INSTRUCTIONS FOR SPRAY OPERATORS

SPRAYING METHODS, THE ENVIRONMENT AND SAFETY

Introduction

This handbook has been jointly produced by GEOPA and the EFA and sets out what they regard as the main guidelines which operators must be familiar with before spraying pesticides.

Chemicals are used in agriculture as pesticides to eliminate unwanted organisms which are considered to be competing with the interests of mankind and therefore regarded as pests or diseases, particularly with regard to crops. Many pesticides are poisonous or harmful to ourselves and/or our fellow creatures in the environment around us.

Nevertheless, for workers employed in agriculture, horticulture, forestry, local authorities etc. it is often part of their job to use these pesticides.

This handbook is meant as a tool for all persons who through their work are in contact with pesticides, i.e. those who deliver, buy or deal in pesticides, etc.

It provides an overview of the applicable law, information about handling pesticides and their effects on health and the environment, and a lot more.

The text has been prepared by Jesper Lund-Larsen (EFA). The handbook has been published with assistance from the European Commission (DG V).

1. **LEGISLATION,** including both EU and national law

2. **PESTICIDE HANDLING,** including risk assessment and safety regulations

3. **WORKING ENVIRONMENT,** including health hazards, personal protective equipment, workplace instructions

4. **PESTICIDES,** including pesticide types, climatic influences, action periods/harvesting periods.

5. **ENVIRONMENTAL IMPACT,** including decomposition, pollution risks, impact on plants and animals

6. **SPRAYING,** including spraying technique, cleaning and maintenance, use of protective equipment and nozzles etc.

1. LEGISLATION, including both EU and national law

Introduction.

Legislation, regulations and codes of practice as regards the safe use of pesticides vary a great deal between countries. European directives in this area, based on the ILO Convention (which is generally accepted as the fundamental instrument regarding health and safety), require the exposure of workers to hazardous pesticides to be eliminated or reduced. This can be achieved by the following step-by-step process;

1. Risk assessment

There is a duty on the employer to carry out a risk assessment before exposing employees to hazardous substances. The risk assessment is based on the factors below.

2. Prevention

Elimination: the employer has to consider whether exposure to the effects of pesticides can be avoided - thus for pesticides the question is "Does a pesticide have to be used at all?". If not, the pesticide should not be used.

Use of least toxic pesticide: if it is necessary to use a pesticide, then the least toxic active ingredient or formulation must be used.

3. Control

If exposure cannot be prevented by elimination or by using the least toxic pesticide, the employer must take the following steps.

Technical measures must be adopted to reduce exposure. These include closed mixing and filling systems, tractor cab ventilation systems, and closed systems for returning empty containers.

Operational measures must be adopted, consisting of safe working practices to reduce exposure, such as warnings to other people to keep away, stock controls, and provision of washing facilities.

Personal protective equipment is the last line of defence, to be used when all the above measures have already been taken. PPE must be both suitable and adequate, in line with EU directives.

4. Maintenance

Employers have a duty to maintain and keep records of all control measures.

5. Monitoring

Employers have a duty to oversee the effective functioning of control measures and to monitor airborne contaminant concentrations.

6. Health surveillance

Employees' heath surveillance must be carried out with regard to certain substances, e.g. OPs. The employer must make sure that employees are not exposed to toxic substances when spraying pesticides.

7. Record keeping

Employers must keep spraying records showing the pesticides used, the locations, quantities and dates, and the pesticide suppliers.

8. Information

Employers must provide employees with information relating to records, training, risk assessments, and product safety data sheets and labelling information.

9. Training

Employees must be given training in control measures, PPE, emergency procedures, and pest control including non-chemical methods.

Approval of pesticides

Approval of pesticides to be offered for sale takes place partly on the basis of EU rules and partly on the basis of national rules.

The object of EU approvals is to coordinate the different rules governing approval in the Member States.

These rules are contained in Directive 91/414/EEC and its annexes (see Annex 1).

This Directive is in force, but not all the annexes have been completed, although this is under way.

Before a new product can be approved, its active substance must have been entered in the EU positive list. All Member States are involved in deciding whether an active substance should be entered in the positive list or not.

The first positive list was supposed to be available by 1 June 1997 (see Annex 2).

As part of the removal of trade barriers between the individual Member States there must be mutual recognition of experiments carried out in the individual Member States. However, this applies only if the experiments have been conducted under conditions which, as regards cultivation methods and climate, correspond to the conditions in another Member State.

If a product has been approved in, for example, Portugal or Italy, which have similar cultivation and climatic conditions to Spain, it will probably be difficult to refuse its approval in Spain. If the product is to be sold in Denmark, however, further documentation will be required, as the cultivation method and climate are quite different in Denmark compared to southern Europe.

2. PESTICIDE HANDLING

Always read the label - which must be in **your** language!

Toxicity classes and symbols

EU classification rules for toxicity classes, risk assessment and safety objectives.

Rules governing storage of pesticides

The provisions governing storage of pesticides have been laid down with the object of removing the possibility of inexpert persons intentionally or unintentionally coming into contact with pesticides.

Storage of "toxic" and "very toxic" pesticides.

Toxic and very toxic pesticides must always be stored under lock and key, i.e. in a room or cupboard which is not accessible without the use of a key.

Other pesticides must be stored out of the reach of children, and not together with food, beverages or feedingstuffs. This in principle means that these pesticides too must be stored in a locked room or cupboard.

Rooms or cupboards in which very toxic pesticides are stored must be marked with a warning sign or symbol.

It would, however, be advisable for rooms or cupboards containing other pesticides also to be marked in some way.

Pesticides must always be stored in their original packaging, in other words they must not be poured into another container.

If the pesticide storeroom is used for mixing pesticides, it must be provided with ventilation in the shape of an air shaft or, better still, an extraction fan.

If the room has a solid floor, it must **not** be provided with any kind of drain allowing spillages to enter the sewer system; it may be provided with an underground tank for their collection and safe removal.

If pesticides are transported out into the field for spraying, they must - unless they are under constant supervision - be stored in the same manner as in a building, for instance in a "transport box" which can be locked.

The pesticide storeroom should be away from inhabited areas and should contain:

- a waste tray,
- a fire extinguisher on the outside,
- a frost protection system
- an electrical system corresponding to norms
- duckboards to keep products off the ground
- absorbent materials for use in case of spillage from recipients
– no smoking signs

Disposal of pesticide residues and empty containers

It is the responsibility of agricultural, forestry and horticultural enterprises using pesticides to dispose of empty containers and pesticide residues in a safe manner.

Pesticides can be disposed of in many different ways, but the most important thing is to ensure that disposal takes place in an environmentally safe manner.

This may be done either by delivering residues and empty containers to firms which specialise in disposing of toxic waste, or by following the guidelines in the supplier's instructions. If it is not a statutory requirement that instructions have to be supplied, you can, if in doubt, ask the producer/importer how to dispose of the pesticide in question.

Cleaning of empty containers

Before a container is disposed of, it must be completely empty and clean. When the spraying solution is being prepared, the container must be rinsed three times to get all the contents into the spray tank.

Deleted: with three lots of water

Rinsing the outside and/or inside of a heavily contaminated container must be done in a place where it is sure that the rinsing water cannot enter sewers, groundwater, watercourses, lakes, drains, etc.

It is particularly important to prevent the water from running into wells, etc.

Storage of empty containers

Empty containers must be stored in the same way as full or partly full ones until safe disposal.

Transport of chemical pesticides

When pesticides are collected and transported from, for example, the trader's store to the purchaser's store, there are rules on the maximum quantities that may be transported without any special precautions, depending on the product's toxicity and/or flammability.

The exact quantity that may be transported must be indicated in the product supplier's instructions, or the information must be available from the supplier. The permitted quantity is based on the European Agreement concerning the International Carriage of Dangerous Goods by Roads (ADR) and in certain cases on national provisions.

Only in special cases will it be necessary for agricultural, forestry and horticultural enterprises to transport quantities which exceed the permitted quantity.

Pesticides must never be transported together with food, beverages or feedingstuffs.

Where pesticides are transported in tractors etc., it is advisable to have a special lockable box where they can be stored when not being used.

Tank mixtures transported in the spray tank are not covered by the above rules. Unlimited quantities may be transported in the spray tank, taking account of the size of the tank and general safety precautions.

Signs

It is recommended that signs be put up to indicate where spraying has been carried out, which pesticides have been used, and when free access to the treated areas will be restored.

3. WORKING ENVIRONMENT

Pesticide health hazards

Pesticides are biologically active substances, and as such they can cause damage to organisms or plants etc. other than the ones they are supposed to eradicate or regulate. There is therefore a risk involved in using them.

A pesticide's acute toxicity is indicated by the toxicity class in which it is placed and the risk assessment. The risk of poisoning caused by repeated use of a specific product is, however, far more difficult to identify than the risk of acute poisoning.

Health hazard for the spray operator

The health hazard for the spray operator consists partly of the risk of acute poisoning, where the operator shortly after working with the product shows signs of being unwell, and partly of the risk of long-term effects, e.g. cancer or impaired reproductive capacity. There may also be a harmful effect on the organs, e.g. the liver, kidneys, brain or nervous system.

It is, however, IMPORTANT to note that the health hazard from handling pesticides can more or less be eliminated if the user acts with care, uses protective equipment and observes the safety precautions for the product in question.

Health hazard for other persons and/or animals

The main health hazard for other persons is the risk of acute poisoning. This may occur when the pesticide is stored incorrectly, e.g. with food, feedingstuffs or medicines, or when it is poured into another container. Poisoning may also occur when spraying solutions or equipment are left unattended in farmyards or on roads, or when empty, uncleaned containers are left freely accessible.

Finally, pesticide residues may cause poisoning. Tractors and other machinery sent for repair without first being cleaned have sometimes caused illness.

Spraying equipment must NEVER be left unattended.

The most common poisoning routes and symptoms

People and animals can absorb toxic substances in three ways:

1. through the mouth (orally)
2. through the skin (cutaneously/dermally)
3. through the lungs (inhalation)

Furthermore, the eyes are often exposed, but this is not regarded as poisoning in the strict sense, as toxic substances are not really absorbed through the eyes, but "only" damage them.

Serious, acute poisoning from pesticides is in many cases caused by unintentional or intentional intake through the mouth or, to a lesser extent, by inhalation or absorption through the skin.

During the spraying process, which comprises both the preparation of the solution and actual spraying, the spray operator's body (i.e. his skin and his protective equipment) will be

exposed to pesticides. The operator will also inhale fine droplets, aerosols, and possibly pesticide vapours, including any organic solvents present.

Studies have shown that when an ordinary hydraulic spray gun is used, about 90% of the quantity settling on the spray operator originates from the mixing and preparation of the solution, compared with 10% during the actual spraying operation.

During mixing and preparation it is mainly the hands that are exposed, as well as the upper body (especially the chest).

During spraying too, it is the hands that are most exposed.

To reduce the spray operator's risk of pesticide poisoning, it is possible to use spraying equipment with accessories such as filling equipment, hydraulic boom lift, hydraulic boom retraction, non-drip valves, self-cleaning filters, tank-rinsing nozzles, and remote control.

A study has shown that spray operator exposure can be reduced by around 75% by using spraying equipment with remote control and other accessories.

Remote-controlled spraying equipment with extra accessories combined with the correct use of personal protective equipment can in most cases provide substantial protection for the spray operator against unnecessary pesticide poisoning.

The above-mentioned studies refer to spray operators using tractor-mounted spraying equipment. Other studies show that when spraying is performed with the tank carried on the back, it is mainly the legs that are exposed, because the operator walks on the ground that has just been sprayed.

UK studies have demonstrated that these "knapsack" sprayers involve a much greater risk than other equipment. (An additional risk is their considerable weight).

Poisoning symptoms

The symptoms of acute poisoning depend on the degree of poisoning, in other words on how large a quantity of poison has been absorbed and how the poison acts.

A poisoning situation typically starts with a general feeling of sickness, but then develops into more severe pain (e.g. headache or stomach-ache), sometimes followed by sweating, slight difficulty in breathing, mental confusion and/or a state of unrest/anxiety. As the poisoning develops, the symptoms become more intense (and other symptoms may be added), and severe poisoning may end in coma and death if expert medical treatment is not provided in time.

Persons who are not completely healthy should never work with pesticides, as they may fail to detect the early symptoms of poisoning, thinking they are due to their illness. As a rule, poisoning symptoms are described on the product label or in the supplier's instructions.

Labels and instructions from the supplier must provide information on first aid

First aid

Under normal circumstances, by following all relevant instructions including the use of the personal protective clothing and equipment, it is possible to carry out spraying without it resulting in poisoning.

If a person falls victim to poisoning, it is important that first aid be administered without delay.

First aid is the initial, sometimes life-saving help given after an accident, poisoning or sudden illness. Quick and correct help administered in the first few minutes may be of vital importance.

First aid

- Bring the poisoned person out into the fresh air
- Remove any soaked clothing
- Wash the contaminated skin with soap and water
- If the substance has entered the eyes, rinse them immediately with large amounts of water
- Summon medical help.

Precise information about first aid will be given on the product label or in the supplier's instructions.

If a person has been poisoned by "very toxic" substances, mouth-to-mouth resuscitation should not be used; other methods should be applied, for example the mouth-to-mask method, to avoid any risk of the helper being poisoned.

If a person becomes ill during or after working with pesticides, a doctor must be summoned instantly. If a doctor is not available, the nearest hospital must be contacted.

As the doctor needs the name of the substance used, it is essential to take the label, packaging or the supplier's instructions.

First aid equipment

The first aid equipment for cases of poisoning is not very extensive. The most important equipment is an eye-bath, together with soap and water for washing contaminated skin.

Clean water must be taken along into the field, so that contaminated skin can be washed quickly.

Choice of protective equipment

As a rule, personal protective equipment and special work clothes must be worn when mixing and spraying pesticides.

It is important that the protective equipment is used correctly and that it fits the user, so that it offers proper protection.

Protective equipment for cleaning spraying equipment

When cleaning spraying equipment, wear boots, gloves, safety goggles and perhaps an apron. If additional protective equipment was used during spraying, keep it on during cleaning.

If a high-pressure cleaner is used for cleaning, overalls and a half-mask with a type P2 filter for liquid aerosols must also be worn.

The reason for using a respirator is that dirt and pesticides are released during cleaning and become airborne.

Personal protective equipment and its quality

When choosing protective equipment, it is not just a matter of selecting the correct equipment. It is also a question of choosing protective equipment of a quality that will offer good and reliable protection during its entire lifetime.

Gloves

Studies show that the hands are the most exposed body parts, both when mixing the solution and during the actual spraying. Gloves are therefore one of the most important items, especially during spraying, when the operator risks coming into contact with the concentrated chemical.

When buying gloves, draw the supplier's attention to the types of pesticides that will be used, to ensure that the gloves you purchase offer the best possible protection. Similarly, when buying pesticides, ask which gloves are suitable.

The best and most reliable protection is obtained by wearing gloves for which the penetration time for the pesticide used is known, and the gloves are then discarded before that time has elapsed.

There are, however, only very few types of glove where the penetration time for selected pesticides has been investigated.

Irrespective of the type of glove used, it will always be a good idea to wear a cotton glove under the protective glove, so that the hands always remain dry, as wet and sweaty hands are more liable to absorb the toxic substances.

Gloves that are used more than once must be rinsed before they are taken off, and every time they have been contaminated with a pesticide.

Gloves with holes or tears must be discarded.

Disposable gloves must be discarded after use, i.e. the first time they are removed from your hands.

It is always best to start the day with a new pair of protective gloves.

Boots

Chemical- and oil-resistant boots are considered most suitable, but sturdy rubber boots may also be worn. If you wear overtrousers or overalls, they should be worn outside your boots, so that you will not get pesticides inside your boots.

Thick cotton socks should be worn inside your boots, to ensure that your feet are always dry. Socks must be changed at least once a day and washed after being soaked in soapy water. Boots should only be worn during spraying, and should be discarded when the spraying season is over.

Ordinary trousers must be tucked inside your boots, as they may otherwise suck up the pesticide.

Damaged boots should not be worn.

Protective overalls

Protective overalls prevent your ordinary working clothes from becoming contaminated with pesticides and prevent pesticide from reaching your skin via your clothes.

If the pesticide is in liquid state, overalls must be waterproof.

Sturdy rainwear offers good protection, but will often be uncomfortable to wear. Waterproof disposable overalls tend to be more comfortable.

In certain cases protective overalls must be supplemented with a hood.

You should, however, remember that although overalls are waterproof, pesticides may still be able to penetrate them. There are no overalls or trousers for which the penetration time has been investigated.

Make sure that your clothes underneath your rainwear or overalls are always dry, and that you change to clean working clothes every day.

Apron

In certain cases a waterproof apron may offer enough protection against splashes. The apron must reach the top of the boots.

Deleted: Safety Four, who make 4H gloves, manufacture an apron made of the same material, which has therefore also been examined for penetration time.

Face shield

A face shield protects your face and eyes from splashes. It must be transparent and sit properly, and it must also be possible to use it together with a respirator.

Safety goggles

Safety goggles (antidim) must hug your face all around your field of vision.

Respirator

A respirator serves to filter the air or supply fresh air. When working with pesticides, it is often necessary to use some kind of filter mask. In cases where the work involves a mist

generator or mist sprayguns, for instance, the use of a respirator with fresh-air supply may be a requirement.

Respirators of the filter type may consist of full masks or half-masks with dust filters or gas filters. Where it is necessary to protect against both dust and gas, a combined dust and gas filter must be used.

Gas filters are divided up into classes and types, where the class indicates filter capacity and the type indicates the gases the filter can offer protection against.

Gas filters are divided up into three classes:
- class 1 (low-capacity filters)
- class 2 (medium-capacity filters)
- class 3 (high-capacity filters).

Respirator, full mask

A gas filter used for work involving pesticides will almost invariably be a class 2 filter.

The filter type is indicated by a letter, and as a rule the individual letters will be linked to a specific colour.

The most common gas filters are the following:

- Filter type A (brown), protecting against vapours from organic solvents. There is also an A-filter which is used for pesticides.

- Filter type B (grey), protecting against chlorine, hydrocyanic acid etc.

- Filter type E (yellow), protecting against sulphur dioxide etc.

- Filter type K (green), protecting against ammonia etc.

A gas filter is capable of absorbing a certain amount of air contamination. After that the contamination will penetrate, which means the old filter must be replaced by a new one before that happens.

It must not be possible to smell the contamination. Assuming the mask is correctly fitted, the filter must be changed before this happens.

It is recommended that all filter types be replaced every day, unless the lifetime of the filter is known. Some suppliers are able to calculate the probable lifetime of their filters, if the contamination concentration and workload are known. The filter must be exchanged well before the end of the calculated probable lifetime.

It is important in all circumstances to check that the respirator hugs the face. You can test this by sealing the filter with plastic foil or with your hand. Now check whether the mask maintains an overpressure or underpressure for 10 seconds.

You can also check the mask's density by releasing a harmless odorous substance outside the mask and checking whether you can smell or taste the substance inside the mask.

A filtering respirator may only be used for a total of three hours during a whole working day. The reason for this is that a filtering respirator is hard on the respiratory organs and can cause water in the lungs if worn for a long time.

If spraying lasts more than three hours in one working day, a respirator with blower or auxiliary motor (turbo equipment) must be used from the start. This type should not be confused with a respirator with air supply.

Respirator with air supply

A respirator with air supply must be used if the concentration of contamination is so great that a filtering respirator is insufficient. There are several types of respirator with air supply:

- Respirators receiving air from a compressor or a stationary pressure tank. The air supply is not time-limited and the respirator is lightweight, but the user's movement is limited by the hose.

- Respirators receiving air from pressure tanks carried on the person's back. The tanks weigh 5 to 18 kg, and the air supply is time-limited, but the user can move about freely.

- Suction masks, where the user breathes through a hose leading to fresh air. This system is less safe than other air-supplying respirators and normally should not be chosen.

Respirators must be delivered with instructions from the supplier in your own language, containing information on protective qualities, adaptation, use, maintenance and storage.

A dust filter mask is either a mask with a replaceable filter or a self-contained filter mask. The dust filter will not protect against gases and vapours. Dust filters are divided into three categories:

- P1 (low-effect filter), which only protects against coarse dust. There is no need to use the filter if the limit value is below 5 mg/m^3.

- P2 (medium-effect filter), which protects against most types of dust.

- P3 (high-effect filter) with protection as P2, plus additional protection against radioactive dust, bacteria and viruses.

A layer of dust on the filter makes it more difficult to breathe. The filter must be replaced when breathing becomes too laboured.

Cleaning and storage of personal protective equipment

After use, personal protective equipment must be cleaned in accordance with the supplier's instructions. If there are no instructions, it must be cleaned in soapy water and dried carefully. Equipment must always be cleaned after use, even if the work is to continue the next day.

You must be completely sure that all pesticide residues have been removed from inside your boots and clothes. When you wear tight-fitting gloves or boots, the skin becomes hot and sweaty and hence softer, so that it is easier for pesticides to penetrate. For the same reason you must ensure that there are no holes in equipment.

Respirators must be looked after carefully. The supplier's instructions must be carefully adhered to. Respirators are best stored in dark and airtight surroundings, so that their suppleness and the filter's lifetime are preserved.

Personal protective equipment and special working clothes must be kept separate from other working clothes, so that they will not become contaminated with pesticides. They must not be stored together with pesticides.

Personal protective equipment that has been used during mixing but is not to be used for spraying must not be placed in the tractor cab, but must be stored in a closed box on the outside of the tractor.

Supplier's instructions + technical data sheets

Suppliers of pesticides must ensure that they are delivered with easily understood instructions covering a number of specific items.

As a rule the supplier must prepare instructions for all pesticides that have to be classified, in other words, those marked with orange danger symbols.

Furthermore the supplier must provide instructions for pesticides which are not marked with colour symbols, but which according to other provisions are considered to be dangerous or a risk to safety and health.

For pesticides that have not been placed in a danger class it is not a requirement that supplier's instructions must accompany the products. This does not mean, however, that you need not take precautions against any safety and health hazards that may occur when working with these pesticides.

The requirements cover only the contents of the supplier's instructions, not the wording. Instructions may be provided on the label or on a separate sheet of paper.

The reason is that the European Commission has adopted a directive on the harmonisation of laws and provisions governing dangerous substances (preparations). This directive also contains requirements concerning the provision of supplier's instructions (technical / safety data sheets).

Contents of the supplier's instructions

The layout and contents of the new technical data sheets are as follows:

1. **Identification of the pesticide or preparation and of the company or enterprise,** i.e. the pesticide's trade name and type, the product approval number and/or the environmental authority's approval number. Also the name, full address and telephone number of the marketing company, and the names and telephone numbers of any advisers referred to, and possibly of the poison information centre of the state university hospital. The toxicity class of the pesticide must also be indicated under point 1.

2. **Information on pesticide ingredients.** Information making it possible for the user to establish which hazards are connected with the pesticide in question. Information must also be provided on the contents of any solvents and carcinogens.

3. **Danger identification.** The greatest dangers of the pesticide, and the greatest risks to persons and to the environment. The most serious harmful effects on people's health and the symptoms that may occur during use and abuse must also be described as well as any long-term harmful effects.

4. **First aid.** The first aid procedure for the pesticide in question must be described here.

5. **Fire-fighting.** How to fight fires that have started in the pesticide concerned, including details of suitable fire-fighting appliances, development of toxic gases and any requirements regarding personal protective equipment for fire-fighting operations.

6. **Measures in the event of accidental spillage.** Information on whether the supplier can accept spilt pesticides, and how spills and residues can be dealt with.

7. **Handling and storage.** Requirements concerning storage of the pesticide in a locked and marked cupboard or room.

8. **Exposure control/personal protective equipment.** A description of the personal protective equipment that must be used during the various phases of spraying. In connection with the choice of personal protective equipment, reference should be made to instructions from the national labour inspectorate or the agricultural safety council, and the advice of the manufacturer of the pesticide should be followed.

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9. **Physical and chemical properties.** Details of the pesticide's physical and chemical properties, appearance, odour and a number of other qualities.

10. **Stability and reactivity.** How the pesticide will react if exposed to high temperatures or high pressure, or if it comes into contact with other substances.

11. **Toxicological information.** Details of the toxicological effects (health hazards) that may arise if the user comes into contact with the pesticide.

12. **Environmental information.** Information about the pesticide's possible effects, reactions and behaviour in the environment, including persistence and decomposition, mobility and toxicity in water.

13. **Disposal.** How residues and empty containers have to be disposed of.

14. **Transport information.** A description of the precautions the user must be acquainted with and which must be observed in connection with transport or conveyance, on or outside the company's premises.

15. **Regulations.** Details of the pesticide's classification, R clauses and S clauses, marking requirements etc., as well as any other provisions which may apply to the pesticide.

16. **Other information.** Details of the necessary training, e.g. requirements for spraying certificates, and recommendations on uses and limitations, and any restrictions applicable to young persons under the age of 18.

Workplace instructions

It is the employer's responsibility to ensure that employees working with pesticides have access to information about the associated dangers, and especially that they know the precautions to be taken against these dangers. Workplace instructions must therefore be available at all places of work.

The employer must prepare workplace instructions

Preparation of workplace instructions

Workplace instructions are in principle the supplier's instructions, plus company-specific information.

They must be regarded as additional to the employer's obligation to provide instructions. The regulations make it quite clear that workplace instructions do not replace the employer's obligation to provide general instructions.

Some pesticides are identical (contain the same active ingredient) and are sold by different suppliers under different brand names. Such pesticides must be supplied with the same (identical) instructions.

Some suppliers leave space for the addition of company-specific information, and the supplier's instructions thus become workplace instructions.

Company-specific information must comprise the following elements:

1. **Field of application.** The name of a responsible person in the company in case of any doubts concerning application.

2. **Application limitations.** The company's own limitations, if any, for the use of the pesticide.

   If the company has any such limitations, they must be written down.

   If the company does not have its own special limitations, it must put "no special limitations".

3. **Requirements concerning special training.** The instructions in the catalogue must contain the requirements based on legislation.

   The company must add any internal provisions, if for example it has a rule to the effect that spraying must be carried out only by persons who have attended a specific course.

4. **Precautions for handling the pesticide.** The company must indicate where personal protective equipment is to be stored, and how it is to be made available to employees.

5. **First aid.** The company must indicate the type and location of on-site first aid equipment.

Availability of workplace instructions

The workplace instructions must be accessible to employees. They must be placed in a central location, e.g. in a common room or the like. It is often useful to place them near the poison cupboard or poison storeroom.

The spraying operation

From the working environment point of view, work with pesticides must be planned and organised so that it can be carried out in a manner which does not in any way jeopardise safety and health. Before starting spraying, the danger represented by the pesticide must be assessed on the basis of the labelling and the workplace and supplier's instructions.

Special precautions before spraying

Before starting to spray pesticides, ensure that there are no other persons in the areas to be sprayed. No one else must be in a greenhouse that is to be treated with pesticides. If other persons have to be in the area or in the greenhouse while pesticides are being sprayed, they must use the same personal protective equipment as the spray operator.

In addition to the above, special consideration must be given to pregnant employees. Pregnant women must be assigned to other work where they are not exposed to any risk of working with pesticides or with plants that have been treated with pesticides.

If this is not possible, they must take sick leave.

Testing of spraying equipment

Before commencing spraying, the spraying equipment must be tested with clean water in order to check the nozzles (replace if necessary) and to check for leaks from hoses or connections. This is to avoid coming in contact with the pesticide.

Preparation of spraying solution

Spraying solutions must be mixed and prepared outdoors or in a well-ventilated room. Tools used for mixing and preparation must be cleaned immediately after use, and must not be used for other purposes.

Do not prepare larger quantities of solution than necessary. Avoid leaving residues in the tank when the area concerned has been sprayed. It should be possible to use all the solution the same day.

Do not prepare more spraying solution than required.

After mixing, remove the empty container so that it is not accessible to children etc. (read the section on disposal of chemical residues and empty containers). A filled spraying machine must never be left unattended.

The spraying operation

Outdoor spraying should not take place if there is too much wind or if there is a risk of spray drift towards neighbouring crops, hedgerows, neighbours' gardens, footpaths, watercourses, etc. When spraying along property boundaries and roads, ensure also that the spray mist does not drift over the road, where it may constitute a danger to pedestrians and motorists.

Beware of exhaust fumes when using combustion engines in confined spaces such as mushroom sheds or greenhouses.

Precautions against malfunctions

In the event of a malfunction while spraying fields, making it necessary to get out of the tractor, drive another five metres with the spray function stopped, so that you avoid stepping on the sprayed area. While rectifying the fault there is a high risk of direct contact with the pesticide, and you must always wear gloves.

Avoid contact with the spraying solution.

If an automatic mist generator operating inside a greenhouse develops a fault, put on your personal protective equipment before entering the greenhouse to rectify the fault, and ensure that the machine cannot inadvertently start during the repair.

Cleaning of spraying equipment

As a precaution, spraying equipment should be cleaned at the end of every working day. On the outside of the equipment there may be dried-up concentrated residues of spray which can be dangerous to people and animals. On the inside there may be residues or deposits that may damage crops. It is therefore important for the spraying equipment to be cleaned thoroughly, both inside and out.

Spray residues that are allowed to dry up can be very difficult to wash off. The equipment must therefore be cleaned as soon as spraying is finished. If this is not possible, it must at least be rinsed thoroughly, or filled with water and left until it can be cleaned.

The rinsing water must not be poured into sewers, drains, ponds, watercourses, wells, etc. If necessary, it may be spread on a crop where permitted, or on a field without crops.

The same rinsing site should not be used for a lengthy period of time, as the rinsing water may then make grooves in the ground along which it may make its way to wells or drains.

There are special cleaning procedures for certain pesticides, which are indicated on the label.

Personal hygiene

It is of course important that personal protective equipment is in order, but it will only offer real protection if its use is combined with appropriate personal hygiene, especially when working with pesticides that can penetrate the skin.

Take a bath/shower and change your clothes EVERY day.

Personal hygiene means washing your hands and face and removing your protective equipment before eating, drinking or smoking.

If you get spray on your skin, immediately wash the contaminated spot with plenty of soap and water. Contaminated clothes should also be removed and washed as soon as possible.

This is one of the reasons why you should always take along clean water and soap when working in the field.

On finishing spraying, take a bath and put on clean clothes. It is also necessary to make sure that the working clothes you have worn are washed, so that you can be certain you are not putting contaminated clothes back on next day.

Wash your hands before and after visiting the toilet.

4. PESTICIDES

Types of pesticide

Pesticides are biologically active substances designed to kill or deter pests, cure or prevent diseases, or regulate vegetation.

Plant protection products = pesticides

For farmers, pesticides are as a rule identical with plant protection products, and they account for the majority of weed, fungus and insect killers.

The best known and most used pesticides are **herbicides**, **fungicides** and **insecticides**.

Insecticides include pesticides to combat insects and mites on plants, as well as those used against pests in houses, storerooms and textiles or against insects in timber and woodwork, etc.

Growth-regulating substances are growth-inhibiting, root-promoting, germination-inhibiting, flower- and fruit-producing pesticides, etc. Examples include Cerone or Cycocel (CCC), used in agriculture for grain crops to shorten and strengthen the stalks and prevent flattening. CCC is also used in fruitgrowing to regulate the number of flowers, and hence the quantity of fruit.

Other groups include nematicides used to combat **nematodes**, e.g. potato root eelworm, and rodenticides used to control **rodents**, e.g. rabbits, water voles, moles, rats and mice.

There are also **deterrents** (repellents), i.e. pesticides serving to keep vermin away from places or crops where they can cause damage.

Biological pesticides, which are mainly used in horticulture, are subject to the same regulations as other chemical agents.

The chemical agent concept covers many other pesticides (e.g. algaecides, soil disinfectants, etc.).

Pesticides and their function

Systemic pesticides and contact agents

Systemic pesticides are absorbed by the plant and transported with the sap flow.

Systemic herbicides are absorbed through the plant's green parts and/or roots and can be transported up or down to the growth points.

Weed killers (herbicides) can be divided into leaf pesticides and soil pesticides, depending on whether they are absorbed through the green parts of the plant or through the roots, but many herbicides can be absorbed through the plant parts both above and below the ground.

Contact agents stay on the plant surface and act only where they touch it. They may be able to penetrate the bloom. This makes a good covering of the plants particularly necessary. Maneb, mancozeb, sulphur and pyrethroids are typical contact agents.

Climatic influence

The effect of pesticides can be influenced by the weather conditions at the time of spraying, and in some cases by the weather during the preceding growth period.

Temperature and air humidity

Both temperature and air humidity can have a significant influence on pesticide absorption, transport and effect. In general, the effect of pesticides increases with temperature and humidity.

Rain

If it rains immediately after spraying, the pesticide may be washed off the plants. This applies above all to water-soluble pesticides. Some pesticides can, however, withstand rain very shortly after being sprayed, because they are absorbed by the plant very quickly. The water-resistance of pesticides may be improved by additives.

Spraying in the morning or evening is recommended, as it is more comfortable and safer for the operator.

Wind

Wind during spraying is undesirable, partly because it causes drift which may harm neighbouring crops, and partly because it affects the settling of the spray on the plants and increases evaporation from the leaves.

Duration of chemical action

The duration of chemical action depends on the pesticide's decomposition time, but also to a large extent on the circumstances under which the pesticide is used.

Formulations

A pesticide consists of one or more active substances, and a solvent or other additives. The chemical composition of the product is called its formulation.

Pesticides are formulated in many different ways. The qualities of the formulation may be of great importance to how the chemical must be handled from the safety point of view.

For special purposes there are many gaseous pesticides (**fumigants)**, for use in greenhouses or in burrows made by rodents or moles.

Adjuvants

Manufacturers use many different secondary substances to ensure that pesticides do not change during transport, storage or use and to improve their effectiveness.

Solvents are an important part of liquid pesticides, and may amount to more than half of the product. Formerly solvents were very often organic, but since their unhealthy effects have become clear, the trend is increasingly towards the use of water-based products.

Dispersing agents or **gels** are added to products to make them durable, i.e. to ensure that the active substances will not be precipitated under normal storage conditions, and that when diluted with water they will not precipitate and form a cake at the bottom or clog up the nozzles. See also under additives.

To prevent products from freezing, anti-freeze may be added, and a **foam-inhibiting agent** may also be added to prevent foaming when the liquid is diluted. Finally, a bactericide is often added to both solid and liquid products.

In all "dry" products, i.e. dusts, powders, tablets and granulates, both for wetting and for suspension in water, the active substance is mixed with a so-called **carrier** which often accounts for a very large proportion of the product. Most are relatively harmless substances, e.g. lime, silicic acid, talc or clay.

However, these substances are dusty, and can therefore be unpleasant to work with. Spray powders and granulates for suspension in water all contain **wetting agents,** which promote the suspension process when mixed in water and thus help ensure even distribution throughout the spraying solution.

Additives

To improve the effect of pesticides, and as not all products can take the required amounts of derivatives in the formulation, it may be necessary to use additives when mixing the spraying solution. These may be products containing surfactants, or they may be oils, minerals or vegetable oils. They are also known as spreaders.

Dispersion agents

Surfactants have an emulgating effect and influence the solution's surface tension, so that the spray drops flatten more on the leaf surface and create a larger contact surface between leaf and spray. At the same time the spray adheres better, as more drops settle on the leaves, and both these factors may help increase penetration into the leaves, creating the possibility of lower dosages.

Penetration oils or spreading adhesives

Penetration oils may be added to facilitate penetration by the active substance, and they often increase resistance to rain, making the effect less dependent on the weather at the time of spraying.

Penetration oils and other additives should not be added unless recommended in the instructions.

Mixing of products

The instructions on the label will indicate which other products the chemical in question may be mixed with.

Mixing products other than those recommended may cause serious undesirable effects or damage.

Stability may be affected when pesticides are mixed. There may also be reactions between active substances or between an active substance in one product and one or more additives in another.

Explanations of some toxicological terms

Term	Explanation	Method
LD-50 value	Illustrates the acute toxicity of a substance. The value indicates the amount (mg per kg body weight) which has killed 50% of the relevant experimental animals (usually rats).	The value is established through short-term experiments in which large doses are administered, often in the form of direct injections.
O-effect value	Indicates the level (dose) at which the experimental animals *have shown no changes* despite a lengthy intake (often up to two years). All internal organs are examined for changes.	The value is established through long-term feeding experiments with small doses, often added to the feed or drinking water.
ADI-value	The acceptable daily intake for human beings, if they consume the relevant substance throughout their life. This value is used when calculating the *limit value* for residues in foodstuffs.	The established O-effect value divided by a safety factor, which is often 100.
Action period	The time elapsing before a treated crop may be harvested. Harvesting in this context includes haymaking, pruning, windrowing, gathering and picking.	The time is established on the basis of breakdown curves.

To compensate for the uncertainty that always exists, it is possible to evaluate the effect on human beings based on the effect on animals, and as "human beings" include both children and adults, sick and healthy, young and old, a safety factor is applied, which as a rule is 100 but in a few cases can be as high as 1000.

ADI *- the acceptable daily intake for human beings without being harmed, if they consume the relevant substance throughout their life.*

This value is used by the authorities for establishing a maximum limit for an active substance in crops where the substance is allowed. In such calculations account is taken of the proportion of an average person's daily diet which is constituted by the crop concerned. In other words residues in grain, potatoes, apples and similar much-eaten foods must be considerably smaller than in chives, parsley etc. which are consumed only in small quantities. Maximum limits are expressed in mg chemical per kg crop.

Maximum limit = the maximum amount of a chemical that may occur in a given crop.

EU limit values have also been established in order to prevent trade barriers, as certain countries have consciously established very low limit values to be able to reject imported goods, while being less keen to analyse domestically produced goods.

***Action period**. The time that has to elapse between spraying and harvesting.*

The **action period** is the time that has to elapse from the crop being sprayed until it can be harvested. Harvesting in this connection includes haymaking, pruning, windrowing, gathering and picking.

The **action period** will almost always be made as long as technically possible, to avoid excessive residues in foods.

The smooth surface of tomatoes helps ensure that the action period is usually only a few days. Although blackcurrants also have a smooth surface, they have a capacity for absorbing foreign substances and therefore require a much longer action period, normally several weeks.

For the same reason a *chemical may have different action periods for different crops.*

The **action period** is not directly related to the product's toxicity, but first and foremost depends on the substance's breakdown time in or on the plants. There are some very toxic products with an action period of 0 to 2 days, while products not placed in toxicity classes may have action periods of three months.

The action period has therefore first of all been established to prevent excessive residues of pesticides in foods or feedingstuffs. If it is not adhered to, the user may be prosecuted.

Presence in greenhouses

It must be ensured that no one but the spray operator is in a greenhouse being sprayed with pesticide. If others have to be in the greenhouse during spraying, they must have the same personal protective equipment as the operator.

When crops are treated in greenhouses, there is another safety aspect, namely the time needed for the air to become free of chemical residues so that normal work can resume without the use of protective equipment.

This problem has not yet been resolved, as conditions differ so much from greenhouse to greenhouse, and only for a very small number of products has the time been established after which it is again safe to go back into the greenhouse to work with the treated plants.

Spraying from planes

The spraying of pesticides from the air may only be undertaken by companies authorised to do so by the authorities.

5. ENVIRONMENTAL IMPACT OF THE USE OF PESTICIDES

Introduction

There is widespread concern, both in agriculture and in society as a whole, about the use of pesticides. The reason is that pesticides are often also poisonous to living organisms other than the weeds, pests or fungus to be destroyed.

How can we assess the environmental impact?

It is not possible to provide a precise picture of the environmental risks involved in using pesticides. However, extensive information is available on the individual substances and on how the environment has been affected in recent years.

I. Pesticides in the environment

a) Decomposition
b) Contamination of foods
c) Contamination of surface and groundwater

II. Environmental impact

a) Impact on wild plants in the fields
b) Changes in the bird fauna
c) Chain reactions
d) Poisoning of honey bees
e) Impact on beneficial animals
f) Impact on micro-organisms in the ground
g) Impact on water organisms

Decomposition of pesticides

Pesticides often need to have a certain lifetime on the plants or in the ground, so that crops are protected against attacks for a certain period or to keep the ground free of weeds until the crop covers it and can cope.

Stable substances on or in the plants will leave residues in the harvested crop, and stability in the ground may damage the organisms living in the ground or a subsequent crop. There may also be a risk of spraying solution residues being washed into the groundwater. There is at any rate a greater risk of unwanted effects from pesticides that decompose very slowly.

It is therefore important for pesticides to disappear once they have produced the required effect.

The most important factor in the disappearance of pesticides is that some of the millions of bacteria and fungi that live in the ground can break them down in the same way as they are also able to break down straw, root remnants and other dead organic material. In just one teaspoonful of earth there may be hundreds of millions of bacteria and more than 100 metres of fungal tissue, and the topsoil of one hectare can contain between 4 and 8 tonnes of these micro-organisms.

The bacteria and fungi in the soil are of special importance for the decomposition of pesticides.

When a field is treated beforehand with one of the herbicides known as hormone preparations, there will be several organisms present which can break down this particular preparation.

Breakdown of the MCPA hormone is therefore faster in soil which has previously been treated with MCPA, because there are now more organisms that can break down this chemical. The soil might be said to have been "enriched" by these special micro-organisms.

Most pesticides are, however, very difficult to break down. Although micro-organisms capable of breaking them down do exist, they cannot live on these pesticides. In other words, there will not be an increase in the amounts of those particular organisms in soil that has been sprayed.

For pesticides that are broken down slowly it must be assumed that the soil is only able to break down a limited amount of spraying solution per hectare. Considerable caution must therefore be exercised, as regards both observance of the dosage and avoidance of spray overlapping, in order to prevent the field's organisms being exposed to a substance for a long time and to stop the chemical damaging the subsequent crop.

The expression "half-life" is often used to indicate how long a chemical remains in the ground. The half-life indicates how much time elapses before half of the chemical has disappeared. After four half-life periods, only 5% of the chemical remains.

The expression "persistence" is used both to quantify resistance and to indicate how long a substance remains active in the ground, e.g. how long it remains a danger to subsequent crops.

Half-life = the time elapsing before half of the chemical has disappeared.

Persistence = the chemical's resistance in the ground. Often corresponds to 4-5 half-life periods.

Risk of contamination of food products

If pesticides are stable on or in plants, or if the crop is sprayed shortly before it is due to be harvested, there is a risk that the crop may contain chemical residues.

To protect consumers against this risk, the authorities establish rules on which pesticides may be used, and how close to the harvest they may be used for the various crops.

Observe the spraying intervals indicated on the label to avoid excessive pesticide residues in the crop.

To make sure the rules are observed, market checks are carried out. 1 500 to 2 000 samples of crops for consumption are analysed each year, and excessive pesticide levels have been found in some of them.

The excesses found have generally been small. By and large it would appear that the rules governing the use of the pesticides are adhered to. But we must naturally try to reduce residues to a minimum by limiting the number of spraying operations.

Pesticides in the air and precipitation, and risk of drift

Pesticides can also damage areas situated outside the sprayed field.

Spray damage for instance frequently affects hedges, gardens or greenhouses adjacent to sprayed fields. Such damage is most common near grain fields sprayed with hormones in the spring (MCPA, dichlorprop etc.). There may also be serious damage to sensitive crops in the vicinity. This so-called drift damage is mainly caused by weed killers drifting with the wind during spraying. The problem is particularly serious when the spray consists of fine droplets (mist) and when the wind is blowing during spraying. Most of this local damage can be avoided with a little thought, and it is important to do so, as it can cost huge sums in compensation and often gives rise to strong and understandable reactions on the part of garden owners etc.

Water contamination by pesticides

In recent years pesticides have also been found in groundwater, drinking water, drain water, watercourses and lakes, and a few cases of serious pollution of wells and watercourses have been recorded. Pesticides do not belong in water, and strict rules have therefore been established to avoid pesticide residues in drinking water. Some of the organisms living in watercourses and lakes are very sensitive to certain pesticides. So there is every reason to protect the water environment.

In the Member States water may for example contain no more than 1 μg (microgram) of pesticide per litre. This corresponds to 1 gram of pesticide in 10 000 m^3 of water, i.e. 1 gram in a 1-hectare basin which is 1 m deep. These rules have been established in order to avoid water contamination by pesticides.

Contamination of surface water

During spraying, pesticides may end up in watercourses or lakes, either as a result of drifting or because the spray boom gets too close to the water. Water pollution may also be caused by rinsing spraying equipment. Heavy rain immediately after spraying may also cause percolation from the sprayed fields.

Avoid spraying near watercourses and lakes, and be mindful of wind drift and surface run-off.

Measurements in watercourses, lakes and drain water often reveal small amounts of residues.

The general aim of reducing the risk of lakes and watercourses being contaminated by pesticides can best be achieved by observing a distance of at least 10 metres from lakes and streams when spraying.

It is essential to prevent rinsing water from the spraying equipment or water used for washing the sprayer and tractor from running into drains and ending up in watercourses. A grass-covered area is a very suitable filter for rinsing water. Better still is a concrete washing site with an underground tank in which the water is collected and subsequently sprayed on a safe area.

Groundwater contamination

Sources of groundwater contamination by pesticides

Groundwater contamination can take place in many different ways.

- Direct pollution of wells
- Seepage from sites used for washing tractors and spraying equipment
- Seepage from public dumping grounds and small private refuse dumps
- Seepage from sprayed pesticides
- Seepage from particularly vulnerable areas (railways etc.).

Pesticide contamination of wells occurs regularly. The risk is particularly high if spraying equipment is filled, rinsed or washed or weeds sprayed near wells. The pollution may also be serious, because the quantities involved may be very large. It may also have serious hygiene and economic consequences, for example if the pesticide spreads into the groundwater. If the water supply network has been contaminated, rinsing with very large amounts of water may be required before the pesticide level falls back below the limit value for drinking water.

Precautions against contamination of wells

- Filling of sprayers with pesticides must not take place near wells
- Rinsing and cleaning of spraying equipment must not take place near wells
- Equipment must have a non-return valve, so that water cannot run back into the well
- The filling hose must not dip into the spray tank, but must hang in a gallows to avoid a syphon effect if the water pump stops
- Stay at the spray tank during filling, so that it does not run over
- Do not use weed killers within 10 metres of wells
- Make sure that well covers fit tightly and that water cannot run into wells from the sprayed ground.

Pollution from washing and filling sites

Filling of spray tanks and washing of spraying equipment often take place at the same site year after year, because of easy access to the water supply. Pesticides from the rinsing water and from surplus amounts of pesticide solution end up in the ground, which then accumulates very high concentrations of pesticides. If there are drains near the washing site, contamination of watercourses may occur.

To limit these risks, Sweden has introduced special sites for washing and filling. These improve the decomposition of chemical waste and increase adsorption. They are built with a drive-on ramp placed on top of a 50 cm deep excavation lined with clay and filled with a mixture of 50% cut straw, 25% peat litter and 25% humus soil. They are called "biobädd" (biobeds) and are sown with grass.

Remember that pesticide residues in the spray tank must be diluted and sprayed on the field. There must be no drain from the washing site which would allow rinsing water to run into watercourses or lakes. It is therefore best to collect rinsing water in an underground tank for safe disposal.

Chemical waste

There used to be no efficient way for farmers, gardeners, machinery station owners etc. to get rid of chemical waste in the form of pesticides, oil, paint or organic solvents. Many

private refuse dumps were therefore established in small gravel or marl pits, where all kinds of waste were deposited. This is now considered highly dangerous and is usually illegal.

Remember that if special rules have been issued for the disposal of chemical waste, stipulating for example that it must be delivered to the municipal reception facility, these rules must be complied with.

Influence of pesticides on plants and animals

The purpose of spraying is to eliminate unwanted fungus, insects or plants. The question is how hard it hits non-targeted species, and whether the effect becomes unacceptable, e.g. because plant species are wiped out, or because birds or predatory insects suffer when their food supply is curtailed.

Impact on beneficial animals and pests

Beneficial animals = predators

In many cases pests are kept down by insects and mites which may therefore be regarded as beneficial animals. The ladybird, which feeds on aphids, is one of the best examples. In other words a kind of natural biological war is raging in the fields. Pest control using insecticides may also harm beneficial animals, and fungicides and herbicides may reduce the effect produced by beneficial animals.

Beneficial animals can often replace pesticides in greenhouses = biological control.

A study of the effects of 84 different pesticides on certain predators showed that most of the insecticides used today not only kill the pests, but also many predators. Only a few of the fungicides had this effect, whereas half of the examined herbicides had a severe impact on predators. To optimise natural control it is necessary to use substances which cause as little harm to beneficial animals as possible.

Beneficial animals for fighting aphids: ladybirds, lacewings, ground beetles, rove beetles, ichneumons and spiders

As far as greenhouses are concerned, advice is often sought on which pesticides will be least harmful to beneficial animals. Attempts are being made to develop new insecticides which will kill pests, without harming beneficial animals. It is also widespread practice to use beneficial animals to control pests without pesticides, e.g. encarsia formosa against whitefly on tomatoes.

Substances which spare beneficial animals in greenhouses: torque, applaud and bacillus thurigensis.

Earthworms are another group of animals in the ground which should be protected. A number of pesticides have turned out to be poisonous to them. Information on the toxicity of new pesticides to earthworms is therefore obtained before they are approved.

Pests

The purpose of treatment with insecticides is to reduce the pest population so that it no longer constitutes an economic burden to the farmer. We cannot fully eradicate pests, but, as mentioned above, beneficial animals are also affected by spraying, and the fear is that this creates better conditions for surviving pests than if there were no spraying.

Micro-organisms in the soil

Bacteria and fungi in the ground are important for the decomposition process. Pesticides can affect the number of different fungus species in the soil, but do not appear to be detrimental to the decomposition process.

Impact on life in watercourses and lakes

The most serious damage to animal and plant life has been found where water from the emptying or rinsing of spraying equipment has got into a watercourse via the sewer system. A concentrated spraying solution can cause serious damage to a watercourse. The contamination resulting from drift and run-off from recently sprayed fields or from seepage into the drain water will normally be much less significant, but may in some cases have an impact on the watercourse. It has been found, for example, that even very low concentrations of some insecticides can damage the fauna, especially the very sensitive animals and insects that live in the water.

The worst pollution is caused by filling, emptying and rinsing spraying equipment.

Insecticides belonging to the pyrethroid group are particularly toxic to fish and to some of the other organisms living in watercourses and lakes.

6. SPRAYING

Having taken account of everything you have read up to this point, the next stage is the actual spraying of the pesticide. Presumably your employer or someone else in authority has decided, in spite of everything, that spraying a pesticide is necessary.

In many countries it is now a legal requirement for a person to be properly trained in the use of pesticides and to have passed an examination or test resulting in the awarding of a certificate before being allowed to handle pesticides. In addition there is usually a minimum age, often 18, before a person is allowed to work with pesticides.

The following key-points are always worth considering before using pesticides;

1. Is a pesticide really necessary?

2. Is there a less toxic (less harmful) chemical on the market that could be equally effective?

3. What about the safety period before harvesting?

4. Are the conditions right for spraying?

Wind - rain - hot - cold.

5. Is the equipment in good working order, with no leaks or danger of burst pipes?

6. Are the right nozzles fitted?

7. Are other people/workers warned and moved from the area to be treated and told not to return until it is safe? Do not forget public paths and rights of way.

8. Has everything possible been done to prevent all domestic animals, including bees, from entering the area?

9. Estimate, or better still calculate, how much solution is needed to do the job, so you do not end up with too much.

10. Make sure to have all the required personal protective equipment and clothing for the job.

11. Prepare and mix the solution in the proper manner.

12. After spraying, clean all equipment and machinery thoroughly, including your protective equipment.
Lock away the remaining pesticides in the chemical store. Dispose of empty containers properly.

13. Record what you have done, i.e. the area and crop sprayed, the chemical used, and how long it took to do the work.

14. Take a bath or shower and put on clean clothing.

7. Alternatives to pesticides

In connection with the various production methods etc., there are many circumstances where alternative methods of control can be used instead of pesticides.

In considering the potential use of alternative methods, it is important to start by establishing the desired levels of pest and weed control.

It is also important to establish in the planning phase whether or not it is possible to tend or cultivate the areas concerned without using pesticides.

These steps already constitute progress towards reducing the use of pesticides.

The following is a list of the possibilities within the various areas.

Consolidated areas and beds

Weed control

Roads, pavements and other consolidated areas

Mechanical brushes and sweepers or gas burners may be used for weed control. It is also possible to use scrapers or rakes etc. on gravelled areas.

A machine that uses steam for weed control is being developed, and time will tell how effective it is.

Beds

Bark chips or ground cover plants can be used. Mechanical weed control can be used between rows.

Pest and disease control

Pests and diseases are not a major problem, and there is no need to control them.

Forestry

Decorative greenery and Christmas trees

Weed control

It is possible to use mechanical control methods, and also to let animals, e.g. sheep, graze between the trees.

Pest and disease control

Removing old tree stumps, maintaining large populations of small birds, and crop rotation all help to reduce the risk of attacks.

Market gardens under glass

Weed control

Weeds are not a major problem and can be removed mechanically or manually.

Pest and disease control

Experience shows that there is ample scope for using biological control methods and resistant strains.

Garden centres and orchards

Weed control

Weeds can be removed by allowing poultry to graze or by using mechanical means.

Pests and disease control

Pests can be controlled by putting up nesting boxes for tits or similar birds. Diseases can be reduced by using resistant species.

Farms

Weed control

Mechanical means can be used, and gas burners have also proved effective.

Pest and disease control

The use of resistant strains and crop rotation reduce the risk of attack.

8. GLOSSARY

Action period. The minimum time which must elapse between treatment and harvest.

Active substance. The active component of a pesticide.

Additives. Adjuvants which are not part of a product's formulation, but are added when mixing the spraying solution.

Adjustable nozzle. Nozzle which can be adjusted to change the nature of the spray.

Aerosol. Spraying solution which is sprayed through a very fine nozzle using a compressed air source. The droplet size is usually 0.5-5.0 gm.

A-filter. Gas filter (respirator protection against pesticide vapours etc.).

Air chamber. Air-filled container. Regulates the pressure on piston and diaphragm pumps.

Algaecide. Algae killer.

Antagonism. When two products are mixed together and the combined effect is less than if they are used separately.

Belt spraying. Method used to spray a broad belt of crops grown in rows.

Bioaccumulation. Accumulation in humans or animals.

Blank cap. Cap without an aperture which can be placed on or in the nozzle to shut off the flow of solution.

Blanket spraying. Spraying method where the whole of the surface travelled over is sprayed.

Boom section. Specific part of the spray boom.

Border spraying. Method where the border of an area (crop) is sprayed.

Break-even point. Threshold from which the yield resulting from treatment exceeds the cost.

Calibration. Adjustment of the sprayer to give the exact dose required.

CDA sprayer. Capable of CDA.

CDA. Controlled Droplet Application. In practice this means that the size of droplets is more consistent than in the case of ordinary hydraulic nozzles.

Centrifugal pump. A pump in which the solution is propelled by one or more rotating paddle-wheels.

Compressed air nozzle. Air and spray solution are mixed in the nozzle.

Contact agent. An agent which remains on the plant surface (possibly penetrating the bloom). Only works where it is in contact.

Cumulative effect. The combined effect of two or more products.

Deflector-type nozzle. Hydraulic nozzle where the jet is directed against an oblique plate or conical projection.

Degree of cover. The extent to which plants or other objects are covered by the spray solution.

Diaphragm pump. A pump in which the solution is propelled by one or several diaphragms.

Distribution valve. Adjustable valve on which one action can shut off the flow of solution from the pump to one or all spray bar sections.

Dose. The amount of spray agent used per unit of area or volume.

Drift. During spraying in calm weather, small drops may move with the air current away from the crop and travel slowly over long distances.

Drip catch. Fixture for collecting drips from nozzles after the flow to the nozzles has been shut off.

Droplet count. Number of droplets per cm^2.

Droplet size distribution. The percentage or proportion of droplets within specific size groups.

Droplet size. The size (diameter) of droplets in the spray, expressed in gm.

Dual cover. Spraying arrangement where each nozzle covers half the surface covered by the adjacent nozzle.

Dual spray boom. Boom to which two parallel spray bars each with its own set of nozzles are attached, or two parallel spray booms generally with separate sets of nozzles.

Ecotoxicological. Poisonous effect on, and contamination of, flora and fauna (ecosystems).

Eddy chamber nozzle. Hydraulic nozzle producing a conical spray.

Eddy chamber. Chamber inside the nozzle where the solution is swirled up.

Eddy insert. Insert serving to swirl up the solution.

Edge spraying. Spraying the edges of fields and roads etc.

Ejector nozzle. Mixer nozzle.

Emulsion. Two immiscible liquids (e.g. oil and water), where one is suspended in the other.

Fan nozzle. Hydraulic nozzle giving a fan-shaped spray without a deflector plate.

Field spraying. Spraying the ground or plants with pesticides, fertilisers, etc.

Filter system. System of one or several filters to protect both pump and nozzles against impurities in the solution. The individual filters are characterised by their location or function.

Flow gauge. Device to measure the flow of solution in l/min.

Fungicide. Fungi killer.

Gear pump. A pump in which the solution is propelled by two revolving intermeshing gears.

Herbicide. Weed killer.

High-pressure sprayer. Sprayer which works at a pressure of more than 2 MPa (20.4 kp/cm²).

Humus soil. Soil with a high content of organic matter.

Hydraulic mixing. Method of mixing in the tank using the return solution or spraying solution under pressure.

Hydraulic nozzle. Nozzle in which droplets are formed using the pressure of the inflowing solution.

Insecticide. Insect killer.

Installation angle. The angle by which the nozzle axis deviates from perpendicular when the spray boom is horizontal and in its normal working position.

Line filter. Filter which cleans the spraying solution. It is placed at the entry to a boom section.

Low-drift nozzle. Nozzle giving a coarser spray and hence less drift.

Low-pressure sprayer. Sprayer which works at a pressure of less than 0.5 MPa (5.1 kp/cm²).

Maximum limit value. The maximum amount of a pesticide allowed in a specific crop.

Mechanical mixing. Method of mixing in the tank using a propeller or other mechanical device.

Medium volume diameter (MVD). The droplet size where half the solution quantity is atomised in drops of less than MVD and the other half in drops larger than MVD.

Medium-pressure sprayer. Sprayer which works at a nozzle pressure of between 0.5 and 2.0 MPa (5.1 to 20.4 kp/cm²).

Mini-agent. Pesticides where the dose is given in grams (e.g. Expres, Ally, etc.).

Mist sprayer. Sprayer used to produce a fine spray.

Mist spraying. System where the jet produces a mist of small droplets conveyed by an air current.

Mixer. Equipment used to mix spraying solutions in the tank.

Mixing time. The time allowed for the spraying agents to be mixed into the spraying solution (by stirring) before the nozzles are opened.

Molluscicide. Slug and snail killer.

Monitor. Electronic equipment for monitoring travelling speed, area treated, volume of solution sprayed per hectare, etc.

Nematicide. Agent used to kill nematodes (e.g. potato root eelworm etc.).

Nematodes. Eelworms.

Nozzle aperture. The part of the nozzle from which the solution or droplets leave the nozzle.

Nozzle body. The part of the nozzle which holds the nozzle insert.

Nozzle height. Distance between the nozzle outlet and the top surface of the object to be sprayed.

Nozzle insert. The part of the nozzle which determines the nature of the spray.

Nozzle nipple. The short pieces of tube on the spray boom or spray bars where the nozzle body or fitting is attached.

Nozzle spacing. Distance between the nozzle axes measured along the spray boom axis.

Nozzle. Device for the fine dispersal of spraying solution.

Operating fittings. Equipment used to regulate pressure and quickly shut off or open the flow of solution to the nozzles.

Overflow valve. Adjustable valve allowing excess solution to flow back into the tank.

Persistence. Decomposition time in the ground.

Pesticide. Common name for all plant protection agents.

P-filter. Particle filter providing respirator protection against dust.

Phytotoxic. Poisonous to plants.

Pneumatic nozzle. Nozzle in which droplets are formed and transported using an air current.

Pressure tank. Tank intended to be pressurised in order to expel the solution, until the pressure drops to a certain level.

Proportional. If two items are proportional, it means that there is a fixed relationship between them. A proportional pressure setting, for example, involves a fixed relationship between the solution returning to the tank and that flowing to the nozzles.

Pyrethroid. Synthetically produced pesticide which resembles pyrethrum, a naturally occurring insecticide.

Remedial. Helps solve an existing problem.

Repellent. Agent which discourages pests.

Respirator. Half mask or full mask with one or more filters to clean the air for breathing.

Retention. Adherence of spray droplets to plants.

Return solution. The solution which flows back into the tank via the overflow valve.

Risk phrases. Standard phrases describing the risk involved in using a given product.

Rodenticide. Poison used to kill rodents (mice, rats, etc.).

Root agent. An agent absorbed through the plant's roots and then transported through the plant.

Rotation nozzle. Nozzle where the jet is directed against a rotating component.

R-phrases. See risk phrases.

RPM. Revolutions per minute.

Safety phrases. Standard phrases describing the safety regulations for a given product.

Selective. Effective against a specific problem, without harming non-targets (e.g. wild oats in a barley field).

Self-priming pump. Pump which does not need priming.

Solution volume. Amount of spraying solution.

Solution. Spraying solution in which the agent is chemically dissolved to form a homogeneous mixture.

Specific. Targeted.

S-phrases. See safety phrases.

Split spraying. Treatment of the same area several times with small doses of the same agent.

Spot spraying. Method where specific parts of the ground or plant surface are sprayed.

Spray angle. Angle formed by straight lines from the nozzle aperture to the outer limits of the sprayed area.

Spray bar. Tube fitted with nipples for attaching nozzles.

Spray boom. Boom to which the spray bar is attached.

Spray monitor. See monitor.

Spray solution. The diluted pesticide in the form in which it is sprayed.

Spray. Fine spray solution emerging from one or several nozzles.

Sprayer section. Part of the spray bar which can be replaced and/or shut-off.

Spread. Distribution of spray solution from a nozzle by spraying against a surface which is perpendicular to the spray.

Strip spraying. Method used to spray a narrow strip of crops grown in rows or the area between the rows.

Suspension. A solid which is comminuted and suspended in a liquid.

Synergism. Where the combined effect of mixtures of two or more products is greater than the sum of the effects of the individual products.

Systemic effect. An agent which penetrates the leaf surface or roots and is then transported through the plant.

Throttle nozzle. Nozzle with the possibility of regulating the flow.

Toxicological. Poisoning effect on living organisms.

Trapeze suspension. The spray boom is suspended loosely, allowing it to swing with the tractor's motion.

Treated width. The width which is treated satisfactorily, measured at right angles from the equipment’s direction of travel.

Treatment frequency. How many times agricultural areas can be treated with recognised or recommended doses of one or more agents.

Vibration jet. Jet where droplets are formed with the help of a vibrating component.

Working pressure. The pressure maintained in the spraying solution on the pressure side of the pump.

9. INDEX

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