Food and Agriculture Organization of the United Nations

Practical Guidelines on pesticide risk reduction for locust control in Caucasus and Central Asia

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ABBREVIATIONS

AChE	Acetylcholinesterase
ADR	European Agreement concerning the International Carriage of Dangerous Goods by Road
ASDC	Automated System of Data Collection
CA	Carbamate
CCA	Caucasus and Central Asia
EC	Emulsifiable Concentrate
GHS	Globally Harmonized System of Classification and Labelling of Chemicals
GIS	Geographic Information System
FAO	Food and Agriculture Organization of the United Nations
HDPE	High Density Polyethylene
L	Litre
MRL	Maximum Residue Limit
NN	Neonicotinoid
OP	Organophosphate
PPE	Personal Protective Equipment
PRG	Pesticide Referee Group
PVC	Polyvinylchloride
PY	Pyrethroid
SC	Soluble Concentrate
UL	Ultra Low Volume (formulation)
ULV	Ultra Low Volume (spraying)
WHO	World Health Organization

A INTRODUCTION

1 OUTLINE OF THE GUIDELINES

Large amounts of insecticides are used for the control of locusts in Caucasian and Central Asian (CCA) countries. Generally, these are broad-spectrum chemical insecticides, such as pyrethroids, neonicotinoids and organophosphates, which may pose a risk to human health and the environment. Locust control units in CCA countries have a history of taking a variety of measures to reduce these risks. However, increasing public scrutiny with respect to health and environmental impact of pesticides, stricter national regulations and a more extensive international policy framework, demand continued improvements of locust control operations.

These guidelines discuss the risks of insecticide handling and use during locust control campaigns, as well as measures that can be taken to minimize those risks. The guidelines follow international best practices as well as experiences of FAO with locust control in other geographical areas. The document also take into account the realities of locust control in the CCA region.

The guidelines target three types of staff in a locust campaign:

1 Decision makers and campaign organizers – i.e. senior staff in the locust control unit – who require guidance on organizational aspects of risk reduction before, during and after the control campaign;
2 Locust control staff – i.e. control team supervisors, pesticide applicators, drivers, store keepers – who require guidance on best practices and risk reduction measures mainly during the control campaign;
3 Monitoring staff – i.e. from specialized human health and environmental monitoring teams – who need guidance and best practises for the monitoring of insecticide application, efficacy, human health and environmental aspects of locust control operations.

In many cases, the advice provided in this document applies to all three target groups. However, the implementation of risk reduction measures will different between these groups.

The Guidelines are broadly structured following the main stages of a locust control campaign. After a general introduction, the risk reduction measures that should be taken during the preparation of the campaign are first discussed. These include insecticide selection, updating contingency plans, ordering of personal protective equipment, organization of monitoring of human health and the environment and training.

The second main section describes the environmental and health risks that may be encountered during locust control operations, as well as measures to reduce those risks. Insecticide transport and storage, use of PPE, insecticide applications, empty container management, and monitoring of human health and environmental risks are covered, among other topics.

Finally, the third section, discusses activities that should be conducted after the end of the control campaign, such as management of empty containers and remaining pesticides, or follow-up to monitoring.

The Selected References at the end of the document provide links to more in-depth guidance on various topics that are discussed in these guidelines.

2 PESTICIDE RISKS IN LOCUST CONTROL

HUMAN HEALTH RISKS

All the insecticides that are used in locust control pose some risks to human health, although certain products are less hazardous than others. In these guidelines a distinction is made between persons that may be exposed to insecticides because they work in the locust control campaign (occupational risks), because they are present close to locust control operations (bystander risks), or because they consume food or water that could have been exposed by insecticides.

OCCUPATIONAL RISKS

Field staff who are directly involved in handling the insecticides and spraying locusts tend to be the most exposed to insecticides, and thus also run the highest risk of being poisoned. However, it is important to realize that almost all other field staff can also be exposed either accidentally or during the normal course of their work (see Fig. 1 and Box 1).

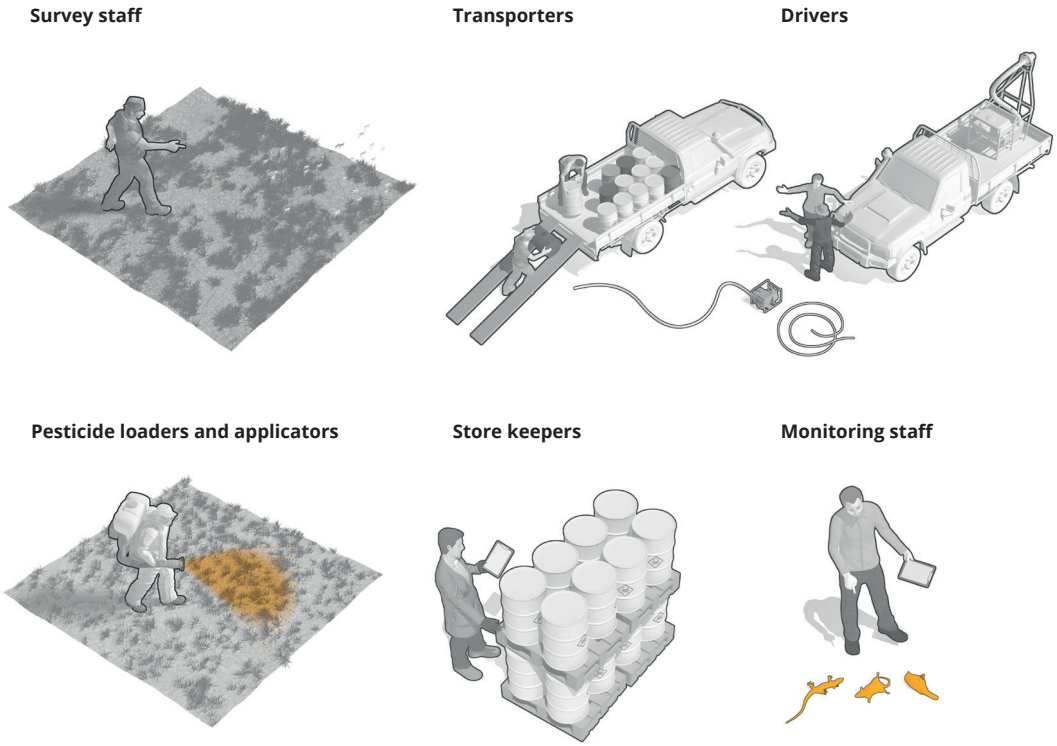


FIGURE 1. **DIFFERENT LOCUST STAFF MAY BE EXPOSED TO INSECTICIDES DURING THEIR WORK**

BOX 1. HOW LOCUST CONTROL FIELD STAFF MAY BE EXPOSED TO INSECTICIDES

How?	When? (this list is not exhaustive)
Backpack, hand-held or vehicle-mounted application	• re-entry into spray cloud (variable wind direction) • Insufficient distance between applicators • leaking or contaminated spray equipment • contaminated vehicle
Aerial application	• entry of pesticide into cockpit (leak in hopper or tubing) • re-entry into drifting spray cloud (variable wind direction) • contaminated aircraft
Mixing and loading	• splashes or leaking spray equipment • leaking or bursting loading equipment or tubing
Storage	• leaking or contaminated container • fire or explosion • vapours of insecticides or solvents
Transport	• leaking containers (transport over rough terrain) • contaminated vehicle
Calibration	• splashes during collection of spray fluid • contaminated equipment, vehicle or aircraft
Monitoring	• entry into sprayed area • collection of sprayed soil, water, vegetation or animals
Survey	• contaminated vehicle (if the same vehicle is used for survey and control activities)

Therefore, when evaluating human health risks during a locust control campaign, the practices of all staff who may come into contact with insecticides should be reviewed. Only then can a complete occupational risk reduction plan be established.

Bystander risks

Shepherds, farmers, inhabitants of villages close to areas to be treated are normally instructed to keep a safe distance from the spraying and avoid re-entering the treated area immediately after the insecticide application. However, sometimes these instructions are not respected or excessive spray drift occurs, and such bystanders could be exposed to the insecticide (Fig. 2). Proper precautionary measures should reduce the risk of bystander exposure to a minimum.

Consumer risks

When crops are treated for the control of locusts, pre-harvest intervals need to be respected to ensure that insecticide residues do not pose a risk to consumers. Similarly, drinking water sources should never be over-sprayed. However, if such measures are not respected, risks to consumers may ensue (Fig. 2).

Consumer exposure
Drift onto crops - residues in food - residues in drinking water - expsoure of livestock

Bystander exposure
insecticide spills - drift - entry into sprayed areas - empty pesticide containers

FIGURE 2. **CCONSUMERS AND BYSTANDERS MAY BE EXPOSED TO INSECTICIDES USED IN LOCUST CONTROL**

ENVIRONMENTAL RISKS

Almost all the insecticides that are at present used for locust control in the CCA region have broad-spectrum activity and are thus not entirely specific to locusts. As a result, they may adversely affect other organisms in the environment (Fig. 3). However, many organisms that could be affected by locust control insecticides, such as fish, pollinators or natural enemies of pests, are important natural resources or perform ecological functions on which local populations depend.

For example, inland fisheries are a vital source of food but insecticides may directly kill fish or adversely affect the invertebrates on which they feed. Bees provide honey, wax and the essential pollination of many crops but they are also very susceptible to insecticides. Many wasps, flies, spiders and beetles prey on crop pests; if these natural enemies are killed by insecticides, pests may become a problem for farmers. Livestock will graze on green pastures just like locusts but no insecticide residues should end up in meat and milk after locust control operations. Many other examples can be given of environmental problems that may be caused by insecticides. These may have a direct impact on the lives of local people in locust-affected countries.

It is therefore important that adverse environmental effects of locust control are kept to a minimum. This is not an easy task. Many different types of environment exist in the CCA region where locust control may be conducted, all with their own characteristics, animals and plants. An insecticide may pose a problem in one environment, but not in another. Environmental risk reduction therefore has to be done on a case-by-case basis. It involves choosing the right insecticide for a given situation or environment, using the appropriate control method, and strictly applying environmental protection measures where possible. These topics will be discussed in more detail in the guidelines.

	Livestock	Wildlife	Pollinators, natural enemies of crop pests	Fish	Soil organisms	Aquatic invertebrates
High			↕			↕
Medium		↕		↕		
Low	↕				↕	

More detailed information about the risk of locust control insecticides for non-target organisms can be found in the latest report of the Pesticide Referee Group

FIGURE 3. INDICATIVE RISK OF LOCUST CONTROL INSECTICIDES TO NON-TARGET ORGANISMS

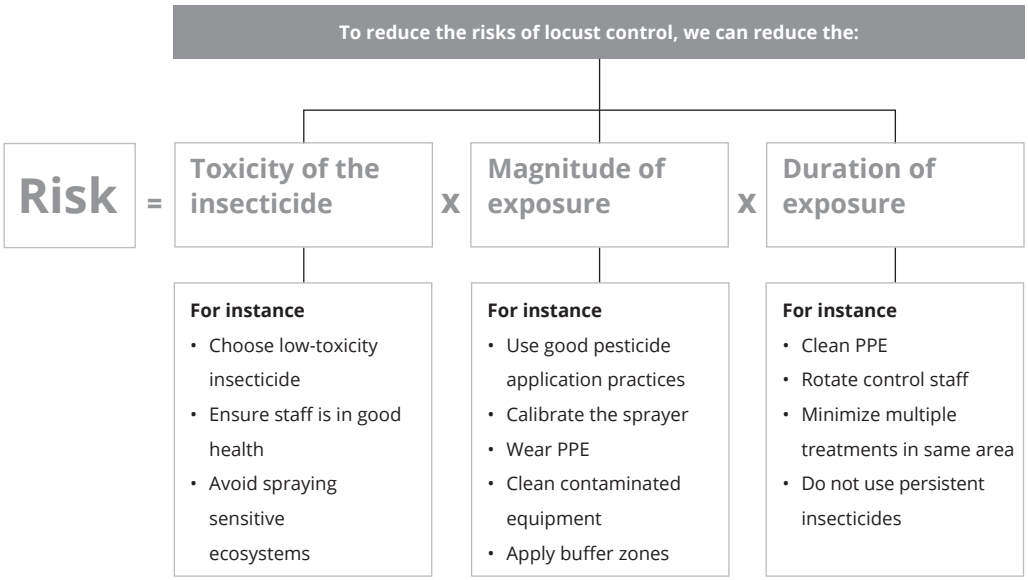


FIGURE 4. FACTORS THAT INFLUENCE THE RISK OF A PESTICIDE TO HUMANS AND THE ENVIRONMENT

WHAT DETERMINES INSECTICIDE RISK?

Various factors determine the risk of an insecticide (Fig. 4). These factors are very similar for both humans and the environment. Risk is a function of the toxicity of the insecticide, the magnitude of exposure to the insecticide and its duration. If any of these factors increases, the risk that an insecticide will cause adverse effects will also increase.

Toxicity

Insecticides show both acute and chronic toxicity. Acute toxicity occurs after short-term exposure to the chemical. This is especially relevant for locust control staff who may be exposed to relatively large doses of insecticides, such as applicators, pesticide loaders and workers who are cleaning equipment or storage sites. Symptoms of acute intoxication normally appear soon after exposure.

Chronic toxicity shows much later after insecticide exposure. It may occur after acute exposure, but also following long-term exposure to relatively small amounts of insecticides. Locust control staff who have been working for many years with insecticides are most at risk of developing chronic effects. Symptoms of chronic intoxication to insecticides can be very diverse, and a causal link between the insecticide and its effects is often difficult to make.

The more toxic an insecticide is (either acutely or chronically), the higher the risk will be of adverse effects. In locust control, this risk factor can be reduced by choosing low-toxicity insecticides.

Magnitude of exposure

If an organism is exposed to larger amounts of an insecticide, there will also be a higher risk of adverse effects. As is being said: “the dose makes the poison”. In locust control, the magnitude of exposure of both humans and the environment is influenced by many factors, such as the dose rate of the insecticide, the number of treatments of the same area, the size of unsprayed buffer zones, the use of appropriate personal protective equipment (PPE), and the quality of equipment calibration.

Duration of exposure

The longer an organism is exposed to an insecticide, the higher the risk will be of adverse effects. For instance, the persistence of the insecticide and the number of treatments of the same area affect environmental exposure. The duration that an applicator works with insecticides or the time he wears contaminated protective clothing affect occupational exposure.

All risk reduction measures in locust control normally attempt to reduce one or more of these three exposure factors (Fig. 4)

BOX 2. RISK FACTORS OF DIFFERENT PESTICIDE APPLICATION METHODS USED IN LOCUST CONTROL IN THE CAUCASUS AND CENTRAL ASIA

Aerial control (water-based and UL formulations)	Ground control	
	Vehicle-mounted sprayers Tractor-trailed or tractor-mounted sprayers (waterbased formulations) and pickup-mounted sprayers (UL formulations)	**Backpack and hand-held sprayers** Motorized sprayers, with or without ULV atomisers. (water-based and UL formulations)
Occupational risk factors		
↑ Large volumes of insecticides used ↓ Generally more experienced staff involved ↓ Fewer opportunities for exposure (mainly mixing and loading) ↓ Staff supervision easier	↑ Moderate volumes of insecticides used ↓ Generally more experienced staff involved ↑ More opportunities for exposure (mixing, loading, spraying) ↑ Staff supervision more difficult	↓ Small volumes of insecticides used ↑ More temporary, less experienced staff involved ↑ More opportunities for exposure (mixing, loading, spraying) ↑ Staff supervision more difficult ↑ Greater likelihood that faulty equipment will expose staff
Environmental risk factors		
↑ Large areas sprayed ↑ More insecticide drift ↑ Higher likelihood of overspraying sensitive areas ↓ Generally more experienced staff involved	↑ Intermediate-sized areas sprayed ↓ Less insecticide drift ↓ Lower likelihood of overspraying sensitive areas ↓ Generally more experienced staff involved	↓ Small areas sprayed ↓ Less insecticide drift ↓ Lower likelihood of overspraying sensitive areas ↑ More temporary, less experienced staff involved

Increases risk: ↑ Decreases risk: ↓

TIP **See the Selected References at the end of the guidelines for further information on this topic.**

B BEFORE THE CAMPAIGN

The planning phase of risk reduction in locust control is very important. Without good preparation, the probability that incidents may happen is greater and environmental and health monitoring will be less effective. Safety measures, environmental precautions and monitoring should therefore always be a standard part of the contingency plans for a locust control campaign.

Experts on pesticide management, environmental protection, as well as senior medical staff, should be involved in campaign planning and organization from the start. This will ensure that they are aware of the specific problems and requirements of a locust control campaign. They may also be able at an early stage to incorporate human health and environmental concerns into the campaign plan. This will avoid surprises later on, when changes in the plan are difficult or impossible to make because insecticides and equipment have already been ordered and personnel has been trained.

3 CHOOSING APPLICATION EQUIPMENT

Locust control in the Caucasus and Central Asia is conducted primarily by ground treatments, using tractor-trailed, vehicle-mounted or backpack sprayers. Aerial control is conducted in some countries. Originally, most pesticide application equipment was intended to spray waterbased insecticide formulations (e.g. EC, SC). Increasingly, specialized sprayers for ultra-low volume application are being used in the region.

The types of application equipment that are chosen for a control campaign will depend on many factors, in particular the ecology of the locust pest, the expected size of the infestation, the topography and accessibility of the terrain, the presence of clean water to mix the insecticide, and the required work rate.

However, occupational and environmental risks are also influenced by the control methods and equipment (Box 2). In aerial control, larger areas are treated, and insecticide drift will occur over a wider area, which increases exposure of non-target animals. On the other hand, less workers are involved, which tend to be better trained, and the likelihood for occupational exposure therefore tends to be less. Each application method has its specific environmental and occupational risks. Overall, there are more environmental concerns with aerial control, and more occupational concerns with ground control, especially when using backpack or handheld sprayers.

As a result, the emphasis on the risk reduction measures that have to be taken at the start of the campaign may differ, and depends on the spraying equipment chosen. For instance, if mostly backpack sprayers are used, specific attention should be given to training and supervision of control staff and ensuring regular distribution of PPE. On the other hand, if aerial control is planned, monitoring of insecticide drift and environmental contamination will need extra priority.

4 SELECTING INSECTICIDES

The selection of an insecticide for locust control is based on many criteria. Its efficacy, speed of action and the type of formulation are key factors, which determine how the insecticide can be used. Human health risks determine who can use the pesticide and which precautions should be taken. Environmental risks influence where the insecticide can be used.

The Pesticide Referee Group (PRG) advises FAO on insecticides that have been shown to be efficacious against locusts, on the correct dose rates to use, and on the human health and environmental risks of the listed pesticides. In addition, an e-Committee of Pesticides has reviewed insecticides used for locust control in the Caucasus and Central Asia, and proposed a minimum list of pesticides that can be used against locusts in all CCA countries (Fig. 5).

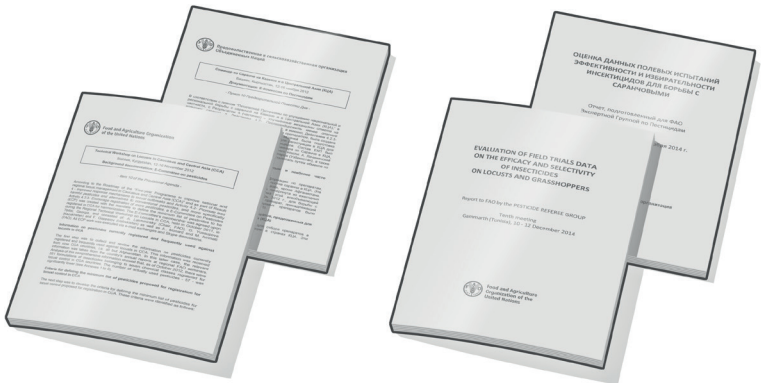


FIGURE 5. MORE INFORMATION ON MODES OF ACTION AND RECOMMENDED DOSE RATES FOR LOCUST CONTROL INSECTICIDES CAN BE FOUND IN THE LATEST PESTICIDE REFEREE GROUP (PRG) REPORT AND THE RECOMMENDATIONS OF THE CCA E-COMMITTEE ON PESTICIDES.

PESTICIDE REGISTRATION

In almost all CCA countries, insecticides have to be registered by the government before they can be used. Generally, commercial pesticide products are registered, not just active ingredients. This means that one or more products containing cypermethrin may be authorized for locust control in the country, but not all of them.

Products that are not registered can generally not be used. It is therefore important that the locust control unit verifies that all types of insecticides that it may need for an effective control campaign are registered in the country. For instance, one may need rapidly acting insecticides to control hoppers close to crop land or swarms (e.g. pyrethroids), more persistent insecticides for large scale control of hoppers in pastures (e.g. benzoylureas) and low risk products for control in crops or ecologically sensitive areas (e.g. biocontrol agents). And to avoid monopolies in insecticide

supplies, which risk increasing costs, more products may need to be registered for each required type of insecticide.

If certain types of insecticides required for locust control are not (yet) registered, the locust control organization should contact the pesticide registration authority in the country to discuss how the range of locust control insecticides can be broadened. This will likely require the involvement of pesticide suppliers and manufacturers that are active in the country, e.g. for conducting efficacy trials or making results available of trials conducted in other countries with similar ecological conditions.

SELECTING INSECTICIDES: HUMAN HEALTH CRITERIA

Occupational and bystander risks

The insecticides used for locust control have different toxicities and do not pose the same risk to control staff or bystanders.

Two international classifications are widely used to classify the hazards of pesticides: the *WHO recommended classification of pesticides by hazard and the Globally harmonized system of classification and labelling of chemicals (GHS)*. Use recommendations for insecticides in locust control, based on the classification of acute toxicity, are provided in Box 3. Note that the acute toxicity classification refers to the toxicity of the formulated product used in the control operations; not of the active ingredient.

WHO Class Ia and Ib, or GHS Acute Toxicity Categories 1 and 2 should, in principle, not be used for locust control due to their high acute toxicity. Most insecticides that are presently recommended for locust control are WHO Class II or III, or GHS Acute Toxicity Categories 3, 4 or 5. Even though these are moderate to slightly hazardous products, they should only be applied by trained, and generally supervised, locust control staff, to minimize occupational risks.

During campaign preparation, the locust control unit should assess whether all control staff are sufficiently trained to use the selected insecticides with minimum risk. If this is not the case, the necessary training should be organized before the start of the control campaign.

The GHS also classifies chronic health hazards of chemicals, which are particularly relevant in case locust control staff apply insecticides for prolonged periods during the year. For a number of chronic hazard categories, it is recommended that a more in-depth occupational risk assessment is conducted for the exposure conditions encountered in locust control in the country, before such an insecticide is used in control operations (see Box 3).

If locust control is likely to be carried out near inhabited areas, the risk of accidental exposure of the local people (e.g. bystanders or farmers re-entering sprayed fields) is relatively high. When purchasing or prepositioning insecticides, this should be taken into account, for instance by favouring WHO class U or GHS unclassified products for those areas.

BOX 3. USE RECOMMENDATIONS FOR INSECTICIDES IN LOCUST CONTROL, BASED ON CLASSIFICATION OF ACUTE AND CHRONIC TOXICITY

WHO hazard class	GHS acute toxicity category	Use recommendations
Ia Extremely hazardous	1 Fatal if swallowed, in contact with skin or if inhaled	Should not be used for locust control
Ib Highly hazardous	2 Fatal if swallowed, in contact with skin or if inhaled	Should not be used for locust control
II Moderately hazardous	3 Toxic if swallowed, in contact with skin or if inhaled	Trained and supervised operators who are known to observe precautionary measures strictly prescribed
III Slightly hazardous	4&5 (May be) harmful if swallowed, in contact with skin or if inhaled	Trained operators who observe routine precautionary measures
U Unlikely to pose an acute hazard in normal use	-- Unclassified	General use, when respecting standard hygienic measures and observing instruction for use given on the label.
	GHS chronic toxicity category	**Use recommendations**
	1A, 1B, 2 Carcinogenicity	Conduct in-depth occupational risk assessment for conditions of use in locust control in the country, before purchasing.
	1A, 1B, 2 Germ cell mutagenicity	
	1A, 1B, 2 Reproduction toxicity	
	1A, 1B, 2 Respiratory sensitization	
	1A, 1B, 2 Specific Target Organ Toxicity (STOT) – single and repeated exposure	

TIP **See the Selected References at the end of the guidelines for further information on this topic.**

Risks to consumers

In certain situations, locust control may take place in cultivated areas, where crops will be sprayed. To ensure that sprayed crops do not pose an unacceptable risk to consumers, pre-harvest intervals should be respected. More information on pre-harvest intervals is given in Section 20 of these guidelines.

Risks of specific insecticide formulations

In locust control in CCA, both water-based formulations (mainly emulsifiable concentrates (EC) and soluble concentrates (SC)) and ultralow volume (UL) formulations are used. These formulations may have different occupational risks: The EC and SC formulated products that are used for locust control tend to be more concentrated that UL formulations. In addition, especially EC formulations may contain relatively hazardous solvents. Therefore, when mixing and loading the insecticides into the sprayer, occupational risks of EC and SC formulations tend to be higher than of UL formulations.

During normal spraying, however, the occupational risk is not so much determined by the insecticide concentration in the formulation, since the application rate per ha is the same. More important determinants of occupational risk are the work rate (the number of ha's treated per day – generally higher for UL insecticides) and the level of protection that the application equipment provides (generally lower for tractors and backpack sprayers than for pickup trucks).

As a result, one cannot say that UL formulated insecticides used in locust control pose a higher human health risk than water-based insecticides. This depends much on the activity of the operator and the application equipment being used.

SELECTING INSECTICIDES: ENVIRONMENTAL CRITERIA

Assessing the risk of locust control insecticides to the environment is not easy. This is because the environment is made up of many different organisms that do not necessarily have similar susceptibilities to a given insecticide. For instance, a product may pose a high risk to fish, but be relatively safe for birds and mammals, or it may be very toxic to bees and natural enemies of pests, but pose a low risk to livestock.

Therefore, which insecticide is environmentally acceptable for locust control will depend very much on the type of environment to be sprayed and the organisms that need to be protected. No general environmental classification exists that is applicable to all locust control situations; it has to be evaluated on a case by case basis, taking into account the specific geographical areas and species that might be exposed to the insecticides.

The FAO Pesticide Referee Group (PRG) evaluates the potential environmental impact of the insecticides that pass their efficacy assessment. Insecticides are classified as posing low (L), medium (M) or high (H) risk to the main groups of organisms that may be exposed by locust control operations. This assessment is done based on Desert Locust control application rates and environmental conditions. Nevertheless, it is also broadly applicable to locust control in CCA. The

FIGURE 6. **THE ENTOMOPATHOGEN *METARHIZIUM ACRIDUM* HAS BEEN SHOWN TO BE EFFECTIVE AGAINST LOCUSTS**

results of this evaluation are given in the latest PRG report. The national locust control unit and the environmental authorities can use this report when evaluating the risks of the insecticides they wish to use for locust control.

SELECTING INSECTICIDES: BIOPESTICIDES

Various biopesticides have been tested against migratory locusts and grasshoppers. So far, the most effective one active ingredient identified is *Metarhizium acridum*, a fungal pathogen, which specifically kills locusts and grasshoppers (Fig. 6). This entomopathogen has a moderate to slow speed of action, immobilizing the locusts within 2-4 days and killing them in 7-20 days. Speed of action mainly depends on ambient temperatures.

Various Several commercial formulations of *M. acridum* for locust and grasshopper control are presently available. A product on the basis of *M. acridum* strain EVCH077 has been tested against Italian and Moroccan Locust in Central Asia and found to be effective. Furthermore, *M. acridum* IMI 330189 has been shown to control Desert Locust, Red Locust, Malagasy Migratory Locust and various species of grasshoppers throughout mainland Africa, Madagascar and the Middle East. The isolate FI 985 is used on a large scale against the Australian Plague Locust, but has also shown to be effective against Migratory Locust subspecies, among others.

Metarhizium acridum is highly specific to Orthoptera and has not shown to infect other groups of insects or non-target organisms. It has very low mammalian toxicity.

This type of biopesticide can be used under circumstances when conventional chemical insecticides cannot be applied, such as in sensitive ecosystems, protected areas, organic agriculture or crops under biological control, or in the close vicinity of water bodies. It is also effective early in the development of locust populations, outside cropping areas.

5 ORDERING INSECTICIDES

WHAT QUANTITIES TO ORDER?

A country that may face a locust outbreak will want to have sufficient insecticides in stock to be able to control it. Locust control units in CCA therefore spend much time conducting surveys to forecast the size of locust populations in the next locust season. Types and quantities of insecticides are purchased on the basis of these forecasts. However, exact estimates of the areas to be treated cannot be made in advance. As a result, insecticides may remain unused at the end of the campaign, or the locust control organization can be short of products during control operations.

From an environmental point of view, the less insecticides are stored in a country the better. This will avoid the possible creation of obsolete pesticide stocks, which are very expensive to dispose of and could contaminate the environment (Fig. 7). Since most pesticides have a guaranteed shelf-life of two years (though if properly stored can often be used for longer), it is recommended that insecticide stocks for locust control do not exceed the average needs of two consecutive campaigns.

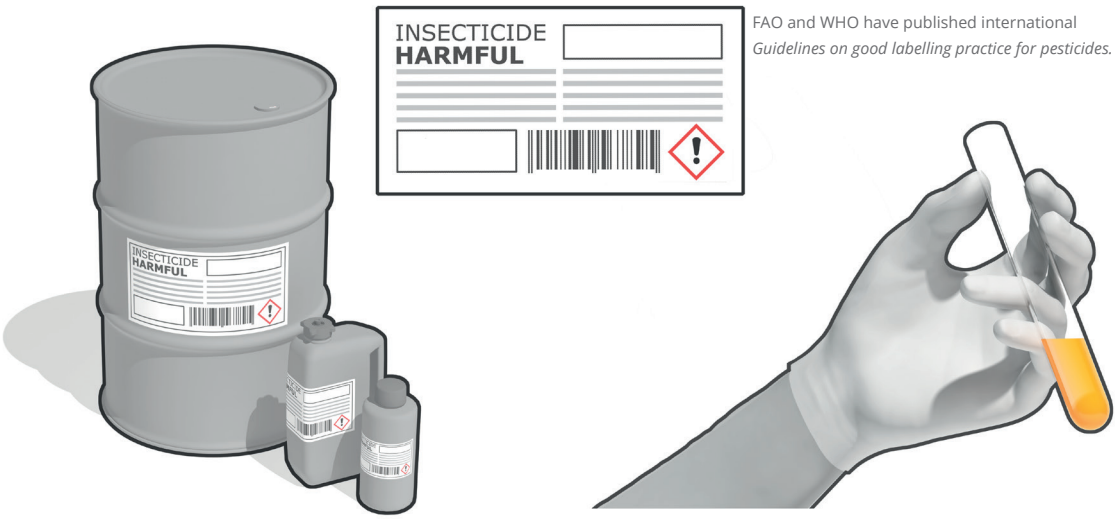
FIGURE 7. **UNUSED NATIONAL STOCKS OF INSECTICIDES DESTINED FOR LOCUST CONTROL MAY BECOME OBSOLETE. IF STORED FOR A LONG TIME, CONTAINERS MAY DETERIORATE AND START LEAKING**

Many countries in CCA procure insecticides for locust control after a tendering procedure. To avoid overstocking, it is important that this procedure is sufficiently flexible to allow the rapid purchase of additional products during a control campaign, if needed. This could be done, for instance, by allowing a second purchase of the pesticide that was already granted a tender, without requiring a new tendering procedure during the same control campaign.

PACKAGING

Insecticides for locust control often have to be transported over rough terrain and may be stored under difficult environmental conditions. Therefore, packaging requirements have to be up to the highest standards. To avoid damage and subsequent environmental contamination, containers must be durable and very robust. Smaller insecticide containers should be made out of high quality HDPE; larger containers (more than about 20 litres) out of steel. International standards for pesticide packaging have been set by the United Nations (Fig. 8).

The size of insecticide containers may also affect the safety of their use. Large drums are heavy and difficult to manipulate. This may not be a problem for aerial control, as the insecticide will be transferred into the aircraft hopper using a pump. However, large drums are inappropriate if control is mostly on a small scale, using hand-held, backpack or vehicle-mounted sprayers. Pouring insecticides from large drums under such circumstances is a very hazardous practice. Therefore, container sizes should be based on the spray equipment expected to be used.



FAO and WHO have published international *Guidelines on good labelling practice for pesticides.*

International standards for insecticide packaging are provided by *the United Nations Recommendations on the Transport of Dangerous Goods.*

Pesticide quality specifications for many insecticides are available from FAO.

FIGURE 8. GOOD STANDARDS FOR PACKAGING AND LABELLING SHOULD BE FOLLOWED WHEN ORDERING INSECTICIDES AND QUALITY CONTROL ENSURED ON STOCKS

LABELLING

All insecticide containers should be properly labelled. The label should conform to national requirements. FAO and WHO have published international labelling guidelines (Fig. 8).

QUALITY CONTROL

The quality of any insecticide imported or locally formulated for locust control should be checked on a regular basis by an independent laboratory. Analysis should preferably be done within two years after the release date of the product, and subsequently annually. Some countries have an effective quality control laboratory that can conduct this type of analysis.

Alternatively, the requirements for quality control should be part of the tendering requirements and thus guaranteed by the supplier. International pesticide quality specifications are available from FAO (Fig. 8).

6 IDENTIFYING SENSITIVE AREAS

All areas in the country that are ecologically and agronomically important or particularly sensitive to insecticides should be identified and mapped. In certain areas chemical locust control may also not be allowed by law (e.g., in case of national parks or nature reserves). The ministry responsible for environment or the national cartography service may already have elaborated such maps, either in digital or paper format (Fig. 9). Similarly, inventories of protected and/or threatened species may be available, that should not be exposed to insecticides.

For those sensitive areas where control operations may take place, locust management options should be evaluated, based on the type of organisms at risk and the likely locust targets that could appear in the area. Subsequently, the most appropriate locust control techniques have to be identified for each area (Box 4). These include the decision whether to allow chemical insecticides, the choice of acceptable products, periods when treatments are or are not allowed, appropriate control methods, etc.

It is important that relevant national expertise in the country be involved in this assessment, such as institutions dealing with environment, biological pest control, (inland) fisheries, beekeeping, national parks, etc.

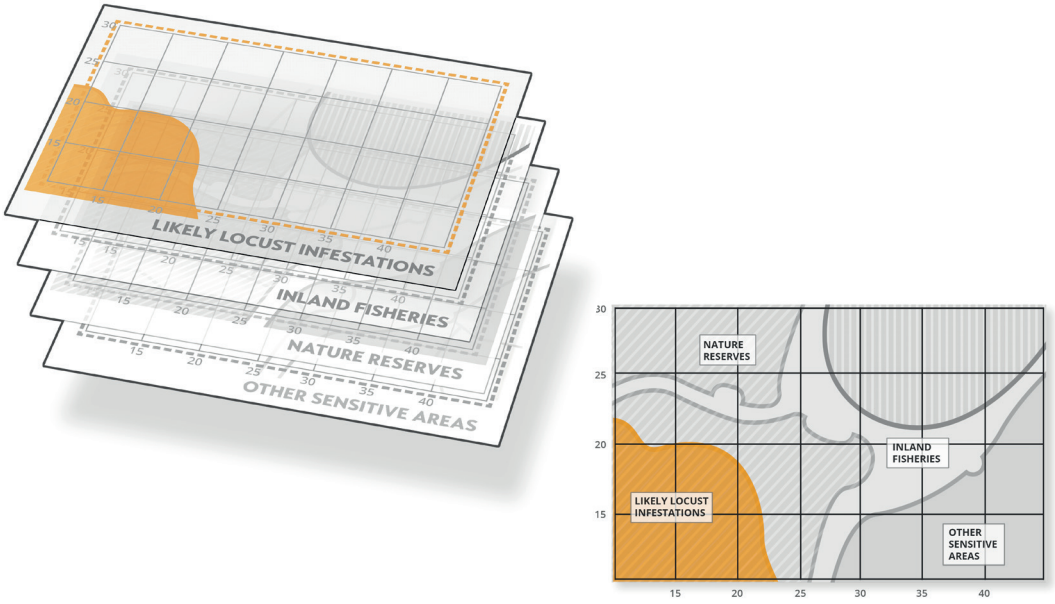


FIGURE 9. MAPS ARE POWERFUL TOOLS TO IDENTIFY ECOLOGICALLY SENSITIVE AREAS AND DEFINE APPROPRIATE LOCUST CONTROL OPTIONS. DIGITAL MAPS IN A GEOGRAPHICAL INFORMATION SYSTEM ALSO ALLOW GRAPHICAL OVERLAYS OF CONTROL INFORMATION

BOX 4. EXAMPLES OF AREAS THAT MAY NEED SPECIAL ATTENTION WHEN CONDUCTING LOCUST CONTROL

Ecologically and agronomically sensitive areas	Examples of management measures
National parks; nature reserves; internationally protected areas	→ No chemical insecticide applications; only biological control agents; only low risk insecticides
Inland or marine fisheries areas	→ Only insecticides posing a low risk to fish and aquatic invertebrates
Beekeeping areas; fruit growing areas	→ Establish information system for beekeepers; no insecticides during flowering of fruit trees; only insecticides with very low risk to bees
Sericulture areas	→ No chemical insecticides in mulberry plantations; only biological control agents
Areas with important biological pest control programmes	→ No chemical insecticide applications; only biological control agents; only insecticides posing very low risks to natural enemies of pests
Areas with (export) crop production	→ Only insecticides which do not exceed maximum residue limits at harvest
Areas with organic crop or livestock production	→ No chemical insecticide applications
Human populations (villages, settlements)	→ Only insecticides posing low risk to human health

Digital maps of sensitive areas should be imported into a geographic information system (GIS), such as the one being developed for locust control in the CCA region. Real-time locust information, collected with the Automated System of Data Collection (ASDC) can then be overlayed over sensitive areas during the campaign, appropriate risk reduction measures identified and control operations documented.

7 PERSONAL PROTECTIVE EQUIPMENT (PPE)

During the campaign planning phase, the necessary personal protective equipment (PPE) has to be selected and ordered, for it to be available at the start of the control operation (Fig. 10). The type of PPE that is needed depends on the toxicity of the insecticides that will be used. Box 5 lists the recommended PPE for locust control, presuming all insecticide formulations are WHO class II, III or U. In addition to PPE, other safety equipment also needs to be available for control teams. This includes eye wash kits, water and soap, and antidotes (in certain cases).

When ordering PPE, one has to take into account that all items have only a limited operational life. For instance, gloves get torn or impregnated by insecticides and overalls will after a while become too contaminated for use, even if properly washed. Sufficient PPE has to be ordered and distributed to allow for such wear and tear. Indicative numbers of PPE are given in Box 5, needed for a three-month control campaign.

Most PPE can be stored for several years and it is therefore better to order too much of it than too little. The exact types and quantities of PPE required will depend on the type of insecticide used (e.g. its formulation and corrosiveness), the type of treatments carried out (e.g. with vehicle mounted sprayers or backpack sprayers), and the expected intensity of the campaign. It is therefore important that the heads of the control bases keep track of the use of PPE and order new materials in time.

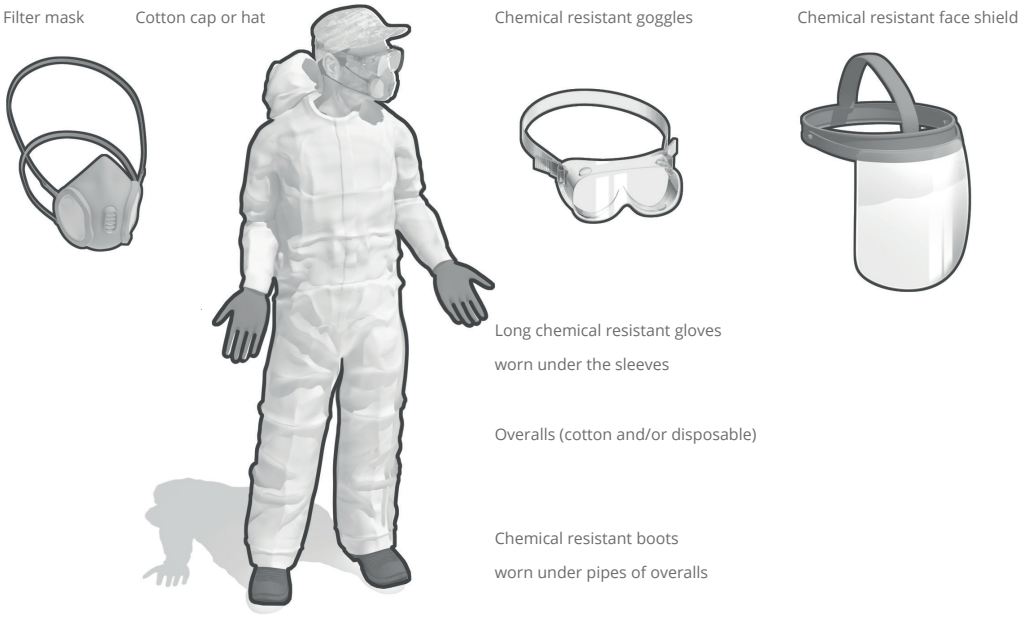


FIGURE 10. PERSONAL PROTECTIVE EQUIPMENT FOR INSECTICIDE APPLICATIONS IN LOCUST CONTROL

BOX 5. RECOMMENDED PERSONAL PROTECTIVE EQUIPMENT FOR LOCUST CONTROL, AND INDICATIVE QUANTITIES NEEDED FOR A 3-MONTH CONTROL CAMPAIGN, PRESUMING SPRAYING TAKES PLACE 40 WORKING DAYS DURING THIS PERIOD

Item	Type of activity				Unit
	Mixing and loading (aircraft, vehicle & backpack sprayers)	**Ground spraying** (backpack or hand-carried sprayers)	**Vehicle spraying** (for drivers in the cabin of the vehicle)	**Insecticide storage**	
Chemical resistant boots	1	1	1	1	per person
Cotton overalls (washable)	2	2	2	2	per person
Splash-proof disposable overalls (type 4)	20[1]	-	-	5	per person
Liquid-tight disposable overalls (type 3)	-	-	-	2	per person
Cotton hat/cap (washable)	2	2	2	1	per person
Chemical resistant industrial apron	1	12[2]	-	1	per person
Nitrile gloves (thickness ≥ 0.4 mm)	10	10	5	5	per person
Heavy PVC chemical resistant gloves	5[3]	-	-	2	per person
Chemical resistant face shield	1	-	-	1	per person
Goggles	1	1	1	1	per person
Respirator half-mask with fixed filters or cartridges[4] (A2 or A2P3 filter, or better)	3	3[5]	1[5]	1	per person
Disposable filter mask (FFP2 or FFP3 filter class)	-	40[6]	-	-	per person
Eye wash bottle	1	1	1	1	per team
20 L jerrycan for washing	1	1	1	1	per team
First aid kit	1	1	1	1	per team
Soap (liquid or bars)	5	5	5	3	per team

1 in case of aircraft loading.
2 when spraying in high vegetation.
3 in case of handling heavy (metal) drums.
4 in case of cartridge filter mask, the required number refers to spare sets of cartridges for one mask).
5 for relatively toxic insecticides (WHO class II).
6 wear in combination with face shield and dispose of immediately after spraying.

Of all PPE, gloves tend to be most exposed to the insecticides. However, even good-quality chemical resistant gloves are not entirely impermeable to insecticides. Especially solventbased products (such as EC and some UL formulations) tend to permeate the gloves. Gloves therefore need to be replaced regularly. FAO recommends the use of nitrile gloves, which tend to be most resistant to UL and EC formulations. However, it is good practice to test the quality of the gloves with the exact insecticide formulations that are used in the country, before purchasing large quantities.

Information on the use and maintenance of PPE is provided in Section 18 of these guidelines.

Do not economize on the amount and quality of PPE to be purchased. The cost of PPE is very limited when compared to the cost of the insecticides and their application.

Always carry out a pre-campaign quality check of the PPE that is still in stock. Gloves may have become permeable after prolonged storage and the filters of respirators may have expired.

8 MONITORING LOCUST CONTROL OPERATIONS

WHAT IS MONITORING?

The term monitoring is used here for the collection, analysis, interpretation and dissemination of data on the effects (both intentional and unintentional) of locust control operations. This includes the quality of the insecticide applications, precautionary measures, control efficacy, effects on human health, impact on non- target organisms, etc. The objective of monitoring is to identify what goes right in operational locust control and what can be improved. Monitoring is therefore an essential element of a control campaign. It aims to optimize control, improve cost-effectiveness and minimize adverse side-effects on human health and the environment (Box 6).

BOX 6. WHY SHOULD A LOCUST CONTROL ORGANIZATION SPEND THEIR LIMITED RESOURCES ON MONITORINGCONTROL OPERATIONS?

1 Quality of the control operations

Monitoring will help to optimize locust control, e.g. by reducing the risk of overdosing or ineffective treatments. In this way, monitoring will earn itself back rapidly and minimize wastage of control campaign funds.

2 Occupational health

Monitoring will help to reduce the risk of poisoning of control staff. Apart from the human suffering that occupational poisoning may cause, it also reduces labour productivity and thus the effectiveness of the control campaign.

3 Environmental health

Monitoring will minimize the environmental impact of locust control. Since the environment provides important natural resources and ecological services, especially in rural areas, adverse environmental effects often result in direct or indirect economic costs.

4 Consumer health and export markets

Monitoring will help to reduce adverse effects on consumer health. When pastures or crops are treated against locusts, insecticide residues should remain below maximum residue limits. Monitoring will help ensure that such standards are observed. Furthermore, if agricultural commodities are exported, exceedance of MRLs may result in loss of export markets.

TYPES OF MONITORING

In these guidelines, three types of monitoring are distinguished: rapid assessments (done by locust control teams), specialized operational monitoring (carried out by special monitoring teams) and in-depth monitoring (executed by research institutions). These three types of monitoring differ by the activities that are carried out, the time span in which the work has to be done and the functional links to the control campaign organization (Box 7).

BOX 7. DIFFERENT TYPES OF MONITORING OF LOCUST CONTROL OPERATIONS

Type?	Who?	How long on a control site?	What?			
			Control quality & efficacy	**Human health**	**Environ-ment**	**Insecticide residues**
Rapid assessments	Control teams	Hours to 1 day	yes	yes	yes	no
Specialized operational monitoring	Monitoring teams	1 day to 1 week	yes	yes	yes	yes
In-depth monitoring	Research teams	Weeks to months	no	yes	yes	yes

Rapid assessments focus on insecticide application quality, control efficacy and the reporting of incidents. Specialized operational monitoring and in-depth monitoring, on the other hand, look in more detail into control efficacy, environmental impact, occupational health and insecticide residues (Box 6). The main difference is that operational monitoring attempts to cover many control actions, in relatively limited detail, while in-depth monitoring looks at only a few control actions, but in much more detail. It could be said that the value of the former is in the numbers and of the latter in the details (Fig. 11).

PLANNING MONITORING

Monitoring activities need to be planned well ahead of the control campaign. Equipment and materials may need to be ordered, staff will have to be trained or their knowledge refreshed, collaboration with other ministries or institutions has to be established, and logistics organized.

PLANNING RAPID ASSESSMENTS

Rapid assessments are carried out by the control teams themselves. As a rule, control staff is very busy during a locust control campaign, searching locust targets, preparing equipment, spraying, cleaning up and moving on to the next spray target. Therefore, any monitoring that can be done by control teams has to be fast and to the point. However, the fact that control staff are busy does

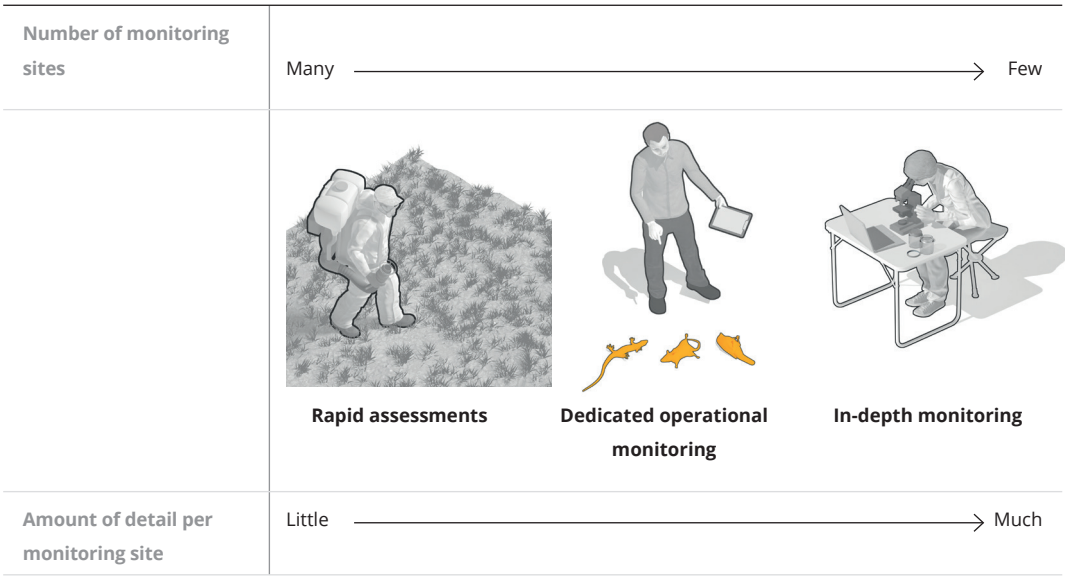


FIGURE 11. **DIFFERENT TYPES OF MONITORING HAVE DIFFERENT GOALS AND RESULTS**

not exempt them from doing some basic checks, e.g. of control parameters and efficacy. Incidents of occupational poisoning or environmental impact must also be registered by the control teams, so that the specialized monitoring teams can follow up.

During the campaign planning phase, it should be decided which monitoring tasks will be assigned to the control teams. Subsequently, control staff have to be informed about and trained in the tasks that are required of them, so that they can carry them out rapidly and correctly.

More details about the various rapid assessment activities are provided in Section 23 of these guidelines.

PLANNING SPECIALIZED OPERATIONAL MONITORING

Most monitoring of locust control operations will have to be carried out by one or more specialized monitoring teams. The advantage of having one or more independent monitoring teams is that control staff can concentrate spraying locusts, while monitoring staff can remain longer in the treated area to assess control quality and impact. It is recommended that CCA countries establish at least one monitoring team as part of the locust control organization. In larger countries, with more extensive control operations, more teams may need to be created.

A specialized monitoring team should be able to operate independently to be able to do its job correctly. This means it should have its assigned staff, own means of transport, equipment and travel funds. A typical monitoring team will use one or two vehicles, depending on the number of staff and whether camping is needed in more remote areas. The team's exact composition

will depend on required monitoring tasks, but it will generally consist of one or more of the following staff: a pesticide application expert, a chemist/insecticide residue expert, an ecologist or ecotoxicologist, a doctor or experienced nurse.

Generally, a monitoring team does not require expensive or complicated equipment; a relatively modest set of materials is needed which can be stored in two or three robust transport cases (Fig. 12). During the campaign planning phase, all the equipment should be checked for proper functioning and missing materials should be ordered.

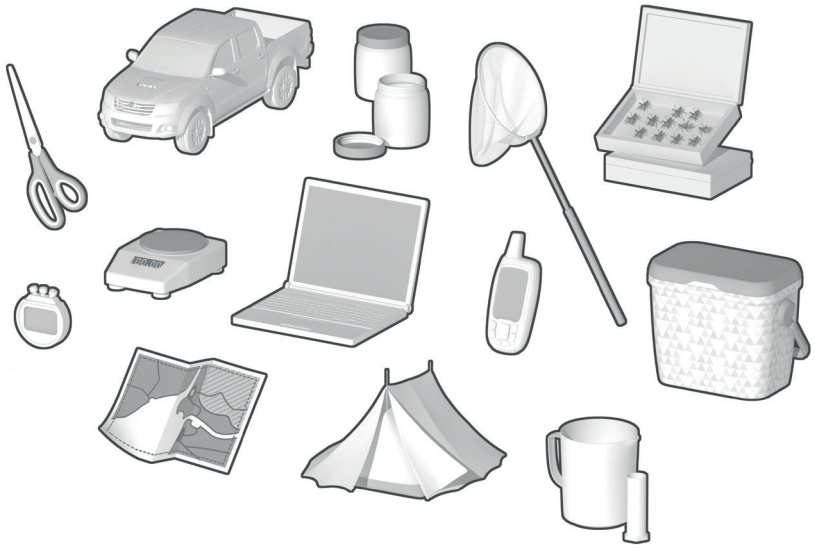


FIGURE 12. A SPECIALIZED MONITORING TEAM SHOULD BE WELL EQUIPPED AND ABLE TO OPERATE INDEPENDENTLY

Even though monitoring staff may be experts in their respective fields, the importance of thorough pre-campaign planning and training cannot be overemphasized. Team members need to be entirely confident with the equipment and with the standard operating procedures for the various monitoring activities.

In advance of the campaign, the monitoring team(s) should collect data on land use and ecology of the areas that may be sprayed to identify any sensitive ecosystems, agriculture or livestock production, or non-target species. Contingency plans need to be prepared and tested in case major incidents occur (e.g. large mortality of non-target organisms, human intoxications or accidental over-spraying of drinking water sources).

Monitoring teams will often require access to external expertise for some of their tasks. Insecticide residues must be sent to and analysed by a specialized laboratory; biological samples may need to be sent to specialist taxonomists; staff of the national poisoning centre may need to be called upon in case of poisoning incidents, etc. Such functional links must be discussed and established before the campaign starts. This is especially important for actions that have to be carried out at short notice.

More details about the various specialized monitoring activities are provided in Section 24 of these guidelines.

PLANNING IN-DEPTH MONITORING

In-depth monitoring differs from specialized operational monitoring in the detail and the duration of the work. It is carried out by specialized and sometimes large research teams. Indepth monitoring also assesses the impact of real-life locust control treatments. But after the insecticide application(s), the research team will generally no longer have much contact with the locust control campaign, because they will continue to work on the treated plots for several weeks or months. In-depth monitoring has therefore different organizational requirements from dedicated operational monitoring.

The need for in-depth monitoring has to be assessed early in the campaign planning phase. Do any insecticides, control methods or non-target organisms require more detailed study? If so, a research team needs to be identified and contracted to carry out the work. Such a team must have the time to prepare the study, link up with relevant national and international institutions, possibly order equipment, arrange for semi-permanent housing facilities, etc. This entire process may take several months. Because of its complexity and high cost, in-depth monitoring of locust control operations will be relatively rare. No further details are given in these guidelines on the organization and execution of in-depth monitoring of locust control, but references are provided for this type of activity at the end of the document.

9 PRE-CAMPAIGN MEDICAL PREPARATIONS

COORDINATION WITH PUBLIC HEALTH INSTITUTIONS

During campaign planning, formal links should be established with the national poison control centre or other relevant national medical institutions. In those regions where locust control may be carried out, local hospitals and health centres should also be contacted. Data sheets on poisoning symptoms, antidotes and treatments for all the insecticides that will be used in the campaign should be made available to local hospitals and medical posts.

PRE-CAMPAIGN MEDICAL EXAMINATIONS

All control staff and other persons who may come into contact with insecticides should undergo a medical examination before the start of the campaign (Fig. 13). This should be carried out by an occupational health physician who has knowledge about insecticide toxicology and is aware of the risks to which locust control staff may be exposed.

FIGURE 13. **ALL LOCUST CONTROL STAFF SHOULD UNDERGO A PRE-CAMPAIGN MEDICAL EXAMINATION**

Specific attention should be paid to medical conditions that may increase susceptibility to insecticides (e.g. skin lesions, liver disease, chronic alcoholism, haemolytic anaemia, malnutrition). Female staff of the locust control organization who are pregnant should, as a precaution, not conduct any activities where they come into contact with insecticides. Pre-campaign examination also establishes a baseline for future health monitoring.

PASSPORT PESTICIDE USE

It is recommended that all staff who handle or apply insecticides keep a so-called pesticide use passport. This is a document in which the types and quantities of insecticides handled/applied during the control campaign are recorded (Fig. 14). Each staff member has his/her own passport.

By maintaining a pesticide use passport, a personal history of insecticide use is being generated, which can be referred to by physicians during medical check-ups. Also, if a staff member gets any health complaints, the passport may help a doctor to identify its cause. A pesticide use passport, or similar pesticide use recording, is a common legal requirement for professional pesticide applicators in many countries.

The passport contains personal information for each insecticide application conducted:

- Which insecticide was applied?
- When was it applied/handled?
- How much of it was applied/handled?
- What spraying equipment was used?
- What were the results of health checks? (if any)
- Were there any exposure or poisoning incidents?

FIGURE 14. A PESTICIDE USE PASSPORT SHOULD BE KEPT AT LEAST BY ALL LOCUST CONTROL STAFF APPLYING INSECTICIDES

CHOLINESTERASE MONITORING

If organophosphate (OP) or carbamate (CA) insecticides are to be used during the campaign, blood acetylcholinesterase (AChE) levels should be obtained for each control agent. These data can be used as a baseline for AChE monitoring during and after the operations. Baseline AChE levels should be taken when the person has not been exposed to OPs or CAs for at least 30 days. Field kits are available to conduct cholinesterase monitoring in a simple and robust way. Sufficient field kits and reagents should be ordered well in advance of the control campaign.

10 CONTINGENCY PLAN FOR EMERGENCY SITUATIONS

In spite of good campaign preparation and staff handling and using insecticides properly, accidents may happen. It is important to be prepared to respond to emergency situations with insecticides, to minimize adverse effects on human health and the environment (Fig. 15).

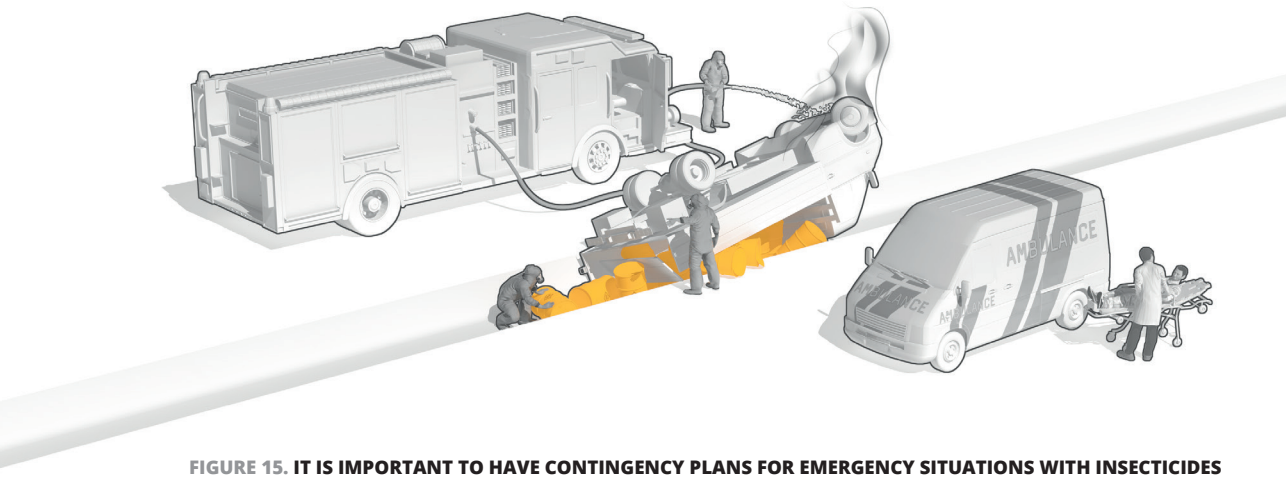


FIGURE 15. **IT IS IMPORTANT TO HAVE CONTINGENCY PLANS FOR EMERGENCY SITUATIONS WITH INSECTICIDES**

The most common insecticide-related accidents that may happen in locust control operations are exposure and poisoning of control staff, drivers or store keepers, insecticide spills during transport of storage, poisoning of livestock and aquatic organisms, and pesticide store fires.

ACCIDENTAL EXPOSURE AND POISONING

In case of accidental exposure of an operator to an insecticide, and possible poisoning that can follow, quick action needs to be taken. Staff needs to be aware and trained on how to conduct first aid and warn the right authorities.

Therefore, during the campaign preparation phase, the following aspects need to be covered:

- Training of control staff and store keepers in first aid in case of pesticide exposure and poisoning (at least one person per control team or store).
- Purchasing of decontamination materials (e.g. jerrycans for clean water, eye wash bottles).
- Identification of medical centres where pesticide poisoning can be treated, in those areas where locust control will be conducted.
- Information of the ministry of health and/or medical centres about the insecticides used in locust control and poisoning treatment guidance (e.g. provision of Safety Data Sheets).

INSECTICIDE SPILLS

Spills may occur during transport, storage or use of the insecticides. They may cause environmental pollution but also pose a risk to human health. It is important that spills are cleaned up as soon as possible, to avoid them spreading too much.

Therefore, during the campaign preparation phase the following aspects need to be covered:

- Training of pesticide store keepers, drivers and control staff in first response to insecticide spills.
- Purchasing of spill containment materials (e.g. absorbents, portable containment bunds, spades, PPE (e.g. liquid-tight overalls).
- Information of emergency services (fire department, ministry of environment) about the insecticides used in locust control).

PESTICIDE STORE FIRE

The insecticide formulations used in locust control are generally not very flammable. However, since in many countries these insecticides may be stored with other (more flammable) pesticides or with fertilizers (the latter being strongly discouraged), fire risks do exist. Chemical fires can be very dangerous, both because of the creation of toxic fumes and explosion risk.
Pesticide store keepers should therefore be aware of emergency procedures.
During campaign preparation, the following aspects should thus be covered:

- Training of pesticide store keepers in emergency procedures in case of fire.
- Purchasing of appropriate fire extinguishers in each pesticide store, including for temporary storage used in locust control. Note that not all types of fire extinguishers can be used to contain chemical fires.
- Information of emergency services (fire department, hospitals) about the pesticides and other chemicals stored in pesticide stores, floor plans of the stores, access routes, etc.

Contingency planning for pesticide-related accidents may be time consuming when the first plans are being elaborated, but require much less work in the following years. Annual updates of the plans and refresher training of staff are required, though.

11 COLLECTION AND DISPOSAL OF EMPTY INSECTICIDE CONTAINERS

FAO strongly discourages to locally burn or bury empty insecticide containers. This will lead to environmental contamination and may pose risks to human health. Empty containers should either be recycled or disposed of through legally allowed methods.

Recycling is the preferred option both for plastic and metal empty containers. For a container recycling programme to be cost-effective, it generally needs to be set up at the national level and not be limited to locust control only. If an empty container recycling programme already exists in the country, the locust control unit needs to ensure that its empty containers can be treated through the scheme.

Alternatively, empty pesticide containers can be disposed of through officially authorized landfilling or incineration. Legally allowed disposal in many CCA countries generally involves transferring empty containers to a hazardous waste landfill site.

Empty pesticide containers need to be rinsed and punctured/crushed before they are sent for recycling or disposal. Rinsing procedures are explained in Section 16 and need to be included in staff training. In case of UL formulated insecticides, rinsing on the control locations may be difficult and empty containers need to be moved to a central location where container rinsing and crushing equipment is available.

Locust control units need to organize the collection, storage and management of empty containers as part of campaign planning. This includes:

- Identification of the most appropriate and legally acceptable container management option. This will generally involve the authorities responsible for hazardous waste in the country.
- Establishment of a contract or agreement with the identified company or companies that will recycle or dispose of empty containers.
- Information and training of staff in empty container handling (triple rinsing, storage, transport).
- Procurement of rinsing and crushing equipment in case much UL formulated insecticides are being used.
- Identification of storage facilities where empty containers can be temporarily stored (Fig. 16).
- Organization of logistics to transport empty containers from the field sites to the temporary stores.

In some countries, the supplier of the insecticides is also responsible for the collection and management of empty containers, as part of the supply contract. In such cases, the locust control unit needs to make sure that collection of the containers and their disposal or recycling is done according to national legislation and/or international standards.

FIGURE 16. **SECURE STORAGE LOCATIONS FOR EMPTY INSECTICIDE CONTAINERS SHOULD BE IDENTIFIED AND PREPARED BEFORE THE START OF THE LOCUST CONTROL CAMPAIGN**

TIP See the Selected References at the end of the guidelines for further information on this topic.

12 TRAINING

Mastering the handling and application of insecticides is one of the most important ways to reduce health and environmental risks. Therefore, campaign staff should be well trained in these topics before control operations commence. Training should not only be limited to insecticide applicators, but also include drivers, store keepers, monitoring teams and medical staff (Box 8).

BOX 8. TOPICS TO BE COVERED BY PRE-CAMPAIGN TRAINING WITH THE AIM TO REDUCE THE HEALTH AND ENVIRONMENTAL RISKS OF INSECTICIDE USE IN LOCUST CONTROL

Target group	Training topics
Control staff	• Insecticide mixing, transfer, pumping • Application techniques • Equipment calibration, maintenance • Safety measures, PPE, recognition of poisoning, first aid • Environmental precautions • Empty container management, triple rinsing • Rapid assessments: efficacy, incidents
Drivers and insecticide transport staff	• Handling, loading and transport of insecticide containers • Safety measures, PPE, recognition of poisoning, first aid • Containment of spills
Storekeepers	• Pesticide store management • Handling, loading and transport of insecticide containers • Safety measures, PPE, recognition of poisoning, first aid • Containment of spills and fire
Monitoring teams	• Quality control of treatment • Health and environmental monitoring techniques • Incident monitoring
Medical staff	• Recognition and treatment of insecticide poisoning

It is recommended that locust control staff be officially licensed or certified in the handling and application of insecticides, after having successfully completed the training. Only certified staff should then be allowed to carry out control. This will increase the incentive to follow the training and the probability that technical standards are complied with. Refresher training sessions should be organized on a regular basis also for staff with more experience. This is a good opportunity to convey new methods and practices, but also to get feedback about constraints encountered by locust control staff.

Good pesticide handling and use practices are especially important since locust control is a government responsibility, and control staff should set an example to farmers, other pesticide users and general public.

Training of locust control staff is probably the most important and effective way of ensuring good insecticide handling and use practices and reducing health and environmental risks.

13 PUBLIC AWARENESS AND INFORMATION

It is important to keep local populations informed about possible environmental and health effects of insecticides, before, during and after locust control operations (see Fig. 17). This to reduce any misunderstandings that may exist about the risks of locust control and to ensure that precautionary measures are taken whenever needed. It is suggested that a specialized communication and information officer is assigned to this task, especially if the campaign is expected to be large.

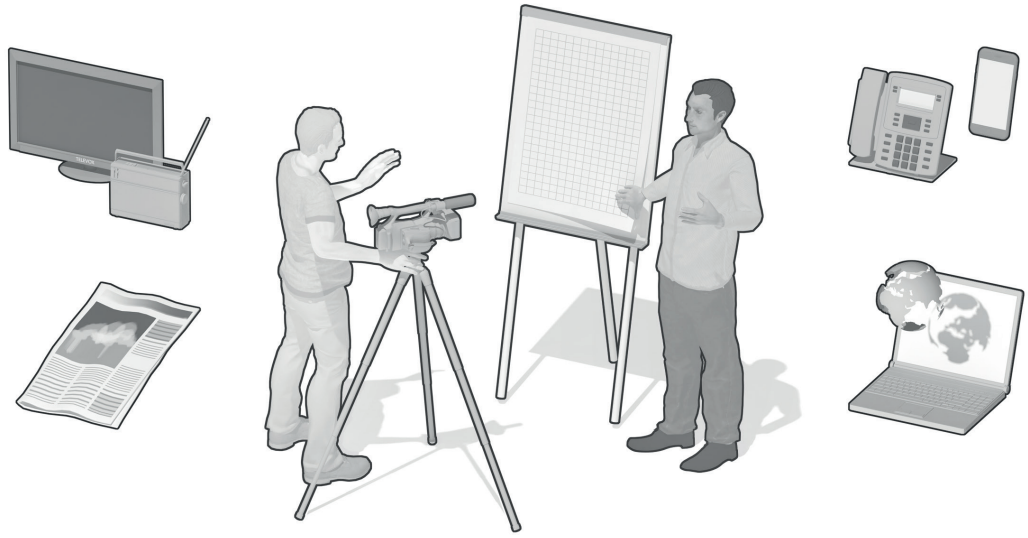


FIGURE 17. DIFFERENT APPROACHES CAN BE USED TO INFORM THE LOCAL POPULATIONS ABOUT SAFETY PRECAUTIONS FOR LOCUST CONTROL OPERATIONS

The main target groups for awareness building and information are:

- Shepherds in/close to treated areas
- Farmers in/close to treated areas
- Beekeepers in/close to treated areas
- Inhabitants of houses/villages close to treated areas
- Local authorities in/close to the treated areas
- Public health authorities in/close to the treated areas

Information materials can be specific for a target group or can be combined to address various target groups. Box 9 lists minimum information that should be covered when addressing these key target groups.

BOX 9. TOPICS TO BE COVERED BY PRE-CAMPAIGN AWARENESS BUILDING AND INFORMATION OF LOCAL POPULATIONS

Target group	Information topics
1 Shepherds in/close to treated areas	• Risks of insecticides to livestock • Stay informed about locations of upcoming locust control • Removal of livestock from the area to be treated • Respect livestock withholding period after the treatment • No re-use of empty pesticide containers
2 Farmers in/close to treated areas	• Risks of insecticide residues on crops • Respect pre-harvest interval after the treatment
3 Beekeepers in/close to treated areas	• Risks of insecticides to honeybees • Low risk of biocontrol agents • Stay informed about locations of upcoming locust control • Removal of beehives from/near the fields that will be treated • Re-entry period for beehives in the treated area
4 Inhabitants of houses/villages close to treated areas	• Human health risks of insecticides • Keep distance from treatments and respect re-entry intervals • No re-use of empty pesticide containers • Pregnant women not to enter treated areas at any time, even after the re-entry period
5 Local authorities in/close to the treated areas	• All messages under 1 – 4 • Keep contact with the locust control teams • Ensure that shepherds, farmers, beekeepers and villagers are informed about treatments • Transmit reports about incidents
6 Public health authorities in/close to the treated areas	• Safety Data Sheets of insecticides being used • First aid and treatment in case of insecticide poisoning

C DURING THE CAMPAIGN

It is during the locust control campaign that human health and environmental risks will be most pronounced. Insecticides need to be transported and (temporarily) stored. Treatments are conducted against locust targets, with associated occupational, bystander, consumer and environmental risks. Empty insecticide containers need to be managed. Monitoring of control quality, human health risks and environmental effects needs to be conducted.

Risk reduction measures will therefore need to be taken on a daily basis, by almost all actors in the control campaign. In the sections below, guidance is provided on the most important measures.

14 INSECTICIDE TRANSPORT

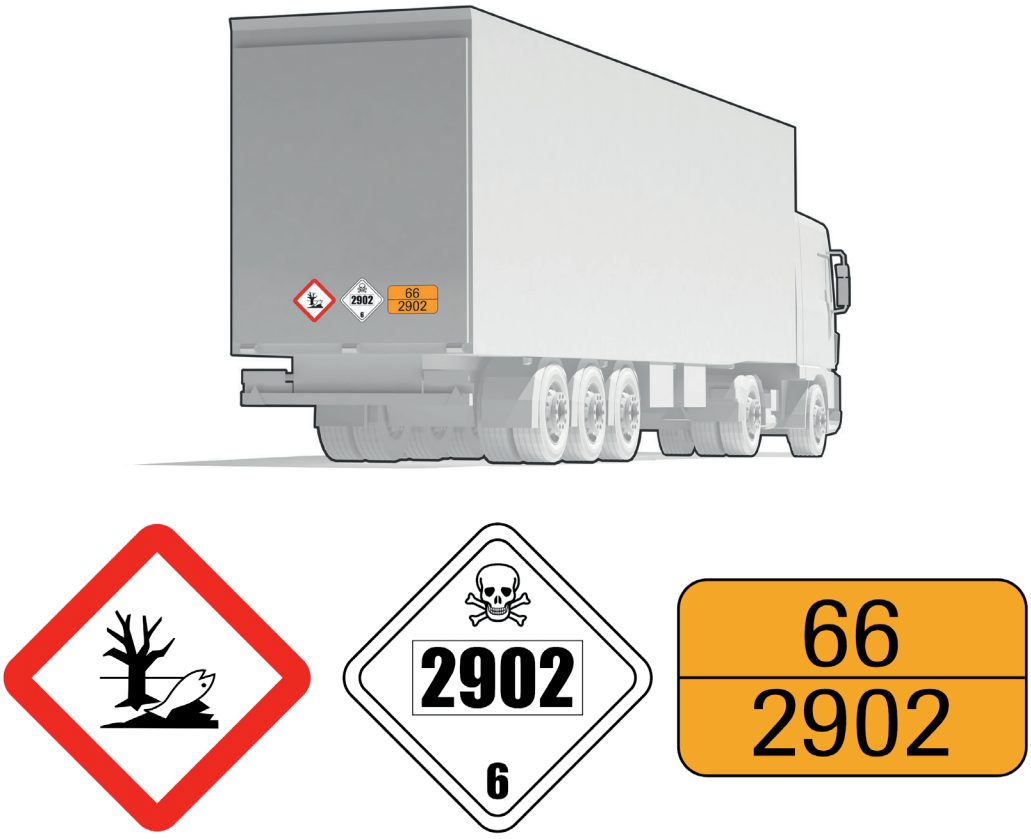
Before an insecticide container reaches the location where it will be used to control locusts, it has often travelled hundreds of kilometres within the country.

LARGE-SCALE TRANSPORT

Large amounts of insecticides may need to be transported between storage facilities in the country or to primary field operations bases and airstrips. This may take place over bad roads, or in areas where there are no roads at all.

Large scale transport of dangerous goods is often regulated by special national legislation, requiring licensing and/or training of transporters. Many countries in the CCA region are signatories to the *European Agreement concerning the International Carriage of Dangerous Goods by Road (ADR)*, which determines, among others, requirements for vehicle crews, equipment, operation, documentation, marking of vehicles and packing (Fig. 18). If national or international transport regulations for dangerous goods apply, they should be followed also for transporting locust control insecticides.

Breakage of containers during transport, or while unloading, is a major risk in locust control operations (Fig. 19). Appropriate tools for loading and unloading larger drums (e.g. planks, bands/ropes, winches or mini cranes) should be available on the truck. Large drums (100 – 200 litres) should never be stacked in more than one layer on the truck bed. Because of their weight they can easily damage the drums in the layer below. Smaller drums, containers and boxes can be stacked in two layers, but not higher. Layers of containers are best separated by pallets and all should be securely fastened both to the pallets and to the truck bed. If this is not possible, stacking should be avoided.



(According to international requirements, many liquid pesticides are marked 60/2902 (toxic) or 66/2902 (highly toxic))

FIGURE 18. NATIONAL OR INTERNATIONAL (ADR) REQUIREMENTS FOR PLACARDING AND MARKING OF VEHICLES TRANSPORTING PESTICIDES SHOULD BE FOLLOWED

It may be tempting to use the truck that transports the insecticides to also send other goods or equipment to the field bases, especially if transportation capacity is limited. However, this should be avoided at all times since the risk of contamination is too high.

Every truck transporting insecticides should have a set of safety equipment on board.

TIP **See the Selected References at the end of the guidelines for further information on this topic.**

SMALL-SCALE TRANSPORT

Typical for locust control is that individual control teams have to transport smaller amounts of insecticides during operations. Because the number of vehicles in a control team tends to be small, such transport may pose problems. Insecticides should never be transported in the vehicle containing food, drinking water or camping equipment. Motorbikes are equally unfit for insecticide transport because the risks of spills and exposure of the driver are high.

It is recommended to use a separate vehicle for transport of insecticides and spraying equipment. All efforts should be made to avoid contamination of the vehicle. If treatments are done with a vehicle-mounted sprayer, the insecticide can sometimes be transported on the bed of the vehicle. In such cases, proper fastening of the containers to the vehicle is crucial, since loose containers may seriously damage the sprayer.

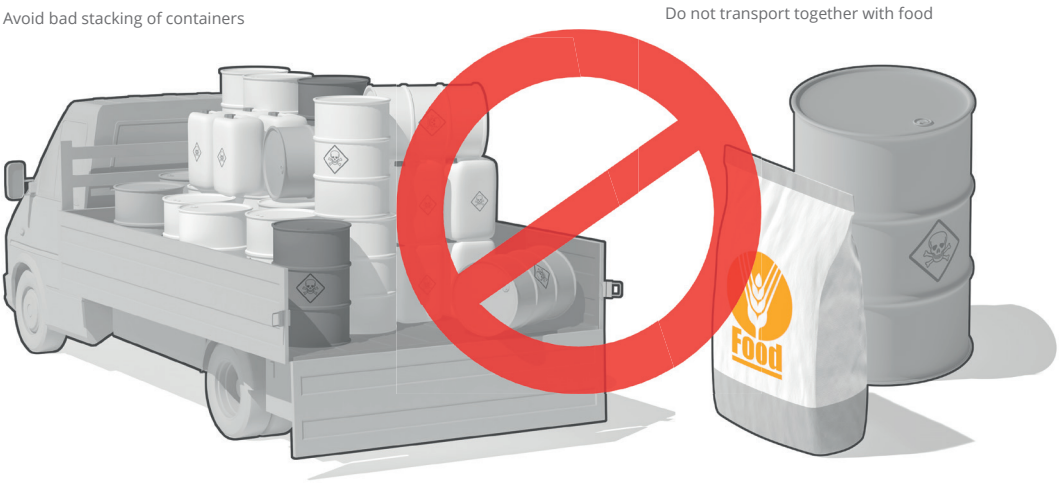


FIGURE 19. **PRECAUTIONS FOR THE TRANSPORT OF INSECTICIDES**

BOX 10. **WHEN TRANSPORTING PESTICIDES, CARRY SAFETY EQUIPMENT ON BOARD**

- personal protective equipment
- jerrycan with clean water
- shovel
- absorbents; decontamination products
- one or more empty drum(s)/containers and pumping equipment
- fire extinguisher (medium capacity)
- safety data sheets of the insecticides being transported

15 INSECTICIDE STORAGE

MIDDLE-SIZED STORAGE

For a major control campaign, large amounts of insecticides may need to be stored temporarily at a limited number of locations, from where they are distributed to the various control sites. Large-scale pesticide stores should be custom-built (Fig. 20). They must have all the necessary safety features to contain possible insecticide spillage, ensure sufficient ventilation and provide protection against rain and sunlight. FAO provides detailed guidelines on the design of pesticide stores.

It is strongly recommended that pesticide stores only contain pesticides. Pesticide application equipment may also be stored in the pesticide store, if properly separated from the pesticides. Under no circumstances should pesticides be stored together with PPE stocks, fertilizers or any type of food.

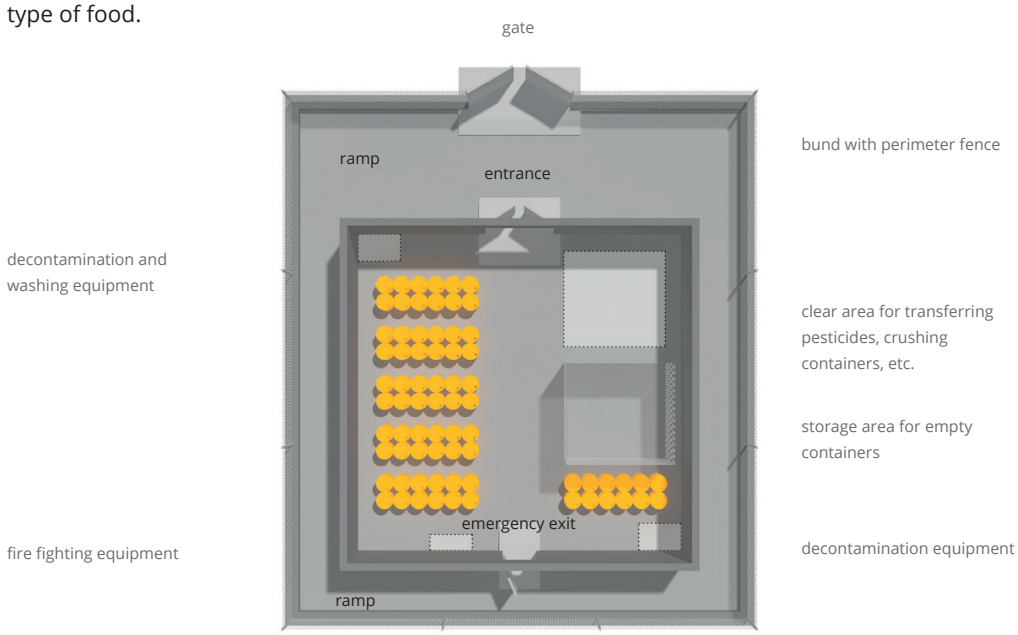


FIGURE 20. **INDICATIVE FLOOR PLAN OF A MIDDLE-SIZED PESTICIDE STORE**

SMALL-SCALE TEMPORARY STORAGE

Typical for locust control is that relatively small amounts of insecticides need to be stored at a locust control base or even at the field site. Small-scale pesticide storage should also comply with strict safety requirements, especially since such it may be located close to habitations. Pre-fabricated stores and storage cabinets exist specially for this purpose (Fig. 21). Locust control units should build or place small pesticide storage units or cabinets at all bases where locust control operations are conducted regularly.

In some cases, insecticides may need to be temporarily stored at the control site, in the field. This may occur if locust populations are far away from bases or, if aerial control is done, next to an airstrip. In such situation, the storage site should be set up well away from habitations and a good distance from, and downwind of, the control camp. Care should be taken that insecticides are stored in the shade, whenever this is possible (e.g. by covering with a tarpaulin). Overheating may lead to build-up of pressure inside the insecticide containers, which may burst or forcefully eject the product when the bungs are opened. Do not store gasoline, kerosene, or other combustible materials close to the pesticides. Storage sites should be guarded at all times to avoid local people being exposed to the insecticides.

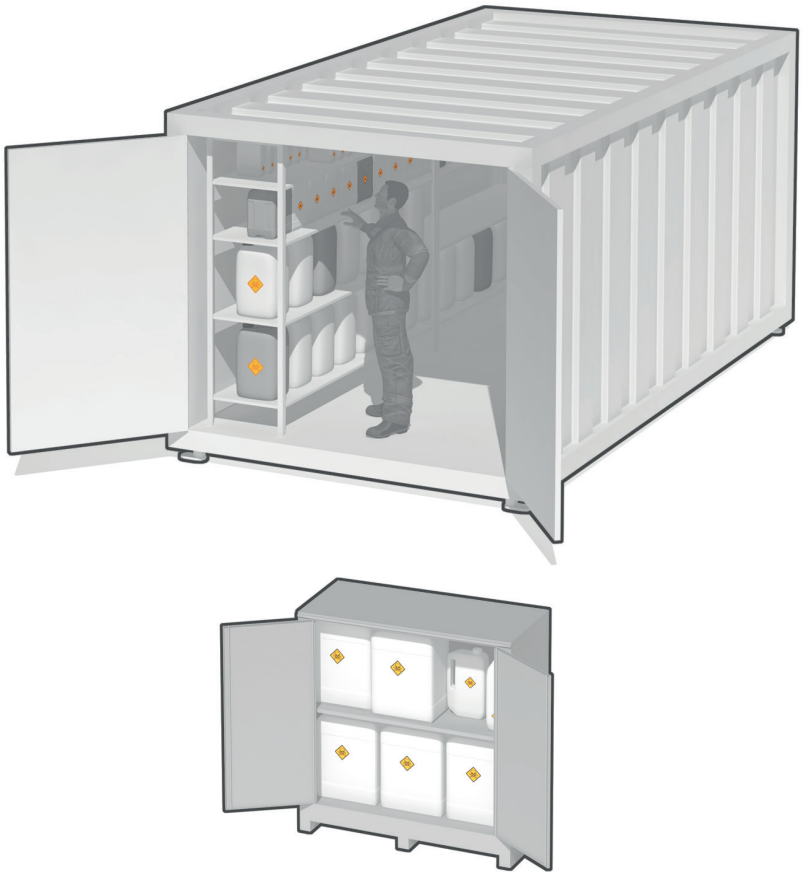


FIGURE 21. **SMALL SCALE PESTICIDE STORAGE. TOP: PREFAB PESTICIDE STORE WITH SAFETY FEATURES (E.G. FIRERESISTANT, INTERNAL BUNDING TO CONTAIN LEAKS, VENTILATION, LOCKS). BOTTOM: STORAGE SAFETY CABINET, FOR SMALL QUANTITIES OF PESTICIDES**

TIP **See the Selected References at the end of the guidelines for further information on this topic.**

16 MIXING AND LOADING INSECTICIDES

PERSONAL PROTECTIVE EQUIPMENT

Mixing the insecticides and loading them into the sprayer probably pose the highest risk during control operations, because the product is concentrated and the risk of splashing is high. Appropriate PPE (especially gloves, face shield, impermeable apron and boots – see Box 5 should be worn. Personnel should be well trained to carry out the mixing/diluting and/or loading operations.

Mixing and loading of the insecticides should always be done well away from habitations, bystanders, animals and water sources.

MIXING INSECTICIDES

The UL formulations used in locust control are generally ready for use and no mixing with diluents is required. An exception is the biopesticide Metarhizium, where dry spores of the fungus need to be mixed with vegetable oil and/or diesel oil. This requires a special mixing procedure, for which a separate instruction is available from the supplier or FAO.

EC and SC formulated insecticides need to be mixed with water. Use clean water to ensure that the insecticide remains efficacious and to avoid blocking of the spray equipment.

LOADING INSECTICIDES

Vehicle-mounted and hand-held sprayers

Depending on the size of the insecticide containers, UL formulations can either be poured directly into the spray tank (for containers up to 10 litres) of transferred using a hand-operated drum pump (for larger containers) (Fig. 22). When pouring the product directly into the spray tank, pour slowly, allowing air to enter the container so avoiding gurgling and splashing. Hand-held sprayers are normally filled by pouring the insecticide directly from the container. A wide funnel should be used to facilitate pouring and avoid spillage.

When loading water-based formulations (EC, SC), it is generally best to half fill the spray tank with water before adding the product and then fill the sprayer with the rest of the water. Pumping water into large tractor-trailed spray tanks is often done using a motorized pump. The EC and SC products used in CCA tend to be packed in relatively small containers (e.g. 5 or 10 litres), which can be poured directly in the spray tank. Pour slowly, allowing air to enter the container so avoiding gurgling and splashing. Some sprayers now have a closed transfer system or a low level induction hopper to add the formulated product to the tank, which greatly reduces the risk of contamination of the operator. Such systems integrate a pressure rinsing option to clean the container.

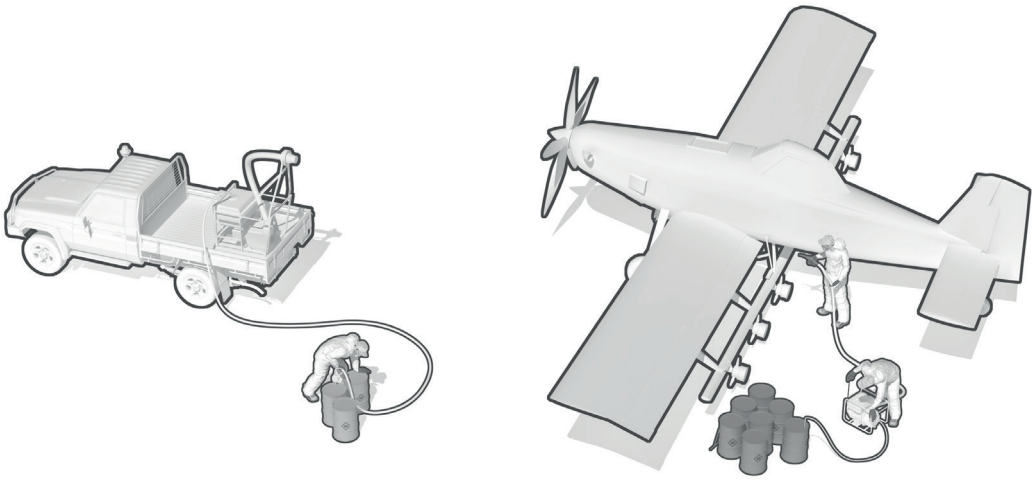


FIGURE 22. **FILLING OF PESTICIDE SPRAYERS WITH INSECTICIDES USING PUMPS. LEFT: MANUAL DRUM PUMP; RIGHT: MOTORIZED AIRCRAFT PUMP**

Filling aircraft tanks

Aircraft spray tanks (also called "hoppers") are generally filled with UL insecticides using a motorized pump (Fig. 22). This is potentially a hazardous operation, because if an accident occurs the operator may literally be drenched by the insecticide.

The main risks associated with pesticide pumps are bursting of hoses and loosening of the connections between the hose and the pump. Both risks are more likely to occur with motor pumps. It is therefore essential that pumping gear is of good quality and well maintained. UL insecticides may be corrosive and can destroy pump hoses relatively rapidly. When hoses/connections are covered with Teflon, corrosion is greatly reduced. Hoses should be checked daily for wear and tear and corrosion, and replaced as soon as needed. Similarly, connections between the hose and the pump may slowly loosen during operation, increasing the risk of operator exposure. They should be checked and fastened on a daily basis.

Directly pouring UL insecticides from drums into an aircraft hopper poses a high risk of operator contamination and may also damage the aircraft. This practice is therefore not recommended.

Filling aircraft hoppers with water-based insecticides follows a different procedure. Since agitation of the spray solution is limited during filling and ferrying, the use of a pre-mix facility is recommended. Water and insecticide formulation are mixed in a ground ("nurse") tank, where frequent re-circulation of the contents will ensure that there is no phase separation. The water-insecticide mixture is then pumped into the aircraft hopper. Although water-based formulations tend to be less corrosive than UL formulations, it is essential that the quality of the pumping materials is checked as well as its compatibility with the mixed insecticide.

RINSING EMPTY CONTAINERS

Empty insecticide containers should preferably be rinsed on the site of the treatment.

Containers that held water-based insecticide formulations should be rinsed with water (Fig. 23). Such containers can be triple-rinsed by hand or using the pressure rinsing equipment, which is part of many modern sprayers.

Plastic rinsed containers must be punctured to avoid re-use for food or drinking water. They should then be stored in a secure location until transport to a central store, where they can be recycled or disposed of. Containers that held UL formulations, which are oil- or solvent-based, cannot be rinsed with water. They should be closed and transported to a central location for further treatment.

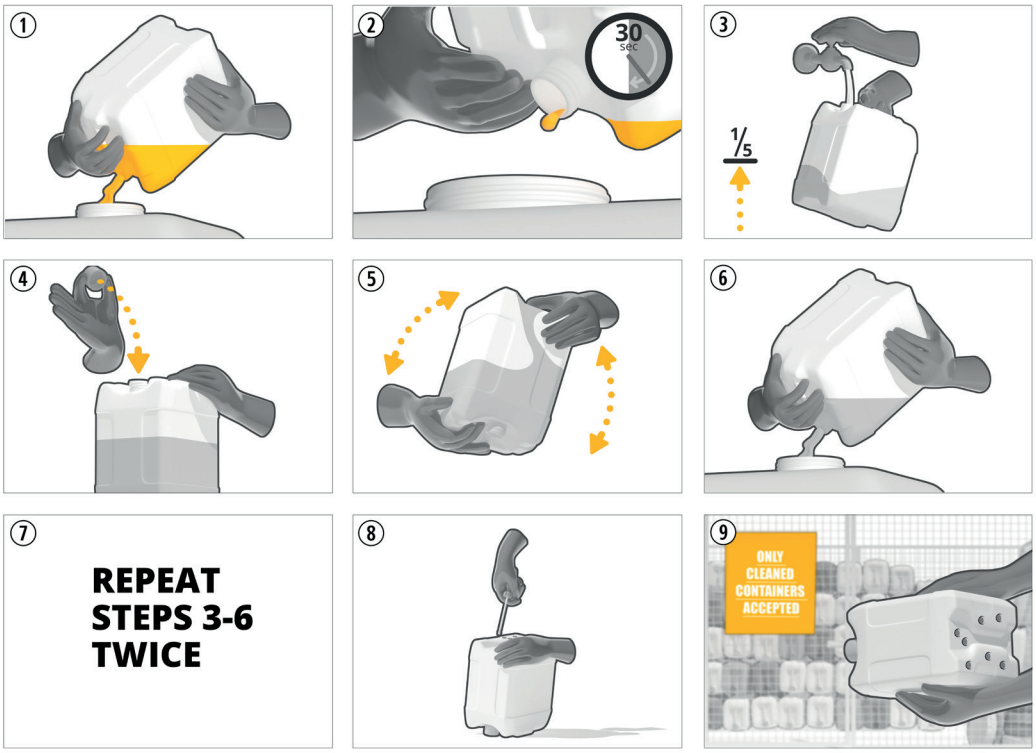


FIGURE 23. **TRIPLE RINSING PROCEDURE FOR CONTAINERS WITH WATER-BASED INSECTICIDES**

17 INSECTICIDE APPLICATION

GOOD APPLICATION PRACTICES

Mastering appropriate application techniques greatly reduces the probability of exposure to the insecticide of control staff, bystanders and the environment. Control staff should therefore be well trained before the start of the campaign (see Section 12) and supervised during the treatments.

Good-quality application equipment, properly maintained and calibrated, is another important risk reduction factor. Sprayers should not leak and must be regularly cleaned. Note that even a well-maintained sprayer, if not properly cleaned, forms a source of exposure to insecticide. Similarly, tractors and spray vehicles should be cleaned after each use, to avoid contaminating the driver or operator.

Locust targets (hopper bands, concentrations of adults or hoppers) need to be treated in the correct way to ensure optimal efficacy, but also to avoid undue exposure of operators, bystanders and non-target areas (Fig. 24). While it is recognized that topography and vegetation may sometimes complicate treatments, strict adherence to good application practices is required at all times (Box 11). Deviating from good spraying practice will almost always result in reduced locust mortality, wastage of insecticides, contamination of the spray vehicle or tractor and exposure of control staff. Furthermore, non-target areas or bystanders risk being exposed.

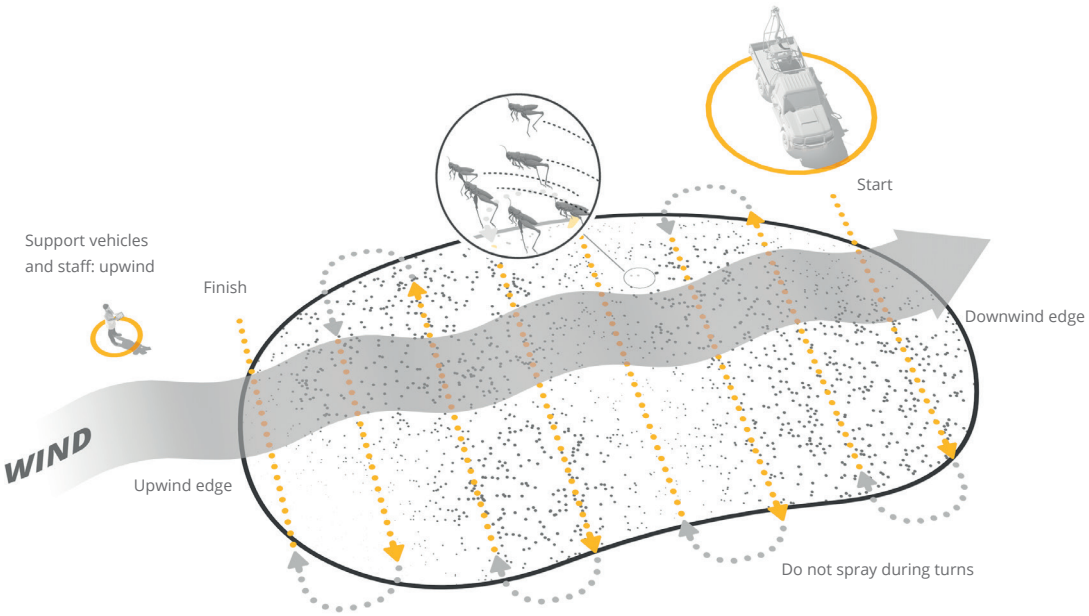


FIGURE 24. GOOD PRACTICE FOR SPRAYING A LOCUST TARGET. ORANGE ARROWS = SPRAYER ACTIVE; GREY ARROWS = SPRAYER CLOSED

BOX 11. GOOD INSECTICIDE APPLICATION PRACTICE INCREASES EFFICACY AND REDUCES CONTAMINATION

- **Check the label** for specific precautions during spraying.
- Make sure that the sprayer settings, speed and track spacing result in the **correct dose rate**.
- **Spray cross-wind** to ensure spread of the insecticide over the target and minimize exposure to spray droplets.
- Always **start spraying at the downwind side of the plot,** and move upwind, to avoid walking / driving / flying through the spray could or the treated area.
- **Stop the sprayer when turning** from one pass to the other.
- **Avoid spraying at low wind speed** since spray droplets will not move away from the sprayer and the operator.
- When applying water-based pesticides, **avoid hot conditions**, as spray droplets evaporate quickly and lead to low efficacy and uncontrolled drift.
- **Avoid spraying under convective conditions**, when droplets will be taken upwards, and will not deposit in the spray plot; operator contamination is also more likely.
- Always keep support vehicles and equipment, as well as any support or supervisory staff, **beyond the upwind side of the plot**.

MINIMIZING EXPOSURE OF CONTROL STAFF

All staff that may be exposed to the insecticide before, during and after the application (applicators, drivers, supervisors and other support staff) should wear appropriate PPE (see Sections 7 and 18). It should be stressed that PPE is only the last line of defence against insecticide exposure. The degree of protection provided by the PPE used in locust control is limited. It will definitely not protect the applicator against careless insecticide application or faulty spray equipment. Good spray practices, discussed above, are the first line of defence against pesticide exposure!

If PPE gets contaminated, it should either be cleaned immediately (if possible) or replaced. Do not continue to work with contaminated PPE as it becomes a continuous source of exposure to the insecticide. At the end of the working day, PPE should always be cleaned and stored away from pesticides, food items and drinking water. Preferably, a dedicated PPE storage box is used, to avoid that PPE gets contaminated by the insecticides (Fig. 25).

Finally, basic occupational hygiene should be strictly adhered to, as this further reduces the risk of exposure to the insecticides.

MINIMIZING EXPOSURE OF BYSTANDERS, LIVESTOCK AND SENSITIVE AREAS

All persons who have no direct role in the insecticide applications should be kept at a safe distance. Inhabitants of the zone in which the treatments take place must be informed of the operation beforehand, and warned not to come close to it (Fig. 26). The same holds true for livestock. During spraying, control staff who are not directly involved in the application should verify that bystanders remain at a safe distance. If it is impossible to avoid spectators, ensure that they remain upwind from the treatment.

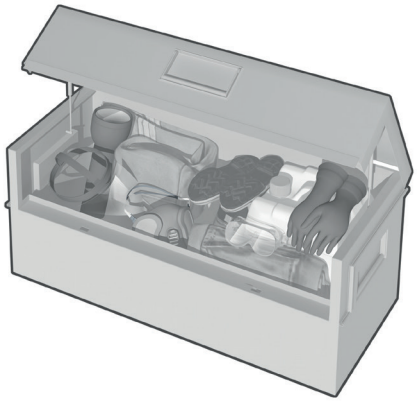


FIGURE 25. PERSONAL PROTECTIVE EQUIPMENT IS BEST STORED IN A SEPARATE DEDICATED STORAGE BOX, WHICH CAN BE PLACED OR FIXED IN THE VEHICLE, TO AVOID CONTAMINATION OF OTHER EQUIPMENT IN THE VEHICLE

Certain areas will be off-limits for all insecticide treatments against locusts. This will normally be the case for villages or habitations, open water and nature reserves. The campaign organization should prepare a list of areas that cannot be sprayed directly or contaminated by insecticide drift (Section 6).

If such areas lie downwind of the spray target, sufficient distance needs to be kept to ensure that insecticides do not drift into them. The size of these unsprayed buffer zones will depend on the type of application (air or ground), the type of spray equipment (e.g. hand-held or vehicle-mounted), weather conditions (e.g. wind speed), topographical conditions (e.g. density and height of vegetation) and the sensitivity of the area to be protected (Box 12).

BOX 12. SUGGESTED MINIMUM BUFFER ZONES TO BE APPLIED IN LOCUST CONTROL FOR THE PROTECTION OF ECOLOGICALLY SENSITIVE AREAS

Note: Distances are indicative; their effectiveness to protect sensitive areas will depend on equipment and weather conditions and should be monitored.

Type of sprayer	Emission height	Minimum buffer distance[1]
Micro-ULVA, manual backpack sprayer	1 m	100 m
Motorized backpack sprayer (with or without ULV attachment)	1 – 2 m	200 m
Vehicle mounted sprayer (Micronair AU 8115, ULVAMast, tractor-trailed airblast sprayer)	2 – 3 m	400 m
Aircraft, ultra-light aircraft (rotary atomisers, nozzles)	10 – 15 m	1500 m

1 Distance to be left unsprayed between the first (downwind) spray run and the area that needs to be protected.

Wells or water holes that lie in, or close to, the area that will be treated should always be covered (Fig. 26). Beehives may also be covered for a short period of time, to protect them from any unexpected spray drift. However, it is important to ensure that the hives do not overheat. Therefore, moving beehives away (at least 3 km) from the treated area is the recommended procedure.

Spray operators, drivers and pilots should always be attentive to unforeseen circumstances. People or livestock may wander into the spray area inadvertently, ponds or water-holes may have been missed during survey of the spray area, a flagman may forget to move upwind in time, etc. In all such cases, application should be stopped temporarily, to avoid exposure of the non-target persons or organisms.

Keep bystanders and livestock away from the treatments

Request beekeepers to move beehives away from the areas to be treated

Cover wells and water holes

FIGURE 26. BEFORE STARTING THE CONTROL OPERATIONS, CONTROL STAFF SHOULD INSTRUCT LOCAL POPULATIONS TO FOLLOW PRECAUTIONARY MEASURES TO AVOID EXPOSURE

Basic occupational hygiene when working with insecticides

- Do not eat, drink or smoke during or immediately after applying insecticides
- Do not touch your face or skin with contaminated hands or gloves
- Wash thoroughly, with clean water and soap, after each treatment
- Always wash your hands and face before eating or drinking after the treatment
- Wash PPE on a regular basis; wash gloves after each treatment; check PPE for damage or contamination after each treatment

TIP

See the Selected References at the end of the guidelines for further information on this topic.

18 USE AND MAINTENANCE OF PERSONAL PROTECTIVE EQUIPMENT

The recommended minimum PPE for locust control is listed in Section 7. It is based on the most hazardous type of insecticides used in locust control (WHO class II). However, it is recommended that this PPE is considered as a standard, even if less hazardous insecticides are used. Locust control is a very visible activity and control staff should set an example for other pesticide users in the country.

As discussed in the previous section, personal protective equipment (PPE) is the last line of defence against exposure to insecticides and will never provide absolute protection in itself.

PPE should be comfortable to wear. Using heavy or impermeable overalls, under the hot conditions often encountered in locust control, may result in overheating (Fig. 27). This may reduce the

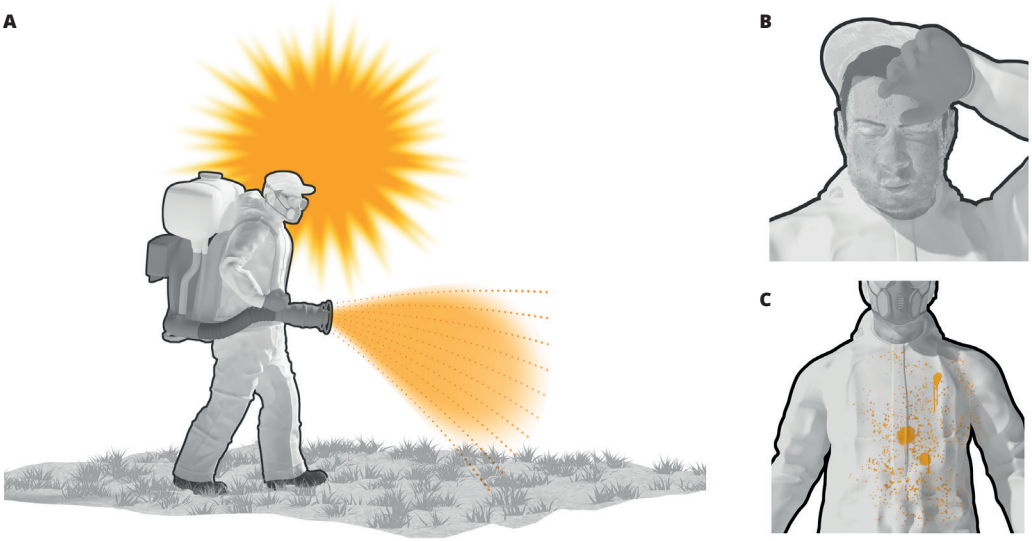


FIGURE 27. **LOCUST CONTROL MAY POSE AN INCREASED RISK OF EXPOSURE TO INSECTICIDES, EVEN WHEN USING APPROPRIATE PERSONAL PROTECTIVE EQUIPMENT (PPE). THIS IS BECAUSE (A) OVERHEATING MAY RESULT IN MISTAKES BEING MADE; (B) SWEATING INCREASES INSECTICIDE ABSORPTION BY THE SKIN; (C) REPLACEMENT PPE MAY NOT BE IMMEDIATELY AVAILABLE, FORCING STAFF TO CONTINUE WORKING WITH CONTAMINATED PPE**

concentration of applicators and result in errors; it can even cause heatstroke, a very serious medical emergency. However, lighter and more breathable overalls tend to be more permeable and extra caution is needed during insecticide handling and spraying.

Gloves should be long, covering most of the forearm. When mixing and loading liquid insecticides, gloves should go on the outside of the overall sleeves, and have the cuff turned over, providing a well to catch any insecticide that may run up the arm (Fig. 10).

When spraying pesticides, overall sleeves are best worn over the gloves.

BOX 13. MAINTENANCE OF PERSONAL PROTECTIVE EQUIPMENT (PPE) USED FOR LOCUST CONTROL

Item	Maintenance	Equipment to be replaced if:
Cotton overalls, cotton hats or caps	Wash immediately if contaminated with insecticide. Otherwise, wash regularly (every 2-3 days) with water and soap, separate from domestic laundry.	• Smell of insecticide remains after washing • Drenched by insecticide
Nitrile or PVC gloves	Wash with water and soap after each treatment	• Damaged or leaking • Permanently stained by insecticide • Contaminated on the inside
Chemical resistant boots and apron	Wash with water and soap after each treatment	• Damaged or leaking • Permanently stained by insecticide • Contaminated on the inside
Respirator half-mask with fixed filters or cartridges	Wash the synthetic rubber part of the mask (inside and outside) carefully with water and soap after each treatment. Do not wash the filters or cartridges!	• Damaged • Shelf-life of cartridge has expired (check on packaging or on filter) • Insecticide can be smelled through the mask: replace cartridges or mask.
Face shield or goggles	Wash with water and soap after each treatment	• Damaged • Visor becomes opaque
Disposable overalls (splashproof or liquid-tight)	Dispose at end of each working day. May be reused once or twice if clearly not contaminated.	• Contaminated • End of working day
Disposable dust masks	Dispose at end of each working day.	• Contaminated • End of working day

Respirator cartridges may become unusable before the end of the effective use period mentioned on the label. This is because they may get clogged up with dust or become ineffective due to high humidity. Check cartridges therefore regularly and discard them immediately if one can smell the pesticide while wearing the respirator.

It is of paramount importance that PPE is properly cleaned and maintained. Contaminated PPE worn directly on the body is a continuous source of exposure to insecticides. This may be more dangerous than wearing no PPE at all. Recommendations on PPE maintenance are given in Box 13. Ensure that sufficient spare PPE is available for each control team, to replace contaminated, worn or damaged items.

!

Gloves are one of the most important pieces of PPE

- Wash the outside of your gloves with water and soap while they are still on your hands
- After removing your gloves, always also wash your hands with water and soap.
- Insecticides gradually permeate gloves, even if they are chemical resistant, whether they are intact or not. Replace gloves gradually.

19 INSECTICIDE POISONING

SIGNS AND SYMPTOMS OF POISONING

Even when all efforts have been made to reduce insecticide exposure, and appropriate personal protective equipment is used, insecticide poisoning may still occur. Unfortunately, the signs and symptoms of insecticide poisoning are generally not very specific and may also be the result of other health problems (Box 14). This means that field staff should be vigilant. If doubts exist as to whether symptoms are related to insecticide exposure or not, the affected person should stop handling the product and see a doctor.

FIRST AID AFTER INSECTICIDE EXPOSURE

First aid after insecticide exposure is of vital importance and may save lives (Fig. 28). The most important aspects of first aid are to stop further exposure to the insecticide, and to stabilize the patient if needed. After that, the patient should be taken to a doctor as soon as possible. Control team leaders should always have the contact information of the nearest medical facility that can treat poisoning.

BOX 14. SIGNS AND SYMPTOMS OF POISONING BY INSECTICIDES USED IN LOCUST CONTROL IN CCA

The most characteristic signs and symptoms are orange

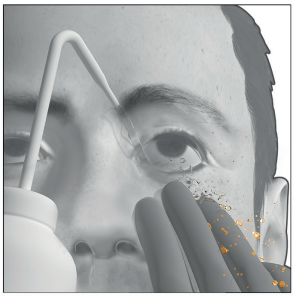
Part of the body	Signs & symptoms	Insecticide group		
		OP	PY	NN
Whole body	discomfort, fatigue, dizziness	X	X	X
Skin, face	irritation, strong tingling		**X**	
	excessive sweating	**X**		
	rash			**X**
Eyes	irritation		X	**X**
	tearing	**X**		**X**
	constricted pupils	**X**		
Nervous system	headache	X	X	X
	trembling muscles, tremor	X	**X**	
	lack of coordination	X		
	hyper-excitability		**X**	
Respiratory system	running nose	X		
	difficult respiration	X		**X**
Stomach & intestines	nausea, feeling sick, vomiting	X		**X**
	diarrhoea	X	X	
	salivation	**X**	**X**	X
Blood	reduction in cholinesterase levels	**X**		

Insecticide groups: OP = organophosphates, PY = pyrethroids, NN =neonicotinoids

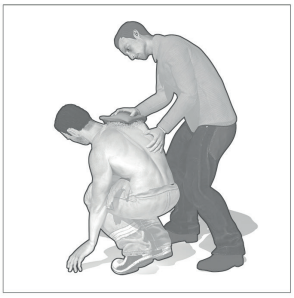
No particular signs or symptoms are identified for poisoning by benzoyl-ureas. Poisoning symptoms of *Metarhizium* are highly unlikely.

TREATMENT OF INSECTICIDE POISONING

The treatment of severe insecticide poisoning is complicated, even in specialized wellequipped hospitals. In locust control, the distances between the control sites and medical facilities may be long, further complicating fast treatment. Therefore, it is absolute priority to avoid insecticide exposure and poisoning! Insecticide poisoning should be treated by trained medical staff, who have details about the right treatment.



If insecticide in EYES – wash thoroughly (15 minutes) with clean water



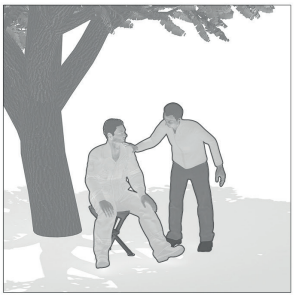
If insecticide on SKIN – wash thoroughly with clean water and soap

If insecticide on CLOTHING – take off clothing and wash skin with water and soap

If insecticide INGESTED – do not induce vomiting but give active charcoal solution

If person is UNCONCIOUS – check that breathing passages are clear; place person on the side with head down and tongue drawn forward

If person STOPS BREATHING – start artificial respiration (make sure you do not get contaminated yourself)



ALWAYS – keep person calm and cool

ALWAYS – take person to nearest medical facility

ALWAYS – bring insecticide label or safety data sheet to medical facility

FIGURE 28. FIRST AID MEASURES TO BE TAKEN IN CASE OF INSECTICIDE EXPOSURE AND POISONING

20 WITHHOLDING PERIODS

After an insecticide treatment against locusts, a minimum time interval needs to be respected before humans or livestock can re-enter the treated area or before treated crops are harvested. This allows insecticide residues to degrade to acceptable levels. Such minimum time intervals are generally called withholding periods (Fig. 29)

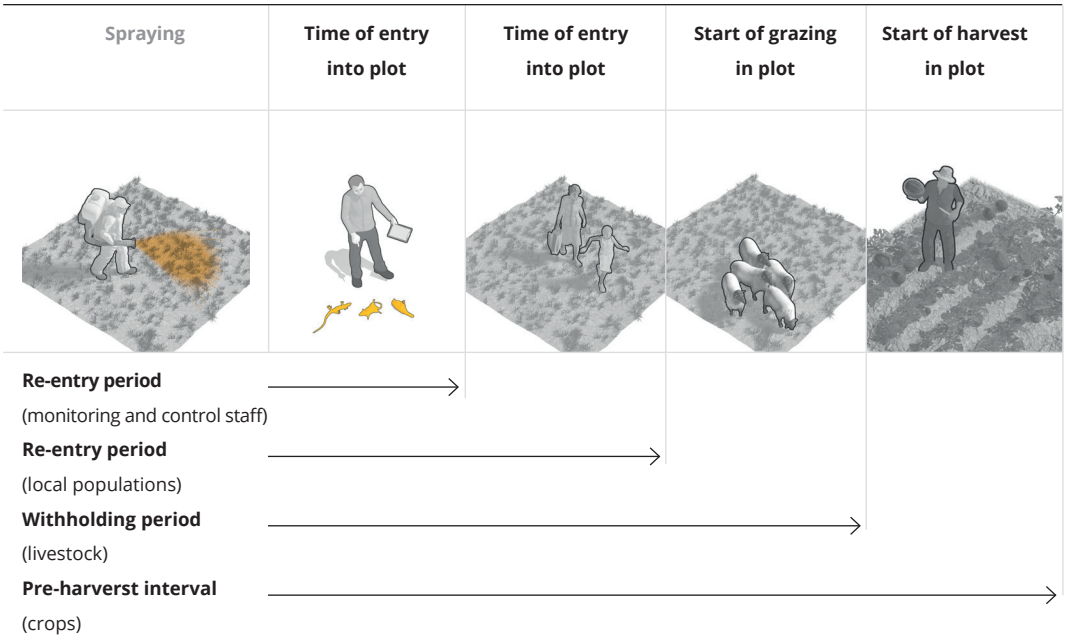


FIGURE 29. **DIFFERENT TYPES OF WITHHOLDING PERIODS APPLY TO INSECTICIDE USE IN LOCUST CONTROL**

Withholding periods are normally proposed by the manufacturer of the insecticide and reviewed by the national regulatory agency responsible for pesticide registration. It is subsequently listed on the pesticide label. Locust control staff should inform the local population about these withholding periods and explain why it is important to respect them. Control staff should set an example by strictly respecting these intervals themselves.

RE-ENTRY PERIOD – MONITORING AND CONTROL STAFF

Monitoring or control staff sometimes need to enter a sprayed plot shortly after treatment, for instance to check locust mortality or take residue samples. If appropriate protective clothing is worn, this should not pose an unacceptable risk to personnel. However, a minimum re-entry period should be respected to allow the spray cloud to settle and avoid inhalation of small spray droplets.

RE-ENTRY PERIOD – LOCAL POPULATIONS

The local population normally does not have protective clothing. Therefore, before bystanders and local inhabitants can re-enter a treated plot, the insecticide deposit on vegetation must have dried up completely and the remaining residue should not pose a risk through dermal exposure (e.g. if people brush against the treated vegetation). Warning signs should be placed at the borders of treated area to inform local populations to stay out of the plot during the reentry period.

WITHHOLDING PERIOD – LIVESTOCK

The withholding period for livestock is generally longer than the re-entry period for the general public. This is because livestock will feed on the treated vegetation. The risk of poisoning of livestock after locust control, at dose rates recommended by the Pesticide Referee Group, is very low. However, minimum withholding periods should be respected to avoid the risk of insecticide residues in meat or milk. In certain countries, livestock is allowed in the sprayed area but then an extended withhold-from-slaughter period is imposed.

PRE-HARVEST INTERVAL – CROPS

The strictest withholding periods tend to be those for the harvesting of crops for human consumption. At harvest, insecticide residues should not exceed the so-called maximum residue limits (MRLs). These may be set by the national regulatory authorities; international MRLs are defined in the Codex Alimentarius.

!

Withholding periods for locust control insecticides are not defined internationally

- Consult the label of the insecticide that you use, to get information about re-entry periods, livestock withholding periods or pre-harvest intervals that should be respected.

21 EMPTY CONTAINERS

Empty insecticide containers, drums or bags are a health risk to humans and the environment because small amounts of the insecticide will always remain in the containers. Empty insecticide containers should therefore never, under any circumstances, be reused for storage of drinking-water or food, not even after cleaning. Control staff should not respond positively to requests from the public for empty insecticide containers (Fig. 30).

FIGURE 30. **HOW NOT TO DISPOSE OF EMPTY INSECTICIDE CONTAINERS**

Empty containers of water-based (e.g. EC, SC) insecticides can easily be triple-rinsed on site (Fig. 21). They should be punctured afterwards, to avoid re-use. ULV insecticide containers should be well drained in the spray tank and then closed (Fig. 31).

Empty containers must never be burned or buried on site, since this is dangerous to both humans and the environment. Instead, all empty containers should be returned to the locust control base, where they should be temporarily stored in a secure location. As a matter of principle, for every full insecticide container handed out to a control team, an empty one should be returned ("one-out-one-in" principle). Pesticide store keepers or persons responsible for the insecticide stock should include empty containers in their stock administration.

Empty containers collected at the locust control base are returned to the central national store(s) whenever possible. Generally, they can be sent back with the same truck that supplies the base with new insecticides.

At the end of the control campaign, all empty containers should be recycled or disposed of in an appropriate manner (Section 27).

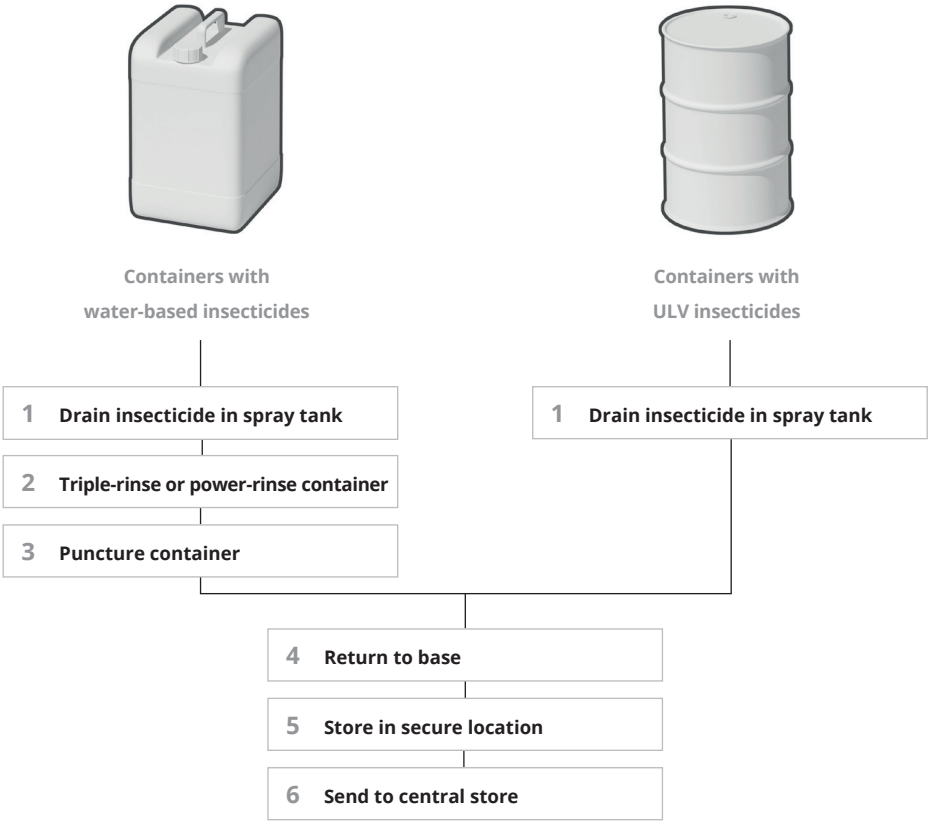


FIGURE 31. THE MANAGEMENT OF EMPTY INSECTICIDE CONTAINERS FOLLOWS DIFFERENT STEPS, DEPENDING ON WHETHER THE FORMULATION IS WATER-BASED OR ULV

1 full drum out of the store = 1 empty one returned

- Store keepers should ensure that the empty insecticide containers are returned for all full ones that have left the store.

22 CLEANING AND MAINTENANCE OF SPRAY EQUIPMENT

CLEANING

It is vital for the continued good operation of the sprayer that it is flushed out and cleaned after use. This is best done immediately after each control operation is finished and in the area that was treated. Technicians and drivers should wear protective clothing when cleaning or maintaining sprayers.

Under no circumstances should any insecticide be left in the sprayer when it is not in use. The spray tank should be drained after the control operation, using the drain valve, and remaining product should be collected for future use (or disposal).

Many vehicle-mounted sprayers have a special rinsing tank for flushing the insecticide from the spray tank and the piping and tubing. Flushing can be done with clean water (for waterbased insecticide formulations), or diesel or kerosene (for UL formulations). A backpack or hand-held sprayer can be flushed in a similar manner by adding some water or diesel to the spray tank. Any inline filters or strainers should also be disconnected and cleaned. The cleaning liquid can then be sprayed out over the treated plot, to avoid contaminating non-target areas. This will also clean the spray head or nozzles.

Aircraft spray tanks should also be flushed and the rinse liquid sprayed onto the treated area. A good commercial detergent can be used and followed by a thorough flush with water. For ULV insecticides an appropriate solvent should be used to rinse the spraying system. If cleaning is incomplete, product deposits may build up in un-purged areas or on rotary atomisers throwing them out of balance. Vegetable oil used as a spray carrier can be fully removed by washing with water and a detergent solution immediately after spraying is completed. Complete spray system rinsing and draining is important as some aircraft plumbing can retain as much as 30 litres of spray solution or ULV product when they are considered “empty”.

After flushing, all external surfaces of the sprayer, the spray vehicle or the aircraft should be washed with water and detergent (Fig. 32). Dirty sprayers and vehicles will contaminate the locust control staff.

ROUTINE MAINTENANCE

If motorized sprayers are used, general motor maintenance needs to be done on a regular basis. This may include checking the oil level of the engine, cleaning spark plugs and checking and cleaning the fuel and air filters. At the end of the control campaign, any fuel should be flushed from the carburettor and the fuel tank.

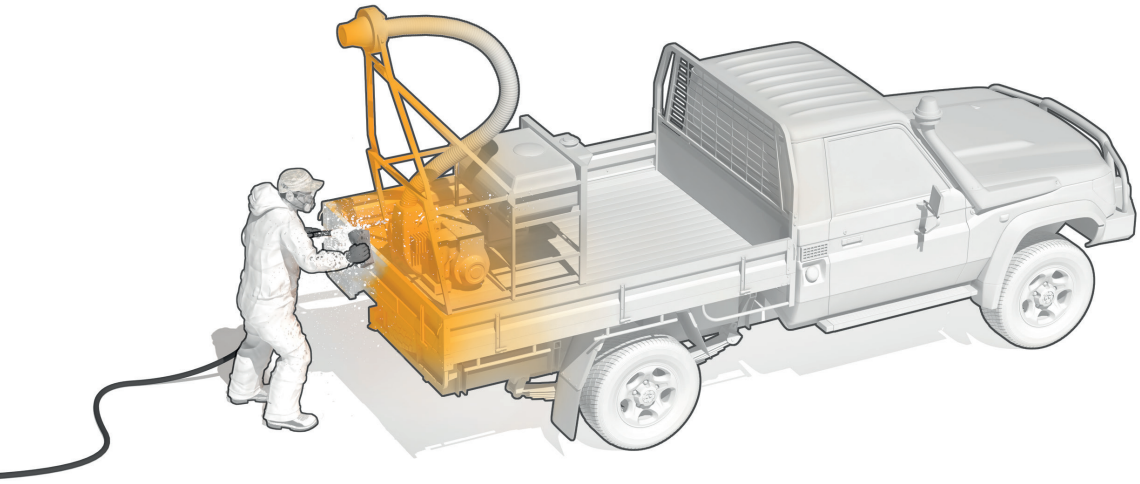


FIGURE 32. RINSING OUT THE SPRAYER AND CLEANING ITS OUTSIDE AS WELL AS THE VEHICLE WILL ENSURE LONGTERM PROPER OPERATION OF THE EQUIPMENT AND MINIMIZE EXPOSURE OF LOCUST CONTROL STAFF TO THE INSECTICIDES

Maintenance of the sprayer will include regularly checking the seals and tubing of the sprayer for any leaks, verifying and cleaning the pesticide filter and checking the functioning of the pump. It is recommended to carry a few spare seals and washers to replace faulty ones. The Manufacturers' handbooks will have further information about the best procedures to clean and maintain the application equipment.

23 MONITORING – RAPID ASSESSMENTS CONDUCTED BY THE CONTROL TEAMS

Monitoring of control operations is not the primary responsibility of control teams, since they need to focus on finding and treating locust targets. However, control teams should conduct limited monitoring, referred to as "rapid assessments". This is very important because in such a way basic data are collected for all insecticide treatments.

The main objective of rapid assessments by the control teams is to alert the campaign management about potential problems during the control operations (Fig. 33).

FIGURE 33. THE PRINCIPAL OBJECTIVE OF RAPID ASSESSMENTS BY LOCUST CONTROL TEAMS IS TO ALERT THE CAMPAIGN MANAGEMENT ABOUT POSSIBLE PROBLEMS WITH THE CONTROL OPERATIONS

The following activities are part of a rapid assessment:

SPRAY MONITORING

Key insecticide application parameters should be collected for each individual control operation. They include: the exact control location, insecticide data, weather conditions during spraying and equipment settings. These parameters are all included in the Automated System of Data Collection (ASDC). Control teams should use the table computers with the ASDC and fill out the data for each sprayed target (Fig. 34). Alternatively, the FAO/CCA Spray Monitoring Form should be used.

Since insecticides and their application represent the most expensive parts of a locust control campaign, incorrect spraying may be very costly. Spray monitoring is therefore essential, both from an economic and an environmental point of view. Furthermore, if a problem with a treatment is observed, knowledge about the insecticide application parameters is required to find solutions.

For environmental and health monitoring of locust control operations, the following information is of particular importance:

- Location of the treatment (preferably latitude/longitude of treated area)
- Area treated (measured or calculated)
- Insecticide information (active ingredient, concentration)
- Dose rate and volume of working solution of the insecticide applied
- Estimated control efficacy
- Personal protective equipment worn by control staff
- Health or environmental incidents (if any)

FIGURE 34. THE AUTOMATED SYSTEM OF DATA COLLECTION (ASDC) SHOULD BE USED TO DOCUMENT THE INSECTICIDE APPLICATION PARAMETERS OF EACH TREATMENT

EFFICACY OF THE TREATMENTS

Efficacy assessments are done to verify whether the insecticide, the control technique and spray parameters are effective. They do not have to be conducted after each treatment, but it is recommended that efficacy is checked regularly, even for those insecticides that have been used for a long time.

EXPOSURE OR POISONING INCIDENTS AMONG CONTROL AGENTS

If any insecticide exposure or poisoning of control staff occurs, it should be reported in as much detail as possible. Some space is reserved for this in the ASDC. The Pesticide Use Passport contains a more detailed form to document accidental poisoning.

PESTICIDE USE PASSPORT

Increasingly, locust control organizations require that a Pesticide Use Passport is filled out to document the pesticide use of individual control staff (see Section 9).

Control staff or their supervisors should fill out the passport after every day that an insecticide has been applied, and for each staff member involved in the treatment.

INCIDENTS OF ENVIRONMENTAL CONTAMINATION OR EXCESSIVE MORTALITY OF NON-TARGET ORGANISMS

Excessive mortality of non-target organisms (e.g. fish, bees, birds), as well as any insecticide spills, should be reported in the ASDC. This will help the specialized monitoring team(s) to further investigate such incidents.

INCIDENTS OR COMPLAINTS REPORTED BY THE POPULATION

Control staff may get complaints about the locust control operations or receive information about presumed incidents due to insecticides (e.g. bee kills, phytotoxicity on crops, spray drift on houses/farms). Information on the date, time, location and type of incident can be noted in the ASDC. The control team should report the incident to campaign headquarters, which can take follow-up action, such as sending a specialized monitoring team.

RESIDUES

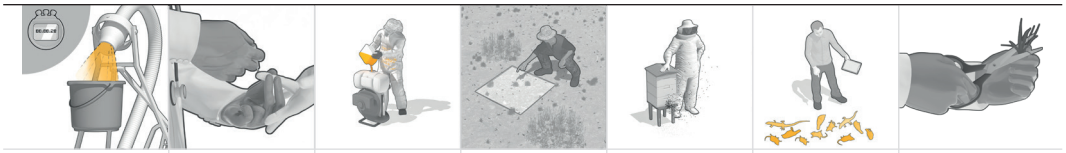
Control teams do not have to take any samples for insecticide residue analysis. Because control staff continuously handle highly concentrated insecticides, the risk of contaminating such samples is too high. Residue sampling should be left to the specialized monitoring team.

24 MONITORING – BY SPECIALIZED MONITORING TEAMS

It is recommended that one or more specialized teams will be active during the locust control campaign to monitor the quality of the insecticide treatments as well as human health and environmental risks.

Specialized monitoring can consist of one or more of the following activities (Fig. 35):

- Spray monitoring
- Efficacy assessments
- Situation analysis of the operation
- Monitoring of human health
- Monitoring of insecticide residues
- Monitoring of ecological impact
- Investigation of incidents



Sprayer calibration	Cholinesterase measurements	Occupational exposure assessments	Efficacy assessments	Ecological side-effects	Incident monitoring	Residue sampling

FIGURE 35. SPECIALIZED OPERATIONAL MONITORING MAY COMPRISE OF ONE OR MORE DIFFERENT ACTIVITIES. WHICH TYPES OF MONITORING IS CONDUCTED WILL DEPEND ON NATIONAL PRIORITIES, AVAILABLE RESOURCES AND DIRECT NEEDS OF THE CONTROL CAMPAIGN

These activities are briefly explained below. More detailed guidance, standard operating procedures (SOPs) and forms are available from FAO.

PRIORITIES FOR MONITORING

It will not be possible to monitor all treatments, because generally only one or a few monitoring teams will be operational during a control campaign. Priorities should therefore be set about the locations and types of treatments to be visited (Box 15).

BOX 15. EXAMPLES OF PRIORITY SITUATIONS FOR SPECIALIZED MONITORING

Issue or situation		Priority for monitoring
New insecticide is being used	→	Efficacy
Organophosphate insecticides are used	→	Cholinesterase inhibition in blood of control staff
Ecologically sensitive areas are treated or are close to treatments	→	Environmental monitoring
Insufficient efficacy is reported	→	Equipment calibration, spray monitoring, efficacy
New (inexperienced) staff on the job	→	Spray monitoring, human health
Important grazing areas are treated	→	Insecticide residues
Important beekeeping areas are treated	→	Honeybee health
Human health or environmental incidents reported	→	Incident monitoring

SPRAY MONITORING

Spray monitoring is the primary responsibility of the control teams. However, if a specialized monitoring team is on site it may take over this task, as this will reduce the workload of the control team and speed up the control operation. Spray monitoring by a specialized monitoring team also provides an independent verification of equipment calibration and good insecticide application practices.

Spray monitoring is a priority, for instance, if insufficient efficacy of an insecticide is reported, or if new inexperienced staff starts on the job.

EFFICACY ASSESSMENTS

The specialized monitoring team can also carry out efficacy assessments of control operations. This is especially useful for insecticides with moderate or slow speed of action. The control team can then move on to new control targets, while the monitoring team stays behind to verify control efficacy. Efficacy assessments are a priority, for instance, if a new insecticide active ingredient or formulation is being used in the country.

SITUATION ANALYSIS OF THE OPERATION

A general risk assessment of a control operation should in principle be made of all treatments that are visited by the monitoring team. FAO has developed an *Environmental and human health monitoring form for locust control operations*, which can be used to make a situation analysis of the quality and possible risks of the treatment. Specialized monitoring teams should conduct a situation analysis, and fill out the form, for each treatment that they evaluate; this only takes limited time.

The information compiled in the forms can be used at the end of the campaign to report on the quality of the control operations, possible constraints that were encountered, as well as (absence) of human health and environmental effects and risks. In the long term, a database will be built up of situations that require specific attention by the campaign organization with respect to control efficacy, occupational health and environmental risks.

MONITORING OF HUMAN HEALTH

Locust control staff run the highest risk of being exposed to, and possibly poisoned by, insecticides. It is therefore important that their health is regularly monitored.

Insecticide exposure monitoring

Exposure to organophosphate insecticides can be evaluated by measuring the inhibition of the enzyme acetylcholinesterase (AChE) in the blood. This can be tested by taking a small blood sample and subsequently analysing it using a field test kit or sending it to a specialized laboratory (Fig. 36). The use of a cholinesterase field kit will avoid transport of samples to a laboratory and allow immediate action if exposure is found to be too high. The cholinesterase kit is best used by medical or paramedical personnel, especially since it involves taking a blood sample. But monitoring staff can also be trained to conduct the assessment.

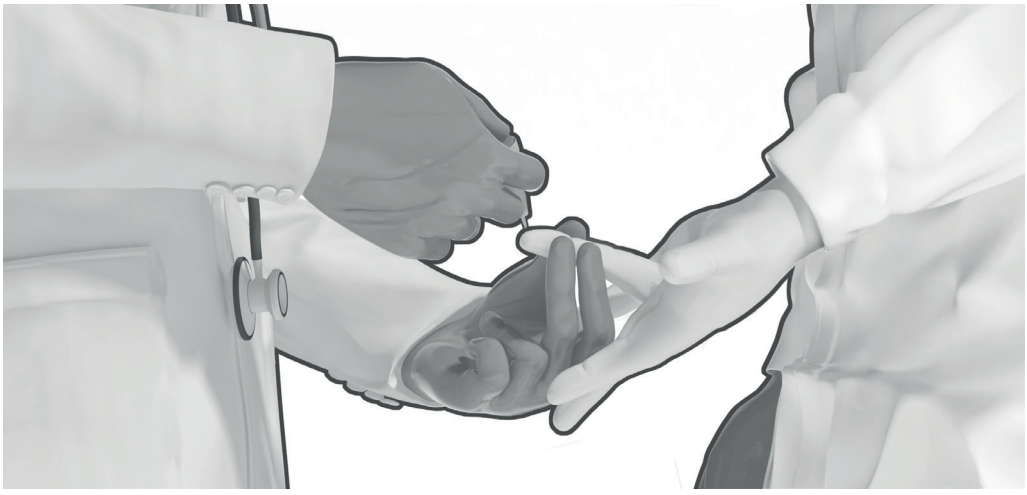


FIGURE 36. **BLOOD SAMPLES CAN BE TAKEN IN THE FIELD TO ASSESS EXPOSURE TO ORGANOPHOSPHATE INSECTICIDES**

If the inhibition of acetylcholinesterase in the blood exceeds certain target levels, staff should temporarily stop working with insecticides until blood levels return to normal (Box 16).

BOX 16. INDICATIVE ACTION THRESHOLDS BASED ON ACETYLCHOLINESTERASE INHIBITION LEVELS

Cholinesterase monitoring is only done when organophosphate insecticides are being used

AChE inhibition (% below baseline[1])	Indication of	Recommended action
> 20%	Exposure	(Senior) field officer should evaluate the work place and correct any unsafe practices
> 30%	Possible health effects	Exposure to the insecticide must stop; staff member should temporarily be taken off work with insecticides
> 50%	Poisoning	Exposure to the insecticide must stop; staff member should temporarily be taken off work with insecticides and seek medical attention
< 20%	Recovery, after any of the above	Recovery after exposure; staff member may resume with insecticides

1 Action thresholds are based on a comparison with individual baseline levels

No field kits are currently available to assess occupational exposure to other groups of insecticides used in locust control, such as pyrethroids and benzoyl-ureas. Urine samples of control staff can be taken, but analysis of insecticide metabolites has to be done by specialized laboratories.

Insecticide use passport

The specialized monitoring team should check the insecticide use passports issued to control staff. Information on the control operations conducted by the staff member should be complete and if cholinesterase measurements are done, the results should be entered in the passport.

Medical check-ups

Medical check-ups of all staff that may come into contact with insecticides are recommended at the start and the end of a control campaign (Section 9). If accidental occupational exposure or poisoning symptoms have occurred, the monitoring team should discuss these with the staff member and his/her supervisor. The staff member should be sent for an additional medical check-up.

MONITORING OF INSECTICIDE RESIDUES

It is sometimes useful to monitor insecticide residues after locust control treatments. Specialized monitoring teams may sample vegetation or water, package and store the samples, and send them to the designated laboratory for analysis.

However, insecticide residue analysis is expensive, and if sampling is not carried out correctly, the entire exercise may be worthless. Therefore, sampling for insecticide residues needs to be very well prepared. Box 17 provides guidance on locust control situations for which residue sampling may be useful. A standard operating protocol is available from FAO for residue sampling.

BOX 17. EXAMPLES OF SITUATIONS WHEN SAMPLING FOR INSECTICIDE RESIDUES AFTER LOCUST CONTROL MAY BE USEFUL

Situation	Type of study	Sampling methods
New insecticide is used for locust control in grazing land	Residue degradation study on grasses/fodder, to assess breakdown of insecticide	Sampling over time, on same location
Existing insecticide is used for locust control in grazing land	Compliance with maximum residue limit or verification of recommended livestock withholding period	Sampling at moment of re-entry of livestock
New insecticide is used for locust control in crop land	Residue degradation study on relevant crops, to assess breakdown of insecticide	Sampling over time, on same location
Existing insecticide is used for locust control in crop land	Compliance with maximum residue limit or verification of recommended pre-harvest interval	Sampling at moment of harvest of crop
Suspected contamination of water or soil	Verification of concentration of residue in relevant matrix	Sampling as soon as possible after incident report; possibly further sampling over time to assess long-term risk
Sensitive areas need to be protected against insecticide spray drift	Verification of effectiveness of buffer zones	Sampling of vegetation, water, or other relevant matrix at outer edge of buffer zone, immediately after treatment

MONITORING OF ECOLOGICAL IMPACT

It is very difficult for specialized monitoring teams to measure ecological impact of locust control operations. This is because the exact location of the insecticide treatments will often only be known shortly before spraying. As a result, pre-spray observations of "normal" population levels or behaviour of non-target organisms is generally impossible. Ecotoxicological studies about the effects of locust control insecticides on populations of nontarget organisms are therefore best conducted through in-depth monitoring, by specialized research institutions. They can conduct experiments and spend more time on the treated plots to assess the impact of the insecticide.

Specialized monitoring teams can, however, conduct specific ecological assessments:

Identify excessive mortality of non-target organisms

If mortality is observed in certain groups of non-target organisms, this may indicate overdosing or accidental drift of the insecticide. This may be the case, for instance, if birds or mammals are found dead in the sprayed fields after the control operation. Since locust control insecticides have relatively low mammalian toxicity, acute mortality in mammals or birds may indicate that the product has been overdosed. Similarly, if large numbers of honeybees are found dead in front of beehives that are located around control operations, this may indicate that buffer zones were not effective.

Identify excessive drift

Locust control treatments will always result in some insecticide drift outside the directly treated area, but such drift will be limited. For instance, ULV treatment with a backpack sprayer may cause drift over 100-200 m, while aerial ULV applications may well drift a kilometre. Insecticide drift of high volume treatments are very variable and depend much on the type of nozzle and spray pressure. Minimum buffer zones are therefore applied between the treated plot and sensitive areas (Box 12).

The distance over which insecticides drift can be assessed by residue sampling, by using oil- or water sensitive papers- or by checking mortality of sensitive organisms outside the spray plot. Since residue analysis is costly, the other two techniques are used most often by monitoring teams.

Identify sensitive non-target organisms

Organisms that are potentially most affected by insecticides are arthropods, both terrestrial and aquatic. It can therefore be expected that locust control treatments will cause mortality in other arthropods than locusts. However, observing dead insects or spiders after an insecticide application does not necessarily mean that the populations of these organisms have been unacceptably affected. Only in-depth studies can show effects on populations of non-target organisms, which is beyond the tasks of the specialized monitoring teams.

However, monitoring teams can assess the extent of mortality of non-target arthropods after treatments and identify which species appear to be most affected. This will help setting priorities

for in-depth studies about the effects of locust control on the populations of sensitive arthropods (e.g. ecologically important species, or endangered species). The locust control organization can then request universities or research institutions to carry out such indepth ecological studies.

INVESTIGATION OF INCIDENTS

Incidents may happen which are caused by locust control operations, or they are alleged to have been caused by locust control. These may include chemical incidents such as insecticide spills or contamination of drinking water, or biological incidents such as for instance honeybee kills, livestock poisoning, or human insecticide exposure or illness.

Local farmers, shepherds or villagers will generally report such incidents to the control team or the head of the control base. The locust control organization will then need to investigate the incident, to assess whether it was really caused by the insecticide application.

Incident monitoring is a difficult exercise because the report of the incident is always done after the treatment and there may be a long delay between the report and the start of the investigation. Also, exact information about the situation before the treatment is rarely available, making it difficult to identify an effect of the insecticide. And finally, the reporting is often done by non-specialist persons, who may be emotionally involved in the incident.

Incident investigations should therefore be done by the specialized monitoring team and not by the control team. The main objective of the investigation is to evaluate the likelihood of a causal relation between the locust control operation and the reported incident. The monitoring team will need to evaluate different lines of evidence and sometimes specialists need to be included in the investigation. An incident evaluation check-list has been developed by FAO to help monitoring teams in this task.

TIP **See the Selected References at the end of the guidelines for further information on this topic.**

25 PUBLIC AWARENESS AND INFORMATION EXCHANGE

PUBLIC AWARENESS

It is essential that populations living and working in areas where locust control is conducted are informed about the operations and aware of their risks. Awareness building about the importance of locust control and of precautionary measures to minimize insecticide risks is done in advance of the control campaign (Section 13).

During the campaign, however, the survey, control and monitoring teams should continue to provide information to local populations and respond to their questions. It is important that these teams have been trained to convey the key precautionary messages and ensure consistency in information provision.

INFORMATION EXCHANGE

Continuous exchange of information about the human health and environmental aspects of the control operations is essential for an effective campaign. Different flows of information exist during the locust control campaign (Fig. 37).

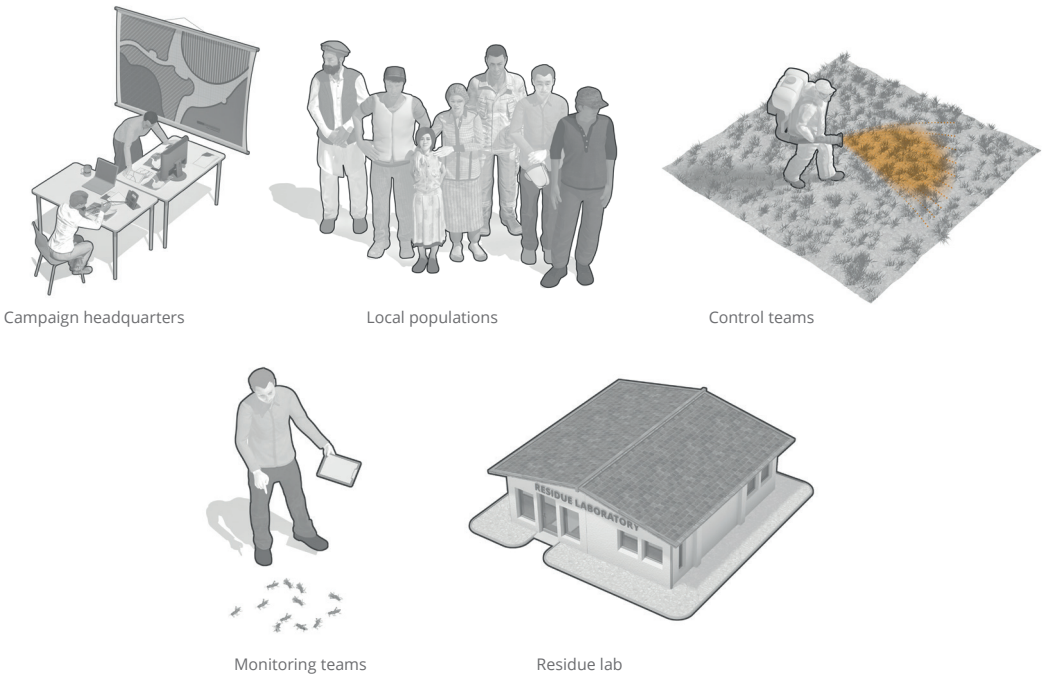


FIGURE 37. EFFECTIVE INFORMATION EXCHANGE SHOULD BE ENSURED ABOUT HUMAN HEALTH AND ENVIRONMENTAL ASPECTS OF THE LOCUST CONTROL OPERATIONS

Control teams should transmit information about problems encountered during the treatments – obtained from the rapid assessments – as soon as possible to the campaign organization and/or to the monitoring teams. This will allow quick follow-up so the problems do not persist during the control operations and adversely affect their effectiveness.

Monitoring teams will gather information that needs to be transmitted to other actors in the campaign. Good communications should, first of all, be ensured with the control teams. Since cooperation by the control teams is essential for effective monitoring, they need to be informed about the assessments that are being planned. The monitoring results should be communicated to the campaign organization and to the control teams, so that corrective action can be taken, if needed. It is important that the monitoring teams are not seen as the "policemen" of the control campaign, but as colleagues that can improve control, solve problems and provide technical assistance when needed.

Monitoring teams should communicate effectively with their technical cooperating agencies (residue laboratory, medical authorities, etc.), which need to be informed in a timely way about assistance they may need to provide, or any patients or samples that may be sent to them. Also, by being aware of the activities and problems in the field, the cooperating agencies can proactively suggest solutions. Cases of poisoning should be reported to the national/regional poison center.

Campaign headquarters should at all times be informed about the location and immediate programme of the monitoring teams. This to ensure that the most effective use is being made of often limited expertise and resources. Campaign headquarters may also receive requests for information on health and environment from the press, other government institutions, or from politicians.

And finally, local farmers, shepherds, beekeepers, and other inhabitants of the treated areas may need to be informed about the results of the monitoring activities. This is in particular relevant if the results of the monitoring directly influence them. In parallel, any incidents reported by local populations should be transmitted as soon as possible to the campaign headquarters.

It is important that the lines of communication for the different human health and environmental issues during control operations are defined before the campaign and properly followed afterwards.

D AFTER THE CAMPAIGN

26 REMAINING INSECTICIDES

Even if insecticide procurement has been correctly planned, it cannot be excluded that some insecticides will remain after the locust control campaign. Most UL, EC and SC formulated insecticides, if properly stored, will remain usable for several years. Pesticide manufacturers generally guarantee a shelf-life of two years, but many products will maintain good quality for longer.

Remaining pesticides are best collected in only one, or a few, good pesticide storage facilities where they can be properly checked and stored. Any containers that have been damaged during transport, and may therefore corrode or leak more rapidly, should be replaced. With insecticides coming from different sources, an effective storage administration system should be kept.

It is good practice to conduct annual quality control of all insecticides older than two years. The chemical analysis should at least include the concentrations of active ingredient and relevant impurities. In addition, key physico-chemical characteristics of the formulation can be verified. If no national pesticide quality control laboratory exists, the samples may be shipped to a foreign laboratory. It is important that the costs of quality control are included in the locust control campaign budget.

The results of the quality control should be compared with the product standards approved during the pesticide registration process. In absence of such national standards, quality specifications published by FAO can be used. If an insecticide does not comply anymore with the quality specifications, it may be possible in some cases to adjust the application rate; in other cases, the product will need to be disposed of. National hazardous waste management legislation should be followed for all insecticide disposal operations.

27 EMPTY CONTAINERS

If container collection has properly functioned during the campaign (Section 21), the empty and rinsed insecticide containers will have been returned to a limited number of storage sites. After the campaign, they should be collected in one location, where appropriate arrangements can be made for further treatment.

There are then basically three ways of dealing with these empty insecticide containers: returning to the insecticide supplier, recycling or disposal.

In some countries, insecticide procurement contracts stipulate that the supplier takes back the empty containers. This is a relatively easy way of managing empty containers, as long as it can be guaranteed that the supplier reconditions or disposes of the containers in a legally acceptable and environmentally sound manner.

Alternatively, empty insecticide containers, if properly rinsed, can sometimes be locally recycled: metal drums can be reused by a smelter; plastic containers can be shredded and reused as resource for new plastic. In the latter case, it is essential to guarantee that such recycled plastics are not used for food or drinks but, for instance, for building materials or electrical tubing.

The least recommended method of container management is disposal, either through high temperature incineration or landfilling. Domestic waste incinerators are often not appropriate to burn pesticides or pesticide containers as the combustion temperature is too low and/or the residence time too short. Specialized hazardous waste incinerators are required. Some countries may have hazardous waste landfill sites, where empty containers can be disposed and environmental contamination is contained.

All three empty container management options will have costs, which should be included in the locust control campaign budget.

28 FINALIZING MONITORING ACTIVITIES

Various monitoring activities will continue for some time after the control operations have stopped.

POST-CAMPAIGN HEALTH EXAMINATIONS

All control staff should undergo, shortly after the control campaign, a medical examination. If required, a final AChE analysis should also be carried out (e.g. if the staff member has shown AChE inhibition late in the campaign). Any staff showing adverse health effects or signs of (chronic) insecticide poisoning should continue to be medically examined.

CONTINUED MONITORING

Sometimes, residue or ecological monitoring needs to be continued after the last control operation. This may be the case if relatively persistent insecticides have been used or if adverse ecological effects have been observed during the control operations and recovery has to be assessed. Thus, not all monitoring teams can always be disbanded immediately after a campaign.

SAMPLE ANALYSIS

Quite often, residue and biological samples will be analysed after the control operations. The person(s) responsible for monitoring need to maintain contact with the relevant cooperating institutions and laboratories. Results of such analyses should then be interpreted and filed by the locust control unit.

REPORTING

The preparation of a detailed report of the results of the monitoring exercises is an essential task of the monitoring team. The report should contain all the results of the observations and field assessments. Furthermore, based on these results, an analysis should be made of the (potential) environmental and health risks of the past locust campaign. Concrete and practical recommendations for risk reduction and improvement of control operations should be made.

Raw data, photographs and forms of the monitoring exercises should be properly filed so that they can be easily accessed when longer-term evaluations of health or environmental aspects are being required, or if an external audit is conducted.

CAMPAIGN EVALUATION

The report of the monitoring exercises should be discussed as part of the campaign evaluation. Recommendations made by the monitoring teams may influence control practices in next year's campaign. On the other hand, experiences from the control operations may need to be taken into account in next year's monitoring.

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