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INSTRUCTIONS FOR SPRAY OPERATORS SPRAYING TECHNIQUE, ENVIRONMENT AND SAFETY

Introduction.

Whether we like it or not, chemicals are used as pesticides to destroy unwanted organisms which are considered to be competing with the interests of mankind and therefore regarded as pests or diseases particularly to crops. Many pesticides are poisonous or harmful to ourselves and/or our fellow creatures in the environment around us.

Nevertheless their use has commercial and other benefits and it is often part of the job for professional workers in rural and other occupations in agriculture, horticulture, forestry, local authorities etc., to use these pesticides.

This book will contain guidelines describing how you can reduce unwanted, excessive and unnecessary use of pesticides. The book is also meant as a tool for all persons who through their work are in contact with pesticides. That is to say, those who deliver the pesticides, those who buy pesticides for companies, those who deal in pesticides, etc.

The book will provide you with a survey of applicable law, some information about handling of pesticides, their action on health and environment, and a lot more.

1. **LEGISLATION,** including EU-rules and national rules

2. **KNOWLEDGE/INTRODUCTION OF CHEMICALS,** including risk assessment and safety regulations

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

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

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

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

1. **LEGISLATION**, including EU-rules and national rules.

Introduction.

Legislation, rules, codes of practises vary a great deal between countries as regards the safe use of pesticides. However European Directives in this area based on the ILO Convention which is generally accepted as the leading authority on health and safety puts forward the view that there should be elimination or reduction of exposure of workers to hazardous chemicals. This is achieved by the following step-by-step process;

1. **Risk assessment**
   There is a duty laid 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 if exposure can be prevented - thus for pesticides, the question is "does a pesticide have to be used at all?". If not, the use of the pesticide can be eliminated.

   Substitution: if a pesticide has to be used, then the least toxic active ingredient or formulation should be substituted.

3. **Control**
   If exposure cannot be prevented by elimination or substitution then the following takes effect:

   Technical and engineering controls should be adopted to reduce exposure. These include closed mixing and filling systems, tractor cab ventilation systems, closed container return systems.

   Operational controls consist of safe working practices to reduce exposure, such as warnings to keep others away, safe stock controls, 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, according to EC Directives.

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

5. Monitoring
Employers have a duty to monitor the effective working of control measures and airborne pollutant concentrations.

6. Health surveillance
Heath surveillance measures should be carried out for certain substances - eg OPs. The employer must make sure that the employee is not exposed to toxic substances when he is spraying pesticides.

7. Record keeping
The employer has to keep spraying records. These records must show the pesticide that has been used, where it was used, in what quantity per hectare, when it was used, and who delivered the pesticide.

8. Information
Employers have to provide employees with information relating to records, training, risk assessments, and product safety data sheets and label information.

9. Training
Training must be provided in control measures, PPE, emergency procedures, and, we would add pest control including non-chemical methods.

Approval of chemical pesticides

Approval of chemical pesticides offered for sale partly takes place on the basis of common EU-rules, partly on the basis of national rules.

The object of the EU-approvals is to coordinate the different rules governing approval in the EU-countries.

These rules are described in Directive No. 91/414/EF with belonging annexes.

Directive No. 91/414/EF has been finished, but not all the annexes have been finished, they are however well on their way.

Before new products can be approved, the product's active substance must have been entered on the EU positive list. All EU-

countries must help deciding whether an active substance should be entered on the positive list or not.

The first positive list must be ready by 1 June 1997;, and it will contain upwards of 90 different active substances (see Annex 1).

As an element of the removal of trade barriers between the individual EU-countries there must be mutual recognition of experiments carried out in the individual EU-countries. This must apply if the experiments have been conducted under conditions which as regards cultivation methods and climate correspond to the conditions in another EU-country.

If a product has been approved in, say, Portugal or Italy, which cultivationwise and climatically has conditions resembling the Spanish ones, it will probably be difficult to refuse approval of it 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. KNOWLEDGE OF HANDLING OF PESTICIDES

Always read the label - make sure it is in your language!

Toxicity classes and symbols

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

Rules governing storage of chemical pesticides

The provisions governing storage of chemical pesticides have been laid down with the object of removing the possibility of inexpert persons consciously or unconsciously getting into contact with the pesticides.

Storage of "Toxic" and "Very Toxic" pesticides.

For storage of toxic and very toxic pesticides it will always apply that they must be stored under lock and key, i.e. in a room or cupboard which is not accessible without the use of a key.

For storage of other pesticides applies that they must be stored, so that they are out of reach for children, and not together with food products, drinkables and feedstuffs. This will in principle mean that these pesticides, too, must be stored in a locked room or cupboard.

When toxic and very toxic pesticides are stored, the room or cupboard must be provided with a warning sign.

It would however be a good idea, if the room or cupboard with the other pesticides were also marked one way or the other.

For chemical pesticides it applies that they must always be stored in their original packing, in other words, the products 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, so that any waste products can enter the sewerage system, but preferably with an underground tank for collecting and safe removal.

If chemical pesticides in connection with the spraying operation are transported out into the field, they must - if they are kept out of sight - be stored in the same manner as in the building, for instance in a "transport box" which can be locked.

Removal of chemical residues and empty packing material

It shall be the responsibility of enterprises within agriculture, forestry and horticulture using pesticides to remove empty packing and any pesticide residues in a safe manner.

Pesticides can be removed in many different ways, but the most important thing is to ensure that removal takes place in an environmentally correct manner.

It may either be done by delivering residues and empty pacing to specialised companies who are experts in removal of toxic waste, or by following the instructions described in the supplier’s directions for use. If it is not a statutory requirement that directions for use have to be supplied, when in doubt ask the producer/importer how the pesticide in question can be disposed of.

Cleaning of empty packing material

Before the packing is removed, it must be completely empty and cleaned. When the spray liquid is prepared, the packing must be

rinsed with three lots of water to get all the contents into the spray tank.

When you rinse the outside and/or inside of strongly polluted packing, it must be done in a place where you are sure that the washings cannot enter sewers, groundwater, streams, lakes, drains, etc.

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

Storage of empty packing material

The empty packing must be stored in the same way as full or partly full packing before safe disposal.

Transport of chemical pesticides

When pesticides are picked up and transported from, say, the commercial storeroom to the building, rules have been laid down establishing how large quantities may be transported without any special precautions, depending on the product's toxicity and/or inflammability.

Exactly how large quantities may be transported must appear from the product supplier' instructions, or the information must be available from the supplier. The allowed free quantity has been established according to ADR, the European Convention governing transport of dangerous goods on highways, and in certain rules laid down nationally.

For enterprises within agriculture, forestry and horticulture it will only in special cases be necessary to transport quantities so large that they exceed the allowed free quantity.

Pesticides must never be transported together with food products, beverages and feed stuffs.

When pesticides are transported in tractors and the like, it is a good idea to have a special lockable box where pesticides can be stored when not used.

Tank mixtures transported in the spraytank are not covered by the above mentioned rules. Unlimited quantities may be transported

here, consideration being given to the size of the tank and general safety precautions.

Sign posting

It is recommended that signs be put up that tell you when spraying has been performed, which pesticide was used, and when there will again be free access to the treated areas.

3. WORKING ENVIRONMENT

Pesticide health hazards

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

A pesticide's acute toxicity appears from the toxicity class in which it is placed and the risk assessment. The risk of some kind of poisoning caused by repeated use of a specific product is however far more difficult to determine 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 illness, partly of the risk of long-term effects, e.g. cancer or an effect on the capacity for reproduction. There may also be an effect on organs, like liver, kidneys, brain or nerve systems.

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 gear and observes the safety precautions mentioned for the individual product.

Health hazard for other persons and/or animals

The health hazard for other persons is mainly the risk of acute poisoning. This may occur when the pesticide is stored incorrectly, e.g. in larders or together with medicine, or when it is poured into another container. Poisoning may also occur when

sprays or spray equipment is left unattended in farmyards or on roads, or when empty, non-cleaned packing is left freely accessible.

Finally pesticide waste 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 paths and symptoms

People and animals can absorb poisonous substances in three ways:

1. through the mouth (oral)
2. through the skin (cutaneous/dermal)
3. through the lungs (inhalation)

Furthermore, the eyes are often exposed, but they are not regarded as proper poisoning paths, as toxic substances to a lesser degree are absorbed through the eyes, but "only" damage them.

Serious, acute poisoning from pesticides is in the vast majority of cases caused by unintentional or unconscious intake through the mouth, and to a lesser extent inhalation or absorption of the substance through the skin.

During the spraying process which both comprises the preparation of the spray and the actual spraying, the spray operator will be exposed to pesticides on his body, i.e. on his bare skin, and on his protective clothing. The spray operator will furthermore inhale the fine droplets, aerosols, as well as pesticide vapours, if any, including any organic solvents.

Studies have demonstrated 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 spray, whereas 10% settles on him during the actual spraying.

During mixing and preparation it is mainly the hands that are exposed, but also the torso, and notably the chest.

When spraying is performed it is also the hands that are most exposed.

To reduce the spray operator's risk of pesticide poisoning, it is possible to use spray equipment with such extra features as filling equipment, hydraulic boom lift, hydraulic retraction of

boom, non-drip valves, self-cleaning filters, tank-rinsing nozzles, and remote control.

A study has shown that the poisoning of the spray operator can be reduced by approx. 75%, when spray equipment with remote control and other extras is used.

The combination of remote-controlled spray equipment with extra features plus correct use of personal protective gear can safeguard the spray operator against unnecessary pesticide poisoning in most cases considerably.

The above mentioned studies comprise spray operators with tractor-mounted spray 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 in the field that has just been sprayed.

U.K. studies have demonstrated that these "knapsack" sprayers result in much greater risk than other equipment. (Also additionally hazardous due to having to carry a considerable weight).

Poisoning symptoms

The symptoms of an acute poisoning depend on the degree of poisoning, in other words, on how large a quantity of poison has been taken and how the poison acts.
A poisoning situation typically starts with general feelings of sickness, but will then develop into more considerable pains (e.g. a headache or a stomach ache), sometimes followed by sweating, slight difficulty in breathing, intellectual confusion and/or a state of unrest/fear. As the poisoning develops, the symptoms are strengthened (and other symptoms may be added), and a severe poisoning may end in coma and death if expert treatment is not offered in time.

Persons who are not completely well and healthy should never work with pesticides, as they may not be able to observe the early symptoms of poisoning, but think they are part of their illness. As a rule poisoning symptoms will be indicated on the product label or in the instructions from the supplier.

Labels and instructions from the supplier should provide information about first aid

First aid

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

If a person becomes the victim of poisoning, it is important that first aid be administered without delay.

First aid is the first, sometimes life-saving aid given after an accident, poisoning or sudden illness. Quick and correct help administered during 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 polluted skin with soap and water
- If the substance has entered the eyes, rinse them promptly with large amounts of water
- Call for medical help

Precise information about first aid will be stated on the product label or in the instructions from the supplier.

When a person is poisoned with "Very toxic" substances, artificial respiration should not be administered by the mouth-to-nose method, but in other ways, for example the mouth-to-mask method, as there is otherwise a risk that the helper may be poisoned.

If a person during or after his work with pesticides becomes ill, a doctor must instantly be summoned. If the doctor is not avalable contact the nearest hospital.

The doctor must know the name of the substance used - therefore bring along the label, the packing or the supplier's instructions.

First aid equipment

The first aid equipment for cases of poisoning is not very extensive. The most important equipment will be an eye-rinsing bottle and soap and water for washing the polluted skin.

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

Choice of protective gear

When chemical pesticides are mixed and sprayed, one should as a rule use personal protective gear and special work clothes.

It is important that the protective gear is used correctly and that it fits the user, so that it will offer the right protection.

Protective gear for cleaning

When the spraying equipment is cleaned, you should use boots, gloves, safety goggles and maybe an apron. If additional protective gear was used during the spraying, keep it on during the cleaning.

If a high-pressure cleaner is used for the cleaning, you should furthermore wear overalls and a half-mask with filter type P2 that can stand liquid aerosols.

The reason why respiratory protection should be used is that dirt and pesticides are released during the cleaning which may float in the air.

Personal protective gear and its quality

When protective gear is chosen, it is not only a matter of selecting the correct protective gear. It is also a question of using protective gear of such a quality that it will offer good and reliable protection during its entire lifetime.

Gloves

Studies show that the hands are most exposed, both in connection with the mixing of the spray and with the actual spraying. Gloves are therefore one of the most important things, especially in connection with mixing where there is a risk of coming into contact with the concentrated chemical.

When you buy gloves, you must draw the glove supplier's attention to the types of pesticides that will be used, to ensure that the gloves purchased offer the best possible protection. In the same way you should enquire, when you buy pesticides, which gloves are suitable for the purpose.

The best possible and most reliable protection is obtained when gloves are used, where the penetration time for the pesticide used is known, and the gloves are then discarded before the stated penetration time has elapsed.

There are however only very few types of gloves where the penetration time for selected pesticides has been examined.

For the 4H glove from Safety Four the penetration time for six selected pesticides has been examined. The examination was made on the undiluted pesticide. The test was stopped after 4 hours (240 minutes).

Benomyl	*> 240*	*Fluazifop-butyl*	*> 240*
Cypermethrin	*> 240*	*Glyphozat*	*> 240*
Diquat dibromide	*> 240*	*Propyzamide*	*> 240*

Table 3.1 shows for the 4H glove the penetration time (min.) for the pesticides tested.

	Nitrile glove	*Chloroprene glove*	*Butyl glove*
Triadimenol	*167*	*175*	*> 480*
Phenmedipham	*> 480*	*223*	*> 480*
Dimethoat	*68*	*36*	*309*
Fluazifop-butyl	*> 480*	*295*	*> 480*
Metamitron	*> 480*	*> 480*	*> 480*
MCPA	*> 480*	*> 480*	*> 480*
Methomyl	*122*	*89*	*> 480*
Fenvalerat	*> 480*	*> 480*	*> 480*

Table 3.2 shows for KCL gloves the active substances whose penetration time (min.) has been examined. (Onsberg 1992).

For the gloves from KCL the examinations have thus been performed on the undiluted pesticide. The examination here lasted 8 hours (480 minutes). The gloves have likewise been examined for the diluted pesticide. After six hours it was not possible to register penetration for any of the pesticides.

The examinations only apply to the KCL gloves, as there is a great difference between the quality of nitrile, chloroprene and butyl rubber, so the examinations cannot be directly related to other glove makers, although their gloves are made of the same material.

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

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

Gloves with holes and tears must be discarded.

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

It will always be a good custom 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 used. If you wear overtrousers or overalls, they should be worn outside the boots, so that you will not get pesticides in your boots.

Thick cotton socks should be worn inside the boots, to ensure that your feet will be dry all the time. The socks must be changed at least once a day. The socks must be washed after having been soaked in soapy water. The boots should only be used in connection with the spraying job, and they should be discarded after the spraying season.

Ordinary trousers must be worn inside the boots, as they may otherwise act as wicks sucking up the pesticide.

Torn boots should not be used.

Protective overalls

The protective overalls must prevent the ordinary working clothes from becoming polluted with pesticides, and it must prevent the pesticide from reaching your skin via your clothes.

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

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

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

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

Make sure that your clothes under the rainwear or overalls are all the time dry, and that you change to clean working clothes every day.

Apron

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

Safety Four, who are also makers of 4H gloves, manufactures an apron of the same material as the gloves. The apron has therefore also been examined for penetration time, like the gloves.

Face screen or shield

The face screen must prevent you from receiving splashes in your face and eyes. It must be transparent and sit properly, and it may also be used together with a respirator.

Safety goggles

Safety goggles must hug your face all the way round your field of vision, and they must be antidim.

Respirator

The respirator may filter the air or supply fresh air. When you work with pesticides, it is often necessary to use some kind of a filter mask. In cases where the work for instance involves a mist generator or mist sprayguns, 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 yourself against both dust and gas, a combined dust and gas filter should be used.
Gas filters are divided up into classes and types where the classes are an expression of the filter capacity and the types indicate the types of 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

If a gas filter has to be used in connection with work involving pesticides, it will almost invariably be a filter of class 2.

The filter type will be indicated with a letter, and as a rule the individual letters will be attached 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 in connection with pesticides.

- filter type B (grey) protecting against chlorine, hydro-cyanic 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 pollution. After that the air pollution will penetrate, but before that happens the old filter must be replaced by a new one.

It must not be possible to smell the pollution. If the mask is correctly adapted, the filter must be changed before you can smell the pollution.

It is recommended to replace any filter at least every month.
Some suppliers are able to calculate the probable lifetime of the filter, when the pollution concentration and the workload are stated. The filter must be exchanged well ahead of the expiry of the calculated probable lifetime.

It is under all circumstances important to check that the respi-rator hugs the face. You can test this by sealing the filter with plastic foil or with your hand. Now check whether the mask keeps an over or underpressure for 10 seconds. You may also check the mask's density by spreading a harmless smelling substance around the mask. Check now whether you can smell or taste the substance inside the mask.

A filtering respirator must only be used for a total of three hours during a whole workingday. The reason for the 3-hour rule is that a filtering respirator is hard on the breathing organs.

If the work lasts more than three hours in one working day, a respirator with blower or auxiliary motor (turbo equipment) must be used from the moment work is started. 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 pollution 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 movements are 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.

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

Upon delivery there must be instructions from the supplier in your own language with information about protective qualities, adaptation, use, maintenance and storage.

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

- P1 (low-effect filter), which only protects against coarse dust. The filter must not be used 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, but which also protects against radioactive dust, bacteria and vira.

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

Cleaning and storage of personal protective gear

After use the personal protective gear 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. The protective gear must always be cleaned after use, also if the work is to be continued the next day.

You must be completely sure that all pesticide residues have been removed from the inside of your boots and clothes. When you wear tight-fitting gloves or boots, the skin becomes warm and sweaty, and hence softer, so that it is especially easy for the pesticides to penetrate. For the same reason you should also be aware of any holes in the 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.

The personal protective gear and the special working clothes must be kept separate from other working clothes, so that they will not become polluted with pesticides. The protective gear and the special working clothes must not be stored together with the pesticides.

Personal protective gear that has been used in connection with the mixing operation and which is not to be used for the spraying must not be placed in the tractor's cab, but stored in a closed box on the outside of the tractor.

Supplier's instructions + Safety data sheets

Suppliers of pesticides must ensure that they are accompanied by easily understood instructions when delivered. The supplier's instructions must contain a number of specific items, if this is technically possible.

As a rule supplier's instructions have to be worked out for all pesticides that have to be classified, in other words, the pesticides that are marked with orange-coloured danger symbols.

Furthermore there must be supplier's 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 danger classes 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 during the work with these pesticides.

Requirements are only made to the contents of the suppliers instructions, not to the wording of them. They may be shown on the label or delivered on a separate piece of paper.

The reason is that the EU-Commission has adopted a Directive concerning harmonization of laws and rules governing dangerous substances (preparations). This Directive also makes demands concerning the preparation of supplier's instructions (safety data sheets).

Contents of the supplier's instructions

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

1. **Identification of substance or preparation and of company or enterprise.** Stated here are the pesticide's trade name, type of pesticide and the product registration number and/or the Environmental Protection Agency's registration number. Also stated are the name, complete address and telephone number of the company responsible for the marketing. Name and telephone number of any advisers referred to, and possibly of the Poison Information Centre of the State University Hospital. The toxicity class of the pesticide must likewise be stated under point 1.

2. **Composition of information about ingredients.** Information must be provided here which makes it possible for the user to establish which hazards are connected with the pesticide in question. There must also be information about the contents of solvents and carcinogenic substances, if applicable.

3. **Danger identification.** The greatest dangers of the pesticide must be stated here, also the greatest risks to persons and to the environment. The most serious harmful effects to peoples' health and symptoms that may occur during use and abuse that it is reasonably easy to foresee must likewise be

described. Long-term harmful effects, if any, must also be mentioned here.

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

5. **Fire-fighting.** Information is provided here about fighting of fires that have started in the pesticide concerned, including suitable fire-fighting appliances, development of toxic gases and requirements to personal protective gear in connection with the fire-fighting operations, if applicable.

6. **Precautions against accidental spillage.** Stated here is the possibility of reception of spilt pesticides, and how waste and residues, if any, are removed.

7. **Handling and storage.** Requirements concerning storage of the pesticide in locked cupboard or pesticide store, including marking of the cupboard or store must be stated here.

8. **Exposure control/personal protective gear.** A description is given here of the personal protective gear that must be used during the various phases of the spraying. When personal protective gear is selected, reference will often be made to the National Labour Inspection's instructions "Safety and Pesticides" or to the Trade Safety Council for Agriculture's instructions regarding choice of personal protective gear.

9. **Physical and chemical properties.** Information is provided here about the pesticide's physical and chemical properties, also its appearance, smell and a number of other qualities.

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

11. **Toxicological information.** A description is given here of the toxicological effects (health hazards) that may arise, if the user gets into contact with the pesticide.

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

13. **Removal.** Here it is stated how residues and empty packing have to be removed.

14. **Transport information.** A description is given of the precautions the user must be acquainted with and which must be observed in connection with transport or conveyance, either within the company's area or outside it.

15. **Information about regulations.** Information is provided here about the pesticide's classification, R clauses and S clauses, content of substances that have to be marked etc., as well as any other Orders the pesticide may be covered by.

16. **Other information.** Here there is information about the necessary training, e.g. requirements for spraying certificates. Recommended use and limitations, and restrictions, if any, for young persons under the age of 18.

Workplace instructions

It is the employer's responsibility that employees working with pesticides have access to information about the dangers that are connected with the use of them, 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 supplemented with some company-specific information.

The workplace instructions must be regarded as a supplement to the employer's obligation to provide instructions. According to the provisions it is however quite clear that these instructions cannot replace the obligation to provide instructions.

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

Some suppliers have made room for the addition of company-specific information, and the supplier's instructions are thus changed into workplace instructions.

The 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 the application.

2. **Application limitations.** This is where the company's own limitations, if any, regarding the use of the pesticide must be stated.

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

   If the company does not have own additional limitations, write "no additional limitations".

3. **Requirements concerning special training.** The instructions in the catalogue contain the requirements, based on legislative provisions.

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

4. **Precautions for handling of the pesticide.** The company must indicate where the personal protective gear is to be stored, and in which way the protective gear is to be made available to the employees.

5. **First aid.** The companies must indicate the type of first aid equipment found in the company, and where this equipment is placed.

Availability of workplace instructions

The workplace instructions must be accessible to the employees, and they should be placed in a central place, e.g. in connection with a staff room or the like. It will often be a good idea to place the instructions near the poison cupboard or the poison room.

Implementation of spraying

From the working environment point of view, work with pesticides must be planned and arranged, so that it can be carried out in a manner which does not in any way jeopardize safety and health. Before the actual spraying is commenced, the danger of the

pesticide must be assessed on the basis of the label and the workplace and supplier's instructions.

Special precautions before spraying is carried out

Before you start delivering pesticides it must be ensured that there are no other persons in the areas where the pesticides are to be delivered. In greenhouses it furthermore applies that no one else must be in the house that is to be treated with pesticides. If other persons have to be in the area or in the house at the time pesticides are delivered, they must use the same personal protective gear as the spray operator.

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

If this is not possible, they must be reported unfit for work.

Testing of spray equipment

Before spraying is commenced the spray equipment must be tested with clean water. In this way you avoid getting in contact with the pesticide, if it should be necessary to change nozzles, or if there should be any leaks at hoses and joints.

Preparation of spray material

Mixing and preparation of sprays should take place outdoors or in well-ventilated rooms. Tools used for the mixing and preparation must be cleaned immediately after use, and they must not be used for other purposes.

One should not prepare larger than necessary quantities of spray. Preferably there should be no remnants left in the tank when the required area has been sprayed. It must be possible to spray all the mixture the same day.

Do not prepare more spray than required

When the mixing has been accomplished, remove the empty packing so that it is not accessible to children etc. (read the section on

removal of chemical residues and empty packing). A filled spraying machine must never be left unattended.

Implementation of spraying

Outdoor spraying should not be carried out, if there is too much wind or if there is a risk of spray drift, so that the spray mist drifts towards the neighbouring crops, hedgerows, neighbour's gardens, footpaths, waterways etc. When spraying is performed along property lines and roads, one must also ensure that the spray mist does not drift over the road, so that it may constitute a danger to pedestrians and motorists.

Beware of exhaust fumes with combustion engines in confined spaces like e.g. mushroom sheds and greenhouses.

Precautions against malfunctions

If there is malfunction in connection with the spraying of fields and it is 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. When malfunctions are remedied, the risk of direct contact with the pesticide is great, and you must always wear gloves.

Avoid contact with the spray

If there are malfunctions with a mist generator operating automatically inside a greenhouse, you must, prior to entering the greenhouse to remedy the defect, put on your personal protective gear and ensure that the machine cannot inadvertently start during the repair.

Cleaning of spray equipment

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

Remnants of spray allowed to dry up may be very difficult to wash off. The spray equipment must therefore be cleaned as soon as the spraying has been finished. If this is not possible, the spray equipment must at least be rinsed thoroughly or filled with water, and left with the water until it can be cleaned.

The rinsing water must not run into sewers, drains, village ponds, water courses, wells, and so on. If need be, it may be spread on a crop where this is allowed, 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 through which the water may make its way to wells and drains.

Please note that there are special cleaning procedures for certain pesticides which are mentioned on the label.

Personal hygiene

It is of course important that the personal protective gear is in order, but it will only offer real protection if the use of it is combined with a degree of personal hygiene. This applies, in particular, if you work with pesticides that can penetrate your skin.

Take a bath and change clothes EVERY day

The personal hygiene means that you wash your hands and face and take off your work clothes before eating, drinking or smoking.

If spray is spilt on your skin, immediately wash the polluted place with plenty of soap and water. Polluted clothes should also be removed and washed as soon as possible. This is one of the reasons why you should always bring along clean water and soap, when you are working in the field.

When the spraying has been completed, you should take a bath and put on clean clothes. It is also necessary to make sure that the work clothes are washed, so that you can be sure that you are not putting on polluted clothes when you start working.

Hands must be washed prior to visits to the toilet and after.

4. CHEMICALS

Types of pesticides

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

Plant protection products = pesticides

To agriculturists pesticides are as a rule identical with plant protection products, and they constitute the majority of all weed, fungus and insect killers.

The best known and most used pesticides are **weed killers** (herbicides), **fungus killers** (fungicides) and **insect killers** (insecticides).

Insecticides not only comprise chemicals against insects and mites on plants, but also against pests in houses, in storerooms, textile, chemicals against insect pests in timber and woodwork, etc.

Growth-regulating substances are growth-inhibiting, root-promoting, sprout-inhibiting, flower and fruit-producing chemicals etc. Examples include Cerone or Cycocel (CCC) which in agriculture is used for grain crops to shorten and strengthen the straw and thus prevent lodged corn. CCC is furthermore used in fruitgrowing as a regulator of the number of flowers, and hence of fruit.

Other groups include chemicals against **nematodes** (nematicides), e.g. chemicals against the potato root eelworm or **chemicals against rodents** (rodenticides), e.g. chemicals against rabbits, water voles, moles, rats and mice.

There are also **deterrents** (repellants), i.e. pesticides serving to prevent vermin damage by keeping them away from places and crops where they can couse damage.

The **biological chemicals**, which are above all used in horticulture, are subject to the same laws as the other chemical agents.

The chemical agent concept comprises many other chemicals (e.g. against algae growth, soil desinfectants, etc.)

Pesticides and their function

Systemic chemicals and contact chemicals

Systemic chemicals are absorbed by the plant and transported round with the sap flow

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

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

Contact chemicals stay on the plant surface and only act where they hit it. They may be able to penetrate the wax layer. This makes good covering of the plants particularly necessary, when you use contact chemicals. Maneb, mancozeb, sulphur and pyrethroids are typical contact chemicals.

Climatic influence

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

Temperature and air humidity

Both the temperature and the air humidity can have a great influence on absorption, transport and effect of the pesticides. In general, the effect of the pesticides is increased at high temperatures and high air humidity.

Rain

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

Spraying in the morning or evening is recommended because this is more comfortable and safer for the operator.

Wind

Wind during spraying is unwanted. Partly it causes a drift which may harm the neighbouring crops, partly it affects the settling of the spray on the plants, and the evaporation from the leaves is increased.

Duration of chemical action

The duration of the action of the chemicals depends on the pesticides decomposition time, but also to a wide extent on the circumstances under which they are used.

Formulations

A pesticide consists of one or more active substances, and a solvent or other derivatives. 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 you should treat the chemical for your own safety.

Also for special purposes there are **fumigants** in many forms, partly for use in greenhouses, partly for use in subterranean passages made by rodents or moles.

Adjuvants

The producers use many different kinds of secondary materials to ensure that the pesticides do not change during transport, storage or use and to improve their effectiveness.

In liquid pesticides the solvent is important. It may amount to more than half of the product. Formerly the solvent was very often an organic solvent, but now that we have become aware of the unpleasant effects of these solvents, we have to a growing extent gone over to water-based products.

Dispersing agents or **gel substances** are added to the products to make them durable, i.e., to ensure that the active substances under normal storage conditions will not be precipitated, and that when diluted with water they will not precipitate and settle like 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 likewise 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 sprinkling and for suspension in water, the active substance is mixed with a so-called **carrier** which often accounts for a very large share of the product. Most often they are fairly harmless substances, like lime, silicic acid, talc, clay, and the like.

These substances are however dusty, and the products may therefore be unpleasant to work with. Spray powders and granulates for suspension in water all contain **moistening agents** that facilitate things when they are stirred in water, and thus help ensuring a homogenous distribution in the spray liquid.

Additives

To improve the effect of the pesticides and as all products cannot stand the required amounts of derivatives in the actual formulation, you may have to add additives when you mix the spray. These may either be products containing surface-active substances, or they may be oils, mineral or vegetable oils. These products are also referred to as spreaders.

Dispersion agents

The surface-active substances have an emulgating effect and influence the liquid'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 to the leaves, as more drops stick to them, and both these factors may help increasing the penetration into the leaves, so that lower dosages perhaps can be used.

Penetration oils or spreading adhesives

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

Penetration oils and other additives should not be added, unless it is recommended in the instructions

Mixing of products - compatibility

From the instructions on the label it will appear which other products the chemical in question may be mixed with.

If you mix other products than the recommended ones, this may cause serious unwanted effects or damage.

The stability may be changed when pesticides are mixed. But there may also be reactions between the active substances and between an active substance in one product and one or more additives in another.

Explanation of some toxicological expressions

Term	Explanation	How
LD-50	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 most often rats).	The value is established during short experiments, where large doses are administered, often in the in the form of direct injections.
O-effect	Indicates the level (dose) value where the experimental animals have shown *no changes*, despite a lengthy intake(often up to two years). All inner organs are examined for changes.	The value is established by means of lengthy feeding experiments with small doses, often added to the feed or to the drinking water.
ADI-value	The acceptable daily intake for human beings, if they take the relevant substance during their entire lifetime. This value is used, when the *limit value* for residues in foodstuffs is calculated.	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. Harvest in this context may also be: hay harvest, cropping, laying in swaths, gathering or picking.	The time is established on the basis of breakdown curves.

Chemical	**LD-50 value mg/kg body weight**
Dimethoat	400
Ripcord	251
Parathion	7
Roundup	5,000
Table salt	3,000
Aspirin	100
Caffeine	190

This table shows examples of the LD-50 value of certain pesticides; the lower the figure, the greater the toxicity, ***The Greater the Danger.***

To compensate for the uncertainty that always exists, one must evaluate the effect on human beings based on the effect on animals, and as "human beings" must comprise both children and adults, sick and healthy, young and old, a safety factor is used which as a rule is 100, but in a few cases right up to 1000.

ADI - the quantity of a chemical a person can eat every day during his whole life without being hurt

This value is used by the authorities for establishing a maximum limit value for the active substance in the crops where the substance is allowed. In such calculations it is considered how large a part of an average person's daily fare is constituted by the crop concerned, in other words, residues in grain, potatoes, apples and similar much-eaten food products must be considerably smaller than in chives, parsley and the like which are only consumed in small quantities. The maximum limit values are stated in mg chemical per kg crop.

Maximum limit value = the maximum amount of a chemical that may be found in a given crop

Maximum limit values have also been worked out in the EU in order to prevent trade barriers, as it has been known that certain countries have consciously established very low limit values to be able to return imported goods, whereas they were not quite so anxious to analyse the domestically produced goods.

***Action period**. The time that has to elapse from spraying to harvest*

The **action period** is the period of time that has to elapse from the crop is sprayed and until the crop can be harvested. Harvest in this connection means combine harvesting, swath-laying, cropping, picking and collecting.

The **action period** will almost always be made as long as technically possible to ensure that there will not be too large residues in the food.

The smooth surface of tomatoes helps ensuring that the action period is as a rule only a few days. Although black currants also have a smooth surface, they have a capacity for absorbing foreign substances, and they therefore require a much longer action period, as a rule 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 products toxicity, but first and foremost depends on the substance's breakdown time in or on the plants. There are some very poisonous products with an action period of 0 to 2 days, and 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 food products or feed-stuffs, and if the term is not adhered to, the user may be punished.

Re-entry in greenhouses

In connection with delivery of pesticides to greenhouses it must be ensured that no one but the spray operator is in the house. If others have to be in the greenhouse when spraying is performed, these persons must have the same personal protective gear as the operator.

When crops are treated in greenhouses, there is another safety aspect, namely when the air will again be free from chemical residues, so that work with the plants can be resumed without the use of protective gear.

These re-entry problems have still not been resolved, because the conditions differ so much from greenhouse to greenhouse, and only for very few products has it been determined when it will again be safe to work with the treated plants.

Spraying from planes

A description will now follow of the special circumstances applying in connection with spraying from planes.

5. ENVIRONMENTAL IMPACTS FROM THE USE OF PESTICIDES

Introduction

There is wide-spread concern, both in agriculture and in society as a whole, over the use of pesticides. The reason is that they are often pesticides which are also poisonous to other living organisms than the weeds, the pests or the fungus we want to destroy.

How can we assess the environmental impacts?

It is not possible to give a true presentation of the environmental risks when pesticides are used. However, we have a

lot of information about the individual substances, and about how the environment has been effected in recent years.

I. Pesticides in the environment
- a) Decomposition
- b) Pollution of foods
- c) Pollution of surface and groundwater

II. Environmental impacts
- a) Impact on wild plants in the fields
- b) Changes of 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

A certain lifetime for the pesticides on the plants or in the ground is often a requirement. The reason may be that the crop must be protected against attacks during a certain period, or that there must be no weeds on the ground 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 organ-isms living in the ground or a subsequent crop. There may also be a risk of such residues being washed into the groundwater. There is at any rate a greater risk of unwanted effects from chemicals that decompose very slowly.

It is therefore important that the pesticides disappear when they have produced the required effect.

The most important reason why the pesticides disappear is that some of the millions of bacteria and fungus that live in the ground can break down the pesticides, 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 fungous tissue, and in the surface soil of one hectare there may be between 4 and 8 tonnes of these micro-organisms.

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

When a field is treated before with one of the herbicides referred to as hormone agents, there will be more of the organisms which can break down this particular agent.

Breakdown of the MCPA hormone is therefore faster in soil which has earlier been treated with MCPA, because there are now more organisms that can break down the chemical. You might say that the soil has been "enriched" with these specialized micro-organisms.

Most pesticides are however very difficult to break down. Although it is true that there are micro-organisms capable of breaking them down, the micro-organisms cannot live on these pesticides. In other words, there will not be an increase of those particular organisms in the treated soil.

For the pesticides that are broken down slowly it must be assumed that the soil is only able to break down a limited amount of spray per hectare. Great caution must therefore be exercised, both as regards observance of the dosage and avoidance of spray overlapping if we wish to avoid that the field's organisms are exposed to the substance for a long time or that the chemical will damage the subsequent crop.

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

Decomposition of pesticides

The expression "persistence" is both used for indicating the resistance and for showing how long a substance remains active in the ground, e.g. how long it can damage a subsequent crop.

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

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

Risk of pollution of food products

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

To protect the consumers against this risk, the Environmental Protection Agency establishes rules for the pesticides that may be used, and how close to the harvest they may be used for different crops.

Observe the spraying times indicated on the label to avoid excessive residues of pesticides in the crop

To make sure that the rules are observed, market control is carried out. 1,500 to 2,000 samples for consumption are analysed each year, and samples have been found in which the limits established for pesticide have been exceeded.

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 keep the residues as small as possible by limiting the number of spraying operations.

Pesticides in atmosphere and precipitation and risk of drift

When pesticides are used, they may also damage the areas situated outside of the sprayed field.

Spray damage for instance frequently occurs in hedges, gardens or greenhouses that are situated next to the sprayed fields. Such damage most often occurs near grain fields sprayed with hormones in the spring (MCPA, dichlorprop etc.). There may also be serious damage to sensitive crops in the vicinity. The so-called drift damage is chiefly caused by weed killers drifting with the wind when they are sprayed. The problem is particularly serious when spraying is done with fine drops (mist) and when it is blowing during the spraying. Most of this local damage can be avoided, if a bit of consideration is shown. It is important to avoid such damage, both because it can cost huge sums in compensation and because it often gives rise to understandable strong reactions from the garden owners etc.

Water pollution with pesticides

In recent years it has come to light that pesticides may also be found in groundwater, drain water, water courses and lakes, and a few cases of serious pollution of wells and streams have been noted. Chemical pesticides do not belong in the water, and strict rules have therefore been established to avoid residues in

drinking water. Some of the organisms living in streams and lakes are very sensitive to certain pesticides. So there is every reason to protect the water environment.

In the EU-countries there may for example be max. 1 µg (microgramme) of pesticide per litre. This corresponds to 1 gramme of pesticide in 10,000 m^3 of water, i.e. 1 gramme in a 1 hectare large basin which is 1 m deep. These rules have been established because we want to avoid water pollution with chemical pesticides, herbicides, insecticides, etc.

Pollution of surface water

During spraying the pesticides may end up in streams and lakes, either as a result of drifting or because the spray boom gets too close to the water. We may also see water pollution caused by rinsing of spray equipment. There may also be percolation from the sprayed fields, if there are heavy downpours right after the spraying.

Avoid spraying near streams and lakes, also be mindful of wind drift and surface run-off

Measurements made in streams, lakes and drain water demonstrate that we will often find small residues.

If we generally wish to reduce the risk of lakes and streams being polluted with pesticides, this can best be achieved by keeping a distance from lakes and streams when spraying is performed.

Prevent rinsing water from the spray equipment or water used for washing the sprayer and the tractor from running into drains and subsequently end up in the water courses. A grass-covered area is a very suitable filter for rinsing water. Better still is a concrete washing site with underground tank where the water is collected and sprayed on a safe area.

Pollution of groundwater

Sources of pesticide pollution of groundwater

Pollution of groundwater can take place in many different ways.

- Direct pollution of wells and borings
- Washout from sites used for washing tractors and spray equipment

- Washout from public dumping grounds and from small private refuse dumps
- Washout from sprayed-out pesticides
- Washout from particularly vulnerable areas (railways etc.)

Pollution with pesticides of wells and borings occur regularly. The risk is particularly great, if you fill, rinse or wash the spray equipment near wells and borings, or spraying against weeds has been done near wells. The pollution may also be serious because the quantities involved may be very large. The pollution may also have serious hygienic and economic consequences, for example if the pesticide has spread in the groundwater. If the water supply network has become polluted, rinsing with very large amounts of water may be required, before the water's pesticide content is once more below the limit value for drinking water.

Precautions against pollution of wells

- Filling of sprayers with pesticides must not take place near wells and borings
- Rinsing and cleaning of spray equipment must not take place near wells and borings
- The 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 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 and borings
- Make sure that well covers fit tightly, and avoid that water can run from the sprayed ground and into the wells

Pollution from washing and filling sites

Filling of spray tanks and washing of spray equipment often take place at the same site year after year, because there is easy access to the water supply here. Pesticides from washing of the spray equipment and from surplus amounts of diluted pesticide often end up at these places and may cause very high concentrations in the ground. If there are drains from the washing site, there have been examples of poisoning of water courses.

To limit the risk of washouts of pesticides from washing and filling they have special sites for this purpose in Sweden. These partly increase the decomposition of chemical waste, partly increase the adsorption. It is therefore built with a driving ramp

placed on top of a 50 cm deep excavation lined with clay and filled with a mixture consisting of 50% cut straw, 25% peat litter and 25% humus-containing soil. The area called "biobädd" is sown with grass.

Remember that pesticide residues in the spraytank must be diluted and sprayed on the field. There must be no drain from the washing site, so that rinsing water can run into streams and lakes. It is therefore best to collect these washings in an underground tank for safe disposal.

Chemical waste

Formerly there was no efficient way for farmers, gardeners, owners of tractor stations and others to get rid of chemical waste, whether in the shape of pesticides, oil, paint rests or organic solvents. Many private refuse dumps have therefore been established in small gravel pits or marlpits where all kinds of waste were deposited. This is now considered highly dangerous and usually illegal.

Remember that chemical waste must now be delivered to the municipal reception facility; if this is allowed by the local authorities.

Influence of pesticides on plants and animals

The purpose of the spray is to eliminate unwanted fungus, insects or plants. The question is only how hard hit the species are that it was not the intention to touch, and whether the effect becomes unacceptable, e.g. because plant species are wiped out, or because birds or predatory insects are injured 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. There is in other words a kind of natural biological war raging in the fields. When you fight pests with insecticides, you may also injure the beneficial animals, and fungicides and herbicides may reduce the effect of the beneficial animals.

Distribution of beneficial animals may often replace pesticides in greenhouses = biological control.

A study of the effect of 84 different pesticides on certain predators showed that most of the insecticides used today not only kill the pests, but also many of the predators. Only a few of the fungicides had this effect, whereas half of the examined herbicides had a strong impact on the predators. To obtain the most effective natural control possible we are interested in using substances which are as gentle to the benefical animals as possible.

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

In greenhouses you are often offered advice today as to which pesticides will be gentle on the beneficial animals, and attempts are made to make new insecticides specific to the pests, in order to go easy on the beneficial animals. It is also a widespread practice to distribute beneficial animals which can handle the control of pests without any use of pesticides. Encarsia formosa against white flies in tomatoes, for example.

Substances which are gentle to beneficial animals in greenhouses: torque, applaud and bacillus preparations

Earthworms is another of the groups of animals in the ground we wish to protect. A number of pesticides have turned out to be poisonous to earthworms. Information is therefore requested about the toxicity of new pesticides to earthworms, before they are approved.

Pests

The purpose of a treatment with insecticides is to reduce the population of pests so that it no longer constitutes an economic burden to the farmer. We neither can nor will exterminate the pests, but as mentioned above, the beneficial animals are also affected during spraying, and it might be feared that better conditions were created in this way for the surviving pests than if there were no spraying.

The soil's micro-organisms

Bacteria and fungi in the ground are important for the decomposition. Chemical sprays may influence the number of different fungus species in the ground, but the pesticides do not appear to damage the decomposition

Impact on the life in streams and lakes

The most serious damage to animal and plant life has been found where the water from emptying or rinsing of spray equipment has been discharged into a stream via the sewer system. The concentration of spray liquid moving along in the water can cause serious damage to the water course. The pollution resulting from drift and run-off of recently sprayed fields or from washout to the drain water will normally be much lower, but may in some cases have an impact on the water course. For some insecticides it has been found, for example, that even very low concentrations of them can damage the fauna when sensitive animals float along in the water to escape the pollution.

The worst pollution is caused by filling, emptying and rinsing of spray equipment

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

6. SPRAYING KNOWLEDGE

Having taken account of all you have read up to this point; now is the moment for the actual spraying of the pesticide. Presumably the employer (the boss) or someone else in authority has decided that spraying a pesticide is necessary after all!

However in many countries it is now a legal requirement to be properly trained in the use of pesticides and to have passed an examination or test resulting in the possession of a certificate before a person is allowed to handle pesticides. In addition there is usually a minimum age, often 18, before a worker is allowed to use 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 available that could be equally effective?

3. What about the safe period before harvesting?

4. Are the conditions right for spraying?
   Wind - rain - hot - cold.

5. Is the equipment in good working order without leaks and danger of split pipes?

6. Are the right nozzles fitted for the job?

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. Are all domestic animals, including bees, as much as practicable, prevented from entering and re-entering the area.

9. Estimate, better still, calculate, how much material is needed to do the job so you do not end up with unwanted spray material.

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

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

12. After applying the pesticide clean all equipment and machinery thoroughly, including your protective clothing.
    Lock away the remaining chemicals in the safe store room.
    Dispose of empty containers properly.
    Record/write down; what you have done; i.e. what area and crop was treated; which chemical was used and how much and how long it took to do the work.
    And now have a bath or shower and put on clean clothing.

7 ALTERNATIVES TO PESTICIDES

Within the various production methods, etc., there are many circumstances where alternative methods of control could be used instead of pesticides.

If one wishes to examine the potential use of alternative methods compared to pesticides, it is important to start by establishing the desired pest and weed control levels.

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.

If this is taken into account, a major step will already have been taken towards reducing the use of pesticides, and from this point it is very simple to avoid their use at all.

Here 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 may be used, or gas burners, for weed control. It is also possible to use dragnets, rakes, etc. on gravelled areas.

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

Beds

Bark chips or ground cover plants may be used; mechanical weed control can be used between rows.

Pest and disease control:

These are not the major problem, and there is therefore no need to control them.

Forestry

Decorative greenery and Christmas trees

Weed control:

It is possible to use mechnical control methods and to use animals, e.g. sheep, to 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 the major problem and so they can be removed mechnically or manually.

Pest and disease control

Experience shows that there are many opportunities for using biological control methods and resistant strains.

Garden centres, fruit and berry orchards

Weed control

Weeds may be removed by releasing poultry to graze or by using mechnical means.

Pests and disease control:

Pests may be controlled by putting up nesting boxes for titmice or similar Diseases may be reduced by the use of resistant species.

Farms

Weed control

Mechanical control may be used, and gas burners have also proven effective.

Pest and disease control

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

8 LITERATURE

9 EXPLANATION OF WORDS