Pesticide Retailer Handbook

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1. Introduction

Pesticides are an important input for agricultural crop production. However, pesticides cost the farmer money to use, and are not the only means by which pests can be controlled. Farmers need to know how to use pesticides effectively and economically within an overall crop and pest management programme. Pesticide retailers can play an important role in providing farmers with this information, and by doing so will also improve their levels of service to farmers and the strength of their business.

In addition, pesticides are dangerous chemicals which need to be transported, stored, handled, and used with care so as to protect the user, bystanders, the food that we eat, and the environment.

Pesticide retailers thus need to know all the characteristics of the pesticide products that they are selling, how to handle and use them safely, the basic procedures in case of accidents, the different aspects of crop and pest management, and how pesticides fit into the overall crop production and protection programme.

A training scheme for pesticide retailers is being introduced to address these considerations. The objectives of the training scheme are to:

* Improve the standards of retailer knowledge and skills.
* Enable certified retailers to give better service to their customers (farmers and others).
* Assist certified retailers to be more competitive through a more satisfied customer base than non-certified retailers.
* Improve the government’s perception of retailers, so that they are treated as responsible people.
* Assist in ensuring that pesticides are transported, stored, handled, sold, and used safely, effectively, and economically.

A retailer will become certified if he passes the standard test at the end of the training course to prove that he has the required knowledge about pesticides. This Handbook is intended to support the course contents, and contains all the necessary information to pass the test.

**Note:**

Additional information on various technical aspects is included in the Handbook in shaded boxes like this one. The contents of these boxes provide more detailed background material, but will not be included in the certification test.

**Certain pesticides and pesticide products are mentioned in this Handbook.**

**These are for example purposes only, and are not a recommendation for**

**the particular pesticide or pesticide product mentioned.**

2. Dealing with Farmers

Any business depends on its customers for success. The more customers that a business can attract, the more successful the business will be. Customers expect service when they come into a shop – if they receive good service they will use that shop instead of other shops.

2.1 Good Service = Good Business

Information is given in the next section on how to help farmers reduce the amount of pesticides they use. As a retailer you may be asking yourself “Why should I help a farmer reduce the amount of pesticide he uses? It means I will sell less, and so make less profit - I should be trying to sell as much pesticide as possible.”

Obviously, as a retailer, you want to have a successful business, which means selling pesticides and making a profit. But there are two ways of looking at this aspect of making a profit. One is to sell as much pesticide as possible to a small number of farmers, whether they need it or not. The other way is to attract as many farmers to the shop as possible, selling each one a smaller amount of pesticide, but actually selling a greater amount when combined over the larger number of farmer customers. Although the first way may be profitable in the short term, the second way will be much more profitable in the long term. The retailer should thus be looking at the second way, in order for his business to prosper and have a long term future.

So how do you attract farmers to your shop? Currently, farmers consider that pesticides sold by retailers are of poor quality, that advice on the selection and use of pesticides is not always given, and that the retailer just wants to take their money. In other words, farmers generally consider that retailers provide a poor level of service. To attract farmers to your shop, therefore, you must provide a better service than your competitors.

This means selling high quality pesticides at a reasonable price, selecting the right pesticide for the pest in question, and providing accurate and practical information on how to use and apply the pesticide.

Furthermore, although pesticides are an important input for agricultural crop production, they cost the farmer money to use and are not the only means by which pests can be controlled. Pesticides must be considered as one possible tool in an overall crop and pest management programme. If you can also provide the farmer with practical information on good crop management and how to reduce pest losses with minimum pesticide use and cost, then you will be giving him the service he needs.

Once farmers discover a retailer who provides good service, they will use that retailer rather than competitors who do not provide the same high level of service. They will also tell their friends which is the best retailer to use. It is up to you to provide the service that the farmer wants, and to help him use pesticides effectively and economically. If you can do this, you will attract farmers to your shop, and have a successful and profitable business.

2.2 The Elements of Good Service

* Constant availability of good quality products at reasonable prices.
* Good quality, practical advice on pesticide selection and use, which is easily understood and remembered by the farmer.
* Knowledge of the farmers’ problems, and appropriate solutions.
* The ability to ask questions to identify the problem.
* A well lit, clean, tidy shop, with products and posters attractively displayed so that the farmer can see what is available.
* Treating the farmer as a friend, and not as a source of money.
* Honesty in all dealings with the farmer.

2.3 The Elements of Bad Service

The elements of bad service are the opposite of those of good service:

* Selling poor quality, out-of-date, or adulterated pesticides.
* Selling any pesticide, regardless of its suitability or the problem, because the farmer asks for the cheapest product, or because the retailer makes the most profit on that product.
* Providing no advice or help to the farmer in the selection of an appropriate solution or product for his problem.
* A dark, dirty, cluttered shop, with products badly displayed, and with leaking or damaged containers, or with no labels.
* Treating the farmer as ignorant, and as someone to just take money from.
* Dishonesty.

3. Crop Management and Pest Management

“Pests” can occur in many situations – for example in crops, where they cause damage and loss to produce; in houses and buildings, where they cause damage and loss to food, structures and fabrics; in public health, where they spread disease; and as general nuisance organisms.

Often, the first reaction to a pest situation is to use a pesticide. However, pesticides are only one solution to a pest problem. There are many other methods available, some of which have been used for hundreds of years – before modern pesticides became available. These other methods concentrate on producing a healthy crop, or on producing an environment which is unfavorable for pest populations. These methods can be implemented at little or no extra cost to the farmer, as they are often part of normal crop production practices

This section outlines these other methods of pest management, describes the place of pesticides in the overall pest management strategy, and gives the principles for effective and economic pesticide use. Although many of the examples given refer to crop protection, the underlying principles apply in almost any pest situation, be that in the field, a house, or wherever.

3.1 Pests, Diseases and Weeds

First of all, we must understand what is meant by a pest. An insect pest, a disease or a weed is any organism that:

* Competes in any manner with humans, domestic animals or useful plants.
* Injures humans, domestic animals, useful plants, structures or possessions.
* Spreads disease to humans, animals or plants.
* Annoys humans or animals.

Put simply, a pest can be defined as: **'Any organism which affects man, his crops, his livestock, or anything he considers to be of value.'**

From this, we can see no organism is inherently a “pest”. To call something a pest is subjective, and depends on the situation in which the organism is found. For example, bees are useful insects as they pollinate flowering plants and produce honey. However, if bees build a nest in a house, then in that situation they would be considered to be a pest.

The types of pests include:

Insects Aphids, beetles, caterpillars, mosquitoes, cockroaches, etc.

Insect-like organisms Mites, spiders, ticks, etc

Weeds Any plant growing where it is not wanted

Molluscs Slugs, snails, etc

Vertebrates Rats, birds, etc

Microbial organisms Bacteria, fungi, nematodes, viruses (which cause plant diseases)

In this Handbook, 'pest' is often used as a general term to include insect pests, weeds and diseases.

3.2 Crop Management and Pest Management

The potential yield of a crop depends on the genetic makeup of the seed. High quality seeds have higher yield potential. The final yield of a crop depends on this genetic potential and how well subsequent crop and pest management practices are implemented.

Crop management includes all the operations, activities and practices that are implemented to grow a crop and produce a yield. These include:

* Selection of a suitable site and soil type for the crop to be grown.
* Use of crop rotations to maintain soil fertility and structure.
* Appropriate land preparation for the crop to be grown.
* Use of certified, clean seed, seedlings or root stocks that are suitable for local production, climatic, and market conditions.
* Where appropriate, transplanting at the correct time.
* Planting at the correct time.
* Using the correct plant spacing.
* Where appropriate, thinning at the correct growth stage.
* Keeping the field free of weeds or maintaining a cover crop, as appropriate.
* Using organic manures to maintain or increase soil organic matter.
* Using the correct amounts of artificial fertiliser at the correct times to meet crop needs and allow for nutrients removed from the field in produce or as crop residues.
* Using the correct amounts of irrigation water at the correct times.
* Minimising losses and damage caused by insect pests, diseases and weeds.
* Pruning of vines and orchards to stimulate production, and improve aeration and sun penetration.
* Trellising of suitable crops to stimulate production, and improve aeration and sun penetration.

To produce a strong and healthy crop with a yield as close as possible to the potential yield, all crop management practices must be implemented in an optimal manner. If any of the practices are implemented below optimum levels, then crop vigour and final yield are reduced.

Minimising losses caused by insect pests, diseases and weeds is also a part of crop management, but is only one element of many. In addition, one factor of pest management that is often misunderstood is that:

**Pest management does not increase the yield potential of a crop,**

**It only protects the crop against loss or damage**

A fundamental of good pest management is thus to produce a strong healthy crop by optimising all crop management practices.

Crop management and pest management are thus inter-linked, and each has an effect on the other. As an example, if plants are grown too close together, there is not only competition between them so that yields are reduced, but also the close spacing both provides an environment which encourages insect pests and diseases, and in addition makes spray penetration difficult so that pesticide applications are less effective.

3.3 Methods of Pest Management

**Cultural control** includes those practices which optimise plant growing conditions, or produce unfavourable conditions for pests. Optimal growing conditions provide a healthy crop which is more able to resist pest attack.

**Time of planting.** Planting at the correct time promotes healthy plant growth and avoids periods of attack by major pests, such as early planting of cotton to avoid late season bollworm attack.

**Timing and amount of fertiliser.** Wrongly timed or excess fertiliser can promote vegetative and dense plant growth which encourages pests such as aphids and whitefly.

**Timing and amount of irrigation.** Similarly to fertiliser, wrongly timed or excess irrigation can promote vegetative plant growth which encourages pests and diseases such as aphids and whitefly in cotton, and blight in tomatoes.

**Plant spacing and density.** Plants sown too close together are weaker and more susceptible to pest attack. Too close spacing also provides suitable micro-climate conditions within the crop for the build-up of pests and diseases, such as aphids and whitefly in cotton, and blight in tomatoes

**Pruning of tree and vine crops.** Allows more air and light, and lowers humidity so that diseases and pests are discouraged.

**Crop rotation.** Helps to minimise the build-up of soil pests, weeds and diseases, such as nematodes, orabanche, fusarium, and root rots.

**Thinning of seedlings.** When seedlings are thinned too late, the plants are weaker and more susceptible to pest attack.

**Trap crops.** Can attract pests away from the main crop, and provide sources of beneficial insects.

**Sanitation** helps to prevent and suppress pests by removing or preventing access to sources of food and shelter. Practices include:

* Ploughing-in or burning of crop residues and fallen leaves, fruit and branches.
* Removal of food sources such as seed and grain (after both planting and harvesting); cleanliness in the store, house or kitchen; good management of animal manure, etc.
* Using clean certified seed, which has no weed seeds.
* Using nets, screens, rodent proof grain stores, etc.

**Resistant crop varieties** have in-built resistance or tolerance to attack by certain pests. The degree of resistance can vary from slight to almost complete. A resistant variety is resistant to some pests, but not all pests. Resistance mechanisms work in three main ways:

* Chemicals in the plant repel the pest, or prevent it from completing its life cycle.
* The plant is more vigorous or tolerant than other varieties, and thus suffers less damage from pest attack.
* The plant has physical characteristics that make it more difficult for the pest to attack it.
* Examples are varieties of tomatoes tolerant to virus diseases and fusarium wilt.

**Mechanical control** is sometimes called physical control, and involves the use of machines or other tools.

* Soil cultivation and tillage, which physically kills some pests, buries them, or exposes them to drying conditions on the soil surface or as food for birds or other predators.
* Soil cultivation also kills weed seedlings, and buries potential food sources for insect pests.
* Traps, such as rat traps and sticky insect traps.

**Biological control** involves the use of natural enemies of pests – predators and parasites (also called beneficial insects) – and encouraging their development. Some pests must always be available to provide a food supply, and there is a time lag between the increase of a pest population and the increase of natural enemies. Biological control also includes methods by which the pest is biologically changed.

* Predators (ladybirds, spiders, lacewings, birds etc) are the most commonly observed natural enemies, but parasites (parasitic wasps, flies etc) often have the greater control effect.
* Natural enemies can be encouraged by using pesticides only when necessary, particularly early in a crop season, and leaving “refuge habitats” around fields where natural enemies can shelter and find food.
* Natural enemies are often common in fields which have not been sprayed with a pesticide. They will often reduce a pest population on their own, without the need for pesticides.
* Diseases of pests caused by viruses, bacteria, fungi and nematodes also control pest populations.
* Pests can be biologically changed by the use of Insect Growth Regulators, which prevent the pest from developing from one stage to another, and by pheromone mating disruption, which prevents the adults pests from finding one another to mate.

**Chemical control** is the use of pesticides, which kill pests, control their activity, or prevent them from causing damage.

The advantage of pesticides is that they provide the quickest and most effective solution to an existing pest problem, with a result that is easily seen by the farmer.

The disadvantages of pesticides is that they provide only a temporary solution, are costly, involve a hazard in use, kill natural enemies of pests, and can cause pest resurgence. In addition, excessive use can result in pests developing resistance to pesticides.

All the other methods of pest control should first be utilised to keep pest populations as low as possible, and pesticides used only when these methods have not been completely successful.

Following a pesticide application, pest numbers may be reduced for a short period but then rapidly increase to much higher levels than were present before the application. This is known as **pest resurgence**, and is due to the pesticide killing the natural enemies of the pest, as well as most, but not all, the pests. The removal of the natural control allows the pests to multiply to much higher levels than before.

In addition, pests may be present which are not normally a problem as their numbers are kept low by natural enemies. With the use of pesticides, this control is removed and they can develop from **secondary pests** to become a major pest problem.

3.4 Economic Principles of Pest Management

A farmer grows a crop as a food supply or to make money. In either case, he wants to maximise his yield or profit, and needs to consider both in economic terms.

* Pesticides are an input in crop production, and cost the farmer money. The more he spends on inputs, including pesticides, the less profit he makes.
* Profit = Value of harvested crop – Cost of production.
* Inputs, including pesticides, need to be used effectively and economically. In other words, the farmer should only use inputs when they will give an economic benefit. As an example from another aspect of crop production, a crop needs water but irrigating every day, or more often than is necessary, does not increase yields. Similarly spraying every day, or more often than is necessary, will not provide increased levels of crop protection.
* Pesticides should thus only be used when pests reach a level where the value of the crop that will be lost is greater than the cost of the pesticide application. The use of a pesticide in this case will give a RETURN on the farmers investment in pesticide use.
* If pests are at a low level, where the value of the crop that will be lost is less than the cost of a pesticide application, the farmer will LOSE money by using a pesticide.

3.5 The Place of Pesticides in Pest Management

Efficient, effective and safe pest management is not a case of “See a pest - spray a pesticide”. It is a case of using all available techniques, all of which play a part in keeping pests at levels below those which cause economic damage or loss. Pesticides are an integral part of pest management, but they are the last, not the first, line of defence against pests. The first line of defence against pests is all the other crop and pest management practices that can be used.

Many crop management practices can reduce the numbers or effects of pests, and involve no extra expense for the farmer. In addition, the use of a range of tactics causes the least disruption to the eco-system, which enables the organisms in the system (plants, beneficial insects, pests) to maintain a balance. It is when this balance is upset, and pest numbers increase to economically damaging levels, that pesticides may have to be used.

The advantages of pesticides are that they provide an effective and quick reduction of pests when numbers reach economically damaging levels, they can control several pests at the same time, and they are easy to use.

The disadvantages of pesticides are that they provide only a temporary solution, are costly, involve a hazard in use and to the environment, kill natural enemies of pests, kill pollinators such as bees, can cause pest resurgence, and excessive use can result in pest resistance.

For economic and effective pest management, therefore, pesticides are used only when necessary - and only when pests are causing economic loss or damage. Crop monitoring and application thresholds are used to determine pest numbers and to time applications at the most vulnerable pest stage. If a pesticide is used, it should be selective, of low persistence and of low toxicity.

No attempt should ever be made to eradicate a pest with pesticides, as this is almost impossible to achieve. In addition, small numbers of pests are required to provide a food source for natural enemies.

3.6 Causes of Failure of Pesticide Applications

Sometimes a pesticide application fails to reduce the level of a pest. In Afghanistan at present this may be due to low quality, fraudulent, or adulterated pesticides. Retailers have a responsibility to their farmer customers to sell only recognised products of high quality.

When a high quality pesticide is used and fails to reduce the levels of a pest, the common causes are:

* **Incorrect pesticide for the pest**. The pest has been correctly identified, but a pesticide has been selected and used which has no effect on the pest. This may be due to the farmer wanting to use a cheap pesticide, or having been given poor advice. Alternatively, the pest has been not been correctly identified, and, although the correct pesticide has been selected and used for the identified pest, the pesticide has no effect on the actual pest which is present.
* **Incorrect timing of the application**. The pest population is not at a susceptible stage. For example, late stage caterpillars are much harder, or impossible, to kill with the recommended pesticide dose.
* **Incorrect dose rate**. A dose rate has been used which is too low to kill the pests. This may occur if the farmer is trying to save money by using less pesticide than recommended, or because of poor application.
* **Incorrect application**. The pesticide has not been applied correctly, so that the pesticide is not applied to the right place where the pest is present (for example, whitefly under the leaves and most of the pesticide applied to the top of the leaves), or has not been applied evenly over the crop, so that there are areas of over- and under-dosing. Other possibilities are poorly calibrated or badly maintained spray equipment which apply an incorrect dose rate.

An additional possible cause of failure with systemic pesticides (see Section 0) is that the plants are under stress so that there is little absorption or movement of the pesticide in the plant. This can apply to insecticides, herbicides and fungicides.

4. Pesticide Laws and Regulations

Pesticides are hazardous materials. They are controlled through laws and regulations in order to ensure safe manufacture, transport, storage and use, and to minimise the risks to handlers, users, bystanders, consumers of agricultural products, and the environment.

Laws and regulations also ensure the quality and effectiveness of pesticides available on the market.

4.1 International Laws and Agreements

There are many international laws, agreements, and conventions which either directly or indirectly affect the distribution and use of pesticides. Some are legally binding on a country as it has signed the agreement to indicate that it will implement the contents.

Examples are:

* The Rotterdam Convention of the Prior Informed Consent (PIC) Procedure for Certain Hazardous Chemicals and Pesticides in International Trade (FAO and UNEP). Includes 29 banned or severely restricted pesticides, 2 of which are sold by retailers in Afghanistan. A legally binding Convention. Afghanistan is not a signatory.
* The International Code of Conduct on the Distribution and Use of Pesticides (FAO). For both governments and industry (including retailers). Not legally binding.

4.2 National Legislation

The majority of countries have their own national legislation which regulates all aspects of pesticide manufacture, distribution, sale and use. Examples of these aspects are given in the list below. Afghanistan is in the process of developing such legislation, and will probably include similar aspects.

* International trade in pesticides
* Roles and responsibilities of regulating authorities
* Requirements for manufacturing and storage facilities, and licensing procedures for such premises
* Requirements for the registration of a pesticide
* Requirements for container labelling and materials
* Control of pesticides imported and sold based on the above criteria
* Licensing and certification of retailers
* Requirements for pesticide retail premises and licensing procedures
* Establishment of Maximum Residue Levels (MRLs) on agricultural produce for consumption and use.
* Record keeping
* Training of handlers, retailers, applicators, users
* Control of pesticide advertising and effectiveness claims
* Offences and penalties for breaking the laws and regulations

National legislation usually also includes the maximum residue levels (MRL) which are allowed on agricultural produce of the pesticides registered in that country. These MRLs also apply to produce which is imported into the country. This has impacts on exporting countries as their produce must meet the requirements of the importing country. The consignment will be rejected if pesticide residues exceed the specified limits or if residues of non-registered pesticides are present.

In Europe and America these requirements are strict. In the Gulf countries and Asia the requirements are becoming more comprehensive and stricter.

4.3 'Private' Rules and Regulations

Major supermarket chains have their own requirements for produce quality because of consumer concerns about pesticide residues. These requirements are even stricter than national requirements, and also usually require that producers are certified under such programmes as GlobalGAP.

GlobalGAP is a pre-farmgate standard, covering all aspects of production from inputs such as seed or animal feed, together with all production activities until the produce leaves the farm. It also requires extensive documentation to be completed during the production process. Producers are certified by external inspectors, either as individuals or as groups.

These national and 'private' rules and regulations must be taken into consideration when developing Afghanistan export crops. Pesticide retailers can help farmers, and the Afghan economy, by providing only reputable pesticides of high quality, together with advice on the actual need for a pesticide to be applied, the correct pesticide to use for each crop and pest, the correct dose rate, and the interval required between a pesticide application and harvest.

5. Pesticides and Formulations

We can define a pesticide as any substance which is used to either directly control a pest population, or to prevent or reduce damage or loss caused by pests. Not all pesticides directly kill the pest, some may inhibit its growth or repel it.

5.1 Pesticide Names

A pesticide may be referred to by several different names, which can cause confusion.

**Active Ingredient**. Only a certain component of a pesticide product has activity against pests. This component is called the active ingredient. There may be more than one active ingredient in a formulation.

**Chemical name**. Each active ingredient is given a chemical name which describes the actual chemical composition. This name is often long and complicated. It may appear on the label in brackets.

**Common name**. Each active ingredient is given an internationally recognised common chemical name that is much easier to use and remember than the chemical name. A specific common name always refers to the same active ingredient, regardless of the manufacturer of the product. Common names are always given on the label.

**Product or Trade name**. Manufacturers give their own name to their products containing a particular active ingredient. It is the product name which appears in large print on the label.

Examples of pesticide names are:

Chemical Name: alpha-cyano-3-phenoxybenzyl-3-(2-chloro-3,3,3-trifluoroprop-1-enyl)-2,2-dimethylcyclopropanecarboxylate

Common Name: Lambda Cyhalothrin

Product Name: Lambda Cyhalothrin, Icon, Super Top

Common Name: Malathion

Product Name: Denadoul, Dimethione, Fifanoun, Killer, Malathion, Super Malathion, Super Sure, Super Dithio

Pesticide manufacturers often use only slightly different names for products containing different active ingredients. For example, products beginning with “Sumi-” are manufactured by Sumitomo (Japan). Also, different formulations of the same active ingredient may be registered for use on different crops. For example, an emulsifiable concentrate formulation may be phytotoxic to a crop while the wettable powder formulation is not.

5.2 Pesticide Classification

Pesticides may be classified in several ways, each way having its own special purpose. Examples of classification are:

Type of pest controlled

Insecticides Control insects.

Fungicides Control fungi.

Herbicides Control weeds.

Acaricides Control mites.

Rodenticides Control rodents (rats, mice).

Molluscicides Control snails.

Nematicides Control nematodes.

Chemical group

**Insecticides:**

Inorganic Pesticides which do not contain carbon. They commonly contain arsenic, copper, mercury, sulphur, tin or zinc. Many of these compounds are now banned or have severely limited uses.

Examples are Kumulus-DF (sulphur)

Organic Pesticides which contain carbon. Some are derived directly from plants and other living material, but most are synthetic in that they have been developed by man. They are the most commonly used pesticides.

- Organophosphates Examples are Chlorpyrifos and Dimethoate

- Carbamates Examples are Carbaryl.

- Pyrethroids Examples are Deltamethrin and Lambda-Cyhalothrin.

Biological / Contain bacteria, fungi, protozoa or viruses, such as *Bacillus thuringiensis*

Microbial and Abamectin.

Botanical Obtained from plant extracts, such as rotenone, neem, and pyrethrum.

**Herbicides**

Herbicides have many different chemical groups, the most common of which include triazines, substituted ureas, and sulfonylureas.

**Fungicides**

As with herbicides, fungicides have many different chemical groups. Common groups are inorganic and dithiocarbamates.

- Inorganic Examples are wettable sulphur.

- Dithiocarbamates Examples are Thiram

Toxicity

Toxicity is the measure of how poisonous the pesticide is to man. High toxicity to man does not necessarily mean that the pesticide is highly toxic to the pest. Formulations are usually less toxic than the pure active ingredient, although with some formulations one or more of the inert ingredients (for example, oil-based solvents) can be more toxic than the active ingredient. The World Health Organisation (WHO) classification is most commonly used, but there are other classifications, such as national systems.

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| **WHO Classification** | |
| Class Ia | “Extremely Hazardous” |
| Class Ib | “Highly Hazardous” |
| Class II | “Moderately Hazardous” |
| Class III | “Slightly Hazardous” |
| [no class] | “Unlikely to Present Acute Hazard in Normal Use” |

The toxicity warning on the product label normally refers to the formulation, not the active ingredient.

Mode of action

**Contact**

The target pest is killed when it comes into direct contact with the pesticide. The pesticide is usually applied to a surface, such as leaves, but may be applied as aerial droplets, for example for flying mosquito or locust control. For a given volume of spray, the more drops per square centimetre of treated surface, the better the effectiveness of the pesticide. Most insecticides are contact pesticides. Good under leaf cover is essential for the control of insect pests such as aphids, whiteflies and spider mites, while good overall plant cover is essential for control of weeds and diseases.

**Stomach**

Insect pests must eat the pesticide to be killed. Most insect contact pesticides are also stomach poisons.

**Systemic**

A pesticide that is absorbed and moved within a plant. Applied to leaf surfaces or to the soil. Within a leaf, movement is mainly from the upper to lower leaf surface. There is very little movement down the plant, so overall plant coverage is essential for pests in the lower parts of the crop. Absorption by the plant is reduced if the plants are under stress. Insect pests are killed when they feed on the plant. Herbicides are largely systemic pesticides, which kill the weed when they are absorbed.

**Vapour action**

A pesticide in vapour or gas form in the air which the pest breathes in. Used as space treatments in enclosed areas such as greenhouses, houses etc.

Selectivity

**Selective**

Selective pesticides control only a limited range of pests, but have little or no activity on other or similar species. While this classification can refer to all pesticides, it is most commonly used for herbicides to identify those which kill the weed species while leaving the crop plants unharmed. Selective insecticides kill the target pest but leave beneficial insects unharmed.

Selectivity can be lost if too high a dose rate is used, particularly with herbicides, resulting in damage to crop plants.

**Broad Spectrum**

Broad spectrum pesticides control a wide range of pests, but also many non-pest species. Broad spectrum pesticides kill beneficial insects as well as pests, while broad spectrum herbicides kill crop plants as well as weeds.

5.3 Pesticide Formulations

Active ingredients are rarely applied in a pure form. Instead, the manufacturer mixes the active ingredient with various other components to make a pesticide formulation. This is done in order to dilute the active ingredient, and to make the product safer and more effective, or easier to measure, mix and apply, or to improve storage. The other components are referred to as inert ingredients, as they have no effect on pests.

Some inert ingredients, such as petroleum based solvents, may be more toxic to humans and crop plants than the active ingredient. More recent formulations, such as suspension concentrates (SC), water dispersible granules (WG), and microgranules (MG), have no hazardous inert ingredients, and also posses improved stability properties.

The properties of a formulation, including effectiveness and safety, depend on the use of high quality ingredients and closely controlled manufacturing processes. In Afghanistan many of the products in the market are sub-standard, counterfeit or fraudulent, with low quality ingredients and manufacturing processes.

Problems associated with sub-standard formulations include:

* Poor quality active ingredient which has reduced effectiveness.
* A lower concentration of active ingredient than that indicated on the label.
* No active ingredient in the product.
* Excessive, often highly toxic, by-products of the active ingredient manufacturing process in the formulation.
* Break down of the formulation in the container during storage. In Afghanistan, this is made worse by the high temperatures prevailing for much of the year.
* Separation out of the spray mix of emulsifiable concentrate formulations
* Settling out of the spray mix of powder formulations.
* Damage or total loss of crops by the product not being effective or phytotoxic.

For effective pest management and safety in use, only high quality formulations from reputable manufacturers should be used.

The same active ingredient may be available in several different formulations. One formulation may be safer to handle or more suitable for a given situation than another formulation of the same active ingredient. Also, different formulations of the same active ingredient may be registered for use on different crops. For example, an emulsifiable concentrate formulation may be phytotoxic to a certain crop while the wettable powder formulation is not.

The common types of formulations are:

|  |
| --- |
| **Emulsifiable Concentrate (EC)**  Liquid formulations where the active ingredient is dissolved in a petroleum solvent. The formulation is diluted with water to form an emulsion for application. Usually contain 25 to 75 percent of active ingredient. ECs are among the most common pesticide formulations. |

|  |  |
| --- | --- |
| **Advantages**   * Easy to handle, transport and store * Can be used with most types of application equipment * Little agitation needed in spray tank, does not settle out * Not abrasive to nozzles and pumps * Do not block filters or nozzles | **Disadvantages**   * Usually high concentration in the formulation * Mixers need more protective clothing than applicators * Easy to over- or under-dose due to mixing and calibration errors * May cause phytotoxicity to crops * Easily absorbed through the skin * Solvents may attack rubber, plastic, hoses, gaskets etc * Flammable |
| **Wettable Powder (WP)**  Dry formulations of fine, insoluble powders. The active ingredient is combined with an inert carrier such as clay or talc, together with wetting and/or dispersing agents. The formulation is diluted with water to form a suspension for application. Usually contain more than 50 percent active ingredient. WPs are among the most common pesticide formulations. | |
| **Advantages**   * Easy to handle, transport and store * Can be used with most types of application equipment * Easily measured and mixed * Usually less phytotoxic than ECs * Absorbed less readily through the skin than ECs | **Disadvantages**   * Mixers need more protective clothing than applicators * Require constant agitation in the spray tank, or they quickly settle out * Abrasive to nozzles and pumps * Can clog filters and nozzles * Risk of inhaling powder during mixing * Inert carriers may leave a deposit on crops, which has to be removed before marketing |

|  |  |
| --- | --- |
| **Suspension Concentrate (SC)**  Used for active ingredients that are not soluble in the more common solvents. They are mixed on a carrier, such as clay, and formulated with a liquid to form a thick, paste-like suspension. The formulation is diluted with water to form a suspension for application. They combine the advantages and disadvantages of both ECs and WPs. | |
| **Advantages**   * Easy to handle, transport and store * Can be used with most types of application equipment * Easily measured and mixed * Usually less phytotoxic than ECs * Absorbed less readily through the skin than ECs | **Disadvantages**   * Mixers need more protective clothing than applicators * Container must be shaken before use to remix formulation * More difficult to accurately measure when mixing than ECs * Require moderate agitation in the spray tank, or they settle out * May be abrasive to nozzles and pumps * May clog filters and nozzles * Inert carriers may leave a deposit on crops, which has to be removed before marketing |
| **Seed Dressings (DS, ES, FS, LS, PS, SS, WS)**  Dry or liquid formulations for application to seeds prior to planting. Dry formulations usually require no further dilution (SS formulations require dilution with water), liquid formulations usually, but not always, require dilution with water. PS formulations are pre-dressed seed. | |
| **Advantages**   * Depending on formulation, similar to EC, WP, SC formulations. * Can be applied to seed on-farm with simple equipment. * Help to avoid early season foliar sprays, and so protect beneficial insects. | **Disadvantages**   * Depending on formulation, similar to EC, WP, SC formulations. * Bulk treatment of seed requires specialist treatment equipment. * Treated seed may be eaten by humans, domestic animals, wildlife. |
| **Granule (G)**  Granule formulations are similar to dusts, except that the particles are larger and heavier. The active ingredient may be coated on the outside or absorbed into the particles. They are applied without any further dilution, and usually contain 1 to 15 percent of active ingredient. They are most commonly used for soil application to control weeds, nematodes and soil living insects. | |
| **Advantages**   * Ready to use, no mixing needed * Slow release of pesticide gives extended protection * Low risk of drift * Little hazard in use to applicator * Require only simple application equipment | **Disadvantages**   * Do not stick to foliage or other non-level surfaces * May need to be incorporated in soil * Can be difficult to obtain even distribution over the target area * Slow release of pesticide results in long persistence * May be hazardous to non-target animals such as chickens and other birds who mistake granules for food grain |
| **Bait (B)**  An active ingredient mixed with food or other attractant material. The bait may be sold pre-mixed, or the pesticide and bait material mixed by the user. Pests are killed by eating the pesticide contained in the bait, either in a single dose, or over time. The concentration of active material is low, usually less than 5 percent. Commonly used in indoor situations, but may be used in agriculture, such as for control of cutworm. | |
| **Advantages**   * May be ready to use * Little pesticide needed – bait applied only where pests are present and pests are attracted to the pesticide | **Disadvantages**   * Can be attractive to non-target organisms (domestic animals, children etc) * Pests may prefer other food or crop to the bait |
| **Fumigant (F)**  Pesticides that form poisonous gases. May be a liquid under high pressure that changes to a gas when released, or a volatile liquid, or a solid that releases a gas under high humidity. Used for structural pest control, food and grain storage, soil sterilization, and greenhouses. | |
| **Advantages**   * Toxic to a wide range of pests. * Can penetrate cracks, wood, soil and grain. * Single treatment will usually kill most pests in the treated area | **Disadvantages**   * Target site must be covered and airtight to prevent the gas from escaping. * Highly toxic to humans and all other living organisms. * Need specialised protective clothing, including respirators. * Need specialised application equipment |

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| --- | --- |
| Soluble | A substance that will dissolve in a *solvent* to form a *solution*.  For example, sugar is soluble in water or tea. |
| Emulsion | A mixture of two liquids in which particles of one liquid are suspended evenly throughout the other.  For example, the butter fat in milk. |
| Suspension | Fine particles of a solid suspended in a liquid.  For example, mud in a river. |

When a spray mix is prepared emulsifiable concentrates will quickly separate into the constituent liquids and wettable powders will quickly settle out of suspension if sub-standard ingredients and/or manufacturing processes have been used in the production of the pesticide formulation.

5.4 Adjuvants

Adjuvants are chemicals incorporated in a pesticide formulation, or added to the tank mix, to increase effectiveness and safety. They generally have no pesticidal effect.

|  |  |
| --- | --- |
| Emulsifiers | Help emulsifiable concentrates to mix better with water |
| Wetting agents | Help wettable powders to mix better with water, and help formulations spread on water repellent surfaces |
| Spreaders | Help the pesticide to spread evenly over the sprayed surface |
| Stickers | Help the pesticide to stick to the sprayed surface |

6. The Container Label

Most pesticides in Afghanistan do not have adequate labels. Such labels are indicative of low quality pesticides. As noted in Section 0, Afghanistan is in process of developing a pesticide Law and Regulations, which will include adequate labelling.

The label on a high quality pesticide from a reputable manufacturer is the primary source of information about a product. Such a label has all the basic information that is needed – the trade name, the active ingredient, the concentration of active ingredient, the crops and pests for which the product is registered, the dose rates, the toxicity, the safety precautions, the pre-harvest intervals, the expiry date, the name of the manufacturer and importer.

When selling a pesticide, the retailer is responsible for giving advice on safe and effective use according to the product label. If a farmer is asking questions or you are giving advice, do not rely on memory. It is too easy to make a mistake. Read the label every time to make sure that the advice you give is correct.

6.1 Parts of the Label

The lay-out of the pesticide label varies between countries. There may be one, two, or three panels, sometimes separated by boxes or lines, with each panel having a different type of information. Example layouts are given in Appendix II.

Regardless of the type of layout, every label on a pesticide container from a reputable manufacturer or source will have the following information:

* Product name of the pesticide.
* Name of the active ingredient(s) in the product.
* Percentage concentration of active ingredient in the product.
* Percentage concentration of inert materials in the product.
* Toxicity of the product.
* Crops and pests for which the product is registered for use.
* Dose or application rates to use.
* Safety precautions to follow when mixing and applying.
* First aid measures and antidotes.
* Pre-harvest interval.
* Date of manufacture, batch number, and expiry date.
* Product registration number
* Name of the manufacturer or importer and contact details.

Also along the bottom of the label should be pictograms, which give information in a graphical format about the precautions to be taken when using the product, and which complement the statements in the label text.

Many pesticides in Afghanistan do not have labels which meet these criteria, which is indicative of a low quality or fraudulent pesticide.

6.2 Toxicity

The FAO Guidelines on Good Labelling Practice for Pesticides include a hazard statement, a symbol, and often a band colour for labels based on the WHO classification system. This system is followed in many countries, although some countries have their own system.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| WHO Class (1) | | Label | | |
| Hazard statement | Symbol | Band Colour (2) |
| **Ia** | Extremely Hazardous | Very Toxic | Toxic | Red |
| **Ib** | Highly Hazardous | Toxic | Toxic | Red |
| **II** | Moderately Hazardous | Harmful | Harm | Yellow |
| **III** | Slightly Hazardous | Caution | None | Blue |
|  | Products unlikely to present a hazard in normal use | Caution | None | Green |

(1) The hazard warning on the label refers to the formulation, not the active ingredient.

(2) This is the most commonly used colour scheme, but may differ in some countries.

6.3 Pictograms

The pictograms on the label are intended to provide graphical advice and warnings concerning the product. They should be in a band across the bottom of the label, one section of the band being concerned with mixing, one with application, and one with general warnings and information.

The meanings of the most common pictograms are as follows:

|  |  |  |  |
| --- | --- | --- | --- |
| Storage |  |  |  |
| Lock_Child |  |  |  |
| Keep locked away and out of reach of children |  |  |  |
|  |  |  |  |
| Activity |  |  |  |
| Liqu_Conc | Dry_Conc | In_Appl |  |
| Handling liquid concentrate | Handling dry concentrate | Application |  |
|  |  |  |  |
|  |  |  |  |
| Advice |  |  |  |
| Gloves | Boots_SA | Eyes | Face_Shield |
| Wear gloves | Wear boots | Wear eye protection | Wear face shield |
|  |  |  |  |
| Nose_Mouth | Respirat | Overalls | Apron |
| Wear mask | Wear respirator | Wear overalls | Wear Apron |
|  |  |  |  |
| Wash |  |  |  |
| Wash after use |  |  |  |
|  |  |  |  |
| Warning |  |  |  |
| Animals | Fish_Water |  |  |
| Dangerous to animals | Dangerous to fish  and water |  |  |
|  |  |  |  |

Examples of colour bands and possible pictograms for some WHO toxicity classifications are given in Appendix II.

7. Pesticide Application and Mixing

The effectiveness of a pesticide in controlling a pest depends on:

* Using the right pesticide for the target pest (Selection)
* Applying the pesticide at the right time (Pest Scouting / Monitoring)
* Applying the pesticide in the right amount (Mixing / Application)
* Applying the pesticide to the right place (Application)

If any of these factors is wrong, the effectiveness of the pesticide application will be reduced, control of the pest will be poor, costs will be increased, and additional (probably also incorrect) applications will be applied. Farmers may often complain that a pesticide did not work, blaming the pesticide itself, when one of the above factors was wrong.

Two of the factors are concerned with application, emphasising the need of correct application for a pesticide to be fully effective.

7.1 Objectives of Pesticide Application

The objectives of applying a pesticide are to:

* Protect the crop from economic damage or loss
* To do this in the most effective and economic way. Pesticides cost money – they must be used effectively to give the farmer a return on his investment.

The final target for a pesticide is the pest. An intermediate target is often the plant surface. The pesticide must thus be taken from the container in which it was purchased and transmitted to the pest. This can be done in various ways, but the most common method in crops is by spray application.

Spay application involves:

* Mixing the pesticide with a carrier to dilute it and carry it to the target. The carrier is commonly water, or a mixture of water and air.
* Putting the spray mix into a sprayer.
* Using the sprayer to break the spray mix into droplets, usually by passing it through a nozzle.
* Using the energy of the droplets themselves, or natural or artificial air movement, to carry the droplets to the target.

For the pesticide to be most effective, there must be sufficient numbers of droplets containing the pesticide applied evenly over each plant in the target area or field. This gives the greatest opportunity for a mobile pest, such as leafworm, to come into contact with the pesticide, for the pesticide to directly contact immobile pests such as aphid, or, in the case of systemic pesticides, to be translocated throughout the plant.

If the pesticide is not applied evenly:

* Areas on the plant and in the field will be under-dosed so that many of the pests are not killed. Crop losses will not be prevented, and costs of control are increased.
* Areas on the plant and in the field will be over-dosed so that excess pesticide is wasted. Costs of control are increased.
* Particularly with underleaf pests (aphid, whitefly, some diseases, etc) there must be good coverage of the lower leaf surface for contact pesticides to be effective.
* If the target area is limited, for example aphids only in parts of the field or application to young seedlings, then spot- and band-spraying can save pesticide, water, and time.

7.2 Plant Coverage, Droplet Size, and Volume of Water

The objective of spray application is to get the pesticide to the target pest, not to drown the pest with water. It is not necessary to use large volumes of water to evenly cover the plants and field, as “washing” the plants results in large amounts of pesticide running off to the ground, where it is wasted, is money thrown away, and causes environmental contamination.

The spray mix is broken into droplets by the sprayer. It is not the volume of water or spray mix that is important, but the number of droplets which are deposited per unit area on the plant. Providing there are sufficient droplets on the plant, each one of which contains pesticide, then effective plant coverage will be obtained and the pesticide will be effective in controlling the pest. If droplet size is halved, then eight times as many droplets will be produced from the same volume of spray mix.

Droplets can be large or small in size.

* If large droplets are produced by the sprayer, to achieve the required number on the plant a large volume of water is needed.
* If small droplets are produced by the sprayer, to achieve the required number on the plant only a small volume of water is needed.

The smaller the droplet, the further it will drift. Very small droplets are thus used for control of locusts and sunn pest using drift spraying with ULV sprayers and formulations. Large droplets are used with herbicides as drift must be avoided because of the risk to adjacent crops.

In general, large droplets are used for the application of herbicides, so as to minimise drift, while small droplets are used for the application of insecticides, fungicides and acaricides to optimise crop penetration and underleaf cover.

7.3 Effectiveness of Spray Applications

Effective spray application is essential for the pesticide to have the greatest effect and to minimise costs.

To illustrate this, on average less than 1 per cent of the pesticide applied actually reaches the pest population.

* If, through poor application, only 0.5 per cent of the pesticide reaches the pest population, the effectiveness of the pesticide is halved, twice the amount is needed to obtain effective control, and the costs are doubled.
* If this can be increased to 2 per cent by more effective spray application, the effectiveness of the pesticide is doubled, only half the amount will be needed, and the costs are halved.

Small changes in the proportion of pesticide applied which actually reaches the pest population thus result in huge changes in effectiveness and costs.

7.4 Nozzles

Different types of nozzles are used for different purposes. The size of the droplets produced depends on the size of the hole in the nozzle and the spray pressure. For any type of nozzle, the larger the hole and the lower the pressure, the larger the size of the droplets produced. Nozzles are generally described by the shape of the spray pattern produced. The most common types are:

|  |  |
| --- | --- |
| Hollow Cone 02Full Cone /  Hollow cone | * Produce a cone shaped spray pattern. With a full cone nozzle, the full area of the cone has spray droplets, with a hollow cone the droplets are only on the outside of the cone. * Full cone nozzles are usually fitted only to air-blast sprayers, hollow cone nozzles are used with hand operated knapsack equipment. * Droplet size tends to be small, and there is a risk of spray drift. * Used at higher pressures than flat fan or deflector nozzles. * Most commonly used for application of insecticides, acaricides and fungicides. |
|  |  |
| Flat fan /  Even spray flat fan  Flat Fan 03 | * Produce a fan shaped spray pattern. * Droplet size tends to be large, with a low risk of spray drift. * Flat fan nozzles deposit most spray directly under the nozzle tip. They are thus used on tractor mounted boom sprayers, where several nozzles can overlap, producing an even spray pattern. Not suitable for single use with hand operated equipment. * “Even spray” flat fan nozzles produce an even deposit of spray across the fan, and are thus suitable for hand operated equipment. * Most commonly used for the application of herbicides. * May reduce the efficacy of insecticide, acaricide and fungicide application. |
|  |  |
| Deflector  Deflector 05 | * Also known as “flooding” or “anvil” nozzles. * Produce a fan shaped spray pattern. * Droplet size tends to be large, with a low risk of spray drift. * Give a relatively even deposit of spray across the fan. * Most commonly used for the application of herbicides. * May reduce the efficacy of insecticide, acaricide and fungicide application. |
|  |  |

7.5 Sprayer Calibration and Maintenance

Accurate calibration of a sprayer is essential to ensure that the correct amount of pesticide is applied to the target area. A sprayer which is not regularly calibrated will apply either too much or too little pesticide, resulting in waste or poor control of pests.

Calibration involves measuring the output of the sprayer, the width of the spray pattern produced, and the speed at which the spray operator is walking or the tractor is moving. Once these factors are known, the amount of spray mix applied to the target area can be calculated. If necessary, adjustments can then be made to one or more of the controlling factors, or to the mixing rate of the pesticide in the water (or to the pressure), to ensure that the correct amount of pesticide is applied.

Regular sprayer maintenance is also essential to ensure that the sprayer is working correctly, and for safety by ensuring there are no leaks. Nozzles should be regularly replaced, at least at the beginning of the season, more often if the sprayer is used frequently or if abrasive formulations such as wettable powders are applied. Calibration of the sprayer with new nozzles fitted will give a base from which to determine when new nozzles should be fitted, as the output will gradually increase as the nozzles become worn.

Leaking sprayers are dangerous, and leaks should be repaired immediately. Seals should be inspected on a regular basis and replaced as necessary. A small toolkit (screwdriver, spanner) should be available in the field to effect immediate repairs. These tools, and some spare parts, may be provided with the sprayer on purchase.

7.6 Comparisons of Sprayer Types

Four types of hand held ground sprayers are commonly used by farmers - pressure sprayers, knapsack sprayers, motorised knapsack mistblowers, and ULV / CDA sprayers.

**Pressure (Compression) Sprayers**

In this type of sprayer, the spray liquid is pressurised by pumping air into the spray tank. Although very cheap, these sprayers are not recommended for agricultural use as the pressure rapidly drops as soon as spraying starts, with subsequent reduction in output and increase in droplet size. However, they are widely used in public health programmes, such as for mosquito control.

**Manual Knapsack Sprayers**

Manual knapsack sprayers are continually pumped by hand to maintain spray pressure. A regular rate of pumping should be maintained. The cost of these sprayers ranges from cheap to moderately expensive. The cheaper versions should be avoided as they have a very short working life, and are very prone to breakdowns and leaks.

Knapsack sprayers are widely used in field and vegetable crops. The most effective method of use of the hand lance provided with the sprayer is to spray sideways into the foliage, or “up and under” the leaf surfaces. For spot spraying in tall orchard trees, an extension can be fitted to the hand lance.

**Motorised Knapsack Mistblowers**

Mistblowers are petrol motor driven knapsack sprayers that produces droplets by air force. The droplets are carried to the crop by a combination of the air forces produced by the sprayer and by natural wind forces. These sprayers are expensive to purchase and run, but they have a greater work output than manual knapsack sprayers.

The drift spraying technique must be used as the natural wind forces are much stronger than those of the sprayer. The spray should be directed downwind over the top of the crop, and allowed to penetrate and settle by natural air movements. The spray should not be directed directly into the crop, as this gives massive overdosing on the plants closest to the sprayer, with very poor penetration into the crop and uneven spray coverage

Misblowers are widely used in field, vegetable and tree crops. However, they are not suitable for treating tall field or orchard crops, unless an additional pump is fitted to pump spray mix to the nozzle.

**ULV and CDA Sprayers**

Ultra Low Volume (ULV) and Controlled Droplet Application (CDA) sprayers use spinning discs to produce small sized droplets of similar size. The discs are driven by a battery powered motor. Pesticides may be applied undiluted or mixed with a small amount of water. Different sprayers are needed for the application of insecticides and fungicides, and for herbicides.

For insecticides and fungicides, the drift spraying technique is used, the small droplets being carried into the crop by natural wind forces. Examples are for control of locust and sunn pest. Understanding how to use this technique is essential for good crop coverage and to avoid unwanted drift out of the target area/crop. With drift spraying, work rates are higher than with manual knapsack sprayers. CDA sprayers for applying herbicides produce larger droplets which fall under the influence of gravity, and drift is less of a problem.

7.7 Mixing

“Mixing” in this context means the preparation of a pesticide formulation for application, such as when a pesticide is “mixed” with water ready for spraying. It does **NOT** mean the mixing of two pesticide formulations to be applied together. This practice is not recommended and should be avoided because of potential adverse effects to the crop or to the spray mix.

Mixing is the most hazardous operation when handling pesticides as the product is in a concentrated form. Precautions are thus essential to protect the handler and the environment.

* Protective clothing should be worn, as indicated on the label. The minimum is gloves, boots, overalls, and goggles (or a face shield for liquids only).
* Take care when opening containers. Plastic and paper bags should be cut with a knife, not ripped open.
* All containers should be placed on a level surface so that they do not tip over and spill pesticide.
* The container should be closed or the cap replaced immediately after the pesticide has been poured out.
* Identify any measures used by local farmers. The quantities of liquid and powders these hold should be calculated so that where necessary the conversion can be made in giving recommendations to farmers.
* Local measures include such things as spoons, matchboxes, cut-down plastic bottles. These measures should be washed after use, and never used for any other purpose.
* When mixing liquid formulations, the liquid can be added directly to the spay tank.
* When mixing powder formulations, the powder should be creamed first with a small quantity of water in a separate container, and then added to the spray tank.

**To mix the pesticide in the spray tank of small sprayers:**

* Read the label.
* Half fill the tank with water, with the filter in the tank opening in place.
* Remove the filter and add the correct amount of pesticide to the tank.
* Rinse the measure with water and add the washings to the tank. Repeat twice more.
* Replace the filter and lid, and shake the sprayer.
* Fill the tank with the remainder of the water, with the filter in the tank opening in place.
* Replace the lid and shake the sprayer again.
* When the filter is removed from the sprayer, place it on a clean surface so that it does not become contaminated with dirt, which can cause wear to the sprayer pump and the nozzles or block filters and nozzles.

**To mix the pesticide for large sprayers:**

* Read the label.
* Half fill the tank with water.
* Mix up the pesticide with some water in a small container. Stir with a clean stick, or similar, NOT the hand.
* Add the pesticide mix to the tank.
* Rinse the mixing container with water and add the washings to the tank. Repeat twice more.
* Fill the tank with the remainder of the water.

8. Transport, Disposal and Spills

8.1 Transport

Pesticides are in their most concentrated and dangerous form when being transported to or from the shop, warehouse, or farm. Accidents can result in broken containers, spills, environmental contamination, and poisoning to you or others. Care and attention to safety are thus needed.

When transporting pesticides:

* Pesticides should never be transported by passenger carrying vehicles such as a bus or taxi.
* Pesticides should never be transported with food, animal feed, or goods intended for consumption or human use (for example, clothing).
* The best type of vehicle is a flat-bed truck, such as a pick-up. There should be no nails or other projections on the load bed, which can damage containers.
* Passengers or animals should not ride with the pesticides in the load bed. Children should never be carried in a vehicle transporting pesticides.
* Pesticides should not be carried in the passenger compartment of the vehicle.
* The vehicle should carry the necessary safety equipment in case of an accident or spillage (protective clothing, shovel, soap and water, fire extinguisher, emergency telephone numbers).
* Pesticides should only be transported in intact, undamaged containers, with readable labels. The containers should be checked for leaks and loose bungs before loading.
* Load the pesticides carefully. Do not throw or slide the containers, as this may cause damage. Tie the load down, and cover the containers with a tarpaulin to protect the containers from the sun. Shelf life will be shortened if the pesticide becomes too hot.
* Unload the pesticides carefully. Do not throw, slide, or drop the containers off the vehicle. If the containers are heavy, roll them down inclined planks onto some old tyres.

8.2 Disposal

Disposal is concerned with both empty pesticide containers, and of unused spray mix.

**Empty pesticide containers:**

* When paper containers are empty, cut them open and shake all the remaining pesticide formulation into the spray tank.
* When plastic or metal containers are empty, drain the container into the spray tank, fill one quarter full with water, replace the cap, shake for 30 seconds, and drain the water into the spray tank. Repeat this rinsing and adding to the spray tank twice more. This procedure is known as triple rinsing.
* The containers can then be disposed.
* Paper and plastic containers can be burnt in a hot fire. Be careful not to burn the containers close to buildings, and ensure that there are no people or animals downwind of the fire who could breath in the smoke.
* Metal containers should be punctured, crushed and buried in a hole at least one meter deep. Do not bury the containers close to water sources (canals etc), or close to buildings.
* The hole should be fenced off and a warning sign erected.

Empty pesticide containers must NEVER be used for another purpose, such as holding water or food. It is impossible to remove all the pesticide, even with triple rinsing.

Unused spray mix:

* The golden rule with spray mix is not to have any left over at the end of the spraying operation.
* Only the correct amount of spray mix should be prepared for the area to be sprayed. This requires a knowledge of the actual area, the application rate of the pesticide, the amount of water required, and correctly calibrated sprayers.
* With practice, farmers should know the correct amount of spray mix to prepare for the area or crop to be sprayed.
* If there is spray mix left in the tank at the end of the spraying operation, it should be sprayed on the field, walking much faster than for the normal spray operation so that the amount of pesticide in the twice treated areas is not too high.

Unused spray mix should NEVER be poured into canals or onto the ground.

8.3 Spills

Spills of pesticide formulation can occur during transport, storage and mixing. There are three stages to dealing with spills – Control, Contain and Clean-Up.

**Control**

* Put on the necessary protective clothing.
* Stop the source of the spill if at all possible. If a container has fallen over, put it the right way up; if a small container is leaking, put it in a larger empty container. If a large drum is leaking or has fallen over, you may not be able to quickly stop the source.
* Keep other people away from the spill. Have someone stay at the site at all times to warn other people to keep away.

**Contain**

* Confine the spill to stop it spreading. Surround the spill with soil or sand as a dam to contain the spill.
* Absorb liquids by covering them with sand, soil, sawdust, newspaper.
* Stop dry pesticide from blowing away by covering with a plastic sheet, or spraying a light mist of water. Do not use too much water as this will make clean-up harder.

**Clean-up**

* For liquid spills, sweep up the absorbent material with the pesticide, and place it in a heavy duty drum or bag.
* For dry spill, sweep up and place in a heavy duty drum or bag.
* If the spill area is non-porous, such as concrete or tiles, wash down the affected area with soap or detergent and water. Do not use too much water, as this will spread the contamination. Soak up the water with absorbent material and place in the drum or bag.
* Wash all equipment and clothing used during the containment and clean up.
* Wash yourself thoroughly.

9. Shop Organisation and Sales

Pesticides retailers are directly involved with the storage and sale of pesticides, and it is essential that they know and understand the principles and procedures involved. This is for their own safety and the safety of their staff and customers, to give the best service to their customers, and to operate a successful business.

9.1 Storage Hazards

The main hazards involved with pesticide storage, whether in a warehouse or shop, are those of fire and environmental contamination. Many pesticides can easily catch fire or the vapours can explode, particularly oil based formulations. If a fire does occur, pesticides will release toxic smoke and fumes, which present severe risks to firefighters and bystanders. Environmental contamination can occur in case of spills, or from the run-off of water used in firefighting.

9.2 Basic Principles for Storage and Display of Pesticides

* Pesticides must be stored and displayed separately. They must never be kept in the same area as food, drink, or medicines (including veterinary medicines) for human or animal consumption. They must also not be kept in the same area as any material that might become contaminated, such as seed, fertiliser, or clothing.
* Pesticides must be kept out of direct sunlight, temperature extremes, water and moisture.
* If stored on shelves, dry pesticides should be placed above liquid pesticides.
* Herbicides should be on the lowest shelves.
* Containers should be inspected regularly to ensure that there are no leakages.
* Shelves should not be over-stocked, as this makes correct stock rotation and the detection of leaking containers more difficult, and increases the risk of shelves breaking due to the weight.
* Materials must be available for cleaning up spills – sawdust/sand, bucket, broom, shovel, drums/strong plastic bags for sweepings, overalls, gloves, boots, face mask.
* Firefighting equipment must be available – fire extinguisher (foam or dry powder), bucket of sand.
* Washing facilities must be available – water, soap, towel.
* There must be no smoking, eating or drinking in the pesticide area.
* No unauthorised access must be allowed into the pesticide area.
* Warning notices should be displayed – 'No smoking', and 'Danger – Pesticides'.

9.3 Location and Construction of Buildings

**General**:

* Walls, roof and shelving should be constructed of non-combustible material (concrete, steel).
* For stores and warehouses, the roof should be of light-weight material that will collapse in the event of a fire.
* Walls and floors should be of non-permeable material, such as concrete or tiles, smooth and without cracks or crevices, so as to allow easy cleaning.
* Shelves should be of non-permeable material, such as metal or plastic, and without cracks or crevices, so as to allow easy cleaning.
* There must be adequate natural or artificial lighting, sufficient to read all parts of the pesticide label.
* The store should be well ventilated. For bulk stores this means upper and lower wall vents, in addition to opposing doors.

**Shops:**

* Shops should be located away from stores selling food, clothing and other materials, and pharmacies.
* An area separate from the main part of the shop should be available for storing stock not on display.
* If physically separated from the shop, the store must meet all the necessary requirements for pesticide storage.
* Stock received last should be kept in this store, with older stock on the display shelves so as to facilitate first-in, first-out stock rotation.

**Stores and Warehouses:**

* Stores and warehouses should be located away from schools, hospitals, markets, human and animal food stores, water sources, open water, or where there is a high water table or possible flooding.
* The store or warehouse should be surrounded by a containment bund, and drains and a sump should be provided into which spills and washings can flow. There should be no drainage access to public drains.
* Access for emergency vehicles should preferably be from two sides, but must be at least from one long side.

9.4 Record Keeping and Stock Control

Record keeping is good business practice. It enables only the quantities needed to be purchased at the right times of the year, existing stock can be taken into consideration when ordering new stock, it facilitates first-in, first-out stock management, and sales records can help in diagnosing the cause if a pesticide failed to work.

Records should be kept of all pesticides received into stock and sold. Record details should include:

* Date of purchase
* Name and address of supplier
* Product name
* Expiry date
* Quantity
* Pack size
* Date of sale
* Details of the purchaser
* Balance left in stock

Expired (out-of-date) stock must never be sold. If a pesticide is approaching its expiry date, consider selling the remainder of the stock quickly by offering a discount. This may involve some financial loss, but it will avoid the problems and potential total financial loss of expired pesticide.

Accumulation of expired stock indicates poor business procedures and stock control.

The solution to the problem is to avoid expired stock in the first place:

* Only the quantities of pesticide that are needed should be purchased.
* **Never purchase more of a pesticide than you can sell in one year.**
* The amount of existing stock should be taken into consideration when ordering new stock.
* The expiry date should be checked when the pesticide is received. Pesticides should not be accepted if they have less than one year until expiry.
* Stock should be sold on a **first-in, first-out** basis. Old stock should be at the front of shelves, and new stock at the back or in a separate store.
* The shelf life of a pesticide is normally two to three years.
* Any period longer than this on the label (dates of manufacture and expiry) are indicative of a poor quality or fraudulent product.
* Organophosphate pesticides have a shorter shelf life than other types. For example, dimethoate has a shelf life of 18 months to two years.

10. Risk, Health and Safety

Pesticides are poisons that are used to kill pests. Human beings have certain body systems similar to those of pests, and so pesticides can also kill people. Some pesticides are extremely toxic to humans and can cause severe adverse effects. Others are less toxic, but too much exposure can also cause adverse effects. The following formula will help determine the potential risks of handling or using a pesticide.

Risk = Hazard x Exposure

**Hazard** is the inherent property of a substance to cause adverse effects. **Exposure** is the amount of time a person is in contact with the substance, or how much they get in or on their body. The combination of these two factors gives the **Risk**.

Every time a pesticide is handled or used, there is an associated **Risk**. The amount of risk depends upon the level of hazard of the pesticide combined with the level of exposure during the conditions under which the pesticide is used. For example, applying a pesticide in windy conditions gives a greater chance of drift onto the operator, or to adjacent crops, livestock, or open water. Under these circumstances, the exposure is increased and so is the risk of adverse effects to the operator or in these adjacent areas.

A pesticide formulation has an inherent hazard. The primary consideration when using a pesticide is to avoid exposure and so reduce the risk.

10.1 How Pesticides Enter the Body

Pesticides enter the body in three main ways or routes:

Dermal exposure - Getting a pesticide on the skin, or in the eyes.

Inhalation exposure - Breathing a pesticide into the lungs through the nose and mouth.

Oral exposure - Swallowing a pesticide through the mouth.

In most pesticide handling situations, the skin is most likely to be exposed. The amount of pesticide absorbed through the skin (and eyes) depends on:

* The pesticide itself and the dilution material. Oil based formulations (emulsifiable concentrates) are absorbed easily. Water based pesticides and dilutions (wettable powders) are absorbed less readily.
* Dry formulations (dusts, granules) are not absorbed as readily as liquid formulations and dilutions.
* The part of the body that is exposed. The scalp, forehead and ears are highly absorptive.
* The condition of the skin. Cuts, abrasions and skin rashes allow the pesticide to penetrate more easily. Hot and sweaty skin absorbs pesticide more readily than cool, dry skin.

10.2 Common Ways of Pesticide Exposure

| Dermal | Eyes | Inhalation | Oral |
| --- | --- | --- | --- |
| Not washing hands after handling pesticides or containers | Rubbing eyes or forehead with contaminated gloves or hands | Handling pesticides in confined or poorly ventilated areas | Not washing hands before eating, drinking or smoking |
| Splashing or spilling pesticide on the skin | Splashing pesticide in the eyes | Handling dusts or powders | Splashing pesticide into the mouth |
| Wearing contaminated clothing | Pouring dry formulations without wearing goggles | Using an inadequate or poorly fitting respirator | Storing pesticide in drink bottles |
| Being exposed to pesticide drift | Being exposed to pesticide drift | Being exposed to pesticide drift | Accidentally applying pesticide to food |
| Applying pesticides in windy weather | Applying pesticides in windy weather | Applying pesticides in windy weather |  |
| Touching treated plants, livestock or soil |  | Not washing hands before smoking |  |

**The primary safety consideration is to avoid exposure to pesticides**. Exposure can be avoided by using pesticides only when necessary, taking the necessary safety precautions, mixing and applying the correct dose, wearing suitable protective clothing, washing often when handling or using pesticides, and observing re-entry and pre-harvest intervals.

10.3 Harmful Effects of Pesticides

Pesticides can cause three types of harmful effects – Acute, Delayed and Allergic.

**Acute effects** are those that occur immediately after the exposure, within minutes or hours. As well as the poisoning effects covered below, there can be physical effects on the body. The mouth, throat and stomach can be burned, making it difficult to eat and drink. The lungs can be burned, making it difficult to breath. The skin can itch, blister, or crack. The eyes can be burned, causing temporary or permanent blindness.

**Delayed effects** are illnesses or injuries that do not appear immediately and may take years to become apparent. They are caused by repeated exposure to a pesticide, pesticide group, or combination of pesticides over a long period of time, or by a single exposure to a pesticide which causes a harmful reaction that does not become apparent until much later. Delayed effects include the development of cancer or tumours, sterility, defects in unborn children, and injury to the body systems (blood, liver, kidneys, brain, lungs etc).

With certain pesticides, a large single exposure will cause an acute effect, while repeated smaller exposures will cause a delayed effect. For example, organophosphate and carbamate insecticides inhibit a chemical, called cholinesterase, in the nervous system of humans. A large single exposure causes immediate acute illness. On the other hand, if someone is spraying frequently, the small repeated exposures can gradually reduce the amount of cholinesterase in the body, although with no obvious symptoms of illness. This process is reversible, and the body can replace the cholinesterase when it is no longer exposed to the pesticide. However, if the cholinesterase level in the body becomes too low, even a small additional exposure may cause immediate severe illness.

**Allergic effects** are reactions that some people, but not all, develop after exposure to pesticides. Allergic effects usually require several exposures before they become apparent. Typical reactions are asthma (difficulty in breathing), skin irritation (rashes, blisters, open sores), or eye and nose irritation (itchy, watery eyes and sneezing).

10.4 General Symptoms and Signs of Acute Pesticide Poisoning

Pesticide poisoning occurs when a pesticide enters the body and interferes with the essential systems of the body. Many of the signs and symptoms of acute pesticide poisoning are similar to those of other illnesses, such as flu. Anyone who has been handling or using pesticides and then develops suspicious signs and symptoms should immediately see a doctor, taking the pesticide label or container with them.

Depending on the type of pesticide and degree of exposure, only some of the symptoms may be apparent, and individual symptoms may appear at different times after the exposure. Symptoms can start anything from ½ hour to 24 hours after exposure. The typical symptoms and signs of pesticide poisoning are:

**Initial:**

* Nausea, vomiting
* Headache, dizziness
* General weakness or tiredness
* Tightness in chest

**Later:**

* Excessive sweating, salivation
* Vomiting, diarrhoea
* Stomach cramps
* Muscle twitches, cramps, aches
* Blurred vision
* Confusion
* Fits or unconsciousness

10.5 First Aid

*This section on First Aid is not included in the Retailer training course due to time constraints. It is given here for information only, and will not be included in the Certification test.*

First aid is the initial treatment of a person suffering from a pesticide exposure, before seeking proper medical attention.

In all cases of pesticide poisoning: Follow the product label instructions if they are available.

The **first action** is to remove the person from the source of the exposure by removing pesticide from the skin, removing contaminated clothing, or getting the person to fresh air. While doing this, be careful to avoid contaminating yourself.

**Pesticide on the skin:**

* Drench skin and clothing with plenty of water.
* Remove contaminated clothing.
* Wash hair and skin with soap and water. If available, a shower is the best way to thoroughly wash and rinse the whole body.
* Dry the victim, and wrap in a blanket or any clean clothing. Do not allow the victim to become chilled or overheated.
* If the skin is burned, or otherwise injured, cover immediately with a loose, clean, dry, soft cloth or bandage.
* Do not apply ointments, greases or powders to burns or injured skin.

**Pesticide in the eye:**

* Wash the eye(s) quickly but gently.
* Hold the eyelid open and wash with a gentle drip of water flowing across the eye rather than directly onto it. If a tap is not available, a tea pot, or similar, can be used.
* Rinse for 10 minutes or more.
* Do not use chemicals in the rinse water.

**Pesticide inhaled:**

* Get the victim to fresh air immediately.
* Warn other people in the area of the danger.
* Loosen tight clothing that would restrict breathing.

**Pesticide in mouth or swallowed:**

* Repeatedly rinse mouth with plenty of water.
* Never induce vomiting if the victim is unconscious or having convulsions.
* Never induce vomiting if the victim has swallowed a corrosive poison, as it will burn the throat and mouth as severely coming up as it did going down. It may also get into the lungs and cause burning there.
* Never induce vomiting if an emulsifiable or oil solution has been swallowed, as these can cause death if inhaled during vomiting.
* Apply artificial respiration if breathing has stopped or if the victim's skin is blue. If pesticide is on the victim's mouth or face, avoid direct contact during artificial respiration.
* Following the first aid, the victim must be taken to a doctor as quickly as possible, with the pesticide container or label so that the doctor can identify the active ingredient.

10.6 Protective Clothing

Protective clothing consists of clothing and devices that are worn to minimise exposure to pesticides and to keep pesticides away from the body. The minimum amount to wear for a specific pesticide formulation and activity is given on the label of a high quality pesticide, either in the text or the pictograms.

Protective clothing only protects if the pesticide remains on the outside and does not come into contact with the body. Protective clothing must be worn in the correct way to prevent this happening. Also, torn, damaged or broken protective clothing should not be used as pesticide can enter and be trapped next to the skin. Contaminated clothing should be removed immediately.

All protective clothing should be washed after every use.

Alternatives to dedicated protective clothing are indicated in the following sections. However, these alternatives give only limited protection, and should only be used if the correct protective clothing is not available.

**Body protection:**

* Any time pesticides are handled, the minimum to wear is overalls. The collar should be fastened to protect the lower part of the neck.
* An alternative to overalls is a long sleeved shirt and long legged trousers. The shirt collar should be fastened to protect the lower part of the neck.
* A wide brimmed cotton or canvas hat can be worn during spraying to protect the head.
* All work clothes, including hats, should be washed after every days use.

**Hand and foot protection:**

* Rubber gloves and rubber boots should be worn when handling pesticide concentrates. They should be unlined, as fabric liners can trap pesticide and are impossible to clean adequately.
* Trousers should be worn outside the boots, not tucked in.
* Gloves should be washed with soap and water before removal, turned inside out and the inside washed. Boots should also be washed inside and out after use.
* Do not use gloves with holes or tears, as the pesticide will get inside and be held next to the skin.
* An alternative to rubber gloves is a plastic bag.
* For spraying operations only, an alternative to rubber boots is canvas shoes. They should be thoroughly washed with soap and water after each days use.

**Eye and face protection:**

* Non-fogging eyewear such as safety glasses and goggles should be worn when there is a chance of mists or dusts, for example during spraying or mixing dry formulations.
* Face shields should be worn when there is a risk of being splashed with insecticide, such as when mixing liquid formulations.
* An alternative is to use ordinary glasses or sunglasses. However, these give only minimal protection to the eyes.

**Inhalation protection:**

* Dust/mist masks are usually shaped filters that cover the nose and mouth to filter out dusts, mists and particles.
* Masks must be disposed of after each days use.
* For spraying operations only, an alternative is a cloth tied over the nose and mouth. This should be washed after every spraying operation.
* Respirators remove contaminants in the air by filtering dusts or mists, or by removing gases and vapours.
* Respirators are usually only needed in specialised operations, or when mixing or applying more toxic products.

11. Environmental Aspects

The environment is everything around us. It includes not only the “natural” elements such as soil, water and air, but also people, plants, animals, indoors/outdoors, fields, gardens, houses, offices, etc. It is important to remember that we depend on the environment for our survival.

Pesticides are poisons that are designed to kill pests, but because they are poisons they can also affect the environment in which we live. They can kill beneficial insects, birds, fish and domestic animals, they can poison sources of drinking and washing water, and they can poison our food and living and working areas. These environmental effects are why many people throughout the world are concerned about, or even against, the use of pesticides.

It is the responsibility of everyone concerned with the handling or use of pesticides to use them correctly and to follow practices which minimise environmental contamination.

11.1 Sources of Environmental Contamination

Pesticides get into the environment by several ways:

* Use at the site of application. Even a correct application puts a pesticide into the environment.
* Excess application leading to run-off from the plants or other treated surfaces.
* Drift during application, or application during windy weather.
* Spills during storage, transport and use which are not cleaned up.
* Water used for personal washing and cleaning equipment and clothing.
* Improper disposal of excess spray mix and pesticide containers.

11.2 Pesticide Movement in the Environment

Once in the environment, pesticides can move to other places:

* Volatilisation from treated surfaces.
* Drift during application.
* Washing from the treated surface to the ground or soil by dew, rain or irrigation.
* Incorporation into the soil with treated crop residues.
* Removal from the field as residues on treated crop surfaces, such as vegetables, fodder and fuel.
* Removal from the field on contaminated mixing and application equipment, clothing and containers.
* Carried across the field in surface irrigation water.
* Leached through the soil into ground water.

The **persistence** of a pesticide is a measure of how long it remains active before being degraded or broken down. A pesticide with long persistence will remain in the environment for a longer period and have more chance to move from the site where it was applied than a pesticide with short persistence.

11.3 Sensitive Areas

Some areas of the environment are more sensitive than others, as people or other living organisms are more likely to be injured by a pesticide.

**Indoors:**

* Places where people – especially children, pregnant women, the elderly and the sick - live, work or are cared for.
* Places where food is processed, stored, prepared, or eaten.
* Places where domestic animals are kept, live and eat.

**Outdoors:**

Areas near open or surface water, or where the ground water is close to the surface.

Areas near schools, playgrounds, hospitals, gardens, or where food or fodder is processed.

Areas where honey bees are active.

Areas near food or fodder crops.

11.4 Residues on Food Crops

Pesticides are applied to food crops to protect them from pest damage or loss, but leave residues that may be eaten by people or animals. For this reason, a **pre-harvest interval** is needed between the time of the pesticide application and harvesting in order to allow time for the pesticide to degrade and for the crop to be safe to eat.

Pre-harvest intervals are given on the pesticide label as the number of days needed between the pesticide application and harvest. The length of the interval depends on the toxicity of the pesticide and its rate of degradation. Pre-harvest intervals are longer for pesticides of high toxicity or slow rates of degradation.

When a food crop is close to harvest, the pre-harvest interval must always be considered when deciding if a pesticide spray is to be applied. If the crop will be harvested within the pre-harvest interval, either the spray should not be applied, a non-toxic (biological) pesticide should be used, or harvesting of the crop must be delayed until the relevant number of days have elapsed after the pesticide application.

Re-entry intervals are also indicated on the product label. These give the number of days which must elapse before a treated field can be safely entered.

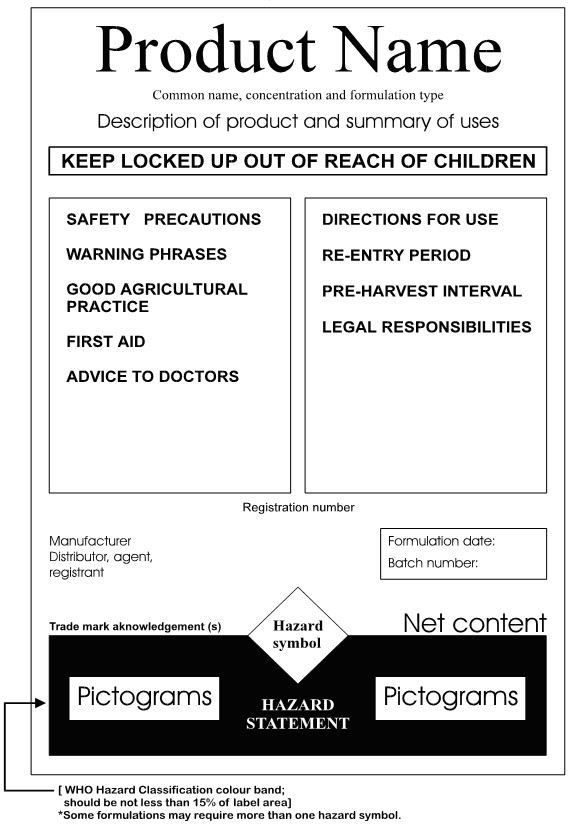
Appendix I: Crop Management Practices for Crops in Northern Afghanistan

The following are examples of crop management practices and non-pesticide methods of pest management that could possibly be used in the Northern Region of Afghanistan.

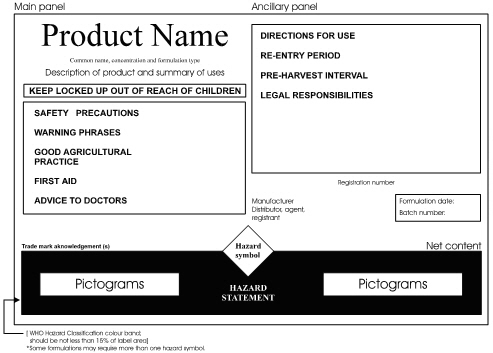
|  |  |
| --- | --- |
| Practice | Insect Pest, Disease, Weed Affected |
| All Crops |  |
| Implement optimum crop management practices to produce healthy and strong plants | Plants are more resistant / tolerant to insect pests, diseases and weeds. |
| Avoid planting seeds or seedlings too deeply, or into cold, wet soil | Seedling diseases (Damping off, Root rot, etc) |
| Crop rotation | Many insect pests and diseases |
| Use correct plant spacing | Provides aeration, avoids micro-climate favourable to insect pests and diseases |
| Avoid excess nitrogen | Makes plants attractive to insect pests, and susceptible to diseases |
| Avoid excess irrigation | Makes plants attractive to insect pests, and susceptible to diseases |
| Avoid water stress | Makes plants more susceptible to attack by insect pests and diseases. |
| Maintain refuge habitats, minimise pesticide use | Preserves and encourages beneficial insects |
| Remove and burn all crop residues and debris | Removes overwintering sites of insect pests and diseases |
| Wheat / Rye / Barley |  |
| Resistant varieties | Smuts, Rusts |
| Clean, certified seed | All weeds and diseases |
| Maintain refuge habitats for beneficial insects | Sunn pest, aphid |
| Maize |  |
| Resistant varieties | Smut, damping off, bacterial wilt, diplodia stalk rot |
| Avoid potassium deficiency | Diplodia stalk rot |
| Vegetables general |  |
| Site selection - Use land without a history of disease or weed pressure. | All diseases and weeds. |
| Crop rotation - 3 year crop rotation best for vegetables. At least one cereal crop before cultivating the same vegetable crop, or fallow for several months. | Nematodes, all diseases |
| Use certified seed | Disease free, weed seed free |
| Seedlings - Produce in greenhouse or tunnel | Helps avoid insect and disease infestations. |
| Ventilate tunnels to reduce humidity | Diseases and insect pests. |
| Keep field free of weeds or cover crops for at least 10 days (3 weeks is best) before planting | Cutworm |
| Ensure balanced fertiliser | Diseases and insect pests |
| Avoid excessive nitrogen | Excess encourages insect pests and diseases |
| Optimal potassium | Increases tolerance to diseases, and essential for fruit formation. |
| Ensure balanced irrigation | Diseases |
| Remove and burn infested plants | All diseases |
| Remove and burn crop residues | All diseases |
| Clean all equipment and feet before leaving field to avoid spreading pests and diseases | Nematodes, *Verticillium wilt*, *Fusarium* wilt, many diseases, Red spider mite |
| Clean and disinfect all equipment at the end of the season | Avoids carry-over to the following season. *Verticillium* wilt, *Fusarium* wilt, many diseases |
| Water Melon / Melon / Cantaloupe |  |
| Crop rotation | Nematodes |
| Resistant varieties | Watermelon mosaic virus, nematodes |
| Early planting | Avoids main attack of melon fly |
| Bagging of fruits | Melon fly |
| Onion |  |
| Resistant varieties | Black mould |
| Plant clean bulbs | Onion maggot, onion bulb fly, onion smut |
| Remove and burn infested plants | Onion maggot, onion bulb fly, onion smut |
| Avoid irrigation prior to harvesting | Black mould |
| Tomatoes |  |
| Crop rotation. Do not grow tomatoes on the same land for at least 3 years. Rotate with wheat, barley, maize, rice, chillies. | Nematodes, *Fusarium* wilt, *Verticillium* wilt, Early blight, *Sclerotinia* |
| Resistant / tolerant varieties | Nematodes, *Fusarium* wilt, *Verticillium* wilt, virus diseases, Early blight, Late blight, *Sclerotinia*, Bacterial canker, Blossom end rot, Fruit cracking. |
| Seedbed sterilisation / solarisation | Nematodes, all bacterial and fungal diseases |
| Establish seedbeds in light soil | Seedling wilt |
| Ensure seedbeds are free of nematodes and diseases to avoid transplanting infected plants into the field | All nematodes and diseases |
| Ensure good seedbed ventilation | All bacterial and fungal diseases |
| Avoid excessive seedbed irrigation | Seedling wilt, Damping off, Root rot |
| Keep field free of weeds or cover crops for at least 10 days (3 weeks is best) before planting | Cutworm. |
| Deep ploughing of field | Cutworm |
| Heavy irrigation / flooding of field prior to sowing | Nematodes, Cutworm, *Sclerotinia* |
| Avoid damaging plants when transplanting | All diseases |
| Use correct plant spacing | Provides aerations, avoids micro climate which encourages bacterial and fungal diseases, aphids, whitefly |
| Immediately gapfill cut seedlings after transplanting | Cutworm |
| Ensure balanced fertilisation | Diseases and insect pests |
| Avoid excessive nitrogen | Excess encourages Blossom end rot, Blight, Powdery mildew, Aphids, Whitefly (which transmit virus diseases, cause delay in maturity and reduced yield). |
| Optimal potassium | Increases tolerance to diseases, essential for fruit formation |
| Increase organic matter of soil | Nematodes |
| Sterilise manure / compost | *Orabanche*, other weeds, Nematodes, fungal and bacterial diseases. |
| Avoid insufficient or irregular irrigation | Fruit cracking, Blossom end rot |
| Avoid excessive irrigation | *Orabanche, Phytophthera* root rot (late blight), *Sclerotinia* |
| Control weeds | Virus diseases, Fruit worm |
| Plough crop residues under as soon as harvesting completed | Late blight |
| Remove and burn crop residues | All diseases |
| Clean all equipment and feet before leaving field to avoid spreading pests and diseases | Nematodes, *Verticillium* wilt, *Fusarium* wilt, many diseases |
| Cotton |  |
| Rotation with cereals | *Fusarium* wilt, Bacterial blight, seedling diseases. |
| Rotation with soyabean | Bacterial blight, Root knot nematode. |
| Avoid growing cotton close to wheat, melon, cucumber, pumpkins, onion. | Aphid, Thrips, Whitefly |
| Resistant varieties | Jassid, Mites, Bollworm, Aphid, Whitefly, Bacterial blight, *Fusarium* wilt |
| Certified, acid delinted seed | Bacterial blight free, weed seed free |
| Deep ploughing | Kills and exposes pests such as cutworm |
| Keep field free of weeds or cover crops for at least 10 days (3 weeks is best) before planting | Cutworm. |
| Fine seedbed – allows plants to germinate and grow strongly | Increased tolerance to diseases, insect pests and weeds |
| Early planting so that plants mature earlier | Avoids late season attack of bollworm, aphid, whitefly |
| Use correct plant spacing | Provides aeration, avoids plants growing too tall, avoids micro-climate which encourages aphids and whitefly. |
| Early thinning | Allows plants to grow strongly, increasing tolerance to pest attack. |
| Avoid excess nitrogen | Excess makes plants attractive to Aphid, Jassid, Whitefly, Bollworm, and encourages *Fusarium* wilt. |
| Avoid excess irrigation | Excess gives an environment around the plants which encourages aphids and whitefly. |
| Keep field free of weeds | Seedlings are very susceptible to weed competition.  Weeds in the crop encourage Aphid, Whitefly, Spider mite. |
| Avoid plant stress (water, fertiliser, weeds) | Spider mites and other sucking pests |
| Remove and burn crop residues | Pink bollworm, Cotton stainer, Stem weevil, Whitefly, all diseases |
| Plough after harvest | Bollworm |
| Potato |  |
| Hand collection early in the season | Colorado beetle |
| Orchards in General |  |
| Use certified planting material | Disease and virus free. |
| Keep low cover of lucerne, alfalfa or grass between trees.  Do not over-irrigate cover crops. | Prevents dusty conditions, which encourages spider mites.  Excess irrigation encourages cankers, root rots and gummosis in trees. |
| Keep vegetation between trees cut short | Rodents |
| Circle trunk with soil | Avoids infection and spread of *Phytophthora*. |
| Remove and burn infested branches, leaves, fruits during the season | Prevents spread of many insect pests and diseases |
| Remove and burn fallen branches, leaves, fruits after harvesting to remove overwintering sites | Many insect pests and diseases |
| Grapes |  |
| Keep low cover of lucerne, alfalfa or grass between vines to prevent dusty conditions. | Prevents dusty conditions, which encourages spider mites. |
| Pruning to improve aeration and lower humidity | Powdery mildew |
| Remove and burn infested branches and fruits | All diseases, scales |
| Collect and burn all fallen leaves, debris and weeds after harvesting to remove ovewintering sites | Spider mites |
| Apricot |  |
| Resistant variety | Shot hole disease |
| Do not intercrop with cereals, vegetables or forage crops | Irrigation of these crops results in over-watering of trees with consequent increase in cankers, root rots, and gummosis |
| Remove and burn nests of tent caterpillars during winter / early spring | Tent caterpillars |
| Remove infected and fallen fruit, burn or feed to animals | Shot hole disease |
| Almond |  |
| Do not intercrop with cereals, vegetables or forage crops | Irrigation of these crops results in over-watering of trees with consequent increase in cankers, root rots, and gummosis |
| Remove and burn nests of tent caterpillars during winter / early spring | Tent caterpillars |
| Remove and burn infested branches | San Jose scale |
| Early harvesting | Carob moth – Only infests almonds once hulls have split |
| Collect and burn fallen fruit at end of season | Carob moth – Overwinters within fruit |
| Pomegranate |  |
| Orchard sanitation | Carob moth |
| Pheromone mating disruption | Carob moth |
| Remove and burn all infected fruit | Carob moth (Pomegranate fruit borer) |
| Bagging of fruit on formation | Carob moth (Pomegranate fruit borer) |
| Apple |  |
| Improve soil tilth and drainage | Nematodes |
| Do not plant apple orchards within 2km of cedar trees | Cedar apple rust |
| Do not plant apple with pear | Fire blight |
| Avoid close spacing of trees when establishing orchard, so as to ensure adequate ventilation and light | Aphids, Mites, Apple scab, Branch wilt, Fire blight, Powdery mildew |
| Resistant varieties | Woolly apple aphid, apple scab, cedar apple rust, fire blight, Powdery mildew |
| Certified, virus-free seedlings | Apple leaf spot virus, Apple mosaic virus |
| Balanced fertilisation | Nematodes |
| Avoid excess nitrogen | Aphids, Fire blight |
| Ensure balanced irrigation | Red spider mite, Nematodes, Branch wilt |
| Avoid over-irrigation | Fire blight |
| Pruning in late winter / early spring to improve ventilation | Aphids, Apple scab, Powdery mildew |
| Remove infested, dead, diseased wood, cankers, mummified fruits | Stemborer, Woolly apple aphid, Apple scab, Fire blight, Powdery mildew |
| Summer pruning of water sprouts | Green apple aphid |
| Avoid excessive pruning | Fire blight |
| Keep low cover of grass and weeds between trees | Prevents dusty conditions, which encourage red spider mite |
| Ensure area around base of trunk is free of grass and weeds | Rodents, Stemborer |
| Keep grass and weeds between trees cut short | Rodents |
| Remove and bury/burn all fallen fruit | Codling moth, Rodents, Apple scab |
| Remove and burn/compost fallen leaves at the end of the season | Codling moth, Apple scab |

Appendix II: Container Labels – Layout Examples

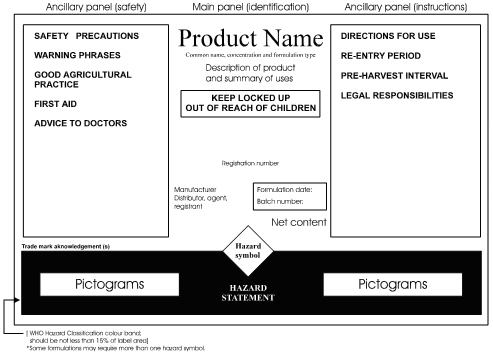
A One Panel Label:



A Two Panel Label:

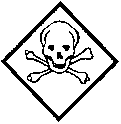


A Three Panel Label:



Examples of Colour Bands and Pictograms

Class Ia or Ib Product

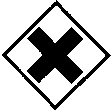


**Very Toxic**



Class II Product

**Harmful**



Unclassified Product

**Caution**





Bibliography

**The following sources of information have been used in support of the preparation of this Handbook.**

International Code of Conduct on the Distribution and Use of Pesticides. FAO. 2003

Pesticide Storage and Stock Control Manual. FAO. 1995

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Guidelines for Personal Protection When Working With Pesticides in Tropical Climates. FAO. 1990

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**Links to the above FAO documents:**

http://www.fao.org/agriculture/crops/core-themes/theme/pests/pm/code/list-guide/en/

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Multilevel Course on the Safe Use of Pesticides and on the Diagnosis and Treatment of Pesticide Poisoning. UNEP / ILO / WHO. 1994

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