

## 1. PESTICIDE SAFETY, STORAGE AND DISPOSAL

G Thyagarajan  
Commonwealth Science Council  
Marlborough House, Pall Mall  
London SW1Y 5HX, UK

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### CONTENTS

WHAT ARE PESTS?	90
WHY CHEMICAL PEST CONTROL?	90
PESTICIDE CLASS AND TOXIC ACTION	91
NATURE OF HAZARDS FROM PESTICIDES	92
Hazards in movement and storage	93
Care and control of storage areas	94
Care in field use and application	95
Disposal of unwanted stocks and containers	95

## WHAT ARE PESTS?

Insects, weeds and fungi constitute the three classes of pests.

There are about one million species of insects, far more than all other animal and plant species combined. The number alive at any given time is reckoned at around  $10^{18}$  of which 99.9% are quite harmless from a human point of view; some of them are even helpful. It is the other 0.1 per cent which come under the category of pests.

Weeds are also considered as pests, although the pure biologist would probably regard them as plants in their own right. Weeds qualify as pests because they (a) compete for nutrients, water and light, (b) occupy valuable space above or below the ground (c) may be poisonous to man, livestock and crops, (d) harbour and transfer diseases and (e) upset crop economics by making harvesting more difficult and reducing produce quantity and value.

Fungi are responsible for many serious diseases. The alleviation of diseases or suffering of plants should be considered as important as alleviation of human or animal suffering from diseases.

## WHY CHEMICAL PEST CONTROL?

The various options available for plant protection range from traditional practices to modern and sophisticated methods. These are: (a) cultural or mechanical methods, (b) biological control, (c) application of pesticides, (d) designed interference and (e) integrated control. Some of these are elaborated in Table 1.

Table 1: Methods of pest control

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### Mechanical methods

Ploughing, harrowing, flooding, draining, oiling, fire, machines to remove tough weeds, quarantine, notification, eradication.

### Biological methods

Use of animals to control weeds (geese for weeds in mint)  
Use of one living organism to control another  
Highly specific predators  
Pathogens (fungi, bacteria, viruses)

### Chemical control

Application of synthetic pesticides  
Use of natural product extracts

### Designed interference

Insect hormones, chemical sterilisation, sex lures, food lures, oviposition lures, electromagnetic energy

### Integrated control

Judicious and planned combination of methods, with environmental compatibility

One other method has proved as effective, fast, easy to use and amenable for widespread utilization as chemical pest control. It continues to be the preferred option for pest management. It is estimated that without pesticides, two-thirds of all crops would be lost, depriving millions of people of food.

The present annual rate of consumption of pesticides is equivalent to an application of 0.5 kg for every person in the world. Since the majority of the world population lives in developing countries, relying in most cases on an agricultural economy, the indispensability of agrichemicals needs no emphasis. Agricultural economists have estimated that if pesticides are not used, the cost of production could increase by anywhere between 60 and 200 per cent depending on the nature of the crop.

#### PESTICIDE CLASS AND TOXIC ACTION

There are in use in the world today approximately 40,000 formulations and products based on about 600 active pesticide ingredients. Though staggering in number, the basic technical materials fall into five broad classes listed in Table 2, with several examples.

Table 2: Pesticide classes and examples

<u>Major pesticide class</u>	<u>Examples</u>
Phosphorus-containing	monocrotophos, tetrachlorvinphos, chlorfenvinphos, diazinon, phosphamidon, parathion, temephos, chlorpyrifos, malathion
Halogen-containing	DDT, ethoxychlor, 2,4-D, 2,4,5-T, endrin, toxaphene, PCP, MCPA, chlordane, heptachlor, endosulfan
Nitrogen-containing	aldicarb, carbaryl, alachlor, captan, monuron diuron, triazine herbicides, diquat, paraquat
Synthetic pyrethroids	permethrin, deltamethrin, cypermethrin fenvalerate
Miscellaneous group	Inorganic sulphur compounds, organic tin compounds, antibiotics, copper, phenolic compounds

Being chemical compounds, most pesticides are active or reactive and perform by being toxic or inducing toxicity to the pest. Toxicity is thus a basis for pesticide function. Phosphorus-containing pesticides act by inhibiting a vital body enzyme called cholinesterase. Symptoms of poisoning by this class are headache, nausea, blurred vision, abdominal pain or diarrhoea, and advanced stages may cause coma, convulsions and lung failure. The mode of action of chlorine-containing compounds is still not clearly understood, one of the reasons being their stability and very slow degradation. The metabolites are often fat-soluble and tend to accumulate in the adipose tissues. The mode of action of other classes of pesticides are also not conclusively understood yet. For example, deposits of DDT and (its principal metabolite) DDE are found in body fat of the general population in many countries of the world. The significance of these body deposits is not clear and no serious adverse effects have been associated with this presence.

Pesticides undergo extensive testing and trials before they are cleared for field use. Registration data requirements are, in many countries, very rigid. A large amount of information is available on the acute, subacute and chronic toxicity of pesticides in different species of experimental animals and is useful for reference and guidance in formulating methods of treatment in cases of pesticide poisoning.

#### NATURE OF HAZARDS FROM PESTICIDES

According to the World Health organisation, there occur, in the developing countries each year, some 375,000 cases of pesticide poisoning, out of which two persons die every 90 minutes.

In discussing the nature of hazards from pesticides, this article excludes hazards associated with the manufacture of basic technical pesticides. Hazards arising in the following stages will be considered here:

- transportation
- formulation at field or user level
- storage
- application
- general handling at farmer level
- disposal of unwanted stocks

The primary requirement for safe handling in all the stages mentioned above is a good and up-to-date knowledge of the physico-chemical and biological properties of the chemical concerned. Dangers arising from misuse or mishandling of pesticides could be physical risks and human or environmental effects. These are summarised and listed in Table 3.

**Table 3: Physical, health and environmental risks of pesticides**

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Physical risks

Explosion under effects of flame or friction  
Exothermic reactions on contact with other substances  
Fire by ignition or contact with air

Health risks

Corrosive effects on living tissues  
Irritation or inflammation of skin and mucous membranes  
Acute or chronic health impairment by inhalation or skin penetration  
Carcinogenic effects  
Fatality in serious incidents

Environmental risks

Death of animals near plantations  
Toxicity to fish  
High residue levels in edible materials  
Unsafe environment to living systems

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**Hazards in movement and storage**

Although every country has laws and regulations governing the transportation and storage of pesticides, accidents continue to arise due to violation of regulations, lack of knowledge or plain carelessness.

1. Toxic leaks and spills may arise from defective containers or from puncturing, tearing or breaking of containers. Such spills may cause acute toxicity to people involved in transportation or in warehouses. More problems may arise if the spill of one type of pesticide contaminates other types, leading to fires, emission of fumes or even explosive reactions, apart from contamination of surrounding areas. To avoid these hazards, pesticide containers should be closely and regularly inspected. Containers showing signs of leakage should be isolated and not transported. Loading of containers should be such that they are secure and would not get displaced or damaged. For example, sharp tools or objects which could fall or hit pesticide containers should be isolated.

Under no circumstances should pesticides be placed or transported along with food, fruits or other materials intended for human or animal consumption. Personnel (handlers and supervisors) should receive training and updating of knowledge which should include first aid and rescue procedures. The use of protective apparel and gadgets (gas masks, goggles, face shields, gloves, boots, etc.) should be enforced.

2. Fire is a major potential hazard when dealing with liquid pesticide formulations which contain organic solvents with low flash points.

Warning statements such as the following used in USA are suggested:

- flash points at or below 20°F (-6.7°C): danger - extremely flammable! Keep away from fire, sparks and heated surfaces.
- Flash points between 20°F and 80°F (-6.7 to 26.7°C): warning - flammable! Keep away from heat and open flame.
- flash points between 80°F and 150°F (26.7 to 65.6°C): do not use or store near heat or open flame.

Proper warnings on the label and compliance can go a long way in averting fire hazards.

When pesticides catch fire, serious danger may arise through dispersion of fire to other inflammable materials, release of toxic vapours and even explosion (e.g. aerosol cans). Even run-off water from pesticide fire-fighting could be toxic and care should be taken to prevent contamination of fresh water systems.

Handling pesticide fires is an extremely difficult and risky operation. Personnel assigned to these operations must themselves be protected and informed appropriately.

Decontamination of affected and suspected areas (as also tools and equipment employed) also needs careful supervision.

3. Heavy rains or floods may also pose a serious problem during transportation and in storage of pesticides, ranging from soaking to being swept away or destroyed. In such events contamination of water and ground is a serious possibility. Coordinated action by the authorities and the public who are likely to be affected is a very important need in such situations.
4. Defects in design, construction or maintenance of pesticide storage areas or sheds are often the cause of accidents involving large inventories. Financial losses apart, fire or spills would leave lasting effects on human health and environment. It is, therefore, very important that pesticide storage areas are carefully selected (with regard to wind direction, ventilation), constructed (material of construction, segregation according to properties and likely risks) and maintained (temperature control, exhaust efficiency, personnel safety and emergency preparedness).

### **Care and control of storage areas**

For convenience and ready reference, the following guidelines are suggested.

1. Pesticides should only be stored in original, approved and labelled containers. They should never be transferred to old bottles or drums in which they could be mistaken.
2. Pesticides should be stored as far away as possible from food stocks, animal movement or human interference.

3. Storage areas should be secure, and pilfer-proof.
4. Inventory maintenance, inspection and monitoring are important.
5. Fire fighting, protective clothing and decontamination equipment should be available and operational at all times.
6. Local authorities (public health, environmental protection, fire service and police) should regularly inspect the areas for compliance with regulations.
7. Safety literature in local languages should be freely available and displayed appropriately.

### Care in field use and application

Apart from the risks and safety aspects discussed in the foregoing paragraphs, people who need to handle pesticides in the field should be specifically careful in dealing with them. There may be need to mix before application in some cases. Common formulations of pesticides applied are: wettable powder, dust, emulsifiable concentrate, soluble powder, granules, fumigants and seed dressings.

Persons directly handling the jobs of mixing, loading and applying pesticides tend to be contaminated by skin contact, mouth ingestion (eating, smoking) and breathing. There is likelihood of acute poisoning if the concerned persons do not exercise the prescribed safety procedures. Manufacturers of pesticides and their formulations and regulatory authorities have a responsibility to make available all the relevant safety and handling information, but the persons who are ultimately concerned with their application have an even greater responsibility. At least three important factors arise:

- care in the choice of pesticide to be used
- care in selecting the right application method and equipment
- thorough knowledge and faithful compliance of instructions, based on respect for the properties of the chemical substances involved.

### Disposal of unwanted stocks and containers

In the pesticide life cycle, from manufacture to end use, the need may arise to dispose of the following:

- empty containers after use
- surplus stocks not likely to be used
- obsolete or time-barred stocks
- spoiled materials arising from spills, leakage or flooding

In spite of impressive progress in the chemistry, technology and application of pesticides, there are still no satisfactory answers to the question of disposal of unwanted pesticides and their containers. The problem is less severe at commercial manufacturing facilities because of first-hand knowledge and access to needed resources. It is simply impossible, in the present conditions, to collect and return empty containers to the manufacturer or to

re-use them. The following options are to be considered depending upon the type, quantity or state of the material for disposal.

- Large metal drums may be purchased and processed by firms suitably equipped to do so.
- Compliance with local regulations on the safe destruction of containers. Containers made of combustible materials can be incinerated at carefully selected locations.
- For disposing of sizeable quantities of unwanted pesticides, none of the available methods is totally acceptable from health and environmental points of view. However, subject to appropriate pre-treatment, the following modes can be employed: (a) incineration, (b) burial in identified land sites, (c) discharging into ocean, (d) lagooning for solar and soil decomposition. It is a good practice to consult experts, preferably the manufacturers of the product, in this regard.
- At farmer and household level, complications may arise by improper attention to storage and handling of pesticide residues and containers. Children, illiterate persons and animals are prone to be affected if sufficient care is not exercised. Where quantities involved are not large, empty containers can be thoroughly rinsed and cleaned with water and drained away, or buried in deep soil pits (under at least 60 cm of top soil). Purchase and stocking of unnecessarily large quantities should be avoided. Pesticides manufactured and distributed by reputable firms generally carry sufficient instructions and guidance in local languages which, if properly and faithfully followed, should make pesticide handling, storage and application, a normal, fearless and effective proposition.

It is important to note that many pesticide formulations which are commercially distributed are sensitive to temperature rise. They may undergo deterioration or degradation, resulting in reduction or loss of activity. A degraded pesticide may have more toxicity than the original material. These aspects should be kept in mind when storing pesticides at farmer or household level.