Pesticides: Poisons to be used with care!

Introduction

Pest by means is a nuisance to man. In general any animal plant or microorganism which harms or causes damage to man, his animals, crops or crop products can be considered as pests. In terms of agricultural pests, if the harm exceeds economic injury level (EIL) the causative agent is considered as a pest. Therefore, the control measures should be taken at the economic threshold level which is below the EIL. Pest control is often practiced in agriculture, public health, ware houses, wood and food storage and in many other sectors. The chemicals used to control pests are known as pesticides.

Classification of pesticides

Pesticides can be considered as the most toxic group of chemicals for the target pest having a versatile nature in use. Pesticides are categorized as insecticides, fungicides, herbicides, nematicides, acaricides, biocides, rodenticides, molluscicides and so on. Pesticides used to kill insects are called as insecticides and similarly the other terms are derived according to the target organism to be controlled. Over 90% of the Global use of pesticides are insecticides, herbicides and fungicides. This is true for Sri Lanka as well.

History in brief

Use of chemicals to control pest dates back to thousands of years. Sulphur has been burned in Greek houses to control pest over 3000 years ago. Subsequently, petrol and tar oils, *Derris* derivatives (rotenone), nicotine extracted from tobacco leaves, Hydrogen cyanide, mercury based compounds have also been used to control pests. It is recorded that in the 2nd half of the 19th century Arsenic was used as "Paris Green" to control potato beetle in U.S.A. Mass scale poisoning due to use of highly toxic inorganic chemicals later compelled for the scientists to develop organic chemicals as pesticides perceived them as safer alternatives.

Then with the increase of world population 'green revolution' occurred. During the Green revolution use of agrochemicals was a necessity to obtain higher yields. Paul Muller, a Swiss postgraduate student produced the first organochlorine insecticide derivative dichloro diphenyl trichloro ethane popularly known as DDT in 1939. It was used at the 2nd world war to control head lice in soldiers and to prevent typhus fever. Later DDT was used in controlling malaria vector mosquitoes. During the early days the inherent nature of persistence of organochlorines was considered advantageous due to its ability of long residual action on the pest. They are nerve poisons, which work on nerve axons to pass signals and to make the insect dead by continuous muscular contractions. Organochlorines build up along the food chains and accumulate in animal fat tissues.

Long term sub lethal exposure of animal to organochlorine mostly exhibits adverse effect on their hormone production system (endocrine system). Studies on environmental impacts of DDT have frequently reported of chronic effects of the chemical on number of animal species. As this was revealed later most of the organochlorines including DDT were banned in many countries.

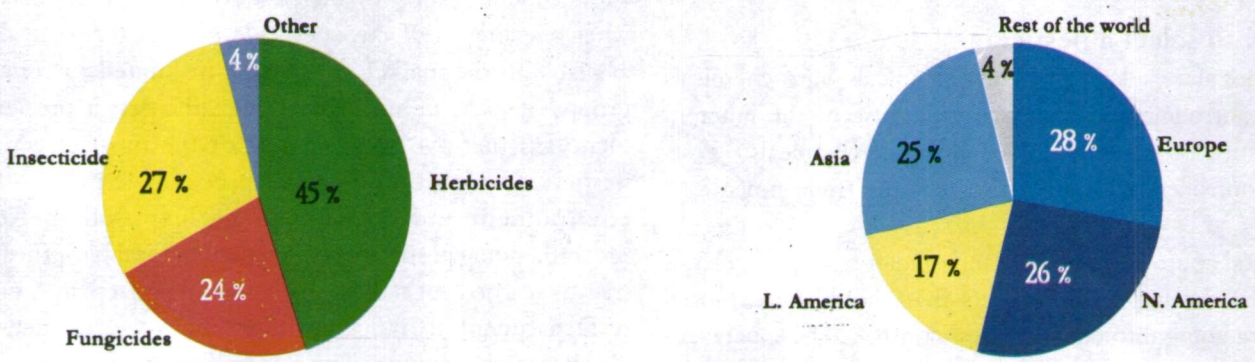

Fig 1. Agrochemical world market in 2004 by categories and region (Total market USD 35.4 bn, crop 30.7 bn, and non crop 4.7 bn)

Present Status

Organophosphates and carbamates were succeeding generation of pesticides to appear. They were nerve poisons as well, which inhibits the enzyme acetyl choline esterase, at the nerve ends. The death of insect brings by the continuous excitation of muscles. These two categories of pesticides are readily degraded in nature (less persistent) but of higher mammalian toxicity.

Then came synthetic pyrethroids, a group of chemicals derived from a naturally occurring insecticide found in *Chrysantamum cinerarifolium.* They were relatively less toxic to mammals but the biological action on pest is similar to that of organochlorines. However, they tend to build up resistance in pests easily. Because of the impressive safety profile of most of the synthetic pyrethroids and effective control of commonly found domestic pests, such as mosquitoes and cockroaches, this group of chemicals easily acquired the domestic chemical pest control sector worldwide. Many formulations of these compounds are used in Sri Lanka, especially in public health programmes. However, these have limited use in agriculture due to possible build up of pest resistance.

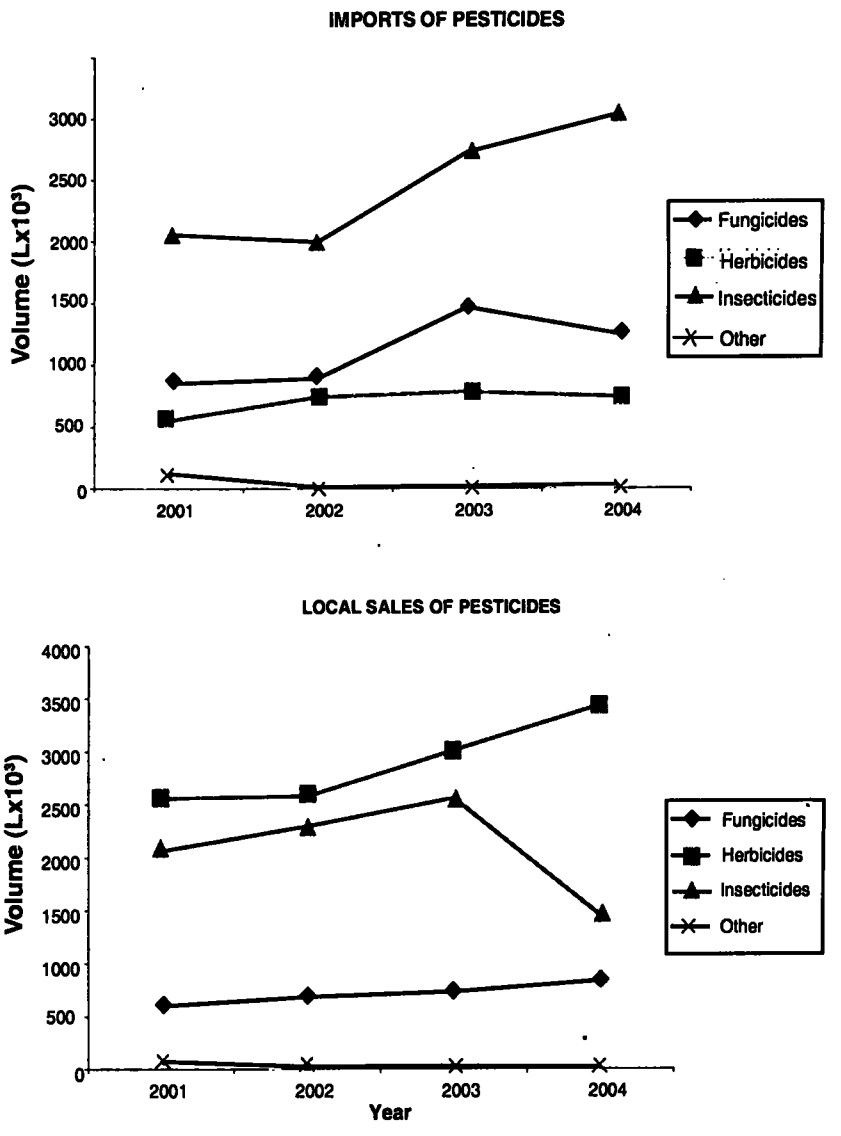

Fig 2. Imports and local sales of pesticides

Other than organophosphates, carbamates and pyrethroids now there are number of new chemical groups emerging with the latest trends in research for more environmental friendly chemicals. Some of them are bio pesticides including botanicals, encapsulated microbial products, pheromones, insect growth regulators, and target specific products.

How to select a pesticide

It is not always desirable to use chemicals/agro-chemicals for controlling pests anywhere because of the inherent toxicities associated with this group of chemicals. Pests are controlled by variety of ways in the environment.

Natural control by parasites and predators, in particular, is one of the important aspects that should be explored before going into chemical pest control. These parasites and predators are also in the same environment where the pest is, which maintain a natural balance among their population. Chemicals affect other useful organisms in the nature, and we have to be very careful on the practice of using pesticides.

Proper identification of the pest is extremely important when selecting an effective pesticide, because the pesticides available in the market are specific or limited to certain groups of pests in most cases. Once the pest is properly identified then we should look for the most effective pesticides which cause least destruction or risk to the environment and the animals get exposed. Before recommending pesticides to the country, local bio-efficacy trials are carried out at the respective crop research institutes of Department of Agriculture and other agencies such as Tea Research Institute. The Researchers carefully design the trials in evaluation of the product to ensure that the pest is effectively controlled at the dosage recommended

Table 1. Insecticide types imported in 2004 to Sri Lanka

Chemical family		Imported Volume (Lx 10^3)
Organo Phosphate	OP	515.56
Organo Chlorine	OC	0.00
Carbamates	CAB	546.45
Botanical	BOT	0.00
Insect Growth Regulator	IGR	122.83
Synthetic Pyrethroid	SP	13.40
Phenyl Pyrozole	PP	6.60
Nitro Guanidine	NG	21.90
Inorganic	IN	3.50
Total		1230.24

(a) (b)

Fig 3. Field application of liquid pesticides: (a) Safe application while wind direction is away from the user, (b) Incorrect and dangerous handling.

with least effect on beneficial organisms, to the crop or related environment. Therefore, it is extremely important that the product recommended for the particular pest is used according to the dosage and dilution rate as prescribed for obtained results. This vital information is available in the label which is approved by the authorities at the time of registering the product after considering all research data.

Farmers are heavily dependent on pesticides due to increasing labour cost to adopt alternative pest control methods. Moreover, chemical pest control is practiced over other options mostly because pesticides have a quick knock down action on pests compared to other control measures. Judicious and correct use of pesticides avoids crop losses and it has become very useful to meet the growing food demand. Integrated pest management (IPM) practices are available and used to minimize the use of these poisonous chemicals in crop production.

Toxicity

World Health Organization (WHO) has established a classification in which all the pesticides are grouped into different hazard classes considering their acute toxicity (toxicity of single or multiple exposures over a relatively short period of time) that might be encountered while any person handling that product. This classification distinguishes between the more and less hazardous forms of each pesticide in liquid and solid forms.

In Sri Lanka, WHO hazard class 1a &1b are prohibited. Pesticides belong to Hazard class II, III are being currently used while focusing on replacing class II pesticides with safer improved alternatives.

Environmental aspects and hazards to farmers and users

Improper and excessive use of pesticides leads to environmental problems such as contamination of ground water, soil and food, pest resistance development, outbreak of secondary pests, loss of diversity of beneficial flora and fauna species. Depending on the nature of toxicity their impact on human health varies. Occupational exposure through dermal and ingestion are the commonest causes for possible health impacts due to pesticides under farming conditions.

While most of these conditions can be significantly minimized by using proper

Table 2. WHO classification of pesticides

Class	LD_{50} for the rat (mg/kg body weight)			
	Oral		Dermal	
	Solids	Liquids	Solids	Liquids
Ia (Extremely hazardous)	5 or less	20 or less	10 or less	40 or less
Ib (Highly hazardous)	5-50	20-200	10-100	40-400
II (Moderately hazardous)	50-500	200-2000	100-1000	400-4000
III (Slightly hazardous)	over 500	over 2000	over 1000	over 4000

Note- LD_{50} the unit to measure acute toxicity, amount of substance required to kill 50% of a population of test animals, expressed in mg/kg. LD – Lethal Dose.

protective measures such as protective clothing (long sleeved shirts, gloves, trousers and face masks etc). Some of the handling practices also improve the safety while application. Avoiding the spray drift from the wind by choosing proper direction of application and use of proper equipment including right nozzle type according to the situation are other important features.

Acute exposure effects or the effects seen within short period of exposure to pesticides, could include headache, dizziness, nausea, vomiting, suffocation, burning sensation in chest etc. If the applicant experiences any of the above symptoms he should immediately stop application of pesticides and wash himself thoroughly before seeking medical advice, if the condition persists.

Apart from immediate toxic response to the exposure of pesticides, medium and long term exposure to lower levels of pesticides also result in numerous other health effects. They are generally classified as sub chronic and chronic effects which include destruction of the reproductive system, damages to certain organs such as kidneys, liver, and physiological system in the body including carcinogenic and other serious health effects. During exposure the person may not recognize easily of the situation in case of chronic exposure because it takes long time to appear the symptoms of some of these health effects. Therefore, taking all necessary precautions at the time of handling pesticides, even if it may not be the preferred choice is extremely important from health point of view. Avoidance of direct contact with pesticides is important in this respect. For example, using necessary personal protective equipment such as gloves etc., thorough wash of contaminated parts of the body using soap and water as quickly as possible are few options generally recommended. It is always important to remember that children and pregnant women are not associated with any pesticide related activity under any circumstance because the health consequences would be greater compared to men and adults. General precautions to be observed in handling and the level of hazards of the formulation are given in the label of the pesticide bottle or container as guidance for the user which should be strictly adhered to by the user.

Label of pesticides sold in Sri Lanka

Pesticide label should conform to the Section 8 of the Control of Pesticides Act which prescribes the information that should contain the label including how the information is presented. Each product has its own trade name decided by the marketing agency but there is a common name accepted internationally for the chemical should appear directly below the trade name in the label with character size of 50% that of the trade name. This avoids undue marketing advantages and possible confusions by the consumer. Along with the common name the label consists information on pests, crops etc. for which the product is officially recommended by Sri Lanka. Dosage which should be applied on the crop or other environment along with such information as dilution is also included. Handling precautions, first aid and in case of emergency, and information for physician are also mandatory on an approved label. The colour band appearing at the bottom of the label provides the vital information of its hazard class as classified by the WHO. **Red** band refers to extremely hazards group, while **yellow,** and **blue** refers to moderately, and slightly hazardous groups. The **green** colour band refers to the group unlikely to cause any hazard. The label contains number of other information along with product related aspects such as registration number. batch number., expiry date, date of manufacture etc, which are very useful for the consumer to get required information at the time of purchase.

Storage of pesticides by the user

Once a product is chosen and purchased another vital aspect is the storage of product or the left over which is intended to be used later. Under any circumstances pesticide should not be just kept in the house for a long period of time which would allow ready access to unwarranted persons and children. ***Specially, children should be given the idea that all pesticides are dangerous poisons that can kill. Adults should develop the idea that pesticides are poisons, and need to be used with care, only if its use become unavoidable.***

Easy accessibility at household environment would result in serious consequences some of which may lead to unfortunate situations such as death of loved ones. Deliberate attempts to terminate the life using pesticide have become a serious social issue in farming community. Therefore, it is extremely important that we should avoid unnecessary and prolong storage of pesticides at household environment. The amount required for immediate use should be brought in and disposes of as early as possible. However, in an instance where a small amount of left over of pesticides or a product to be used in immediate future (in couple of days) can be stored in a safe storage box located outside the house at a place which is not reachable by children and kept always under lock and key. Special precautionary measures are needed to be observed in case of storage of bulk quantities of pesticides.

Legal control in Sri Lanka

The government has the overall responsibility of assuring proper management of pesticide use in the country, and should take specific powers to regulate the distribution and use of them within the country. In Sri Lanka, legal provisions are established under Act No. 33 of 1980 on imports, formulation, packing, labeling, storage, transport, sale and use of pesticides. The Registrar of Pesticides is the licensing Authority who is advised on policy and technical matters by the Pesticide Technical Advisory Committee (PeTAC).

Office of the Registrar of Pesticides implement the regulatory process while conducting programmes, surveys, studies of environmental impacts and training of various target groups including school children etc. For example one ongoing programme is collaborated with the Health Ministry to assess the impact of banning two most potent agents connected with majority of suicides in Anuradhapura and Polonnaruwa districts. The use of them is prohibited in Polonnaruwa areas since 2003 and the trend in pesticide related deaths are monitored in which results show a tendency in declining the death rate. Another possible relationship with these agents in Anuradhapura area is pesticides and Chronic Renal (Kidney) Failure. Samples were analyzed to quantify the residues of possible contaminations in drinking water and the findings were below the levels internationally accepted for potential adverse health effects.

Gas chromatograph for residual analysis

In Nuwara-Eliya area where heavy use of pesticides is practicing, random water samples were analyzed in connected water bodies by gas chromatography. Profenofos and Chlorpyrifos residues were detected in Lake Gregory and Castlereigh reservoirs whereas no residues were detected in Kothmale and Ambewela reservoirs.

Another study is in progress to detect the residue levels in vegetables offered at the market for awareness, educational and regulatory control on possible contamination of food. It would make the seller understand the consumer demand of pesticide free foods and the farmer aware of the proper use of pesticides. These analytical processes are expensive with the need of experienced technical staff, and scares resources are wisely used for preventive and educational purposes.

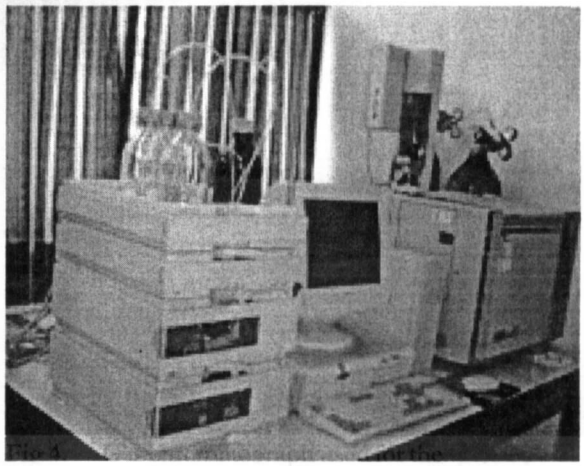

Fig 4. Gas chromatograph used for the detection of pesticide residues in water and food samples

Sri Lanka has just become a party to the Rotterdam Convention on the Prior Informed Consent (PIC) procedure for certain hazardous chemicals in international trade. Rotterdam Convention entered into force in February 2004. It helps participating countries make informed decisions about the potentially hazardous chemicals that might be shipped to them, and to facilitate the dissemination of these decisions to other countries.

Future controls

Sri Lanka has already phased out all highly hazardous pesticides including Persistent Organic Pollutants (POPs) under the Stockholm convention. POPs are persistent and last for a very long period of time in the environment. They are potent carcinogens and show teratogenic, oncogenic effects or are highly toxic to humans in other ways. They bioaccumulate along the food chains. Aldrin, Dieldrin, DDT, Chlordane, Endrin, Heptachlor, Hexachlorobenzene, Mirex and Toxaphene were identified as POP pesticides.

Pesticides or pest killers have become essential poisons especially for agri-production, but we should learn to use these poisons with care. Also, we should use the minimum required amount as recommended, while avoiding harmful effects on humans and other organisms in the nature.

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