms, and budworms – were once "secondary pests." Toxic chemicals killed off their predators, unbalanced nature, and thus made them "major pests."

13.3.6. Animal Bio-invasions

Fish and marine life are threatened by accidental release of GM fish currently under development in several countries – trout, carp, and salmon several times the normal size and growing up to 6x times as fast. One such accident has already occurred in the Philippines – threatening local fish supplies.

13.3.7. Killing Beneficial Insects

Studies have shown that GM products can kill beneficial insects – most notably the monarch butterfly larvae. Swiss government researchers found Bt crops killed lacewings that ate the cotton worms which the Bt targeted. A study reported in 1997 by New Scientist indicates honeybees may be harmed by feeding on proteins found in GM canola flowers. Other studies relate to the death of bees (40% died during a contained trial with Monsanto's Bt cotton), springtails and ladybird beetles.

13.3.8. Poisonous to Mammals

In a study with GM potatoes, spliced with DNA from the snowdrop plant and a viral promoter (CaMV), the resulting plant was poisonous to mammals (rats) – damaging vital organs, the stomach lining and immune system. CaMV is a pararetro virus. It can reactivate dormant viruses or create new viruses – as some presume have occurred with the AIDES epidemic. CaMV is promiscuous, why biologist Mae Wan-Ho concluded that "all transgenic crops containing CaMV 35S or similar promoters which are recombinogenic should be immediately withdrawn from commercial production or open field trials. All products derived from such crops containing transgenic DNA should also be immediately withdrawn from sale and from use for human consumption or animal feed."

13.3.9. Animal Abuse

Pig number 6706 was supposed to be a "super pig." It was implanted with a gene to become a technological wonder. But it eventually became a "super cripple" full of arthritis, cross-eyed, and could barely stand up with its mutated body. Some of these mutations seem to come right out of Greek mythology – such as a sheep-goat with faces and horns of a goat and the lower body of a sheep. Two US biotech companies are producing genetically modified birds as carriers for human drug delivery – without little concern for animal suffering. Gene Works of Ann Arbor, Michigan has up to 60 birds under "development." GM products, in general, allow companies to own the rights to create, direct, and orchestrate the evolution of animals.

13.3.10. Genetic Pollution

Carrying GM pollen by wind, rain, birds, bees, insects, fungus, bacteria – the entire chain of life becomes involved. Once released, unlike chemical pollution, there is no cleanup or recall possible. As mentioned, pollen from a single GM tree has been shown to travel 1/5th of the length of the United States. Thus there is no containing such genetic pollution. Experiments in Germany have shown that engineered oilseed rape can have its pollen move over 200 meters. As a result German farmers have sued to stop field trials in Berlin.

In Thailand, the government stopped field tests for Monsanto's Bt cotton when it was discovered by the Institute of Traditional Thai Medicine that 16 nearby plants of the cotton family, used by traditional healers, were being genetically polluted. US research showed that more than 50% of wild strawberries growing inside of 50 meters of a GM strawberry field assumed GM gene markers. Another showed that 25-38% of wild sunflowers growing near GM crops had GM gene markers.

A recent study in England showed that despite the tiny amount of GM plantings there (33,750 acres over two years compared to 70-80 million acres per year in the US) wild honey was found to be contaminated. This means that bees are likely to pollinate organic plants and trees with transgenic elements. Many other insects transport the by-products of GM plants throughout our environment, and even falling leaves can dramatically affect the genetic heritage of soil bacteria. The major difference between chemical pollution and genetic pollution is that the former eventually is dismantled or decays, while the later can reproduce itself forever in the wild.

As the National Academy of Science's report indicated – "the containment of crop genes is not considered to be feasible when seeds are distributed and grown on a commercial scale." Bioengineering firms are also developing fast growing salmon, trout, and catfish as part of the "blue revolution" in aquaculture. They often grow several times faster (6x faster for salmon) and larger in size (up to 39X) so as to potentially wipe out their competitors in the wild. There are no regulations for their safe containment to avoid ecological disasters. They frequently grow in "net pens," renown for being torn by waves, so that some will escape into the wild. If so, commercial wild fish could be devastated according to computer models in a study of the National Academy of Sciences by two Purdue University scientists (William Muir and Richard Howard). All of organic farming – and farming per se – may eventually be either threatened or polluted by this technology.

13.3.11. General Economic Harm to Small Family Farms

GM seeds sell at a premium, unless purchased in large quantities, which creates a financial burden for small farmers. Many GM products, such as rBGH, seem to offer a boom for dairy farmers – helping their cows produce considerably more milk. But the end result has been a lowering of prices, again putting the smaller farmers out of business. We can find similar trends with other GM techniques – as in pig and hen raising made more efficient. The University of Wisconsin's GM brooding hens lack the gene that produces prolactin proteins. The new hens no longer sit on their eggs as long, and produce more. Higher production leads to lower prices in the market place. The end result is that the average small farmer's income plummeted while a few large-scale, hyper-productive operations survived along with their "input providers" (companies selling seeds, soil amendments, and so on).

In an on-going trend, the self-sufficient family farmer is shoved to the very lowest rung of the economic ladder. In 1910 the labor portion of agriculture accounted for 41% of the value of the finally sold produce. Now the figure has been estimated at between 6-9% in North America. The balance gets channeled to agri-input and distribution firms – and more recently to biotech firms. Kristin Dawkins in Gene Wars: The Politics of Biotechnology, points out that between 1981 and 1987, food prices rose 36%, while the percentage of the pie earned by farmers continued to shrink dramatically.

13.3.12. Losing Natural Pesticides

Organic farmers have long used "Bt" (a naturally occurring pesticidal bacterium, Bacillus thuringiensis) as an invaluable farming aide. It is administered at only certain times, and then sparingly, in a diluted form. This harms only the target insects that bite the plant. Also in that diluted form, it quickly degrades in the soil. By contrast, genetically engineered Bt corn, potatoes and cotton – together making up roughly a third of US GM crops – all exude this natural pesticide. It is present in every single cell, and pervasively impacts entire fields over the entire life span of crops. This probably increases Bt use at least a million fold in US agriculture. According to a study conducted at NYU, BT residues remained in the soil for as much as 243 days. As an overall result, agricultural biologists predict this will lead to the destruction of one of organic farming's most important tools. It will make it essentially useless. A computer model developed at the University of Illinois predicted that if all US Farmers grew Bt resistant corn, resistance would occur within 12 months. Scientists at the University of North Carolina have already discovered Bt resistance among moth pests that feed on corn. The EPA now requires GM planting farmers to set aside 20-50% of

acres with non-BT corn to attempt to control the risk and to help monarch butterflies survive.

13.3.13. Monopolization of Food Production

The rapid and radical change in the human diet was made possible by quick mergers and acquisitions that moved to control segments of the US farming industry. Although there are approximately 1500 seed companies worldwide, about two dozen control more than 50% of the commercial seed heritage of our planet. The consolidation has continued to grow, In 1998 the top five soy producers controlled 37% of the market (Murphy Family Foods; Carroll's Foods, Continental Grain, Smithfield Foods, and Seaboard). One year later, the top five controlled 51% (Smithfield, having acquired Murphy's and Carroll's, Continental, Seaboard, Prestige and Cargill). Cargill and Continental Grain later merged.

With corn seed production and sales, the top four seed companies controlled 87% of the market in 1996 (Pioneer Hi-Bred, Holden's Foundation Seeds, DeKalb Genetics, and Novaris). In 1999, the top three controlled 88% (Dupont having acquired Pioneer, Monsanto having acquired Holden's and DeKalb, and Novaris. In the cotton seed market, Delta and Land Pine Company now control about 75% of the market. The concentration is staggering. National farming associations see this dwindling of price competition and fewer distribution outlets as disfavoring and threatening the small family farm. Average annual income per farm has plummeted throughout the last decade. Almost a quarter of all farm operating families live below the poverty level, twice the national average – and most seek income from outside the farm to survive. A similar pattern is developing in Europe.

13.3.14. Impact on Long -Term Food Supply

If food production is monopolized, the future of that supply becomes dependent on the decisions of a few companies and the viability of their seed stocks. Like the example of Peru, there are only a few remaining pockets of diverse seed stocks to insure the long-term resilience of the world's staple foods. Food scientists indicate that if these indigenous territories are disturbed by biotech's advance, the long-term vitality of all of the world's food supply is endangered.

13.4. Conclusion

Genetically-modified foods have the potential to solve many of the world's hunger and malnutrition problems, and to help protect and preserve the environment by increasing yield and reducing reliance upon chemical pesticides and herbicides. Yet there are many challenges ahead for governments, especially in the areas of safety testing, regulation, international policy and food labeling. Many people feel that genetic engineering is the inevitable wave of the future and that we cannot afford to ignore a technology that has such enormous potential benefits. What will happen if this technology is allowed to spread? Fifty years ago few predicted that chemical pollution would cause so much vast environmental harm. Now nearly 1/3rd of all species are threatened with extinction (and up to half of all plant species and half of all mammals). Few also knew that cancer rates would skyrocket during this same period. Nowadays approximately 41% on average of Americans can expect cancer in their lifetime. So we must proceed with caution to avoid causing unintended harm to human health and the environment as a result of our enthusiasm for this powerful technology. The use of genetically modified organisms in foods was recently banned in Europe.

14. Effects of Smoking on Human Health

14.1. Introduction

Tobacco has a negative effect on almost every organ of the body. According to the U.S. Department of Health & Human Services, tobacco use is the leading preventable cause of death in the United States, resulting in more than 443,000 deaths each year. Worldwide, recent studies have shown that tobacco is responsible for about 6 million deaths each year. In March 2012, the U.S. Department of Health & Human Services reported that, from 1975 to 2000, nearly 800,000 deaths from lung cancer in the United States were prevented due to declines in smoking as a result of tobacco control programs and policies. This data was presented in the *Journal of the National Cancer Institute* (NCI).

A report called *Smokeless Tobacco and Public Health: A Global Perspective* was released by the National Cancer Institute in December 2014. According to this report, more than 300 million people in at least 70 countries use harmful smokeless tobacco products. Cigar smokers and smokeless tobacco (chew or spit tobacco) users have similar health risks as cigarette smokers, including oral cancer, esophageal cancer, and pancreatic cancer, as well as oral health problems like mucosal lesions, leukoplakia, and periodontal disease. Smokeless tobacco products also contain nicotine, and users often demonstrate signs of dependence similar to those of cigarette smokers.

14.2. Toxic Chemicals in Tobacco Smoke

Tobacco smoke contains chemicals that are harmful to both smokers and nonsmokers. Breathing even a little tobacco smoke

can be harmful. Cigarettes contain about 600 ingredients. When they burn, they generate more than 7,000 chemicals, according to the American Lung Association. Of the more than 7,000 chemicals in tobacco smoke, at least 250 are known to be harmful, including hydrogen cyanide, carbon monoxide, and ammonia. Among the 250 known harmful chemicals in tobacco smoke, at least 69 can cause cancer.

Many of the same ingredients are found in cigars and in tobacco used in pipes and hookahs. According to the National Cancer Institute, cigars have a higher level of carcinogens, toxins, and tar than cigarettes.

These cancer-causing chemicals include the following : Arsenic, Benzene, Beryllium (a toxic metal), 1,3–Butadiene (a hazardous gas), Cadmium (a toxic metal), Chromium (a metallic element), Ethylene oxide, Nickel (a metallic element), Polonium-210 (a radioactive chemical element) and Vinyl chloride.

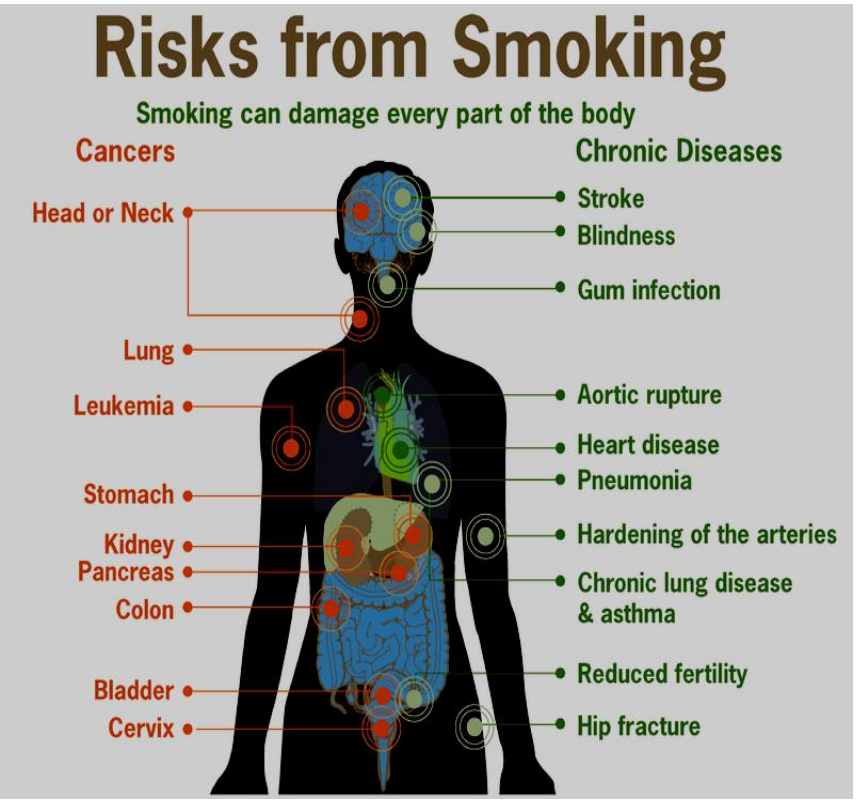
Other toxic chemicals in tobacco smoke are suspected to cause cancer, including Formaldehyde, Benzo[α]pyrene and Toluene.

14.3. Effects of Smoking on Human Health

Tobacco use most commonly leads to diseases affecting the heart and lungs and will most commonly affect areas such as hands or feet with first signs of smoking related health issues showing up as numbness, with smoking being a major risk factor for heart attacks, Chronic Obstructive Pulmonary Disease (COPD), emphysema, and cancer, particularly lung cancer, cancers of the larynx and mouth, and pancreatic cancer. Overall

life expectancy is also reduced in long term smokers, with estimates ranging from 10 to 17.9 years fewer than nonsmokers.

About one half of long term male smokers will die of illness due to smoking. The association of smoking with lung cancer is strongest, both in the public perception and etiologically. Among male smokers, the lifetime risk of developing lung cancer is 17.2%; among female smokers, the risk is 11.6%. This risk is significantly lower in nonsmokers: 1.3% in men and 1.4% in women.



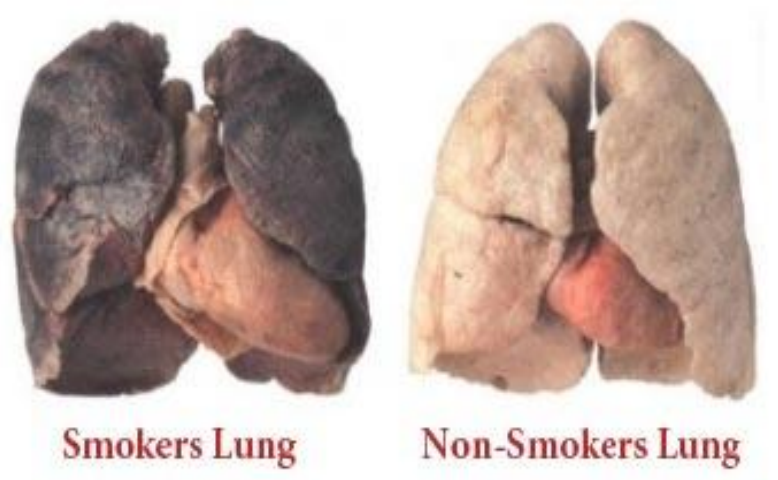
Smoking harms nearly every organ of the body. Tobacco smoke is enormously harmful to your health. There's no safe way to smoke. Replacing your cigarette with a cigar, pipe, or hookah won't help you avoid the health risks associated with tobacco products.

When using a hookah pipe, you're likely to inhale more smoke than you would from a cigarette. Hookah smoke has many toxic compounds and exposes you to more carbon monoxide than cigarettes do. Hookahs also produce more secondhand smoke. In the United States, the mortality rate for smokers is three times that of people who never smoked, according to the Centers for Disease Control and Prevention.

14.3.1. Effects on Lung

Cigarette smoking is the major cause of chronic obstructive pulmonary disease (COPD), which includes chronic bronchitis and emphysema. Chronic bronchitis occurs when the airways in your lungs have become narrow and partly clogged with mucus. Smoking destroys the tiny air sacs, or alveoli, in the lungs that allow oxygen exchange. When you smoke, you are damaging some of those air sacs. Alveoli don't grow back, so when you destroy them, you have permanently destroyed part of your lungs.

When enough alveoli are destroyed, the disease emphysema develops. Emphysema causes severe shortness of breath and can lead to death. Smoking also increases your risk of getting the flu and colds. Your airways are lined with tiny brush like hairs, called cilia. The cilia sweep out mucus and dirt so your lungs stay clear. Smoking temporarily paralyzes and even kills cilia. This makes you more at risk for infection. Smokers get more colds and respiratory infections than non-smokers. Long-term smokers are also at increased risk of lung cancer.



14.3.2. Smoking and Heart Disease Risk

Smoking can cause atherosclerosis leading to coronary artery disease and peripheral arterial disease. Inhalation of tobacco smoke causes several immediate responses within the heart and blood vessels. Within one minute the heart rate begins to rise, increasing by as much as 30 percent during the first 10 minutes of smoking. Carbon monoxide in tobacco smoke exerts its negative effects by reducing the blood's ability to carry oxygen. Both of these conditions can become permanent with prolonged use of cigarettes.

Smoking also increases the chance of heart disease, stroke, atherosclerosis, and peripheral vascular disease. Several ingredients of tobacco lead to the narrowing of blood vessels, increasing the likelihood of a blockage, and thus a heart attack or stroke. According to a study by an international team of

researchers, people under 40 are five times more likely to have a heart attack if they smoke.

Recent research by American biologists has shown that cigarette smoke also influences the process of cell division in the cardiac muscle and changes the heart's shape. The usage of tobacco has also been linked to Buerger's disease (*thromboangiitis obliterans*) the acute inflammation and thrombosis (clotting) of arteries and veins of the hands and feet.

Smoking tends to increase blood cholesterol levels. Furthermore, the ratio of high-density lipoprotein (the "good" cholesterol) to low-density lipoprotein (the "bad" cholesterol) tends to be lower in smokers compared to non-smokers. Smoking also raises the levels of fibrinogen and increases platelet production (both involved in blood clotting) which makes the blood viscous. Carbon monoxide binds to haemoglobin (the oxygen-carrying component in red blood cells), resulting in a much stabler complex than haemoglobin bound with oxygen or carbon dioxide—the result is permanent loss of blood cell functionality.

Blood cells are naturally recycled after a certain period of time, allowing for the creation of new, functional erythrocytes. However, if carbon monoxide exposure reaches a certain point before they can be recycled, hypoxia (and later death) occurs. All these factors make smokers more at risk of developing various forms of arteriosclerosis. As the arteriosclerosis progresses, blood flows less easily through rigid and narrowed blood vessels, making the blood more likely to form a thrombosis (clot). Sudden blockage of a blood vessel may lead to an infarction (stroke). However, it is also worth noting that the effects of smoking on the heart may be more subtle. These conditions may develop gradually given the smoking-healing cycle (the human body heals

itself between periods of smoking), and therefore a smoker may develop less significant disorders such as worsening or maintenance of unpleasant dermatological conditions, e.g. eczema, due to reduced blood supply. Smoking also increases blood pressure and weakens blood vessels.

14.3.3. Effects on Brain

Smoking blocks the carotid artery. So, blood supply to the brain cells are cut off. This results in stroke, called cerebral thrombosis. Smokers' risk of having a stroke is 1.5 times more than non-smokers. Smoking increases your risk of having a stroke by at least 50%, which can cause brain damage and death. And, by smoking, you double your risk of dying from a stroke.

One way that smoking can increase your risk of a stroke is by increasing your chances of developing a brain aneurysm. This is a bulge in a blood vessel caused by a weakness in the blood vessel wall. This can rupture or burst which will lead to an extremely serious condition known as a subarachnoid haemorrhage, which is a type of stroke, and can cause extensive brain damage and death. The good news is that within two years of stopping smoking, your risk of stroke is reduced to half that of a non-smoker and within five years it will be the same as a non-smoker.

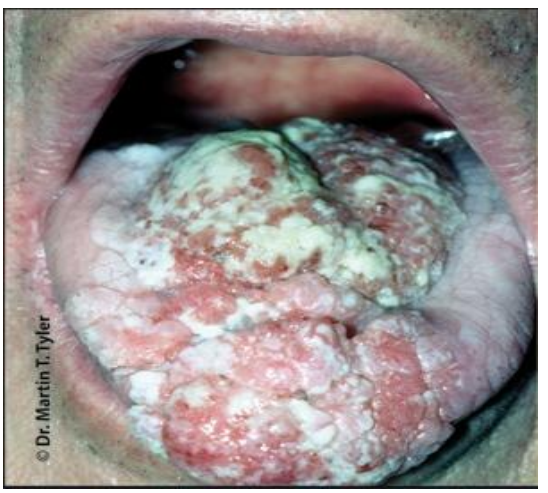
Smoking also lowers down the smokers' IQ. This fact has been established by a study conducted by University of Michigan researchers

14.3.4. Oral Problems

Smokers are at great risk of developing oral problems. Tobacco use can cause gum inflammation (gingivitis) or infection

(periodontitis). These problems can lead to tooth decay, tooth loss, and bad breath.

Tobacco exposure, whether in the form of chewing tobacco or smoking cigarettes, pipes, or cigars, greatly increases your risk of getting mouth cancer and other mouth diseases. In fact, people who smoke cigarettes are about 5 to 10 times as likely to get mouth (oral) cancer as are non-smokers. In the following figure, white spots are a form of oral cancer caused primarily by smoking.



Another disease that can affect the gums besides cancer is periodontal (gum) disease. This disease is known in its early stages as *gingivitis*. Gingivitis is a condition where the gums swell, redden, and bleed because of a buildup of bacteria. Although non-smokers can also develop gingivitis because of poor oral hygiene, the toxic chemicals from tobacco increase your risk of developing this gum disease.

Full-blown periodontal disease is a more serious infection that leads to pockets forming around the teeth. As these pockets become infected, the body tries to kill off the bacteria, but instead it causes damage to the gums and bone holding the teeth in place. This can eventually lead to tooth loss. If you quit smoking and maintain good oral hygiene, you can greatly reduce your chances of gum disease.

14.3.5. Smoking affects Digestive System

Smoking has been shown to have harmful effects on all parts of the digestive system, contributing to such common disorders as heartburn and peptic ulcers. It also increases the risk of Crohn's disease and possibly gallstones. Smoking seems to affect the liver, too, by changing the way it handles drugs and alcohol.

Heartburn is common among Americans. More than 60 million Americans have heartburn at least once a month, and about 15 million have it daily. Heartburn happens when acidic juices from the stomach splash into the esophagus. Normally, a muscular valve at the lower end of the esophagus, the lower esophageal sphincter (LES), keeps the acid solution in the stomach and out of the esophagus. Smoking decreases the strength of the esophageal valve, thereby allowing stomach juice to reflux, or flow backward into the esophagus.

Smoking also seems to promote the movement of bile salts from the intestine to the stomach, which makes the stomach juice more harmful. Finally, smoking may directly injure the esophagus, making it less able to resist further damage from refluxed material.

Stomach acid is also important in producing ulcers. Normally, most of this acid is buffered by the food we eat. Most of the

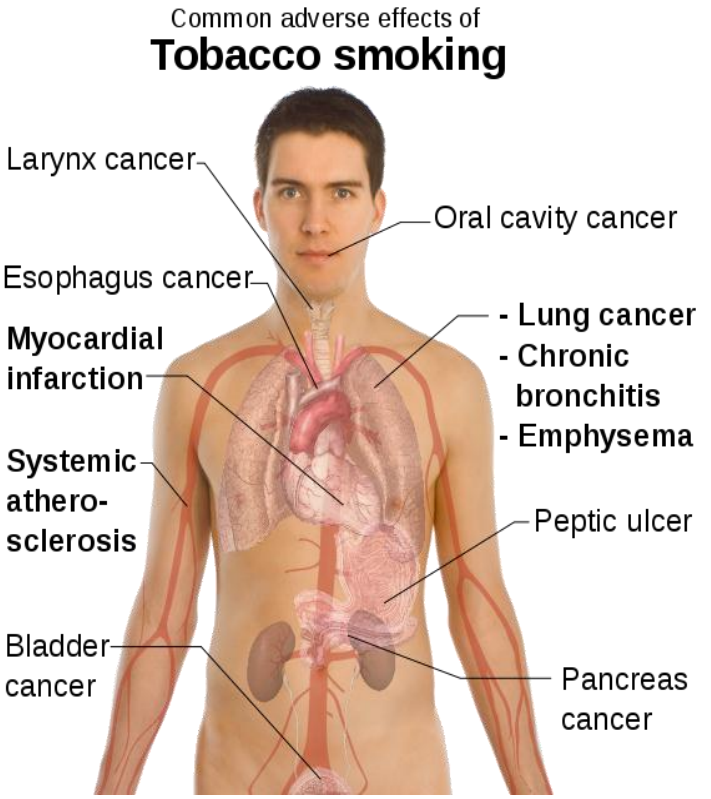
unbuffered acid that enters the duodenum is quickly neutralized by sodium bicarbonate, a naturally occurring alkali produced by the pancreas. Some studies show that smoking reduces the bicarbonate produced by the pancreas, interfering with the neutralization of acid in the duodenum. Other studies suggest that chronic cigarette smoking may increase the amount of acid secreted by the stomach.

People who smoke are more likely to develop an ulcer, especially a duodenal ulcer, and ulcers are less likely to heal quickly among smokers in response to otherwise effective treatment. This research tracing the relationship between smoking and ulcers strongly suggests that a person with an ulcer should stop smoking.

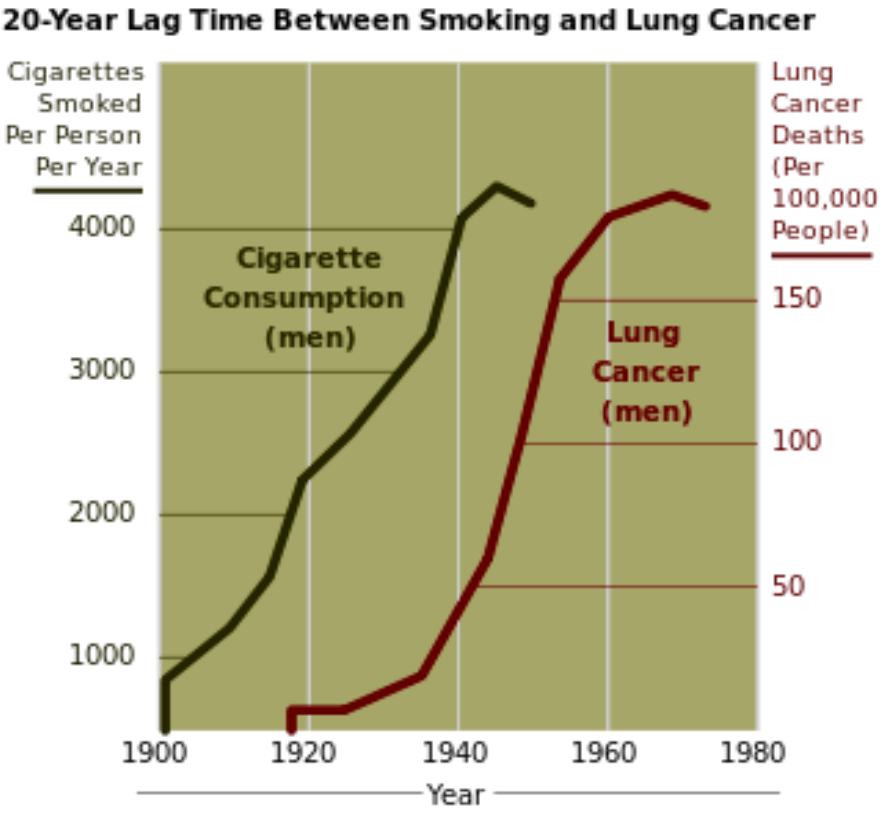
14.3.6. Smoking cause Cancer

Tobacco smoke contains more than 7,000 chemicals. About 70 of them are known to cause cancer. The primary risks of tobacco usage include many forms of cancer, particularly lung cancer, kidney cancer, cancer of the larynx and head and neck, bladder cancer, cancer of the esophagus, cancer of the pancreas and stomach cancer. Studies have established a relationship between tobacco smoke, including secondhand smoke, and cervical cancer in women.

There is some evidence suggesting a small increased risk of myeloid leukaemia, squamous cell sinonasal cancer, liver cancer, colorectal cancer, cancers of the gallbladder, the adrenal gland, the small intestine, and various childhood cancers. The possible connection between breast cancer and tobacco is still uncertain.



The risk of dying from lung cancer before age 85 is 22.1% for a male smoker and 11.9% for a female smoker, in the absence of competing causes of death. The corresponding estimates for lifelong nonsmokers are a 1.1% probability of dying from lung cancer before age 85 for a man of European descent, and a 0.8% probability for a woman. Smoking causes 84% of deaths from lung cancer and 83% of deaths from chronic obstructive lung disease, including bronchitis.



The most serious damage smoking causes in your mouth and throat is an increased risk of cancer in your lips, tongue, throat, voice box and gullet (oesophagus). More than 93% of oropharangeal cancers (cancer in part of the throat) are caused by smoking.

14.3.7. Smoking affects Eyes

Smoking tobacco or being exposed to tobacco smoke can also increase your risk for developing a number of eye disorders

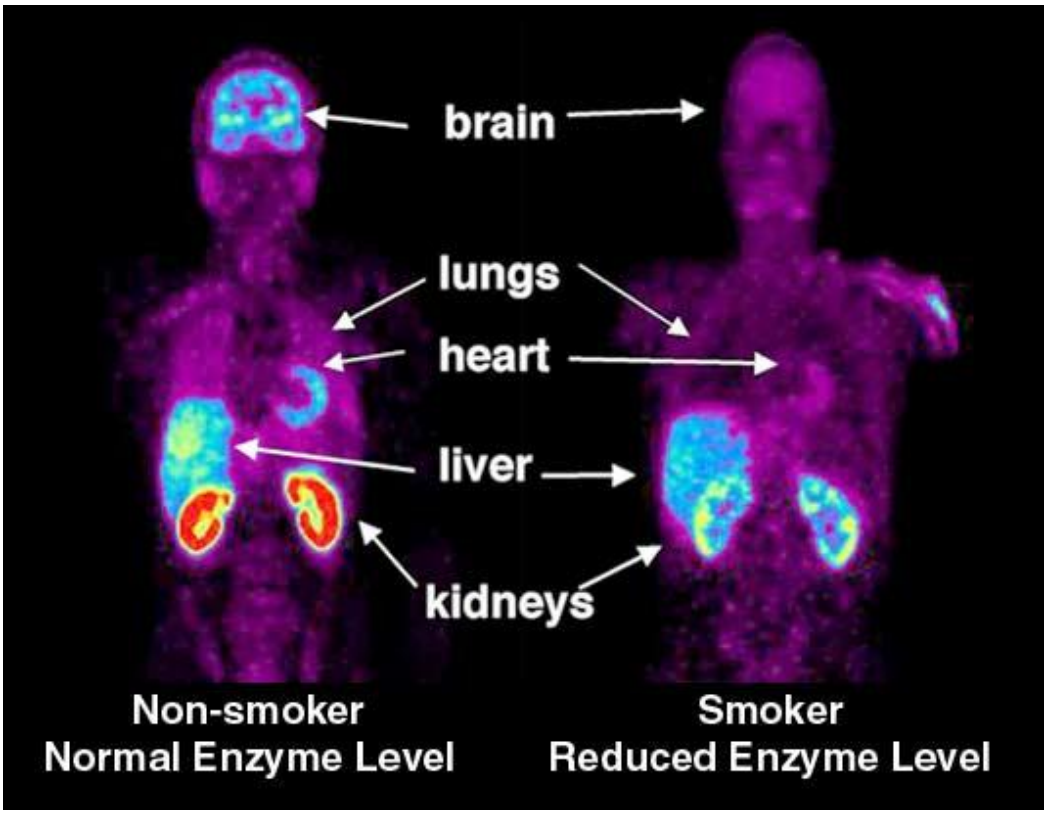
and diseases. Smoking can cause chronic redness of your eyes. Tobacco smoke, even passive smoke inhaled by children, can alter the tear film of eyes, exacerbating dry eye syndrome and allergic eye conditions. Smoking may increase your risk for developing cataracts, or clouding of the lenses, much earlier and possibly much worse than people who do not smoke. Smoking reduces the supply of antioxidants in our eyes, which may lead to cataracts.

Smoking contributes to the development of arteriosclerosis, or hardening of the arteries, that can contribute to or worsen vascular disease of the eyes. Smoking decreases blood flow throughout the body, which could result in damage to the optic nerve. Toxic optic neuropathy, caused by methyl alcohol consumption, results in rapid deterioration in vision and irreversible blindness if not treated within 24 to 48 hours.

14.3.8. PET Scans Show Smoke affects Peripheral Organs

New research, with support from the National Institute for Biomedical Imaging and Bioengineering and the National Institute on Drug Abuse, National Institutes of Health, and the Department of Energy, shows that cigarette smoke also decreases levels of a critical enzyme called monoamine oxidase B (MAO B) in the kidneys, heart, lungs, and spleen. Too much or too little of this crucial enzyme can have an effect on a person's mental or physical health. MAO B is important because it breaks down the chemicals that allow nerve cells to communicate and regulate blood pressure.

PET, or positron emission tomography, employs computer technology and radioactive compounds to produce images of biochemical processes within living systems.



The illustration shows the concentration of radioactive tracer bound to monoamine oxidase B (MAO B). Red shows the highest concentration. Clearly, lower concentrations are seen in the smoker. In certain areas, such as the lungs and brain, concentrations are so low as to be virtually absent. This demonstrates decreased amounts of MAO B in the peripheral organs of smokers compared with nonsmokers. The researchers observed that MAO B activity in the peripheral organs was reduced by one-third to almost one-half in smokers compared with nonsmokers.

14. 3.9. Smoking affects Skin, Hair, Nails and Ears

The substances in tobacco smoke actually change the structure of your skin. Smoking causes skin discoloration, wrinkles, and premature aging. Smoking reduces the amount of oxygen that gets to your skin. This means that if you smoke, your skin ages more quickly and looks grey and dull. Smoking prematurely ages your skin by between 10 and 20 years, and makes it three times more likely you'll get facial wrinkling, particularly around the eyes and mouth. Smoking even gives you a sallow, yellow-grey complexion and hollow cheeks, which can cause you to look gaunt. The good news is that once you stop smoking, you will prevent further deterioration to your skin caused by smoking.

Fingernails and the skin on your fingers may have yellow staining from holding cigarettes. Smokers usually develop yellow or brown stains on their teeth. Hair holds on to the smell of tobacco long after you put your cigarette out. It even clings to nonsmokers.

Smoking reduces the oxygen supply to the cochlea, a snail-shaped organ in the inner ear. This may result in permanent damage to the cochlea and mild to moderate hearing loss.

14.3.10. Higher risk of Infertility

Both men and women who smoke may have difficulty achieving orgasm and are at higher risk of infertility.

14.3.10.1. Male infertility. Incidence of impotence is approximately 85 percent higher in male smokers compared to non-smokers, and it is a key cause of erectile dysfunction (ED).

Smoking causes impotence because it promotes arterial narrowing.

Erectile dysfunction, a condition that prevents a man from being able to get or keep an erection, is twice as likely to affect those who smoke. Even men who are exposed to second-hand smoke have a greater risk of experiencing erectile dysfunction. Millions of men are affected by erectile dysfunction, but one way to significantly reduce your risk is to quit smoking.

Studies on male smoking have shown a decrease in the quality of semen. Sperm concentration refers to the number of sperm found in a measured quantity of semen. Studies have shown a 23% decrease in sperm concentration in men who smoke. Sperm motility refers to the swimming capabilities of the sperm. If sperm cannot swim properly, they may have trouble reaching the egg and fertilizing it. In men who smoke, researchers found a 13% decrease in sperm motility.

14.3.10.2. Female infertility. Smoking is harmful to the ovaries, potentially causing female infertility, and the degree of damage is dependent upon the amount and length of time a woman smokes. Nicotine and other harmful chemicals in cigarettes interfere with the body's ability to create estrogen, a hormone that regulates folliculogenesis and ovulation. Also, cigarette smoking interferes with folliculogenesis, embryo transport, endometrial receptivity, endometrial angiogenesis, uterine blood flow and the uterine myometrium. Some damage is irreversible, but stopping smoking can prevent further damage. Smokers are 60% more likely to be infertile than non-smokers.

14.3.11. Kidney damage

Smoking is a significant risk factor for developing kidney cancer, and the more you smoke the greater the risk. For example, research has shown that if you regularly smoke 10 cigarettes a day, you are one and a half times more likely to develop kidney cancer compared with a non-smoker. This is increased to twice as likely if you smoke 20 or more cigarettes a day.

In addition to increasing the risk of kidney cancer, smoking can also contribute to additional renal damage. Smokers are at a significantly increased risk for chronic kidney disease than non-smokers. A history of smoking encourages the progression of diabetic nephropathy.

14.3.12. Diabetes

Various clinical studies have linked smoking with increased risk of insulin resistance and type 2 diabetes. According to a case-control study of 234 cases with newly diagnosed type 2 diabetes and 468 diabetes-free controls, There was more than 2 fold increase in the incidence of diabetes among current smokers compared with never-smokers. Those who had been smokers for 10 or more pack-years had twice the risk of diabetes versus non-smokers. Since smoking may raise blood glues levels and increase insulin resistance-it makes it more difficult for people with diabetes to control their glucose levels compared with non-smoking individuals with diabetes.

14.3.13. Effect of Smoking on Urinary Bladder

According to the American Cancer Society, smoking is one of the main causes of bladder cancer. The accumulation of

carcinogenic chemicals in urine damages cells in the bladder. Bladder cancer occurs when cells in the lining of the bladder grow uncontrollably and form tumors that can invade normal tissues and spread to other parts of the body. Persons who smoke have more than twice the risk for bladder cancer than non-smokers. Research indicates that smoking may cause about 30% of bladder cancers among women and 50% among men.

Bladder cancer is the fifth most common type of cancer in the United States and causes approximately 13,000 deaths annually. Not smoking is the most important behavior to reduce bladder-cancer risk. The risk for bladder cancer among smokers who quit smoking eventually returns to normal.

14.3.14. Influenza

A study of an outbreak of A (H1N1) influenza in an Israeli military unit of 336 healthy young men to determine the relation of cigarette smoking to the incidence of clinically apparent influenza, revealed that, of 168 smokers, 68.5 percent had influenza, as compared with 47.2 percent of nonsmokers. Influenza was also more severe in the smokers; 50.6 percent of the smokers lost work days or required bed rest, or both, as compared with 30.1 percent of the nonsmokers.

According to a study of 1,900 male cadets after the 1968 Hong Kong A2 influenza epidemic at a South Carolina military academy, compared with nonsmokers heavy smokers (more than 20 cigarettes per day), had 21% more illnesses and 20% more bed rest, light smokers (less than 20 cigarettes per day) had 10% more illnesses and 7% more bed rest.

The effect of cigarette smoking upon epidemic influenza was studied prospectively among 1,811 male college students.

Clinical influenza incidence among those who daily smoked 21 or more cigarettes was 21% higher than that of non-smokers. Influenza incidence among smokers of 1 to 20 cigarettes daily was intermediate between non-smokers and heavy cigarette smokers.

Surveillance of a 1979 influenza outbreak at a military base for women in Israel revealed that influenza symptoms developed in 60.0% of the current smokers vs. 41.6% of the nonsmokers. Smoking seems to cause a higher relative influenza-risk in older populations than in younger populations. In a prospective study of community-dwelling people 60–90 years of age, during 1993, of unimmunized people 23% of smokers had clinical influenza as compared with 6% of non-smokers.

14.3.15. Smoking affects Blood and the Immune System

14.3.15.1. High white blood cell count. Smoking cause high white blood cells (the cells that defend your body from infections) count. A high white blood cell count is like a signal from your body, letting you know you've been injured. White blood cell counts that stay elevated for a long time are linked with an increased risk of heart attacks, strokes, and cancer.

14.3.15.2. Longer to heal. Nutrients, minerals, and oxygen are all supplied to the tissue through the blood stream. Nicotine causes blood vessels to tighten, which decreases levels of nutrients supplied to wounds. As a result, wounds take longer to heal. Slow wound healing increases the risk of infection after an injury or surgery and painful skin ulcers can develop, causing the tissue to slowly die.

14.3.15.3. Weakened immune system. Cigarette smoke contains high levels of tar and other chemicals, which can make

your immune system less effective at fighting off infections. This means you're more likely to get sick. Continued weakening of the immune system can make you more vulnerable to autoimmune diseases like rheumatoid arthritis and multiple sclerosis. It also decreases your body's ability to fight off cancer!

14.3.16. Smoking affect Bones

Recent studies show a direct relationship between tobacco use and decreased bone density. Smoking is one of many factors—including weight, alcohol consumption, and activity level—that increase your risk for osteoporosis, a condition in which bones weaken and become more likely to fracture.

Significant bone loss has been found in older women and men who smoke. Quitting smoking appears to reduce the risk for low bone mass and fractures. However, it may take several years to lower a former smoker's risk.

In addition, smoking from an early age puts women at even higher risk for osteoporosis. Smoking lowers the level of the hormone *estrogen* in your body, which can cause you to go through menopause earlier, boosting your risk for osteoporosis. smoking leads to a thinning of bone tissue and loss of bone density. This causes bones to become weak and brittle. Compared to non-smokers, smokers have a higher risk of bone fractures, and their broken bones take longer to heal.

14.3.17. Muscle deterioration

When you smoke, less blood and oxygen flow to your muscles, making it harder to build muscle. The lack of oxygen also makes muscles tire more easily. Smokers have more muscle aches and pains than non-smokers.

14.3.18. Susceptibility to Infectious diseases

Tobacco is also linked to susceptibility to infectious diseases, particularly in the lungs. Smoking more than 20 cigarettes a day increases the risk of by two to four times, and being a current smoker has been linked to a fourfold increase in the risk of invasive pneumococcal disease. It is believed that smoking increases the risk of these and other pulmonary and respiratory tract infections both through structural damage and through effects on the immune system. The effects on the immune system include an increase in CD4+ cell production attributable to nicotine, which has tentatively been linked to increased HIV susceptibility. The usage of tobacco also increases rates of infection: common cold and bronchitis, chronic obstructive pulmonary disease, emphysema and chronic bronchitis in particular.

Smoking increases the risk of Kaposi's sarcoma in people without HIV infection. One study found this only with the male population and could not draw any conclusions for the female participants in the study.

14.3.19. Smoking and Pregnancy

Mothers who smoke while pregnant are exposing their unborn baby to nicotine (a highly addictive substance), carbon monoxide, and thousands of other chemicals (including cancer-

causing agents) that are found in tobacco. With each puff of a cigarette, these toxic chemicals travel through the mother's blood, cross through the placenta, and enter the baby's body. When an unborn baby is exposed to nicotine, their heart rate increases and they begin breathing at a faster rate.

Women who smoke while pregnant have a higher risk of miscarriage or serious birth complications. Complications to the baby that can occur include:

- higher risk of death at or soon after birth
- high risk of getting infections or having other health problems
- slower growth of the fetus
- smaller size at birth (on average, 150 grams less than babies born to non-smokers)

After a baby is born, mothers who smoke while breast-feeding can still expose their baby to harmful chemicals through breast milk. Despite this fact, it is important to note that a smoking mother's breast milk is still preferred over formula for a baby's growth and development.

Women who smoke have about a 50% higher chance of giving birth to a child with behavioral disorders. Later in life, children of mothers who smoke are more likely to have: asthma, changes in behavior, impaired learning, a nighttime cough, respiratory infections and slower growth.

Pregnant mothers who are exposed to secondhand smoke are also more likely to have a baby with low birth weight. Babies born to mothers who smoke while pregnant are at greater risk of low birth weight, birth defects, and sudden infant death syndrome

(SIDS). Newborns who breathe secondhand smoke suffer more ear infections and asthma attacks.

14.3.20. The Dangers Secondhand Smoke

Cigarette smoking can harm your health even if you're not a smoker. Exposure to secondhand smoke is believed to cause the lung cancer or heart disease deaths of about 49,000 non-smokers every year. Nonsmokers who are exposed to secondhand smoke in their homes or workplaces have a 25 to 30 percent increase in their heart disease risk and a 20 to 30 percent increase in their lung cancer risk. Children whose parents or caregivers smoke have an increased risk of asthma, bronchitis, pneumonia, coughing, wheezing, and ear infections. Babies of smokers have a higher risk of sudden infant death syndrome, or SIDS.

14.4. Conclusion

The chemicals in cigarette smoke are inhaled into the lungs and from there travel throughout the body, causing damage in numerous ways. Nicotine reaches the brain in 7 to 10 seconds after smoke is inhaled. Nicotine has been found in every part of a smoker's body, including breast milk. Carbon monoxide, which is present in cigarette smoke, binds to hemoglobin in red blood cells, preventing these cells from carrying all of the oxygen they normally would. This can lead to symptoms of carbon monoxide poisoning. Cancer-causing agents (carcinogens) in tobacco smoke damage important genes that control the growth of cells, causing them to grow abnormally or to reproduce too rapidly. Seventy such cancer-causing chemicals have been identified in cigarette smoke to date.

In 2000, smoking was practiced by 1.22 billion people, predicted to rise to 1.45 billion people in 2010 and 1.5 to 1.9

billion by 2025. As of 2002, about twenty percent of young teens (13–15) smoke worldwide, with 80,000 to 100,000 children taking up the addiction every day—roughly half of whom live in Asia. Half of those who begin smoking in adolescent years are projected to go on to smoke for 15 to 20 years.

The WHO states that "Much of the disease burden and premature mortality attributable to tobacco use disproportionately affect the poor". Of the 1.22 billion smokers, 1 billion of them live in developing or transitional nations. Rates of smoking have leveled off or declined in the developed world. In the developing world, however, tobacco consumption is rising by 3.4% per year as of 2002. The WHO in 2004 projected 58.8 million deaths to occur globally, from which 5.4 million are tobacco-attribute- and 4.9 million as of 2007. As of 2002, 70% of the deaths are in developing countries.

According to WHO (2011) report, almost six million people die from tobacco use each year worldwide. The report explains that tobacco is expected to kill 7.5 million people worldwide by 2020, accounting for 10 percent of all deaths. That number is expected to increase to 8 million by the year 2030. Smoking causes an estimated 71 percent of lung cancers, 42 percent of chronic respiratory disease and almost 10 percent of cardiovascular disease, the report states.

To reduce tobacco use, WHO recommends strategies including tobacco tax increases, distributing information about the health risks of smoking, restrictions on smoking in public places and workplaces, and comprehensive bans on tobacco advertising, promotion and sponsorship.

Education and counselling by physicians of children and adolescents has been found to be effective in decreasing the risk

of tobacco use. Many government regulations have been passed to protect citizens from harm caused by public environmental tobacco smoke. Myanmar has prohibited smoking in university campuses in the country since 2006 in an effort to create tobacco-smoke-free environment for the health of the university students. The ban also applies to a wide range of public accessible areas such as hospitals, schools, airports, cinemas, stadium and marts. The law introduces some strict restrictions with regard to sale and production of cigar and totally bans all forms of tobacco advertisement including advertising through sponsoring sports matches.

Quitting smoking reduces the risk of cancer and other diseases, such as heart disease and COPD, caused by smoking. People who quit smoking, regardless of their age, are less likely than those who continue to smoke to die from smoking-related illness. Quitting smoking reduces the risk of developing and dying from cancer. However, it takes a number of years after quitting for the risk of cancer to start to decline. This benefit increases the longer a person remains smoke free the risk of premature death and the chance of developing cancer from smoking cigarettes depend on many factors, including the number of years a person smokes, the number of cigarettes he or she smokes per day, the age at which he or she began smoking, and whether or not he or she was already ill at the time of quitting. For people who have already developed cancer, quitting smoking reduces the risk of developing a second cancer.

Second-hand smoke is also a major source of air pollution. In fact, the cancer risk from exposure to second-hand smoke is much greater than the combined risk of all other regulated air contaminants. There is no safe level of exposure to second-hand smoke. The best thing to do is to remove the source of smoke. So, if you smoke, quit. It is the single best way to protect yourself

and those around you. To reduce the health risks of second-hand smoke by making your home and car smoke-free environments**.** A smoke-free environment means not smoking inside the home or car. Since smoke can easily seep through closed doors and cling onto fabrics, this rule needs to be applied at all times in all areas of your home and vehicle.

15. Impact of toxic chemicals on society

(1) More than 7 million accidental poisonings occur each year, with more than 75% involving children under age 6.

The Columbia University College of Physicians & Surgeons

(2) Cancer rates have increased since 1901 from only 1 in 8,000 Americans, to 1 in 3 today! By the year 2010, this disease will afflict 1 of every 2 individuals!

American Cancer Society

(3) Of chemicals commonly found in homes, 150 have been linked to allergies, birth defects, cancer, and psychological abnormalities.

Consumer Product Safety Commission

(4) Unregulated air pollution has caused one in six children in the Central Valley of California to suffer from asthma. More than 5000 children in the San Joaquin Valley Air District are hospitalized each year for asthma. Up to 2.2 million Californians suffer from asthma.

California's State Department of Health Services

(5) Over 80 percent of adults and 90 percent of children in the United States have residues of one or more harmful pesticides in their bodies. Petrochemical cleaning products in the home are easily absorbed into the skin. Once absorbed, the toxins travel to the blood stream and are deposited in the fatty tissues where they may exist indefinitely.

"In Harm's Way," a study by
"The Clean Water Fund" and
"Physicians for Social Responsibility"
May 11, 2000

(6) More than 75,000 chemicals are licensed for commercial use. More than 2,000 new synthetic chemicals are registered every year. In 1998, U.S. industries manufactured 6.5 trillion pounds of 9,000 different chemicals .In 2000, major American companies dumped 7.1 billion pounds of 650 different industrial chemicals into our air and water.

Alexandra Rome, Co-director of the Sustainable Futures Group at Commonweal, a nonprofit health and environmental research institute, until 2000.

(7) The Washington (state) Department of Health discovered that one fourth of tested farm workers handling pesticides were overexposed to extremely hazardous chemicals. Carbamates or organophosphates can cause dizziness, breathing problems, muscle twitching, and paralysis.

The 2050 Project Newsletter, Fall 1994; State of the World 1994, Worldwatch Institute

(8) Within 26 seconds after exposure to chemicals such as cleaning products, traces of these chemicals can be found in every organ in the body. More than 1.4 million Americans exposed to household chemicals were referred to poison control centers in 2001. Of these, 824,000 were children under 6 years.

Chec's HealtheHouse, the resource for environmental healthrRisks affecting your children

16. Conclusion

Industries are mostly situated along the riverbanks for easy availability of water and also disposal of the wastes. But these wastes include various acids, alkalis, dyes and other toxic chemicals. **Industrial pollutants that run into streams, rivers, or lakes can have serious effects on wildlife, plants, and human. So industrial waste management is much needed to protect our environment.**

Industrial waste management is the collection, transport, processing, recycling or disposal, and monitoring of waste materials. The term usually relates to materials produced by human activity, and is generally undertaken to reduce their effect on health, the environment or aesthetics. Waste management is also carried out to recover resources from it. Waste management can involve solid, liquid, gaseous or radioactive substances, with different methods and fields of expertise for each. Waste management practices differ for developed and developing nations, for urban and rural areas, and for residential and industrial producers. Industrial wastewater treatment covers the mechanisms and processes used to treat waters that have been contaminated in some way by anthropogenic industrial or commercial activities prior to its release into the environment or its re-use.

Pesticides have contaminated almost every part of our environment. Pesticide residues are found in soil and air, and in surface and ground water across the nation, and urban pesticide uses contribute to the problem. Pesticide contamination poses significant risks to the environment and non-target organisms ranging from beneficial soil microorganisms, to insects, plants, fish, and birds. Contrary to common misconceptions, even herbicides can cause harm to the

environment. In fact, weed killers can be especially problematic because they are used in relatively large volumes. **The best way to reduce pesticide contamination (and the harm it causes) in our environment is for all of us to do our part to use safer, non-chemical pest control (including weed control) methods.**

Farmers can produce fruits and vegetables that are safe to eat. Reducing the use of pesticides and choosing less toxic pesticides may reduce risks placed on society and the environment from pesticide use. If farmers provide the correct pesticides dosage, stop spraying well in time before harvesting (waiting period) and use the least dangerous pesticides this would provide a greater guarantee that their products will be safe to eat.

This can be done by means of **"Integrated Pest Management" (IPM),** which is a sustainable approach to managing pests and crops, in which many different tools are combined to avoid pests or to keep pest populations at acceptable levels.

IPM farmers will always first try to avoid pest problems. One way to do this is to use crop varieties that are resistant to pest attack. In this way he can grow a healthy crop and can avoid the use of pesticides.

In a healthy crop there will be some pests, but there will also be natural enemies of these pests. For example ladybird beetles are well known predators that feed on aphids and other small insect**.** Spiders and many tiny wasps will also help to keep pest populations at low levels. Unfortunately, pesticides not only kill pests, but they also kill the spiders and the beneficial insects. An IPM farmer understands this and will avoid pesticides in order to not disrupt this biological control. In some cases it is even possible to artificially rear these beneficial insects and release

them in the field to help controlling pests in a natural way. For example predatory earwigs can be easily mass-produced by farmers to enhance biological control in their crop.

For an IPM farmer there are many options to reduce pest populations that don't require pesticides. For example traps made with yellow sticky substances can be used to attract and catch certain small flying insects. Another example is the use of plants that are known to repel pests because of their smell.

Integrated pest management, the use of multiple approaches to control pests, is becoming widespread and has been used with success in countries such as Indonesia, China, Bangladesh, the U.S., Australia, and Mexico.

Alternatives to pesticides are available and include methods of cultivation, use of biological pest controls (such as pheromones and microbial pesticides), genetic engineering, and methods of interfering with insect breeding. Application of composted yard waste has also been used as a way of controlling pests. These methods are becoming increasingly popular and often are safer than traditional chemical pesticides. Cultivation practices include polyculture (growing multiple types of plants**),** crop rotation, planting crops in areas where the pests that damage them do not live, timing planting according to when pests will be least problematic, and use of trap crops that attract pests away from the real crop. In the U.S., farmers have had success controlling insects by spraying with hot water at a cost that is about the same as pesticide spraying.

Release of other organisms that fight the pest is another example of an alternative to pesticide use. These organisms can include natural predators or parasites of the pests. Biological

pesticides based on entomopathogenic fungi, bacteria and viruses causing disease in the pest species can also be used.

Interfering with insects' reproduction can be accomplished by sterilizing males of the target species and releasing them, so that they mate with females but do not produce offspring. Another alternative to pesticides is the thermal treatment of soil through steam. Soil steaming kills pest and increases soil health. Some evidence shows that alternatives to pesticides can be equally effective as the use of chemicals. For example, Sweden has halved its use of pesticides with hardly any reduction in crops. In Indonesia, farmers have reduced pesticide use on rice fields by 65% and experienced a 15% crop increase. A study of maize yields in northern Florida found that the application of composted yard waste with high carbon to nitrogen ratio to agricultural fields was highly effective at reducing the population of plant-parasitic nematodes and increasing crop yield ranging from 10% to 21%.

Farmers can produce crops without using pesticides by organic farming. While Integrated Pest Management is a method of farming that tries to avoid or minimize the risks of pesticide use, there are also farmers that still go a further step "organic farming**". In "organic farming" the farmers grow their crop entirely without synthetic pesticides and even without synthetic fertilizers.**

Organic farming is cultivation and production (Nutrient, pest & disease management) of crops by biodegradable organic inputs. Physical (structure), chemical (nutrients transformation and mineralization) and biological activity (decomposition) favors the crop stand and growth.

Organic farming methods combine scientific knowledge of ecology and modern technology with traditional farming practices based on naturally occurring biological processes. While conventional agriculture uses synthetic pesticides and water-soluble synthetically purified fertilizers, organic farmers are restricted by regulations to using natural pesticides and fertilizers. The principal methods of organic farming include crop rotation, green manures and compost, biological pest control, and mechanical cultivation. These measures use the natural environment to enhance agricultural productivity: legumes are planted to fix nitrogen into the soil, natural insect predators are encouraged, crops are rotated to confuse pests and renew soil, and natural materials such as potassium bicarbonate and mulches are used to control disease and weeds.

Only decomposable materials (organic manure and biocontrol agent) are used. It does not leave any harmful residue in the crop or the soil environment. Availability of much of calcium and potassium in organically managed soils improves the uptake in crops. It provides the natural resistance to crops against pest and diseases. Eliminating pesticides will not produce lower yields. In fact, organic agriculture produces the same yields as conventional agriculture and requires lower inputs. It allows for healthier soils which allows for healthier plants.

The health benefits of organic food products. In the 21st century, a growing number of men and women from around the world are recognizing the benefits of organic food. These people are beginning to appreciate the health benefits that can be derived from organic food. Indeed, there are a number of significant benefits of eating organic food.

Traditional farming and gardening practices utilize an extensive array of different types of chemicals. For example, as a general rule in the cultivation of crops of all varieties, the typical farmer utilizes chemical insecticides, herbicides and fertilizers. Without fail, when these crops are harvested, those remains at least trace amounts of these various chemicals that were utilized during the planting and growing processes. When a consumer purchases and consumes these traditionally grown food items, the trace chemicals end up in a person's body. Over time, these insecticides, herbicides and fertilizers can accumulate in a person's body.

One of the most significant health benefits associated with eating organic food rests in the fact that these products are free from any potentially harmful chemicals. Organically grown food items are pure and completely wholesome.

A number of recent research studies have also considered the benefits of eating organic food. Some of these research endeavors focused on the **effects organic foods might have on lowering the incidence of certain diseases, including some types of cancer.**

It has been demonstrated that organically grown fruits and vegetables have significantly higher levels of antioxidants than do traditionally cultivated food products. Because **organically grown fruits and vegetables are higher in antioxidants, these items have been demonstrated to work to reduce the risk of certain types of cancers.**

Antioxidants also have a restorative process when it comes to skin and muscle deterioration. Foods that are high in antioxidants help to slow and inhibit the deterioration of muscles and skin associated with the aging process. **Through the use of organic food, a person will not only obtain an optimal level of wellness, but he or she will be taking important steps towards preventing serious diseases such as cancer.**

Government of the Union of Myanmar have expressed concerned about the toxic effects of pesticides on human and wildlife and have initiated regulatory policies to safeguard against these adverse effects of pesticides use. **Pesticide Law was enacted in 1990. Formation of Pesticide Registration Board was issued by the Government of the Union of Myanmar on 25th February 1992 by notification No 2/92.** Under Pesticide Registration Board the technical Committee, with technical personnel from ministries concerned, has been set up for evaluation of pesticide efficacy, quality, pesticide residue, toxicology, occupational and public health aspects and to recommend for registration to Pesticide Registration Board.

Myanmar has established a Pesticide Analytical Laboratory (PAL) with the technical and financial assistance of FAO. PAL is capable of carrying out product and residue analysis. Then they are classified for general and restricted use. Some may be banned or suspended.

Myanmar is participating in PIC procedure implemented by United Nations Environmental Program/Food and Agriculture Organization (UNEP/FAO) and the Director General of Department of Agricultural Planning, Ministry of Agriculture and

Irrigation is acting as designated national authority for pesticide import. The country is receiving the Decision Guidance Document (DGDs) from UNEP/FAO and responding to the decision of import accordingly. **Taking into account of the criteria in DGDs and the country's experience, pesticides of highly toxic to fish, wildlife and humans are banned from use in Myanmar (Table 22).**

Table 22. Banned pesticides in Myanmar
(Pesticide Registration Board, 2010)*

No	Pesticide	Used Category
1	Aldrin	Insecticide
2	BHC	Insecticide
3	Captafol	Fungicide
4	Chlordane	Insecticide
5	Chlordimeform	Insecticide
6	Cyhexatin	Insecticide
7	Dieldrin	Insecticide
8	Dinoseb	Herbicide
9	EDB	Fumigant
10	Endrin	Insecticide
11	EPN	Insecticide
12	Inorganic mercury compounds	Fungicide
13	Organic mercury compound	Fungicide
14	Parathion Ethyl	Insecticide
15	Strobane	Insecticide
16	2,4,5-T	Herbicide
17	Toxaphene	Insecticide
18	Monocrotophos	Insecticide

*** Personal communication**

In order to prevent an increasing number of pesticide-related human deaths, Myanmar Pesticide Registration Board is insisting that all pesticide applicators have proper training and certification.

The contamination of food from the indiscriminate use of pesticides is a common problem. The residues in crops at harvest must be maintained below the maximum residue limit. The government officials of Myanmar have expressed concerns over residue problem in both domestic and export markets.

The residues in crops at harvest must be maintained below the *Maximum Residue Limits* (MRLs) set by the Government of the Union of Myanmar and international organization. Acceptable residue levels are based on an estimate of level of pesticide residue intake below which the risk to health is too small to be a concern. This level is known as the **"Acceptable Daily Intake" (ADI)** and is defined as the amount of residue that may be consumed every day during an individual's active lifetime that no harm will result. The FAO/WHO Codex Alimentarius Commission sets international standards of MRLs and ADIs for agricultural crops intended for international trade. **The Pesticide Registration Board of the Government of the Union of Myanmar adopts these standards to ensure that safety levels of pesticide residues in food are not violated.**

There should be effective monitoring to ensure that food is not being sold that contains pesticides residues above the *Maximum Residue Limits* (MRLs) set by the Government of the Union of Myanmar and international organization**.**The government should provide funding for research into alternatives

to chemical pesticides, as well as free advice to farmers on the alternatives to using pesticides.

A thorough understanding of the toxic effects of industrial pollutants, pesticides and toxic chemicals is the essential basis for an effective environmental management system. Thus training in environmental protection must receive top priority. A trained cadre of personnel not only in government but integrated within industries will ensure that the toxic hazards are identified and managed to prevent significant harm to the environment. Education and training in environmental toxicology, pollution control and pollution prevention is the cornerstone of an environmental management system.

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