UNIT -5 PESTICIDES AND ITS HAZARDS

A pesticide is defined as a chemical agent used to destroy or control pests. Pesticides are chemicals designed to kill or control insects, weeds, fungi, rodents and microbes. Many pesticides have been found to be harmful to human and animal health or to the environment. As pesticides are used in many different sectors (e.g. agriculture, forestry, food industry, etc.) they may put workers in different occupations at risk of acute poisoning or occupational diseases

The Latin word **"cida"** which means **to kill**. The generic term "pesticides" can apply to a wide spectrum of chemicals, including insecticides, rodenticides, herbicides, fungicides, biocides, and similar chemicals. **The Food and Agriculture Organization of the United Nations (FAO) presents following definition of pesticides**:

'Pesticide means any substance, or mixture of substances of chemical or biological ingredients intended for repelling, destroying or controlling any pest, or regulating plant growth'.

Pesticide is a more general term than **Plant Protection Product** (PPP). Plant protection products are 'pesticides' that protect crops or desirable or useful plants. They contain at least one active substance and have one of the following functions:

- protect plants or plant products against pests/diseases, before or after harvest;
- influence the life processes of plants (such as substances influencing their growth, excluding nutrients);
- preserve plant products;
- Destroy or prevent growth of undesired plants or parts of plants.

The term 'pesticide' is often used interchangeably with 'plant protection product', however, pesticide is a broader term that also covers non plant/crop uses.

Pesticides are substances that are used to protect humans against the insect vectors of disease-causing pathogens, to protect crop plants from competition from abundant but unwanted plants (i.e., "weeds"), and to protect crop plants and livestock from diseases and depredations by fungi, insects, mites, and rodents.

History:

The first recorded use of pesticide was around 1550 B.C., when Egyptians used unspecified chemicals to drive fleas from homes.

The Greek poet, Homer (ca. 800 B.C.) wrote of the mythological hero, Odysseus, during his wanderings in the Odyssey, burning sulfur "to purge the hall and the house and the court." Around 900 B.C.,

Arsenic was used as an insecticide in China, and by 1870 A.D., many inorganic chemicals were used as pesticides.

In modern times, however, pesticide use has been much more prevalent, and by 1990, about 300 insecticides were in use, as were 290 herbicides, 165 fungicides, and other pesticidal chemicals, with a grand total of more than 3000 formulations (actually, there is an even larger number of separately registered commercial products, many based on the same or similar formulations) .

Classification of pesticides

In general groups of pesticides are classified and named according to the type of pest they control (Table 1).

Table 1: Classification of pesticides based on their purpose

Algicides	kill algae in lakes, canals, swimming pools, water tanks and other sites.
Antifoulants	kill or repel organisms that attach to underwater surfaces, such as barnacles that cling to boat bottoms.
Antimicrobials	kill microorganisms such as bacteria and viruses.
Attractants	lure pests to a trap or bait, for example, attract an insect or rodent into a trap. (However, food is not considered a pesticide when used as an attractant.)
Biopesticides	are derived from natural materials such as animals, plants, bacteria and certain minerals.
Biocides	kill microorganisms.
Defoliants	cause leaves or foliage to drop from a plant, usually to facilitate harvest.
Desiccants	promote drying of living tissues, such as unwanted plant tops.
Disinfectants and sanitizers	kill or inactivate disease-producing microorganisms on inanimate objects.

Fungicides kill	fungi (including blights, mildews, molds and rusts).
Fumigants	produce gas or vapor intended to destroy pests, for example in buildings or soil.
Herbicides	kill weeds and other plants that grow where they are not wanted.
Insect growth regulators	disrupt the molting, maturing from pupal stage to adult, or other life processes of insects.
Insecticides	kill insects and other arthropods.
Miticides (also called acaricides)	kill mites that feed on plants and animals.
Microbial pesticides	are microorganisms that kill, inhibit, or out-compete pests, including insects or other microorganism pests.
Molluscicides	kill snails and slugs.
Nematicides	kill nematodes (microscopic, worm-like organisms that feed on plant roots).
Ovicides	kill eggs of insects and mites.
Pheromones	disrupt the mating behavior of insects.
Plant growth regulators	alter the expected growth, flowering or reproduction rate of plants (does not include fertilizers).
Plant Incorporated	are substances that plants produce from genetic material that has been

Protectants	added to the plant.
Repellents	repel pests, including insects (such as mosquitoes) and birds.
Rodenticides	control mice and other rodents.

Most pesticides listed in Table 1 are used **in agriculture** for one of the following purposes:

- Protecting plants or plant products against all harmful organisms (e.g. fungicides, insecticides, molluscicides, nematicides, rodenticides).
- Influencing the life processes of plants (e.g. Plant Growth Regulators).
- Preserving plant products (e.g. fumigants).
- Destroying undesired plants or parts of plants (e.g. defoliants).
- Checking or preventing undesired growth of plants (e.g. herbicides).

These purposes may be briefly defined as plant protection and pesticides intended to use for these purposes compose a large group named **plant protection products (PPP)**

Pesticides are also classified in accordance to how or when they work

- Contact pesticides generally control a pest as a result of direct contact. Insects are killed when sprayed directly or when they crawl across surfaces treated with a residual contact insecticide. Weed foliage is killed when enough surface area is covered with a contact herbicide.
- Systemic pesticides are pesticides which are absorbed by plants or animals and move to untreated tissues.
- Foliar pesticides are applied to plant leaves, stems and branches.
- Soil-applied pesticides are applied to the soil. Some are taken up by roots and translocated inside the plant. Other soil-applied herbicides kill weeds by affecting the germinating seedling. Most soil applied pesticides require tillage or water to move them into the soil.
- Fumigants are chemicals that are applied as toxic gas or as a solid or liquid which forms a toxic gas. The gas will penetrate cracks and crevices of structures or soil.
- Preplant herbicides are applied to the soil before seeding or transplanting.
- Premergent herbicides are applied to the soil after planting but before emergence of the crop or weed.
- Postemergent herbicides are applied after the crop or weed has emerged.
- Eradicant fungicides control fungi that have already infected plants.
- Protectant fungicides prevent fungal infections. They retard fungal growth or prevent the organisms from entering treated plants.
- Selective pesticides will only control certain pests.
- Non-selective (or broad-spectrum) pesticides will control a wide range of pests.
- Suffocating insecticides clog the breathing system of insects and may affect eggs.

- Residual pesticides do not break down quickly and may control pests for a long time.
- Non-residual pesticides are quickly made inactive after application and do not affect future crops or pests[9].

Pesticides can be grouped into **chemical families**. Pesticides with similar chemical structures have similar characteristics and usually a similar mode of action. **Insecticides** include following main chemical families: **organochlorines** (removed from the market due to their high toxicity), **organophosphates, carbamates, pyrethroids** [8]. Typical chemical families of **herbicides** are following: **phenoxy herbicides, benzoic acid herbicides, triazines, ureas** [10]. Substitution of chemical compounds is possible using so-called **biopesticides**. There are three major classes of biopesticides: **microbial pesticides, plant-incorporated-protectants (PIPs), biochemical pesticides** [11]. The active ingredients of pesticides are mixed with other compounds to improve their effectiveness, safety, handling and storage, such as solvents, mineral clays, stickers, wetting agents, or other adjuvant materials. This mixture is called 'pesticide formulation'. **Pesticide formulations** can be divided into three main types: **solids, liquids or gases** [9].

HAZARDS

The ability of a pesticide to cause adverse health effects after long-term or repeated exposure to a pesticide (e.g. when operator is frequently wetted with a pesticide spray during its application) is **sub-chronic toxicity** (term from few weeks to few months) or **chronic toxicity** (term from few months to years). Pesticides which tend to accumulate or break down slowly in human organism usually are of the greatest chronic exposure hazard. Estimation of the sub-chronic and chronic toxicity of a pesticide is based on a number of different long-term tests (periods ranging from 30 to 90 days for the sub-chronic and about 90 days to several years for the chronic toxicity) performed on animals in order to predict long-term effects which may be cause by a pesticide , Such effects include:

- **Carcinogenicity** – production of cancer or assistance to carcinogenic chemicals.
- **Oncogenicity** – induction of tumor growth (not necessarily cancers).
- **Mutagenicity** – ability to cause genetic changes.
- **Teratogenicity** – ability to cause birth defects.
- **Reproductive disorders** – causing in e.g. reduced sperm count, sterility, and miscarriage.
- **Hormone disruption** – ability to disrupt the endocrine system.
- **Neurotoxicity** – causing in neurological problems.
- **Allergenic sensitization** – development of allergies to the active ingredients of pesticides.
- **Damage of other particular organs or systems** – damage of the lungs, liver, immune system, etc. .

When there is sufficient evidence of carcinogenicity in humans pesticides are additionally classified by the International Agency for Research on Cancer (IARC) . Hazardous effects of pesticides determined from human experience are also suitable for the purpose of classification for health hazards. When data from both humans and animals are available their quality and reliability should be evaluated .

Classification by hazards

The CLP Regulation includes the following health hazard classes and categories:

- Acute toxicity (Category 1, 2, 3 and 4).
- Skin corrosion/irritation (Category 1A, 1B, 1C and 2).
- Serious eye damage/eye irritation (Category 1 and 2).
- Respiratory or skin sensitisation (Category 1).
- Germ cell mutagenicity (Category 1A, 1B and 2).
- Carcinogenicity (Category 1A, 1B and 2).
- Reproductive toxicity (Category 1A, 1B and 2) plus additional category for effects on or via lactation.
- Specific target organ toxicity (STOT) – single exposure ((Category 1, 2) and Category 3 for narcotic effects and respiratory tract irritation only).
- Specific target organ toxicity (STOT) – repeated exposure (Category 1 and 2).
- Aspiration hazard (Category 1). [17] [31]

There are many tangible benefits to humanity of the use of pesticides. The most important of these have been:

(1) an increased production of food and fiber because of the protection of crop plants from pathogens, competition from weeds, defoliation by insects, and parasitism by nematodes;

(2) the prevention of spoilage of harvested, stored foods; and

(3) the saving of many millions of human lives by the prevention of certain diseases.

Unfortunately, the considerable benefits of the use of pesticides are partly offset by some important human-health and environmental damages. For example, each year, there is an estimated global total of 1 million pesticide poisonings, resulting in 20 thousand fatalities (Pimentel *et al.,* 1992). Although developed countries account for about 80% of global pesticide use, they only sustain about half of the associated poisonings (Pimentel *et al.,* 1992). The frequency of poisoning incidents is much greater in developing countries because of (1) illiteracy, (2) relatively lax regulations, standards, and (especially) enforcement, and (3) an inadequate availability of protective equipment and clothing and washing facilities for workers.
There have been some rare but spectacular incidents of pesticide-related toxicity to humans. The most widely known case occurred in 1984 at Bhopal, India, where more than 2.8 thousand people were killed and more than 20 thousand seriously injured by a large emission (about 40 tonnes) of poisonous methyl isocyanate vapor, a chemical intermediate in the production of an agricultural insecticide (Rozencranz, 1988).
Another important problem with most pesticide applications is that they kill many organisms that are not the pests that are the target of the treatment. This is an important consideration whenever pesticides with a wide spectrum of toxicity (i.e., not specifically toxic only to the pest) are broadcast sprayed over large areas, such as entire agricultural fields or stands of forest. Many nonpest organisms are exposed to these sorts of treatments, in addition to the intended target of pests. Depending on the pesticide and the susceptibility of the nonpest species, this exposure can result in a substantial, unintended, but unavoidable nontarget mortality.
For example, in a typical agricultural field or forestry plantation, only a few species of plants would be sufficiently abundant to significantly interfere with the growth of crop plants. These

noncrop, competitive plants are the "weeds" that might be targeted by an herbicide application. However, there would be many other species of plants in the same community that do not interfere significantly with the growth of the crop plants. These nontarget plants are also affected by the herbicide application, but to no beneficial purpose in terms of pest management. In fact, the nontarget plants may have beneficial roles to play in their ecosystem, by helping to prevent erosion and nutrient leaching, or by providing food and habitat for animal wildlife. Similar stories could be developed about nontarget arthropods, birds, and other species that are exposed to insecticide during a spray directed against a particular, pest insect. In general, any broadcast spray of a broad-spectrum pesticide causes a substantial mortality of nontarget species.

An ecologically more pervasive problem is a widespread, environmental contamination by persistent pesticides, including the presence of chemical residues in wildlife, in drinking water, and in humans. Ecological damage has included the poisoning of wild life by some pesticides and the disruption of ecological functions such as productivity and nutrient cycling. Many of the worst cases of environmental damage caused by pesticides have been associated with the use of relatively persistent chemicals, such as DDT. Modern pesticide usage mostly involves less persistent chemicals, although these can be very toxic.

Production and usage of pesticides in India

The production of pesticides started in India in 1952 with the establishment of a plant for the production of BHC near Calcutta, and India is now the second largest manufacturer of pesticides in Asia after China and ranks twelfth globally (Mathur, 1999). There has been a steady growth in the production of technical grade pesticides in India, from 5,000 metric tons in 1958 to 102,240 metric tons in 1998. In 1996–97 the demand for pesticides in terms of value was estimated to be around Rs. 22 billion (USD 0.5 billion), which is about 2% of the total world market.

The pattern of pesticide usage in India is different from that for the world in general. As can be seen in India 76% of the pesticide used is insecticide, as against 44% globally (Mathur, 1999). The use of herbicides and fungicides is correspondingly less heavy. The main use of pesticides in India is for cotton crops (45%), followed by paddy and wheat.

Hazards of pesticides

Direct impact on humans

The high risk groups exposed to pesticides include production workers, formulators, sprayers, mixers, loaders and agricultural farm workers. During manufacture and formulation, the possibility of hazards may be higher because the processes involved are not risk free. In industrial settings, workers are at increased risk since they handle various toxic chemicals including pesticides, raw materials, toxic solvents and inert carriers

Impact on environment

Pesticides can contaminate soil, water, turf, and other vegetation. In addition to killing insects or weeds, pesticides can be toxic to a host of other organisms including birds, fish, beneficial insects, and non-target plants. Insecticides are generally the most acutely toxic class of pesticides, but herbicides can also pose risks to non-target organisms.

Surface water contamination

Pesticides can reach surface water through runoff from treated plants and soil. Contamination of water by pesticides is widespread.

Ground water contamination

Groundwater pollution due to pesticides is a worldwide problem. According to the USGS, at least 143 different pesticides and 21 transformation products have been found in ground water, including pesticides from every major chemical class. During one survey in India, 58% of drinking water samples drawn from various hand pumps and wells around Bhopal were contaminated with Organo Chlorine pesticides above the EPA standards (Kole and Bagchi, 1995). Once ground water is polluted with toxic chemicals, it may take many years for the contamination to dissipate or be cleaned up. Cleanup may also be very costly and complex, if not impossible (Waskom 1994; O'Neil, 1998; US EPA, 2001).

Soil contamination

Pesticides and Transformation products could be grouped into:(a) Hydrophobic, persistent, and bioaccumulable pesticides that are strongly bound to soil. Pesticides that exhibit such behavior include the organochlorine DDT, endosulfan, endrin, heptachlor, lindane and their TPs. Most of them are now banned in agriculture but their residues are still present. (b) Polar pesticides are represented mainly by herbicides but they include also carbamates, fungicides and some organophosphorus insecticide TPs. They can be moved from soil by runoff and leaching, thereby constituting a problem for the supply of drinking water to the population. The pesticides and their TPs are retained by soils to different degrees, depending on the interactions between soil and pesticide properties. The most influential soil characteristic is the organic matter content. The larger the organic matter content, the greater the adsorption of pesticides and TPs.. Strong mineral acid is required for extracting these chemicals, without any analytical improvement or study reported in recent years

Effect on soil fertility (beneficial soil microorganisms)

Heavy treatment of soil with pesticides can cause populations of beneficial soil microorganisms to decline. According to the 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” (Savonen, 1997).

For example, plants depend on a variety of soil microorganisms to transform atmospheric nitrogen into nitrates, which plants can use. Common landscape herbicides disrupt this process: triclopyr inhibits soil bacteria that transform ammonia into nitrite (Pell *et al*., 1998);

Glyphosate reduces the growth and activity of free-living nitrogen-fixing bacteria in soil (Santos and Flores, 1995) and

2,4-D reduces nitrogen fixation by the bacteria that live on the roots of bean plants (Arias and Fabra, 1993; Fabra et al., 1997), reduces the growth and activity of nitrogen-fixing blue-green algae (Singh and Singh, 1989; Tözüm-Çalgan and Sivaci-Güner, 1993), and inhibits the transformation of ammonia into nitrates by soil bacteria (Frankenberger *et al*., 1991, Martens and Bremner, 1993). 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 (Kelley and South, 1978). 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 (Chakravarty and Sidhu, 1987; Estok *et al*., 1989). Triclopyr was also found to be toxic to several species of mycorrhizal fungi (Chakravarty and Sidhu, 1987) and oxadiazon reduced the number of mycorrhizal fungal spores (Moorman, 1989).

Contamination of air, soil, and non-target vegetation

Pesticide sprays can directly hit non-target vegetation, or can drift or volatilize from the treated area and contaminate air, soil, and non-target plants. Some pesticide drift occurs during every application, even from ground equipment (Glotfelty and Schomburg, 1989). Drift can account for a loss of 2 to 25% of the chemical being applied, which can spread over a distance of a few yards to several hundred miles. Studies consistently find pesticide residues in air. According to the USGS, pesticides have been detected in the atmosphere in all sampled areas of the USA (Savonen, 1997). Nearly every pesticide investigated has been detected in rain, air, fog, or snow across the nation at different times of the year (U.S. Geological Survey, 1999).. Herbicides are designed to kill plants, so it is not surprising that they can injure or kill desirable species if they are applied directly to such plants, or if they drift or volatilise onto them. Many ester-formulation herbicides have been shown to volatilise off treated plants with vapors sufficient to cause severe damage to other plants (Straathoff, 1986). In addition to killing non-target plants outright, pesticide exposure can cause sublethal effects on plants. Phenoxy herbicides, including 2,4-D, can injure nearby trees and shrubs if they drift or volatilise onto leaves (Dreistadt *et al*., 1994). Exposure to the herbicide glyphosate can severely reduce seed quality (Locke *et al*., 1995). It can also increase the susceptibility of certain plants to disease (Brammall and Higgins, 1998). This poses a special threat to endangered plant species.

Non-target organisms

Pesticides are found as common contaminants in soil, air, water and on non-target organisms 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. Chlorpyrifos, a common contaminant of urban streams (U.S. Geological Survey, 1999), is highly toxic to fish, and has caused fish, kills in waterways near treated fields or buildings (US EPA, 2000). 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 warm water fish” (U.S. EPA, 1996). Several cases of pesticide poisoning of dolphins have been reported worldwide. Because of their high trophic level in the food chain and relatively low activities of drug-metabolising enzymes, aquatic mammals such as dolphins accumulate increased concentrations of persistent organic pollutants (Tanabe *et al*., 1988) and are thereby vulnerable to toxic effects from contaminant exposures. Dolphins inhabiting riverine and estuarine ecosystems are particularly vulnerable to the activities of humans because of the restricted confines of their habitat, which is in close proximity to point sources of pollution. River dolphins are among the world's most seriously endangered species. Populations of river dolphins have been dwindling and face the threat of extinction; the Yangtze river dolphin (Lipotes vexillifer) in China and the Indus river dolphin (Platanista minor) in Pakistan are already close to extinction (Renjun, 1990; Perrin *et al*., 1989; Reeves *et al*., 1991; Reeves and Chaudhry, 1998). In addition to habitat degradation (such as construction of dams) (Reeves and Leatherwood, 1994), boat traffic, fishing, incidental and intentional killings, and chemical pollution have been threats to the health of river dolphins (Kannan *et al*., 1993b, 1994, 1997; Senthilkumar *et al*., 1999). Earlier studies reported concentrations of heavy metals (Kannan *et al*., 1993), organochlorine pesticides and polychlorinated biphenyls (PCBs) (Kannan *et al*., 1994), and butyltin compounds (Kannan *et al*., 1997) in Ganges river dolphins and their prey. The continuing use of organochlorine pesticides and PCBs in India is of concern (Kannan *et al*., 1992; Kannan *et al*., 1997a; Kannan *et al*., 1997b; Tanabe *et al*., 1998). The Ganges river basin is densely populated and heavily polluted by fertilizers, pesticides, and industrial and domestic effluents (Mohan, 1989). In addition to fish, other marine or freshwater animals are endangered by pesticide contamination. Exposure to great concentrations of persistent, bioaccumulative, and toxic contaminants such as DDT (1,1,1-trichloro-2,2-bis[*p*-chlorophenyl]ethane) and PCBs has been shown to elicit adverse effects on reproductive and immunological functions in captive or wild aquatic mammals (Helle *et al*., 1976; Reijnders, 1986; The weed-killer trifluralin is moderately to highly toxic to aquatic invertebrates, and highly toxic to estuarine and marine organisms like shrimp and mussels (U.S. EPA, 1996). 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 (Ambrosi *et al*., 1978). 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 (U.S. Water News Online, 2000). The herbicide oxadiazon is also toxic to bees, which are pollinators (Washington State Department of Transportation, 1993). Herbicides may hurt insects or spiders also indirectly 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 (Asteraki *et al*., 1992). Non-target birds may also be killed if they ingest poisoned grains set out as bait for pigeons and rodents (US EPA, 1998). 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 (Extoxnet, 1996). Brodifacoum, a common rodenticide, is highly toxic to birds. It also poses a secondary poisoning hazard to birds that may feed on poisoned rodents (US EPA, 1998). 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 (U.S. EPA, 1996). Exposure of eggs to 2,4-D reduced successful hatching of chicken eggs (Duffard *et al*., 1981) and caused feminisation or sterility in pheasant chicks (Lutz *et al*., 1972). Herbicides can also adversely affect birds by destroying their habitat. Glyphosate treatment in clear cuts caused dramatic decreases in the populations of birds that lived there (MacKinnon *et al*., 1993) Effects of some organochlorines (OCs) on fish-eating water birds and marine mammals have been documented in North America and Europe (Barron *et al*., 1995; Cooke, 1979; Kubiak *et al*., 1989). Despite the continuing usage, little is known about the impacts of OCs in bird populations in developing countries. Among the countries that continue to use OCs, India has been one of the major producers and consumers in recent years. As a consequence, wild birds in India are exposed to great amounts of OC pesticides (Tanabe *et al*., 1998). Use of OCs in tropical countries may not only result in exposure of resident birds but also of migratory birds when they visit tropical regions in winter. The Indian sub-continent is a host to a multitude of birds from western Asia, Europe and Arctic Russia in winter(Woodcock, 1980). Hundreds of species of waterfowl, including wading birds such as plovers, terns and sandpipers, migrate each winter to India covering long distances (Grewal, 1990). While concentrations of OC pesticides in wholebody homogenates of birds have been reported elsewhere (Tanabe *et al*., 1998), concentrations of OCs in prey items and in eggs of Indian birds have not been reported.

Conclusion

The data on environmental-cum-health risk assessment studies may be regarded as an aid towards a better understanding of the problem. Data on the occurrence of pesticide-related illnesses among defined populations in developing countries are scanty. Generation of base-line descriptive epidemiological data based on area profiles, development of intervention strategies designed to lower the incidence of acute poisoning and periodic surveillance studies on high risk groups are needed. Our efforts should include investigations of outbreaks and accidental exposure to pesticides, correlation studies, cohort analyses, prospective studies and randomised trials of intervention procedures. Valuable information can be collected by monitoring the end product of human exposure in the form of residue levels in body fluids and tissues of the general population. The importance of education and training of workers as a major vehicle to ensure a safe use of pesticides is being increasingly recognised.

Because of the extensive benefits which man accrues from pesticides, these chemicals provide the best opportunity to those who juggle with the risk-benefit equations. The economic impact of pesticides in non-target species (including humans) has been estimated at approximately $8 billion annually in developing countries. What is required is to weigh all the risks against the benefits to ensure a maximum margin of safety. The total cost-benefit picture from pesticide use differs appreciably between developed and developing countries. For developing countries it is imperative to use pesticides, as no one would prefer famine and communicable diseases like malaria. It may thus be expedient to accept a reasonable degree of risk. Our approach to the use of pesticides should be pragmatic. In other words, all activities concerning pesticides should be based on scientific judgement and not on commercial considerations. There are some inherent difficulties in fully evaluating the risks to human health due to pesticides. For example there is a large number of human variables such as age, sex, race, socio-economic status, diet, state of health, *etc.* – all of which affect human exposure to pesticides. But practically little is known about the effects of these variables. The long-term effects of low level exposure to one pesticide are greatly influenced by concomitant exposure to other pesticides as well as to pollutants present in air, water, food and drugs.

Pesticides are often considered a quick, easy, and inexpensive solution for controlling weeds and insect pests in urban landscapes. However, pesticide use comes at a significant cost. 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 countries, 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.