



Food and Agriculture  
Organization of the  
United Nations



World Health  
Organization

## International Code of Conduct on Pesticide Management

# Guidelines for personal protection when handling and applying pesticides





International code of conduct  
on pesticide management

# **Guidelines for personal protection when handling and applying pesticides**

Food and Agriculture Organization of the United Nations  
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# Contents

Foreword .....	vii
Abbreviations and acronyms .....	viii
Definitions.....	ix
Introduction.....	1
Background.....	1
Objectives and targeted audience .....	1
Scope and structure.....	3
Issues related to personal protection .....	4
FAO/WHO tiered approach in pesticide risk reduction .....	4
Understanding pesticide risks in relation to personal protection.....	5
The concept of pesticide risk .....	5
Hazard in relation to personal protection .....	6
Exposure in relation to personal protection: routes of exposure .....	7
Limiting pesticide exposure of human health and the environment.....	9
Issues in low- and middle-income countries.....	10
Special considerations for personal protection and PPE in tropical climates .....	11
<b>1. Personal protection and PPE: technical considerations .....</b>	<b>13</b>
<b>1.1. Principles of personal protection .....</b>	<b>13</b>
1.1.1. General protection when working with pesticides .....	13
Users .....	13
Storage and transportation .....	13
Application and use .....	13
Phases after use .....	14
1.1.2. Understanding the label and requirements for PPE.....	14
1.1.3. Personal hygiene and special precautions with PPE .....	15
1.1.4. Other farm workers.....	16
1.1.5. Pesticide retailers.....	16
1.1.6. Vulnerable groups .....	16
1.1.7. Bystanders and residents.....	17
1.1.8. Non-occupational uses .....	17
1.1.9. First aid.....	18
<b>1.2. PPE and factors that determine its requirements.....</b>	<b>19</b>
<b>1.3. Determining the appropriateness of PPE.....</b>	<b>23</b>
1.3.1. Use of PPE in a regulatory framework .....	23
1.3.2. Assumptions to be made in risk assessment exposure calculations.....	24
1.3.3. How governments ensure appropriate PPE on labels .....	25
<b>1.4. Types of PPE .....</b>	<b>25</b>
1.4.1. Body protection, including feet and hands .....	25

Coveralls .....	26
Aprons and tabards .....	29
Footwear .....	30
Gloves .....	30
1.4.2. Head, face, eyes and ears.....	<b>33</b>
Hat .....	33
Face shield .....	33
Safety glasses and goggles .....	33
Ear protection .....	34
1.4.3. Respiratory system .....	<b>34</b>
Nuisance dust masks .....	35
Particulate air filters (or particulate air filter masks) .....	36
Respirators .....	37
Considerations for use of RPE .....	38
1.4.4. Considerations of PPE size and fit .....	<b>39</b>
<b>1.5. Correct use of PPE .....</b>	<b>40</b>
<b>1.6. Cleaning, maintenance and storage of PPE .....</b>	<b>41</b>
1.6.1. Cleaning .....	41
1.6.2. Maintenance .....	42
1.6.3. Storage .....	42
<b>1.7. Disposal of PPE .....</b>	<b>42</b>
<b>2. Personal protection and PPE: policy considerations .....</b>	<b>43</b>
2.1. Awareness-raising, risk communication and training.....	43
2.2. Availability .....	44
2.3. Quality and affordability .....	44
2.4. Monitoring .....	45
2.5. Stakeholder involvement.....	45
2.6. Registration.....	46
2.7. Risk mitigation .....	46
<b>Summary of considerations to reduce risks when handling and applying pesticides and technical considerations in use of PPE.....</b>	<b>48</b>
<b>References .....</b>	<b>50</b>
<b>Additional reading.....</b>	<b>53</b>
<b>Annex 1: Classifications of acute hazard in the GHS and by WHO .....</b>	<b>54</b>
<b>Annex 2: PPE for applying public health pesticides.....</b>	<b>55</b>
<b>Annex 3: PPE for applying agricultural pesticides.....</b>	<b>56</b>
<b>Annex 4: The FAO Pesticide Registration Toolkit .....</b>	<b>57</b>
<b>Annex 5: Standards for PPE and RPE .....</b>	<b>58</b>

## Boxes

Box 1.	Provisions related to PPE and protective clothing in the International Code of Conduct on Pesticide Management .....	2
Box 2.	Provisions related to PPE and biopesticides.....	4
Box 3.	The concept of risk.....	5

## Tables

Table 1.	Examples of factors that determine pesticide exposure.....	20
Table 2.	Indicative protection and reduction of exposure with different types of PPE in the EFSA model .....	24
Table 3.	Types of chemical-resistant clothing.....	27
Table 4.	Protective clothing described by ISO standard 27065:2017 .....	28
Table 5.	Footwear and chemical protection .....	30
Table 6.	Gloves and chemical protection .....	31
Table 7.	Levels of protection for gloves as described by ISO standard 18889:2019 ..	32
Table 8.	Colour codes and uses of respirators.....	37

## Figures

The figures in these guidelines are the property of FAO and WHO, except when indicated otherwise.

Fig. 1.	Routes of exposure to pesticides .....	7
Fig. 2.	Variation in absorption rates in different parts of the body in comparison with the rate of dermal absorption through the forearm (1.0) .....	8
Fig. 3.	Examples of common PPE pictograms for pesticide use .....	14
Fig. 4.	Example of warning near a treated field .....	17
Fig. 5.	First aid for eye .....	18
Fig. 6.	Recovery position for an unconscious person .....	19
Fig. 7.	Example of a container with a built-in measure .....	22
Fig. 8.	Engineering controls: enlarged filler opening in a tank and a deep-set filter to avoid splashing of spray liquid .....	22
Fig. 9.	Basic protective work clothing .....	26
Fig. 10.	An apron (show in black) .....	29
Fig. 11.	How to wear gloves .....	31
Fig. 12.	Safety goggles .....	34
Fig. 13.	Ear defenders .....	34
Fig. 14.	Nuisance dust mask: not recommended for protection against pesticides ...	35
Fig. 15.	Surgical mask: not recommended for protection against pesticides .....	36
Fig. 16.	Example of a particulate air filter mask .....	36
Fig. 17.	Example of a twin filter half-face respirator .....	37
Fig. 18.	Example of a powered full-face respirator .....	38
Fig. 19.	Wearing gloves when cleaning and brushing nozzles .....	41
Fig. 20.	Small, lockable store for pesticide containers .....	42

## Foreword

These guidelines are intended to provide guidance for preventing the risk of pesticides by reducing exposure with use of **effective personal protection, particularly personal protective equipment**. The guidelines are designed primarily for use by government authorities in charge of pesticide management and risk reduction but may also be useful in sectors such as the pesticide industry, nongovernmental organizations and other relevant entities.

These guidelines **update and replace** the 1990 *FAO guidelines on personal protection when working with pesticides in tropical climates*.

In preparing and approving these guidelines, the members of the FAO/WHO Joint Meeting on Pesticide Management ensured that they are most applicable to stakeholders in low- and middle-income countries, while maintaining close harmonization with practices in other parts of the world.

**FAO and WHO welcome readers' feedback on use of these guidelines.**

FAO and WHO consider that these guidelines are a living document that could be further improved. They therefore particularly value any feedback from users of the guidelines and welcome any comment. They also value examples of how the guidelines were used.

Please send your suggestions, comments and examples to [pesticide-management@fao.org](mailto:pesticide-management@fao.org) indicating the title of the guidelines and the relevant section and page.

## Abbreviations and acronyms

AOEL	Acceptable Operator Exposure Level
CEN	European Committee for Standardization
EFSA	European Food Safety Agency
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
GAP	Good Agricultural Practices
GHS	Globally Harmonized System of Classification and Labelling of Chemicals
HHP	Highly hazardous pesticide
HIC	High income countries
ILO	International Labour Organization
IPM	Integrated Pest Management
IVM	Integrated Vector Management
ISO	International Organization for Standardization
JMPM	FAO and WHO Joint Meeting on Pesticide Management
LMIC	Low- and middle-income countries
LIC	Low-income countries
MEL	Maximum Exposure Limit
NGO	Nongovernmental organization
OECD	Organisation for Economic Co-operation and Development
OEL	Occupational Exposure Limit
PCO	Pest Control Operator
PPE	Personal protective equipment
RPE	Respiratory protective equipment
RTU	Ready-to-use (products)
ULV	Ultra-low volume
WHO	World Health Organization

## Definitions

*All the definitions below are from Article 2 of the International Code of Conduct on Pesticide Management (FAO/WHO, 2014), unless otherwise indicated.*

**Application equipment:** any technical aid, equipment, implement or machinery which is used for the application of pesticides.

**Biological pesticide (or biopesticide):** a generic term generally applied to a substance derived from nature, such as a microorganism or botanical or semiochemical, that may be formulated and applied in a manner similar to a conventional chemical pesticide and that is normally used for short-term pest control [adapted from ISPM Pub. No. 3, 1996 (IPPC, 2005)] (*FAO/WHO, 2017*).

**Container:** any object used to hold a pesticide product.

**Disposal:** any operation to recycle, neutralize, destroy or isolate pesticide waste, used containers and contaminated materials.

**Environment:** surroundings, including water, air, soil and their interrelationship as well as all relationships between them and any living organisms.

**Exposure to pesticides:** any contact between a living organism and one or more pesticides (*FAO/WHO, 2016*).

**Formulation:** the combination of various ingredients designed to render the product useful and effective for the purpose claimed and for the envisaged mode of application.

**Hazard:** the inherent property of a substance, agent or situation having the potential to cause undesirable consequences (e.g. properties that can cause adverse effects or damage to health, the environment or property).

**Highly Hazardous Pesticides:** pesticides that are acknowledged to present particularly high levels of acute or chronic hazards to health or environment according to internationally accepted classification systems such as WHO or GHS or their listing in relevant binding international agreements or conventions. In addition, pesticides that appear to cause severe or irreversible harm to health or the environment under conditions of use in a country may be considered to be and treated as highly hazardous.

**Integrated Pest Management:** the careful consideration of all available pest control techniques and subsequent integration of appropriate measures that discourage the development

of pest populations and keep pesticides and other interventions to levels that are economically justified and reduce or minimize risks to human and animal health and/or the environment. IPM emphasizes the growth of a healthy crop with the least possible disruption to agro-ecosystems and encourages natural pest control mechanisms.

**Integrated Vector Management:** the rational decision-making process for the optimal use of resources for disease vector control. IVM aims to improve efficacy, cost-effectiveness, ecological soundness and sustainability of disease vector control interventions for control of vector-borne diseases.

**Label:** the written, printed or graphic matter on, or attached to, the pesticide or the immediate container thereof and also to the outside container or wrapper of the retail package of the pesticide.

**Life cycle:** all the stages a pesticide might pass through from production to its degradation in the environment after use, or its destruction as an unused product. The life cycle includes manufacture, formulation, packaging, distribution, storage, transport, use and final disposal of a pesticide product and/or its container.

**Manufacturer:** a corporation or other entity in the public or private sector (including an individual) engaged in the business or function (whether directly or through an agent or entity controlled by or under contract with it) of manufacturing a pesticide active ingredient or preparing its formulation or product.

**Packaging:** the container together with the protective wrapping used to carry pesticide products via wholesale or retail distribution to users.

**Personal protective equipment:** any clothes, materials or devices that provide protection from pesticide exposure during handling and application. In the context of the Code, it includes both specifically designed protective equipment and clothing reserved for pesticide application and handling.

**Pest:** any species, strain or biotype of plant, animal or pathogenic agent injurious to plants and plant products, materials or environments and includes vectors of parasites or pathogens of human and animal disease and animals causing public health nuisance.

**Pesticide:** any substance, or mixture of substances of chemical or biological ingredients intended for repelling, destroying or controlling any pest, or regulating plant growth.

**Pesticide management:** the regulatory and technical control of all aspects of the pesticide life cycle, including production (manufacture and formulation), authorization, import, distribution, sale, supply, transport, storage, handling, application and disposal of pesticides and their containers to ensure safety and efficacy and to minimize adverse health and environmental effects and human and animal exposure.

**Pest control operator:** any person or company that apply pesticides as a profession.

**Poisoning:** occurrence of damage or disturbance caused by a poison, and includes intoxication

**Product (or pesticide product):** the formulated product (pesticide active ingredient(s) and co-formulants), in the form in which it is packaged and sold.

**Risk:** the probability and severity of an adverse health or environmental effect occurring as a function of a hazard and the likelihood and the extent of exposure to a pesticide.

**Toxicity:** a physiological or biological property which determines the capacity of a chemical to do harm or produce injury to a living organism by other than mechanical means

**Vulnerable groups:** persons that include pregnant and nursing women, the unborn, infants and children, the elderly, HIV/AIDS affected people and, when subject to high exposure to pesticides over the long term, workers and residents.



# Introduction

## Background

These guidelines were prepared by the [FAO/WHO Joint Meeting on Pesticide Management \(JMPM\)](#) to provide further guidance on the provisions of the FAO/WHO International Code of Conduct on Pesticide Management (hereafter referred to as the “Code of Conduct”) that are related to personal protection of pesticide users. These guidelines update and replace the 1990 *FAO guidelines on personal protection when working with pesticides in tropical climates*. They reflect the joint FAO/WHO approach to pesticide management, thus addressing personal protection of both agricultural and public health operators and applicators, the latter being engaged in using insecticides for vector control. An overview of the most relevant provisions in the Code of Conduct that relate to personal protection is provided in Box 1.

## Objectives and targeted audience

The purpose of this document is to provide guidance on preventing the risk of pesticides by reducing exposure with effective personal protection, with particular attention to personal protective equipment (PPE). First, it provides technical information on personal protection and on the selection and use of PPE. Secondly, in line with the Code of Conduct, it addresses various policy issues and recommends measures to improve personal protection and specifically the use and availability of adequate- quality, affordable PPE. These guidelines are meant to enhance current national legislation and regulations on personal protection and PPE or where there are none, to provide guidance.

The guidelines are **intended primarily for government authorities in charge of pesticide management, pesticide risk reduction and labour safety**, but may also be useful for entities such as the pesticide industry, nongovernmental organizations (NGOs) and officers and consultants in the field involved in organizing, or advising on, pesticide use. These include plant protection services, vector control services and any private sector entities associated with distributing pesticides or organizing pesticide application, such as plantations, contract growing schemes and pesticide application service providers.

These guidelines are specifically targeted at stakeholders in low-and middle-income countries (LMIC) in which there is limited legislation, compliance and enforcement and limited availability of PPE. Social, economic and climatic conditions and agricultural practices of local small-scale farmers should be considered when addressing personal protection. Adequate measures, including restricted use, could be taken to reflect LMICs with regard to registration, including PPE requirements.

## **Box 1. Provisions related to PPE and protective clothing in the International Code of Conduct on Pesticide Management**

*Role of PPE in determining whether specific pesticides should be made available:*

**Art 3.6 Pesticides whose handling and application require the use of personal protective equipment that is uncomfortable, expensive or not readily available should be avoided, especially in the case of small-scale users and farm workers in hot climates.**

Art 5.1.8 Governments should, with the cooperation of the pesticides industry, limit the availability of pesticides that are sold to the general public through non-specialized outlets, to low hazard products (WHO Class U) or low risk and ready to use products that require no dilution or other preparation, and can be applied with limited need for personal protective equipment;

Art 7.5 Prohibition of the importation, distribution, sale and purchase of highly hazardous pesticides may be considered if, based on risk assessment, risk mitigation measures or good marketing practices are insufficient to ensure that the product can be handled without unacceptable risk to humans and the environment.

*Ensuring the availability of PPE*

Art 5.3: Government and industry should cooperate in further reducing risks by:

5.3.1 promoting the use of personal protective equipment which is suitable for the tasks to be carried out, appropriate to the prevailing climatic conditions and affordable.

*Ensuring the quality of PPE*

Art 5.1: In establishing pesticide production facilities of a suitable standard in developing countries, manufacturers and governments should cooperate to:

Art 5.5.1 adopt engineering standards and operating practices appropriate to the nature of the manufacturing operations and the hazards involved, and ensure the availability of appropriate protective equipment;

Art 6.1 Governments should:

Art 6.1.12 permit pesticide application equipment and personal protective equipment to be marketed only if they comply with established standards.

*Policy*

Art 6.1 Governments should:

Art 6.1.1 introduce the necessary policy and legislation for the regulation of pesticides, their marketing and use throughout their life cycle, and make provisions for its effective coordination and enforcement, including the establishment of appropriate educational, advisory, extension and health-care services, using as a basis FAO and WHO guidelines and, where applicable, the provisions of relevant legally binding instruments. In so doing, governments should take full account of factors such as local needs, social and economic conditions, levels of literacy, climatic conditions, availability and affordability of appropriate pesticide application and personal protective equipment;

*Advertising*

Art 11.1 Governments should approve and implement legislation to regulate the advertising of pesticides in all media to ensure that it is in line with the conditions of registration as regards label

directions and precautions, particularly those relating to proper maintenance and use of application equipment, appropriate personal protective equipment, special precautions for vulnerable groups and the dangers of reusing containers.

Art 11.2: Pesticide industry should ensure that:

Art. 11.2.12 advertisements do not contain any visual representation of potentially dangerous practices, such as mixing or application without sufficient protective clothing, use near food or use by or in the vicinity of children;

## Scope and structure

These guidelines apply to all types and uses of pesticides, including biopesticides (see Box 2) but particularly to agricultural and public health pesticides. They are structured as follows:

**Introduction** Lays out the issue of personal protection when handling and applying pesticides, stressing the importance of understanding the pesticide risks and of limiting exposure to human health and the environment.

**Part 1** Provides *technical* information about personal protection and PPE, including the requirements, types and correct use of PPE.

**Part 2** Provides *policy* guidance to improve the availability and ensure the quality and use of PPE.

The focus is on personal protection during handling and application of pesticides. It covers specific phases that present risks of exposure, such as mixing and loading pesticides, applying the products outdoors or indoors and rinsing protective and application equipment. These phases, which usually take place in a professional context, are those in which personal protection and PPE are most relevant. **Therefore, these guidelines focus on pesticide handling and application by farmers, farm workers and professional pest control operators (PCOs).** Although they do not address use of pesticides in kitchen gardens by home owners, gardeners and other non-professional users, section 1.1.8 on non-occupational uses outlines the risk and exposure situations in which PPE might be necessary. Other potential exposure periods such as pesticide sales or by-standing are not described, as the emphasis of the document is not on pesticide exposure; however, the introductory chapter describes pesticide risks related to personal protection, and Part 1 includes sections on the principles of personal protection, including for farm workers, pesticide retailers, vulnerable groups, bystanders and residents (see sections 1.1.4–1.1.7).

The previous guidelines focused on personal protection when working with pesticides in tropical climates, whereas these new guidelines are intended to provide more general guidance on personal protection and PPE, while maintaining emphasis, where applicable, on situations in the tropics. In hot and humid conditions, pesticide operators and applicators may find it difficult to wear adequate protection against exposure because of the discomfort caused by heavy protective



apparel with low heat dissipation. Furthermore, in LMICs, manually operated application equipment, such as knapsack sprayers, is often used, which requires further body protection. **Thus, throughout the document, sections that address issues relevant to tropical climates are indicated with the logo shown on the left.**

### **Box 2. Provisions related to PPE and biopesticides**

For the purpose of these guidelines, the term “biopesticides” is used to include products with active substances based on microbials, botanicals or semiochemicals (FAO/WHO, 2017). These substances are distinguished from conventional chemical pesticides by a combination of the material and/or nature of their active substance and their use. Further, the level of risk resulting from use of biopesticides is often lower than that for conventional chemical pesticides, and the requirements for PPE for these substances may be different from those necessary for conventional chemical pesticides. Any such differences are noted.

While many biopesticides can be used without PPE, it is good practice to use at least minimum equipment such as gloves and eye covers. As good application practice, immuno-suppressed personnel should avoid application of microbial pesticides (see section 1.1.6 on vulnerable groups)

## **Issues related to personal protection**

### ***FAO/WHO tiered approach in pesticide risk reduction***

Application of pesticides is one method used to manage pests in agriculture and disease- carrying vectors in public health and animal health. While pesticides provide benefits, their use carries risks to human health and the environment. In the *FAO Guidance on pest and pesticide management policy development* (FAO, 2010), three steps in pesticide risk reduction are recognized:

1. *Reduce reliance on pesticides. Determine to what extent current levels of pesticide use are actually needed. Make optimum use of non-chemical pest management and eliminate unjustified pesticide use.*

As indicated in the *FAO/WHO Guidelines on highly hazardous pesticides* (HHPs) (FAO/WHO, 2016), “pest and vector management based on Integrated Pest Management (IPM) and Integrated Vector Management (IVM) would be preferred. The same applies to other agro-ecologically<sup>1</sup> based production systems, such as organic agriculture.”

2. *Select pesticides with the lowest risk. If use of pesticides is deemed necessary, select products with the lowest risk to human health and the environment from the available registered products that are effective against the pest or disease.*

Particular attention should be given to substituting highly hazardous products as per the *FAO/WHO Guidelines on HHPs* (FAO/WHO, 2016).

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<sup>1</sup> FAO describes agroecology as the science of applying ecological concepts and principles to the design and management of sustainable food systems (FAO, 2014).

3. *Ensure proper [correct] use of the selected products for approved applications and in compliance with international standards.*

Correct use includes, among other aspects, the appropriate PPE for each pesticide product in order to minimize exposure during pesticide handling and application.

Although these guidelines mostly refer to step 3, on reducing exposure once a product has been selected, steps 1 and 2 should first be considered, as eliminating unnecessary use remains the first step in reducing exposure. Relevant aspects of steps 1 and 2 are nevertheless covered in these guidelines, linked to PPE requirements related to decisions about registration, which may still result in restricting or not authorising a product, i.e. when the use of PPE will not be sufficient to mitigate the risk. In addition, the use of adequate PPE and access to the protective equipment specified on the product label may prove difficult, especially in LMICs, making it to implement step 3 effectively.

**It should be recalled that PPE is one of least effective strategies<sup>2</sup> for reducing exposure to pesticides, as it requires supervision of workers and monitoring to ensure the provision of correct PPE. PPE must be stored and cleaned correctly, so that clean PPE is used, fitted correctly and worn throughout exposure.**

### *Understanding pesticide risks in relation to personal protection*

#### *The concept of pesticide risk*

In order to consider personal protection from pesticides it is important to understand the concept of risk (Box 3).

#### **Box 3. The concept of risk**

**Risk** is a function of **Hazard** and **Exposure**:  $R = f(H \times E)$

The hazard of a product is determined by the intrinsic toxicological properties of the active ingredient. Risk reduction can thus be achieved in two ways: reduction in hazard or reduction in exposure.

Reduction in hazard generally involves choosing a less hazardous alternative, which could be a non-chemical approach to pest management, a different chemical compound or a different formulation of the same compound.

Reduction in exposure can be achieved in a variety of ways.

*From the FAO/WHO Guidelines on HHPs (FAO/WHO, 2016)*

<sup>2</sup> In the area of industrial hygiene, the approach of hierarchy of control is used. The hierarchy starts with the controls perceived to be most effective and moves down to those considered least effective. It flows as follows: elimination (physically remove the hazard), substitution (replace the hazard), engineering controls (isolate people from the hazard), administrative controls (change the way people work) and, last, PPE (protect the worker with PPE). (Druley, 2018).

Pesticide risk management in occupational use addresses three distinct phases that require different levels of personal protection:

1. handling concentrated pesticide formulation, which involves **mixing and loading** into application equipment (e.g. the spray tanks of manual sprayers such as hand-held/knapsack sprayers, mechanical mounted or trailed sprayers, or aircraft);
2. **applying** the diluted product or mixture of products (Note: some ultra-low volume (ULV) formulations e.g. for locust control, do not require dilution before application.); and
3. **rinsing/cleaning** contaminated PPE and application equipment, and **disposing** of the rinsate.

Other phases may involve potential exposure, such re-entering treated areas, rinsing empty containers or safeguarding obsolete pesticides. For the latter activity, FAO has prepared comprehensive guidance as part of the *FAO Environmental Management Tool Kit (EMTK) for Obsolete Pesticides series*. Volume 4 of the EMTK provides advice on PPE for safeguarding activity (FAO, 2011).

Handling of concentrated formulation generally presents a greater **risk** than handling the diluted product; however, application of diluted product generally results in longer and therefore possibly greater exposure.

Determining the appropriate level of personal protection depends on the **hazard** of the product and anticipated **exposure**, which are largely determined by the type of pesticide, the phases of use (mixing, loading, applying, cleaning), the application method, the applicator or operator and the application conditions.

#### *Hazard in relation to personal protection*

In most countries, the hazard of pesticides is classified according to the *Globally Harmonized System of Classification and Labelling of Chemicals* (United Nations Economic Commission for Europe, 2017), or/and *The WHO Recommended Classification of Pesticides by Hazard and Guidelines to Classification 2009* (WHO, 2010, being revised). Information on the hazard category (GHS) or class (WHO) from these two sources should be written on labels. In many countries, the hazard classification for acute toxicity based on the WHO classification is indicated by a coloured band (Annex 1). More information is provided in the *FAO/WHO Guidelines on Good Labelling Practice for Pesticides* (FAO/WHO, 2015).<sup>3</sup> It should be noted that the coloured bands do not currently reflect chronic effects, and this may mislead users on the risk levels.

Reduction of hazard involves choosing a less hazardous alternative. This could be a non-chemical approach to pest management, a different, less hazardous chemical compound or a different formulation of the same compound. If a substitute chemical compound is used, preference should

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<sup>3</sup> The FAO/WHO Guidelines on Good Labelling Practice for Pesticides (FAO/WHO, 2015) will be revised to take this concern into account.

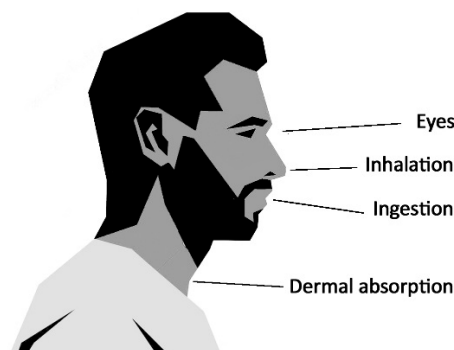
be given whenever possible to pesticides with the least acute and chronic toxicity, as these usually pose a lower risk and therefore generally require less comprehensive PPE.

### *Exposure in relation to personal protection: routes of exposure*

Direct human pesticide exposure includes occupational exposure (operators, applicators and workers) and exposure of bystanders and residents. As PPE is generally available to and worn only by individuals in an occupational setting, these guidelines mainly address occupational exposure (see section 1.1.8 for non-occupational uses).

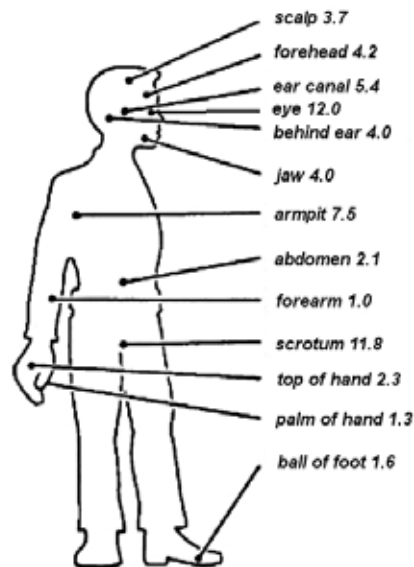
A pesticide may enter the body through the skin (dermal exposure), mouth (oral exposure), nose and lungs (inhalation exposure) and eyes (ocular exposure) (Fig. 1). Most occupational exposure to pesticides occurs through the dermal and inhalation routes, during mixing and loading and application from splashes and spray, including spray drift or by contact during re-entry into treated crops or areas or contaminated surfaces, equipment and materials.

**Fig. 1. Routes of exposure to pesticides**



- The risk of dermal exposure is high during preparation of mixtures and applying diluted spray. The extent to which a pesticide penetrates a person's skin varies (Fig. 2). The most vulnerable areas of the body most likely to be exposed such as the hands or the scrotum should be well protected. In addition, absorption is greater into injured or inflamed skin than into intact skin.

**Fig. 2. Variation in absorption rates in different parts of the body in comparison with the rate of dermal absorption through the forearm (1.0)**



Source: Adapted from Johnson et al., 1996

- Exposure via inhalation may occur because of the volatility of a pesticide, in particular if it is highly volatile (i.e. with a vapour pressure  $> 5 \times 10^{-3}$  Pa) or if the droplets or particulates (e.g. microbials) are of a size that can be inspired (diameter  $< 10 \mu\text{m}$ ). Even if a chemical is not very volatile, there can still be significant exposure to inhalable aerosols, depending mainly on the application method; air blast or hand-held equipment with nozzles produce inhalable aerosols. Situations that pose an increased risk of inhalation include fogging or indoor application, unintentional spills inside stores that create vapours and applications that do not follow Good Agricultural Practices (GAP).<sup>4</sup> Wearing incorrect PPE (e.g. cloth around the face, mask in inappropriate conditions or wrong size) when handling and applying pesticides will increase the risk.
- Oral exposure is less likely if precautions are taken to avoid contact between contaminated hands and the face. Oral poisoning can occur during clearing of blocked nozzles, but it usually occurs outside the occupational context, often due to accidental or intentional ingestion of chemical pesticides or consumption of treated seeds, contaminated food from unwashed hands or contaminated water. Storage of water or food in used pesticide containers is also a common cause of poisoning.
- Ocular exposure of unprotected eyes to chemical pesticides results in absorption into ocular tissues and potential effects on the conjunctiva, cornea, lens, retina and the optic nerve, possibly leading to defective vision. Corrosive products can cause severe eye damage or even blindness. Serious ocular exposure can result from airborne chemical

<sup>4</sup> In this case, GAP refers to application of pesticides in correct weather conditions, e.g. not at wind rates  $> 3\text{m/s}$  or  $> 30^\circ\text{C}$ .

dusts or particles, splashes or spills, broken hoses, spray mists or from rubbing the eyes with contaminated hands, clothing or PPE, such as unwashed gloves (Fishel, 2018).

### *Limiting pesticide exposure of human health and the environment*

Further to the FAO/WHO tiered approach to pesticide risk reduction, described above, selection of the least toxic method or product and reducing hazard can contribute to reducing exposure. Besides the use of appropriate PPE for each pesticide, discussed in these guidelines, the measures include using pesticides correctly according to GAP.

Pesticide that is not deposited on the target area may land on bystanders and surfaces in the environment. To minimise these routes of exposure and environmental pollution in line with the FAO/WHO three-step approach to pesticide risk reduction, farmers and operators who use pesticides are advised to:

1. determine the extent to which pesticide use is actually needed; make optimum use of non-chemical pest management and eliminate unjustified pesticide use;
2. select the least hazardous pesticides for a particular pest problem and/or a formulation that poses least risk; and
3. ensure correct use of the selected product:
  - read the label carefully to determine correct use, risks and required PPE, in line with GAP;
  - check the application equipment before using a pesticide to ensure that it is in good condition, with no leaks and functioning nozzles; use application equipment that is well calibrated and adapted to the use (FAO, 2001a, 2001b, 2001c, 2001d, 2001e) to minimise spray drift and personal exposure;
  - after rinsing containers three times, put the rinse water back into the sprayers together with the spray mix;
  - establish untreated buffer zones<sup>5</sup> around spray areas to protect waterways and other non-target areas downwind of treated fields;
  - do not spray in inappropriate weather conditions, that is, when it is too windy (> 3m/s), to prevent spray drift, when it is raining or > 30 °C; check wind direction before application;
  - avoid spraying in close proximity to other people (e.g. workers harvesting or weeding) and to buildings (e.g. houses, schools); a 48-h notice period is recommended to inform bystanders and residents of forthcoming applications (see section 1.1.7);
  - avoid spilling pesticides;
  - clean equipment away from water sources; and
  - dispose of containers as indicated on the label (see section 1.1.1).

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<sup>5</sup> A buffer zone is defined as a strip of land of specified minimum width between the edge of an area where pesticide application is permitted and sensitive non-target areas, e.g. watercourses, wetlands, woodlands, sensitive crops, schools, hospitals (Stephenson et al, 2008).

### *Issues in low- and middle-income countries*

Pesticide users in high-income countries (HIC) and in LMIC differ significantly, with typically > 40% of the population in LMIC working in agriculture. Poverty, limited education and literacy, distances, poor access to medical assistance and ineffective extension systems are amongst the factors that affect the feasibility of reaching all farmers with training and advice on pesticide use and associated personal protection. Furthermore, LMIC tend to have less institutional capacity to enforce pesticide legislation, including compliance with safety instructions on labels, such as wearing of PPE.

PPE as prescribed on labels or in training programmes is often not available or not used in LMIC because it is too expensive or too uncomfortable, particularly in hot, humid climates (see next section). In many LMIC, the PPE available in rural shops is often of inadequate quality or unsuitable (e.g. household gloves and simple dust masks) for protection against many formulations, in particular of HHPs. In addition, training or advice may not have been given on how to use and wear the PPE.

In LMIC, small-holders, agricultural workers (including children in some countries<sup>6</sup>) and vector control operators commonly use manually operated application equipment such as knapsack sprayers. Such equipment often results in greater occupational exposure than vehicle-mounted or trailed equipment; therefore, extra care is required to ensure that the correct protective clothing is worn according to the label.

Other factors that affect the intended use of pesticides and of required personal equipment include: limited user knowledge about pesticide risks, inability to read or understand labels, incomplete labels, labels not available in the local language and the relatively high cost of following label instructions (e.g. buying recommended PPE). In such cases, HHPs should not be used and alternatives should be sought.

For these reasons, there may be a significant gap between the common conditions of use in LMIC and the PPE requirements prescribed on the label, potentially leading to high human exposure and consequently to risks that exceed estimates that are based on the assumption that label instructions are followed. The use situations encountered in LMIC should be factored in when deciding on registration. Risk assessors who evaluate pesticide risks should consider realistic use conditions, in particular for estimating and calculating occupational exposure.

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<sup>6</sup> Article 6.1.2 of the Code of Conduct states that “Governments should (...) introduce legislation to prevent the use of pesticides by and sale of pesticides to children. The use of pesticides by children in a work situation should be included in National Hazardous Work Lists for children under International Labour Organization Convention No. 182 on the Worst Forms of Child Labour in countries which have ratified it;”



## *Special considerations for personal protection and PPE in tropical climates*



Pesticide registration, handling and application must receive special attention in tropical climates under hot and/or humid conditions, as warm, wet conditions can increase the speed of pesticide breakdown, and users of PPE may undergo heat stress and feel uncomfortable wearing protective apparel with low heat dissipation, in particular respirators, face-masks and coveralls. The conflict between PPE use and climate, not to mention economic issues (see previous section), has been well recognized by FAO and WHO. The previous guidelines on personal protection stated that *“the wearing of additional protective clothing and other equipment may cause severe discomfort and even physical distress due to heat stress if they are made of inappropriate materials. Alternatively, operators may dispense with protective apparel and become subject to greater exposure and possible contamination.”*

Tropical climates may affect workers’ health, productivity, safety and behaviour.

- As the workers sweat more, they are at risk of greater exposure from the high rate of dermal absorption.
- The conditions may lead to heat stress and dehydration, which can cause acute and chronic illness and, at worst, death. The symptoms of heat stress include fatigue, headache, nausea, fainting, loss of coordination, severe thirst and a dry mouth. All these signs can be increased when wearing PPE.
- Overall, heat-stressed people become less efficient and more prone to work accidents.
- Hot and humid conditions also affect workers’ attitude and behaviour, resulting in lower acceptance of PPE and hence reduced PPE use.

Recommendations for tropical situations should always focus on providing sufficient protection for pesticide users while ensuring that they can work comfortably and efficiently if PPE is necessary. They include:

- avoiding use of “pesticides whose handling and application require the use of personal protective equipment that is uncomfortable, expensive or not readily available” (Article 3.6 of the Code of Conduct);
- adjusting tasks or workplace conditions to minimize heat stress;
- organizing work early and late in the day to avoid the hottest part times and ensuring that spraying is not done if temperature is  $> 30^{\circ}\text{C}$ ;
- scheduling rest periods long enough to allow the body to cool down;
- drinking plenty of water, before and after work; and
- selecting a level of PPE appropriate for the task, according to the minimum PPE requirements on the label (i.e. not over protecting the body).

**Generally, and even more so in hot climates,  
operators must be physically fit, healthy and well hydrated.**

The ambient temperature must be considered when establishing requirements for PPE. In hot areas, when temperatures exceed 30 °C, the risk of heat-related health effects increases. Therefore, consideration must be given to the PPE required and whether application should be permitted in such circumstances.

# 1. Personal protection and PPE: technical considerations

## 1.1. Principles of personal protection

### 1.1.1. *General protection when working with pesticides*

Further to the measures outlined in the introductory section on limiting exposure of human health and the environment, users should take care when dealing with pesticides and in key steps of the pesticide life-cycle,<sup>7</sup> such as storage and transport, application and use and the phases after use. These phases should be adequately addressed to minimize risks and ensure personal protection without considering (yet) the use of PPE.

#### *Users*

Besides any physical protection, pesticide handlers and applicators should take care at all times. In some countries and in the European Union (EU) (European Commission, 2019), pesticide applicators, operators, advisers and distributors are required to be officially trained and are subject to certification. In particular, users should be aware of the potential risks, including hazards and main routes of exposure (see introduction) to the materials used; know their surroundings and how they might increase exposure (e.g. no water to remove residues on hands before eating, washing contaminated clothing with family clothes); be in good health, be alert and not work with pesticides when ill, malnourished, pregnant, or breastfeeding (see section 1.1.6); and, above all, read and understand the label (see 1.1.2).

#### *Storage and transportation*

Pesticides should always be stored securely, away from livestock, separated from food and drinks and locked away to prevent access by children and others not directly involved in their use. Pesticides should never be decanted into food containers, drinking bottles or unmarked containers, as this illegal practice may result in accidental exposure of other people. Pesticide containers should be transported separately from food and drinks and be well secured in vehicles to prevent spills.

#### *Application and use*

The following precautions should be taken during pesticide application.

- Pesticides should be applied at all times with the understanding that all chemical pesticides are toxic, following label directions and avoiding contact or contamination of self, others, the environment, clothes, eating utensils and other surfaces.
- Application equipment should be maintained, checked and calibrated before each use. Any leaking, worn or damaged components should be mended or replaced before use.

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<sup>7</sup> See the definition of “pesticide management” and refer to the Code of Conduct.

- **The appropriate protective clothing should be used as a last line of defense, with the understanding that PPE reduces exposure but does not fully prevent it, even when the correct PPE is used.**
- Good personal hygiene (see below section 1.1.3) should be practised at all times.
- First aid directions should be available (see section 1.1.9) in the event of an accident or unplanned exposure.

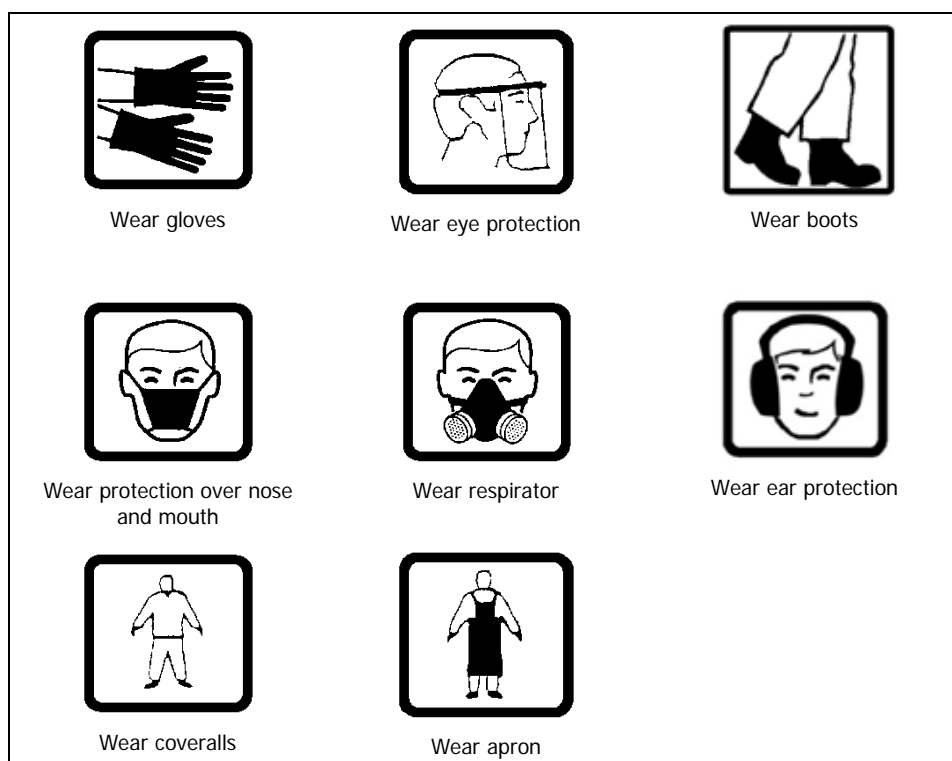
### *Phases after use*

After application, empty containers should be cleaned by triple rinsing (not in waterways), collected and disposed of in accordance with local procedures. They should not be discarded and burnt in the field or re-used as containers for storage of food or water. These steps should be taken in accordance with the disposal instructions on the label. More information is provided in the *FAO Guidelines on management options for empty pesticide containers* (FAO, 2008).

### **1.1.2. Understanding the label and requirements for PPE**

As stated in the *Guidelines on Good Labelling Practice for Pesticides* (FAO/WHO, 2015), the label is the primary means of communicating information to the pesticide user. It includes precautionary statements to reduce risk, such as pictograms, “signal” words (Annex 1), and associated directions on PPE and safety. Figure 3 provides some examples of common PPE pictograms for pesticide use.

**Fig. 3. Examples of common PPE pictograms for pesticide use**



Users should first notice the label, then read or have it read to them. Understanding the label information, including pesticide hazard and risks and the PPE required, is essential for implementing the instructions in their use context. This can be supplemented by “understanding” mechanisms such as consulting a trainer or extension agent, using leaflets or cards that explain the scientific intention of the pictograms. Examples of label cards can be found in the labelling guidelines (FAO/WHO, 2015).

Authorities in each country should ensure that only registered pesticide products are sold and that they bear a label in a language understood by the users. Labels should comply with national legislation and be large enough to contain the required information. If necessary, for example, additional information should be provided in a separate leaflet for small bottles or sachets. The font size must be large enough to be read and easily understood by the users of the pesticide. Labels and safety data sheets (SDS) should be accessible in an appropriate language. “Quick response” (QR) codes that provide information on the product in a number of languages, as discussed in the labelling guidelines (FAO/WHO, 2015), could be useful.

If a specific PPE is required for use when applying a pesticide, the label should clearly state the PPE required, which must be available in the country of use. The companies that supply the product should ensure that the required PPE is available at the point of sale in an adequate quantity and an affordable price.

### *1.1.3. Personal hygiene and special precautions with PPE*

**PPE does not provide a 100% guarantee  
that a person will not have some exposure to pesticides.**

All users of pesticides should be instructed in the importance of washing their hands and other exposed parts of the body immediately if they are contaminated with a pesticide. Water and soap must be always readily available to wash off any splashes or spills. Removal of concentrated liquid pesticides from a gloved hand is very important, as some solvents gradually penetrate a glove. It is also important to wash gloved hands before removing the gloves.

As the body sweats during work, especially when manually operated application equipment is used, the operators and applicators must be provided with clean water to drink throughout the day. They should never eat, drink or smoke while applying pesticides. During rest breaks, they should pay particular attention to ensuring that their hands and face, especially around the mouth, are washed well before eating or drinking and that food does not come into contact with the PPE or work clothes used during spraying.

Even users who are well protected with PPE should take a shower in an area that does not contaminate family clothes or outside play or work areas, and they should change from their work clothes at the end of each day after using pesticides. Work clothing and PPE must be washed separately from other family clothes and kept in a separate place. Boots used during pesticide use should not be worn when returning home, as pesticide residues may contaminate the family, in particular children and domestic animals.

More details on cleaning, maintenance and storage of PPE is given in section 1.6.

#### ***1.1.4. Other farm workers***

Farm workers other than those handling and applying pesticides must be informed of the “re-entry” requirements on labels and not enter a sprayed field or glasshouse too soon after pesticide treatment. If they have to enter the sprayed field for some reason, they should check whether PPE requirements for “early entry” have been set and they should wear appropriate protective clothing. Otherwise “re-entry” intervals must be strictly complied with.

It is recommended that workers who handle a crop that has been treated with pesticides (e.g. sorting, bundling or packing fruit, vegetables or flowers) wear gloves.

#### ***1.1.5. Pesticide retailers***

Pesticide retailers should take the necessary precautions when handling pesticides and have the appropriate safety equipment in case of an incident (e.g. spill) in the store. As outlined in the *FAO Guidelines for retail distribution of pesticides with particular reference to storage and handling at the point of supply to users in developing countries* (FAO, 1988), “*All necessary safety, first-aid and rescue equipment and supplies which may be required, should be available and readily accessible before handling a pesticide. Depending on the hazard of the material being handled, such necessary supplies may include specific or all-purpose gas masks; respirators; goggles or face shields for eye and face protection; water-proof and impervious complete outer clothing, including gloves, boots, hat and long-sleeved, buttoned coat or suit completely covering the worker; adequate emergency water supply for washing off corrosive or toxic materials getting on the skin; and facilities for washing eyes such as fixed portable eye-wash fountains.*”

#### ***1.1.6. Vulnerable groups***

It is strongly recommended that vulnerable people, such as children, the elderly and immunosuppressed (e.g. HIV/AIDS) people not handle pesticides and not be allowed to mix and apply pesticides, because of their greater sensitivity to chemical products. In addition, in countries where risk assessment and registration procedures are not adequate, pregnant and nursing women should also not be involved in pesticide-related activities because of their increased risks (e.g. to fetuses and newborns).

### 1.1.7. *Bystanders and residents*

By definition, bystanders and residents do not handle or spray pesticides. Therefore, this section describes personal protection and limiting exposure, and not specifically PPE.

The presence of bystanders and livestock should be avoided when pesticides are applied. Children and pregnant and breast-feeding women should never be allowed to be present where pesticides are being mixed or applied. Bystanders who come close to an agricultural sprayer may be advised to wash their skin as soon as possible, whether or not they felt spray on their skin. A warning (Fig. 4) should be posted for bystanders who may walk along a path at the side or through a treated field. Residents living close to sprayed fields and in other areas where pesticides are to be applied to control disease vectors, such as public buildings, schools and parks, should be warned and informed of the product to be used 48 h before spraying. For those who wish to be forewarned of an application, it may be possible to send a text message by mobile phone. In addition, a no-spray buffer zone should be established around schools.

**Fig. 4. Example of warning sign near a treated field**



Source: Dobson et al, 2003

When indoor treatments are applied as part of a vector control programme or by a pest control company, residents and domestic animals must remain outside for at least 6 h. On their return, they should avoid touching treated surfaces for the period recommended on the label of the product. Applicators should inform residents accordingly.

### 1.1.8. *Non-occupational uses*

Although this document focuses on pesticide handling and application by farmers and professional PCOs, pesticides may be used non-professionally inside or outside a house. In such cases, minimal PPE can be expected to be worn. In assessing products, some countries assume that non-professional users do not wear any PPE, while others assume limited protection such as gloves, long-sleeved shirts and long trousers (Organization for Economic Co-operation and Development, 2009). In LMIC, “street pesticides”<sup>8</sup> may cause additional concern, as the risks

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<sup>8</sup> Street pesticides are pesticides for agricultural uses (registered or not) that are sold informally and illegally for household use; most are repackaged in common drink glass or plastic bottles and have no label or PPE requirements (Rother 2010, 2013).

may be underestimated or ignored and no PPE worn. Some LMIC therefore stress the importance of **wearing gloves as a minimum for all pesticide uses**.

### **1.1.9. First aid**

In cases of accidental exposure or signs or symptoms of pesticide poisoning, first aid treatment should be provided immediately. If it is obvious that a person has been exposed to a pesticide, he or she should be transported to a hospital or other medical care provider as soon as possible. The doctor should be given the label of the pesticides to which the patient was exposed.

In view of the acute and chronic risks posed by most HHPs, their use should be avoided if no medical facility that would have appropriate antidotes and instructions on their use is located near the application area. This is in line with Article 3.6 of the Code of Conduct, which states that *“pesticides whose handling and application require the use of personal protective equipment that is uncomfortable, expensive or not readily available should be avoided, especially in the case of small-scale users and farm workers in hot climates.”*

The key aspects of first aid for an occupational exposure are:

- Remove the patient from any pesticides and from the contaminated area immediately.
- Quickly remove any contaminated clothing and PPE in a manner safe for both the patient and for the helper, and cover the patient with a blanket or clean clothes.
- Wash exposed parts of the body with soap and plenty of clean, cold water without contaminating others. Then put on clean clothing. If the eyes have been splashed with a pesticide, wash them immediately with  $\geq 500$  mL of clean water and gently irrigate the eyes for at least 15 min (Fig. 5).
- Keep the patient in the “recovery position”, on their left side with the neck extended (Fig. 6).
- Follow the first aid instructions on the label.

**Fig. 5. First aid for eye**



Source: Dobson et al, 2003

**Fig. 6. Recovery position for an unconscious person**



If the patient has ingested toxic pesticides, medical attention should be given immediately. Do not give any water or milk, as this will push the pesticide on into the bowel, where it will be absorbed more quickly. If the patient is unconscious, never give anything by mouth. If the patient is fully conscious and seen within 10-15 min of ingestion, as a general rule, do not induce vomiting to try to remove some of the pesticide (unless the label says so). Vomiting a potentially corrosive pesticide (such as paraquat or MCPA) or any product that could damage the lungs (as indicated on the label), can be dangerous. In addition, it could delay transport to a hospital.

Farms and organizations that use pesticides regularly should have trained first aiders on their staff and have a first aid kit and a supply of clean water readily available. People who regularly apply organophosphate or carbamate pesticides should have routine medical examinations and should have baseline examinations before using those pesticides for the first time, preferably as part of occupational health monitoring, which includes checking the cholinesterase level in their blood. If the cholinesterase levels drop significantly<sup>9</sup> below the baseline, the person should be told to stop applying organophosphate or carbamate pesticides, and his or her exposure risk should be carefully examined for future application and for other people conducting similar applications.

## 1.2. PPE and factors that determine its requirements

In the Code of Conduct, PPE is defined as “*any clothes, materials or devices that provide protection from pesticide exposure during handling and application. In the context of the Code, it includes both specifically designed protective equipment and clothing reserved for pesticide application and handling*”.

<sup>9</sup> The significance of cholinesterase levels that are below an individual’s baseline should be based from advice from occupational health experts and the normal range of variation seen in the testing laboratory. If such advice is not available, reference can be made to published sources, such as California Office of Environmental Health Hazard Assessment (2015), which suggests that a 20% decrease from baseline is the first level that should trigger an intervention.


The main purpose of PPE is to minimize human exposure to a pesticide. PPE is designed to keep pesticides away from the body. It is not effective if the pesticide does not remain outside. Unfortunately, even if PPE is specified on a label, in LMIC many pesticides are applied without PPE; as a result, users become ill and require medical treatment. Various reasons for not using PPE are listed at the beginning of Part 2.

The protective equipment required will depend on factors linked directly to pesticide exposure. The examples listed in Table 1 can be considered by registration authorities when reviewing a proposed label and deciding on the PPE that is necessary.

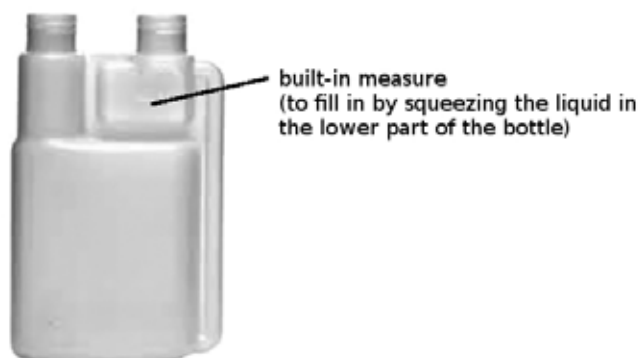
**Table 1. Examples of factors that determine pesticide exposure**

<i>Factor</i>	<i>Comments</i>
<b>Hazard of the formulated pesticide being applied</b>	The operator or applicator requires more protection when using highly hazardous (acute and chronic) pesticides. Comprehensive PPE is required for products in WHO hazard classes Ia, Ib and II, and in GHS categories 1A, 1B, 2 and 3, especially during mixing and loading.
<b>Formulation type</b>	<p>Generally, dry, granule-type formulation products pose lower risks of dermal or inhalation absorption; the latter however, depends on whether dust can be created from the granules.</p> <p>The risk is higher with dusts, powders and liquid formulations.</p> <p>The risk is highest with fumigants.</p> <p>The pesticides most commonly purchased by farmers and used by workers engaged in vector control are concentrated formulations that are diluted with water and then applied to a surface (crop foliage, soil, house wall) or dispersed as space treatment (fog). A few liquid formulations are applied undiluted as ULV sprays, e.g. for locust control.</p> <p>Some pesticides are now marketed as “ready-to-use” (RTU) and have already been diluted (e.g. for home and garden application, mainly for non-professional uses).</p>
<b>Phase of pesticide use</b>	The operator or applicator is most exposed to a concentrated pesticide when measuring, loading and mixing the spray liquid and is exposed to less concentrated product during application.

<b>Type of packaging</b>	<p>The design of the package or container can reduce the risk of exposure during opening, pouring and disposal and hence limit the need for PPE.</p> <p>Packaging that is too large (thus increasing the number of handling operations and creating constraints for storage and excess) or too small (making it hard to label adequately and easy for children to access) can both be problematic.</p> <p>Small sachets that contain the quantity required for one spray tank reduce exposure. Dry particulate formulations are preferably supplied in sachets containing a sufficient amount for a single sprayer load. Water-dispersible granule (WG) formulations are less hazardous to use than those that are wettable powders (WP).</p> <p>A built-in measure (Fig. 7) in small containers ensures the correct dose and minimize exposure of the hands to concentrated pesticide. It is recommended when small quantities are required for portable sprayers. Containers that are designed to prevent reuse or have to be returned to the manufacturer reduce the risk of reuse for food or water or contaminating the environment.</p> <p>“Closed transfer” systems can reduce the requirements for PPE during loading. They reduce exposure to the pesticide, as the product is transferred directly from a container into the sprayer tank without exposure of the user.</p>
<b>Type of equipment used to apply the pesticide</b>	<p>The risk of exposure of applicators or operators is high when they use manually operated knapsack sprayers with a hand lance. The operator can reduce exposure by directing the spray to the side and downwind, thus offsetting the sprayed area so that the applicator does not walk through it constantly, and keeping the body always upwind.</p> <p>The equipment should be well maintained (i.e. cleaned after each use and before storage, calibrated before each use and not used if leaking). Leaking sprayers and liquid running from the lance over the hands are common causes of severe exposure and poisoning. PPE is required when cleaning equipment.</p>
<b>Type of spray applied</b>	<p>Most spray droplets measure <math>\geq 200\text{--}400\ \mu\text{m}</math>, and the main route of exposure is absorption through the skin. Droplets with diameter in the range <math>10\text{--}100\ \mu\text{m}</math> tend to be filtered out in the nose and are less likely to enter the lungs, but they may accumulate and be absorbed through the mucous tissue of the throat and nose.</p> <p>Respiratory protection is required when using sprays with small droplets (e.g. fogs, “spacial” applications) that could easily be inhaled or absorbed through the nose.</p>
<b>Engineering controls added to application equipment</b>	<p>Manufacturers of pesticide application equipment should follow specifications published by the International Organization for Standardization (ISO) or equivalent national standards. Many equipment specifications have recently been changed to reduce occupational exposure to pesticides. Examples of such changes include enlarging the filler opening in a tank and including a deep-set filter to avoid splashing of spray liquid (Fig. 8). Other engineering measures to reduce exposure include drift-reducing nozzles, closed cabins on tractors and close-circuit pesticide pumping systems.</p>

<b>Duration of the exposure</b>	For short exposure to low-hazard products, disposable PPE may be used, although these are not available in many LMIC. In most other cases, (permeate) protection that prevents passage of the pesticide is required.
<b>Weather condition during application</b>	In hot weather, more pesticide is absorbed from skin and inhalation is increased due to high evaporation of pesticides. Windy conditions also increase inhalation.
	
<b>Re-entry into treated areas</b>	Specific PPE may be required for early entry to treated areas, as permitted under some legislation. It may be required for contact with anything that has been treated, including plants, soil and hard surfaces.

**Fig. 7. Example of a container with a built-in measure**



**Fig. 8. Engineering controls: enlarged filler opening in a tank and a deep-set filter to avoid splashing of spray liquid**



### 1.3. Determining the appropriateness of PPE

The type of PPE needed depends on the factors listed in section 1.2, especially the toxicity of the pesticide being used and the formulation type. The PPE necessary to prevent unacceptable exposure and risk should be indicated on the label of each product. If PPE is required, users should evaluate whether it is feasible and realistic under the local conditions of use of the pesticide.

Hazard and risk for operators and applicators are generally assessed for:

- mixing and loading the concentrated pesticide formulation into the spray equipment;
- applying the concentrated (e.g. ULV) or, often, the diluted pesticide product;
- cleaning the spray equipment and rinsing empty containers of either concentrated or diluted pesticide product; and
- storing left-over concentrated pesticide formulation.

The PPE requirements will depend on the above-listed use phase and the product.

These guidelines recommend that when pesticides are used, at the very least, **long-sleeved shirts, long trousers, boots, socks and chemical-resistant gloves should be worn, even if the label does not require any PPE**. The suggested basic minimum requirements for PPE for pesticide activities in public health (e.g. indoor residual spraying, manual thermal fogging or cold fogging, truck cold fogging or thermal fogging, applying larvicides) and in agriculture (e.g. handling unopened packs, mixing and filling spray tanks, spraying with a lance or from a tractor, applying granules or treated seeds, maintaining and cleaning equipment, disposing of waste) are listed in Annexes 2 and 3.

#### 1.3.1. Use of PPE in a regulatory framework

PPE is used in a regulatory framework to mitigate risk (with many other measures, such as reducing the concentration of the formulation or adding engineering controls) if the risk has been estimated or calculated to be unacceptable to the pesticide operator or applicator. The risk of the formulated pesticide product for operators and applicators is assessed by estimating exposure in either a model or from measurements and comparing the outcome with the acceptable operator exposure level (AOEL).



**Registrars and risk assessors should always keep in mind that, when the correct PPE for the product is not available to the user or the conditions of use are such that it is unlikely to be worn, the pesticide should not be registered for use. According to Article 3.6 of the Code of Conduct, “pesticides whose handling and application require the use of PPE that is uncomfortable, expensive or not readily available should be avoided, especially in the case of small scale users and farm workers in hot climates.”**

### 1.3.2. Assumptions to be made in risk assessment exposure calculations

An “exposure scenario” is a description of a situation where the operator or applicator is exposed to a pesticide, including data on the type of application equipment, pesticide formulation and application rate, and possible levels of personal protection. The FAO Pesticide Registration Toolkit (see Annex 4) gives links and explanations of various models of human exposure used in Europe or the USA, such as the European Food Safety Authority (EFSA) Calculator and the CropLife OPEX/US Tool. By choosing appropriate exposure scenarios and selecting the level of PPE (e.g. with or without gloves, with or without coverall, etc.), these existing models can be used in LMIC to obtain an initial indication of occupational exposure and assess the risks of operators and applicators for exposure. In addition, according to the EU *Guidance on Assessment of Exposure for Operators, Workers, Residents and Bystanders in Risk Assessment for Plant Protection Products* (European Food Safety Agency (EFSA), 2015), first-tier exposure for operators should be assessed on the assumption that “work clothing” (see definition in below section 1.4) is worn, with no PPE.

“Exposure reduction” could be assumed when use of respiratory equipment and PPE clothing when no measured data are available in the relevant exposure models (Table 2).

**Table 2. Indicative protection and reduction of exposure with different types of PPE in the EFSA model**

<i>Type of PPE</i>		<i>Exposure reduction</i>
<b>Respiratory</b>	Mask – FFP1* and similar	Inhalation: 75% Dermal (head): 20%
	Mask – FFP2* and similar	Inhalation: 90% Dermal (head): 20%
<b>Clothing</b>	Work wear: arm, body and legs covered (cotton)	Dermal (body): 90%
	Protective (chemical resistant) coveralls	Dermal (body): 95%
	Gloves	Liquid formulations (hands): 90% Solid formulations (hands): 95%
	Hood	Dermal (head): 50%
	Hood and visor	Dermal (head): 95%

Source: Adapted from EFSA, 2015

\* FFP: Filtering Facepiece Particle (see also Annex 5)

Engineering controls are most likely to be used by large commercial farmers and by PCOs, who are in a position to make the necessary investment. Engineering controls are less likely to be used by small-holder farmers and organizations with limited financial means. When engineering

controls are used, such as an enclosed tractor spray cabin, less PPE may be required; however, the operator should ensure that the correct PPE is worn for activities without engineering controls, such as mixing and loading.

### *1.3.3. How governments ensure appropriate PPE on labels*

During registration, governments should review the PPE indicated on the proposed label and, after the risk assessment, should decide whether the level of protection is sufficient. Some governments, such as in Sweden (Kemikalieinspektionen, undated), have prepared guidance to companies that manufacture or sell pesticides on labelling their products, including safety instructions. International guidelines (FAO/WHO, 2015) also provide advice on good labelling practice. Governments should strengthen their capacity for enforcement and compliance and check regularly that labels contain all the required information, especially for PPE use during different pesticide activities.

More technical information on types of PPE is given in the following section 1.4.

## **1.4. Types of PPE**

### *1.4.1. Body protection, including feet and hands*



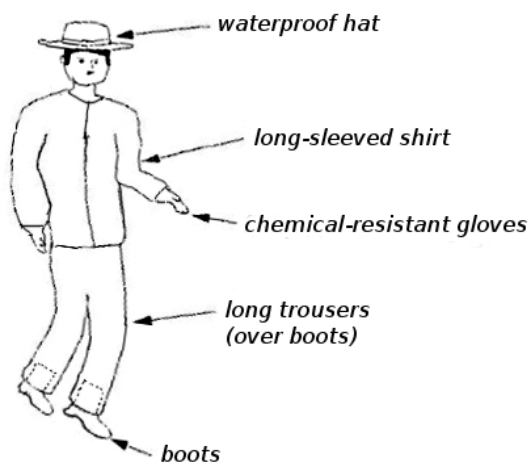
In hot, tropical climates, no user of manually operated spraying equipment wants to wear full protective clothing when applying highly toxic pesticides, because wearing protective clothing and other equipment may cause severe discomfort and even physical distress due to heat stress if they are made of inappropriate materials.

Therefore, pesticides should preferably be applied early or late in the day, and the least toxic pesticides or alternative methods that are effective against the pest should always be recommended.

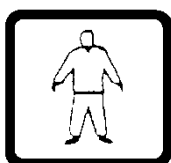
**As a minimum precaution and to reflect real-life situations in LMIC, users should wear lightweight work clothing that covers most of the body, such as a long-sleeved shirt, long trousers, a hat, chemical-resistant gloves and boots that do not absorb spray.**

In this context **work clothing** is defined as clothing that can be obtained readily and worn by operators and applicators during working hours (Fig. 9). It does not include the additional items of PPE that might be recommended on labels.

**Fig. 9. Basic protective work clothing**




### *Coveralls*



To minimize exposure of the body, pesticide applicators and operators should wear coveralls (often referred to as “overalls”) that cover the whole body. A coverall may be a single-piece suit or a combination of jacket and trousers (in two parts). The latter is often more suitable in tropical climates, especially when the lower part of the jacket overlaps the top of the trousers and allows air to circulate around the body thus reducing heat build-up. It should fit tightly around the neck and wrists and may have a hood attached to cover the head and neck. The garment should have no openings or pockets, to avoid contamination from hands. Each member of a spraying team should have two coveralls for use on alternate days, so that the contaminated coverall can be cleaned. A spare coverall for use in case of an emergency is also recommended.

Coveralls are usually assigned a “type” or a “class”, depending on the manufacturer. In general, the definitions in Table 3 can be applied.

**Table 3. Types of chemical-resistant clothing**

	<b>Type 1</b>	Fully enclosed, gas-tight	Protection against hazardous gases, liquids, aerosols and solid particles
	<b>Type 2</b>	Gas-tight for use with airline breathing apparatus	Protection against hazardous gases, liquids, aerosols and solid particles
	<b>Type 3</b>	Liquid-proof	Protection against pressurized liquids (typically used when handling WHO class Ia, Ib or II liquid pesticides)
	<b>Type 4</b>	Splash- and spray-resistant	Protection against sprayed liquids (typically used when handling WHO class III and U liquid pesticides and some solid pesticides that are irritants or corrosive)
	<b>Type 5</b>	Particulate-resistant Spray-tight (limited)	Protection against dusts and particles (suitable for use when handling most solid pesticides but may be compromised by sweat. Welded seams may be required against ultra-fine particles)
	<b>Type 6</b>	Limited protection against splashes and particles	Typically used when there is no direct contact with pesticides

Type 1 indicates the highest protection and type 6 provides the least. **Four types, types 3 to 6, are relevant to chemical pesticide use.** Not all the materials in the table are impermeable. Most types 3 and 4 garments are for single use and are multi-component with a nonwoven base. The protection depends on the laminated or coated layer on the nonwoven base. Nonwoven material is used because it is light and relatively inexpensive. Coveralls made of lightweight, nonwoven materials vary in suitability from type 3 to 6.



In the tropics, a spray operator will find types 3 and 4 uncomfortably hot, as the material is not “breathable”, whereas types 5 and 6 are much lighter but are not recommended against liquid chemicals. Nonwoven materials made of high-density polyethylene fibres are less durable than cotton and therefore have to be replaced more often, according to the type of work involved. If disposable coveralls are not changed regularly, they will no longer provide adequate protection and can increase skin contamination.

Reusable coveralls made of advanced woven or knitted material coated with water-repellent polymers can be washed and have a longer life but should be carefully inspected for damage. They should be washed separately from family clothing and the wash water disposed of so as not to contaminate water sources or areas where humans or animals play, eat or work.



Under tropical conditions, cotton garments are among the most comfortable and are usually readily available. They give adequate protection in many cases, but they do not provide sufficient protection when HHPs or WHO class II pesticides are applied. It is advisable to choose garments made of material that is as thick and heavy as can be worn with reasonable comfort in the prevailing climate. When cotton becomes wet, it no longer provides protection and can increase skin contamination.

The design should cover and protect zips and be elasticated at the wrists. They can be washed with soap, detergent or washing soda (sodium carbonate), preferably after each day of use. The fabric of some coveralls is treated with a water-resistant finish; however, fabrics with repellent finish may require special care. If garments are hand-washed and the garment is not rinsed properly, the surfactant in the garment can allow pesticide penetration. Coveralls can also be used in combination with plastic aprons or tabards (see next section) to prevent spillage or spray wetting the fabric, especially when preparing a spray with a concentrated pesticide. They will also protect the operators and applicators when they walk between plants while spraying them, as the sprayed foliage could wet the cotton coveralls. Trousers with a waterproof section from just above the knees or even from the ankles are useful in some situations to protect the legs when the spray operator moves through sprayed foliage.

In 2017, a new international standard (ISO 27065:2017) was developed specifically for protective clothing worn by pesticide operators applying liquid pesticides and for re-entry workers (ISO, 2017). The standard provides performance requirements for whole body garments (e.g. one-piece coveralls and two-piece garments such as a shirt or jacket and trousers) and partial-body protective clothing (e.g. aprons). Three performance levels are described in Table 4.

**Table 4. Protective clothing described by ISO standard 27065:2017**

Level C1 protective clothing	suitable when the potential risk is relatively low. Level C1 protective clothing provides the least protection and is not suitable for use with concentrated pesticide formulations. It can be used as the base protective clothing with additional items worn when the potential risk is relatively higher. Level C1 garments are primarily reusable garments made of commonly available cotton and cotton/polyester workwear fabrics. The minimum requirements for this level is based on garments commonly used for operator exposure studies.
Level C2 protective clothing	suitable when it has been determined that the protection required is higher than that provided by Level C1 protective clothing. Level C2 protective clothing typically provides a balance between comfort and protection. This protective clothing is not suitable for use with concentrated pesticide formulations. It can be used as the base protective clothing with additional items worn when the potential risk is relatively higher. Level C2 garments include reusable cotton and cotton/polyester garments with a repellent finish. It is important to note that the performance of fabrics with repellent finish varies considerably; not all fabrics with repellent finish meet the requirements. Disposable/single use garments that meet Level C2 requirements are primarily are nonwoven fabrics with microporous membrane.

Level C3 protective clothing	suitable for use when it has been determined that the potential risk is high. Precautionary measures such as short duration for use are necessary for Level C3 suits/coveralls that may cause heat build-up resulting in heat exhaustion/stress. Level C3 protective clothing is suitable for use with diluted as well as concentrated pesticides.
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Source: ISO, 2017

### *Aprons and tabards*



Aprons are worn over coveralls when opening a pesticide container and preparing a spray, especially if type 5 or 6 coveralls are worn. They may be made of rubber or PVC. They are particularly important for tractor drivers to prevent spillage on the coverall before entering the tractor cab. The apron (Fig. 10) should cover the front of the body up to the neck and down to the knees. A clean plastic sheet or plastic sack cut to form an apron can be worn as a temporary measure and disposed of after use.

**Fig. 10. An apron (shown in black)**



Source: Dobson et al, 2003

Tabards are like ponchos, with long flaps at the front and back and open along each side. They are therefore considered less hot by operators. Some have a reinforced mesh on the back that protects the operator's back, as this part of the tabard is liable to damage by contact with the sprayer.

## Footwear



When chemical pesticides are used, the feet should be protected by non-absorptive boots, such as chemical-resistant boots. Boots should not be lined. Simpler boots may be sufficient for handling biological pesticides.

The bottoms of the **trouser legs should be pulled over the boots to prevent pesticide from entering the boot**. After application, before the footwear is removed, it should be hosed with water to rinse away any chemical or dirt. Examples of boots that provide different levels of protection are listed in Table 5.

**Table 5. Footwear and chemical protection**

<b>PVC</b>	Protect feet against moisture and improves traction
<b>Butyl</b>	Protect against most ketones, aldehydes, alcohols, acids, salts and alkalis
<b>Vinyl</b>	Resist solvents, acids, alkalis, salts, water, grease and blood
<b>Nitrile</b>	Resist animal fats, oils and chemicals

## Gloves



The hands are some of the most likely parts of the body to be exposed to pesticides, so **wearing gloves is considered the minimum level of protection**. Gloves can significantly reduce exposure to pesticides. **Non-absorbent, chemical-resistant gloves are important parts of PPE**, especially for handling concentrated pesticide and preparing spray.



As preparing spray is usually rapid, gloves may be worn even in hot, humid conditions. Although wearing protective gloves may be uncomfortable for operators, this does not impede them or have adverse consequences.

**Reusable gloves and single-use gloves are the two main categories of gloves**. If wearing gloves is not a mandatory legal requirement, it is always recommended to use reusable gloves for mixing, loading, spraying (because of liquid running back down the lance and wetting the hands) and cleaning equipment. Single-use gloves are also recommended for checking that equipment has no leaks, especially at the trigger valve on manually operated sprayers.

Chemical-resistant gloves are made of various materials and are used for protection against a wide range of chemicals as shown in Table 6.

**Table 6. Gloves and chemical protection**

<b>Nitrile</b>	Generally, gloves made of nitrile (a synthetic tri-polymer, which is like rubber when vulcanized) provide good protection against the majority of pesticide formulations using chlorinated aromatic solvents. Thin ones are disposable, while thicker ones can be reused. They are relatively inexpensive and are the most commonly used gloves for pesticide use (they have been used for most operator exposure studies.)
<b>Neoprene</b>	These are required for handling corrosive pesticide chemicals and are resistant to oils, greases, alcohols, resins, alkalis, organic acids and other compounds; however, neoprene is poorly resistant to chlorinated aromatic solvents, phenols and ketones and is not recommended for fumigants.
<b>Butyl rubber</b>	These are resistant to gas and water vapours and are recommended for certain fumigants.

Gloves should be flexible, easy to put on or take off and comfortable, so that the operator can handle small items, such as nozzles. They must not be slippery. Selecting the right size is important, and they should be long enough to cover the wrists. The recommended minimal length of gloves is 30 cm (elbow length), in particular for mixing, loading and cleaning operations. Great care is needed when wearing gloves. It is important when moving pesticide containers to ensure that the gloves are not exposed to sharp surfaces that can result in cuts or scratches.

**Reusable, long gloves should usually be worn outside long-sleeved shirts or coveralls to protect the sleeves from pesticides.** If the gloves are inside the sleeves, pesticide can run off the gloves into the sleeves when the arms are raised. **Single-use, thin gloves can be worn tucked inside sleeves** (Figures 11a and 11b)

**Fig. 11a and 11b. How to wear gloves**



Any spillage on gloves should be washed off immediately, as the solvents in some formulations can penetrate slowly the material of the glove. This is particularly relevant for concentrated pesticides. Gloves should be removed before entering a tractor cab.

**Gloves, do not:**

- Do not use household cleaning gloves or gloves made of inexpensive latex (natural rubber), as they can easily tear, absorb some pesticides e.g. pyrethroids, and are too thin to protect the hands;
- Do not use gloves with a lining, as they can accumulate products and contaminate the skin;
- Never use leather or cotton gloves, as they absorb pesticides; or
- Do not use gloves worn by medical staff.

**Practical tip:**

Gloves should be removed by using the first removed glove as protection during the removal of the second glove, **taking care not to contaminate the hands with the first glove.**

**Reusable gloves should be washed before they are removed** and should be cleaned inside and outside after a day’s use. Check gloves before reusing to ensure that there are no holes, cracks or weaknesses (e.g. lumps, pinholes or thin patches).

In 2019, a new international standard (ISO 18889:2019) was developed specifically for protective gloves for pesticide operators and re-entry workers. The standard gives minimum requirements for gloves (Class G1 and G2) that provide chemical protection to the whole hand and gloves (class GR) that provide protection only to the fingertips and palm-side of the hand (suitable for certain re-entry tasks) (ISO, 2019). The following performance levels are described in Table 7.

**Table 7. Levels of protection for gloves as described by ISO standard 18889:2019**

G1 gloves	suitable when the potential risk is relatively low. These gloves are not suitable for use with concentrated pesticide formulations and/or for scenarios where mechanical risks exist. G1 gloves are typically single use gloves.
G2 gloves	suitable when the potential risk is higher. These gloves are suitable for use with diluted as well as concentrated pesticides. G2 gloves also meet the minimum mechanical resistance requirements and are therefore suitable for activities that require gloves with minimum mechanical strength.

GR gloves (with partial protection)	GR gloves provide protection only to the palm-side of the hand for a re-entry worker who is in contact with dry and partially dry pesticide residues that remain on the plant surface after pesticide application. This glove category is suitable only for re-entry activities where it has been determined that protection provided to the fingertips and palm-side of the hand is sufficient. They cannot be used in place of G1 and G2 gloves that protect the whole hand. GR gloves also have mechanical properties that are required for several re-entry tasks. Breathable material in the back of the hand provides comfort.
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Source: ISO, 2019

### 1.4.2. Head, face, eyes and ears

#### *Hat*

If coveralls have no hood, spray operators must wear a non-absorbent, waterproof hat. This also protects the ears, which have a high absorption rate, and prevents hair from collecting spray droplets.

#### *Face shield*



A transparent plastic visor gives a comprehensive protection to the face and eyes from splashes particularly when opening containers and mixing and filling sprayers. It may also be worn at other times when spray or splashes of pesticide could occur. They are often preferred to goggles and safety glasses as they provide protection for the whole face.

#### *Safety glasses and goggles*



Safety glasses and goggles (Fig. 12), usually made of scratch-resistant polycarbonate, provide eye protection but are less comfortable than face shields and may not be acceptable to pesticide operators in hot, humid conditions. Safety glasses and goggles that allow some air ventilation at the sides are more comfortable to wear and less likely to mist up quickly.

Goggles are fully enclosed glasses and provide more protection than safety glasses. Goggles may be required when there is a risk of dusts, such as when handling dry formulations, and when there is a risk of splashes during mixing and loading and of mists during spraying.

**Fig. 12. Safety goggles**



Before use, eye protection equipment should be examined carefully for any signs of damage. If there is any doubt about its adequacy, it should be replaced. During use, the equipment should be cleaned when necessary to ensure clear vision. After use, it should be washed to remove any contamination.

### *Ear protection*

Some motorized application equipment emits excessive noise. Motorized knapsack mist-blowers and foggers can emit noise in excess of 85 dB. Operators using such equipment should use ear protection.

Earplugs do not lower the noise level much, but are small and convenient to carry and use when noise is encountered unexpectedly. Otherwise, ear defenders (Fig. 13) are required.

**Fig. 13. Ear defenders**



### *1.4.3. Respiratory system*

**Respiratory protective equipment (RPE)** is used to protect against inhalation and absorption through the nose or mouth. After pesticide risk has been assessed and after risk mitigation, the label will indicate whether RPE is necessary and, if so, what type. RPE is often necessary when applying dusts, sprays, fogs or fumigants, especially in enclosed spaces and greenhouses. It should be noted that **training is essential for workers using any form of RPE.**



Pesticide applications requiring RPE should be avoided in hot, humid tropical conditions, as half-mask and full-face respirators can be very uncomfortable due to condensation of respiration and moisture inside. If they are necessary, they should be used for a short period during the coolest part of the day.

RPE varies from simple disposable masks to respirators (see Figs 16–18 below). Respiratory protective devices can be categorized as air-purifying and air-supplied. As most pesticide contaminants can be removed from the atmosphere by air-purifying devices, these are the most commonly used.

Air-purifying devices include nuisance dust masks, particulate air filters and respirators (gas masks). Most liquid pesticides are not volatile and form fine droplets or liquid particles in the air. Particles, solid or liquid, but not vapours, are removed by particulate air filters. Respirators protect against vapours (such as during soil fumigation) and very fine aerosols.

#### *Nuisance dust masks*

Nuisance dust masks provide protection only from *large* dust particles and *large* spray droplets (aerosols) > 10 µm and should be used only when the dusts and droplets are not hazardous to health. In addition, they offer minimal protection, because of their poor sealing (they are usually held in place by a simple elasticated strap). This type of mask will not protect the wearer from hazardous dust particles, liquid in air emulsion small particles or vapours of pesticides. **Simple nuisance dust masks are therefore not considered protective devices and are not recommended.**

**Fig. 14. Nuisance dust mask: not recommended for protection against pesticides**



Similarly, surgical masks, intended to be worn by health professionals during surgery and during nursing, are also not recommended for pesticide use.

**Fig. 15. Surgical mask: not recommended for protection against pesticides**



*Particulate air filters (or particulate air filter masks)*

Particulate air filters and masks should not to be confused with simple nuisance dust masks, although they might look similar; however, particulate air filters provide much greater respiratory protection.

These filters are used for protection against airborne particulates of solid (dusts, powders) or liquid  $> 0.3 \mu\text{m}$  but not for protection against vapours or gases. They are recommended for operations involving treated seeds and application of pesticides in the form of granule formulations or of water-diluted pesticides that do not form fine aerosols  $< 0.3 \mu\text{m}$ . More elaborate air filter masks incorporate a one-way valve to facilitate breathing out (Fig. 16).

**Fig. 16. Example of a particulate air filter mask**



Particulate air filters should be changed as per the manufacturer's specifications to protect against accumulation of material, e.g. when sowing treated seeds or applying pesticides in the form of granule formulations. More European and US standards are listed in Annex 5.

Some masks can be washed and carefully dried for re-use, but disposable masks should be disposed of after 1 day's use or less if they are contaminated, as operators must not breathe through a contaminated mask.

## Respirators


Respirators are recommended to protect operators from vapours, gases and very fine aerosols (< 0.3 µm). They are also recommended for pesticide operations in which there is a high concentration of airborne liquid droplets, e.g. in enclosed areas such as greenhouses.



Half-mask respirators cover the mouth and nose and are fitted with one or two replaceable cartridges or canisters. The cartridge is selected according to the pesticide being applied. A cartridge should have an expiry date and a colour code indicating the uses for which the respirator is recommended, as shown in Table 8. These colour codes should not be confused with the colour coding of pesticide

labels that reflect the product toxicity. There is also a number 1, 2 or 3 to indicate the level of protection, 3 providing the most protection.

**Table 8. Colour codes and uses of respirators**

Type	Colour code	Use
A	Brown	Organic gases and vapours
P	White	Particulates and dusts
B	Grey	Inorganic gases and vapours (e.g. Cl <sub>2</sub> )
E	Yellow	Acidic gases and sulfur dioxide (SO <sub>2</sub> )
K	Green	Ammonia (NH <sub>3</sub> )
APBEK		Multi-purpose

The dates and duration of use must be recorded and the cartridge replaced as recommended by the manufacturer (usually after x uses or after x hours). Employers should ensure that replacement cartridges are always available and that replacement schedules are strictly followed. The same applies to small-holders. On a twin-filter respirator, the two filters must be identical (Fig. 17).

**Fig. 17. Example of a twin filter half-face respirator**



Source: Dobson et al, 2003

A full-face respirator incorporates a visor and may have only one filtering canister (Fig. 18). It protects the eyes, nose and mouth and provides a better seal than a half-facepiece respirator. Applicators working for long periods who require RPE can use a powered full-face respirator that incorporates a helmet and a battery-powered fan to pass fresh air through a filter or cartridge between the visor and the face.

**Fig. 18. Example of a powered full-face respirator**



Source: Dobson et al, 2003

### *Considerations for use of RPE*

The most important aspect of RPE is how well it forms a seal and thereby prevents contaminants from passing through the filter mechanism. The effectiveness of the seal should be checked by **testing the fit**, by covering the front of the mask with both hands and exhaling sharply. If any leakage is detected, the position of the RPE should be checked and the tension adjusted by shortening the strap. There should be no smell of pesticide when the mask is on, as a leak due to a poor fit to the applicator's face or from a crack in the RPE will allow contaminated air to bypass the filter, making the respirator ineffective. A good seal and properly maintained equipment are thus essential (see also section 1.6).



The instructions should indicate the maximum relative humidity (e.g. > 80%) and the temperature range (e.g. -20° C to +35 °C) during storage.

When choosing RPE, it is important to consider:

- *Face size and shape*: Ensure that the straps are adjusted so that the mask or respirator is correctly positioned and fits the face very tightly.

- *Facial characteristics*: Facial hair (e.g. a beard), for example, will affect the seal and the user may require a hooded helmet. Glasses may also affect the visibility through a half-mask respirator as they may mist up.
- *Work rate*: Heavier breathing during a high work rate will draw more air through the filter, thereby increasing the exposure of the filter to the contaminants and reducing the effective life-time of the filter. The specifications should be checked before starting work.
- *Wear time*: This is linked to work rate. Before wearing a respirator, always check that the filter is in date and can be used; also check the work rate and the manufacturer's guidance.
- *Non-wear (storage) time*: This subtle effect depends on the storage conditions and frequency of use.

**RPE – do not:**

- Do not use respirators if you have not been trained or are in poor health;
- Do not use a nuisance dust mask to protect against pesticides;
- Do not use a respirator in an oxygen-deficient environment;
- Do not use particle air filters to protect against gases or vapours, or gas or vapour filters to protect against particles;
- Do not use a respirator that is dirty, damaged or incomplete; or
- Do not reuse a respirator if the label indicates “NR” (non-reusable).

A few pesticides and formulations have been assigned an Occupational Exposure Limit (OEL) or Maximum Exposure Limit (MEL). The labels on these products should specify the appropriate PPE or RPE.

The ISO standards that apply to PPE items and specialized RPE are listed in Annex 5.

**If the respiratory protection available is insufficient to mitigate the risk of a particular product, that product should not be used**

**1.4.4. Considerations of PPE size and fit**

As a general rule, all PPE pieces should fit the user well. PPE cannot protect a worker from hazards if it does not fit. Equipment such as respirators can be tested to ensure that it is well adapted; however, users who require small sizes might have difficulty to find them because PPE and other work clothing are often designed for the average man, nor is it designed for people who wear glasses. These users may therefore face risks to their safety and health. Examples of what can go wrong if PPE does not fit are listed below (adapted from Bukowski, 2018).

- If gloves do not fit correctly because they are too big or clumsy, you may not be able to do your job well.

- If your hat falls off every time you look up, you might have to use one hand to hold it on.
- Safety boots may be one of the most difficult pieces of PPE for female workers to find. The common notion is that women should simply wear a man's boot that is "two sizes smaller."
- Goggles labelled as "one size fits all" may be too large for a small person's face and could allow pesticides to enter through gaps in the seals.
- Adapting a man's protective clothing to fit a woman, such as rolling up sleeves or trouser legs, can be dangerous because the excess material can become caught in machinery or tractor.

Employers should therefore provide pesticide applicators with protective equipment of the right size and PPE vendors should sell all sizes, including small ones.

### 1.5. Correct use of PPE

Pesticide applicators and operators must be trained and, in many countries, must obtain a certificate of competence to apply pesticides. Correct use of PPE, including storage and maintenance, can be covered in separate training courses, as different workers are likely to be involved. Workers should also learn how to put on and take off PPE equipment. For example, particular care is needed in removing gloves (see section 1.4.1) to avoid exposing the skin to any residue on the surface of the gloves.

In general, PPE should be removed in the order listed below.

- Wash gloves and the boots before removing them.
- Remove first all head and face protection (masks, goggles).
- Remove coveralls.
- Remove boots.
- Last, remove gloves.
- Wash your hands and shower.

If overalls have to be removed with contaminated gloves, such as during an activity, great care must be taken not to expose the skin to pesticides.

When a hazardous pesticide is recommended in an area, the pesticide supplier should ensure that the required PPE is also available through their distributors; otherwise, the pesticide should not be used. PPE is also required during cleaning and maintenance of application equipment (Fig. 19). Users should be trained before handling pesticides in operating and calibrating a sprayer, cleaning nozzles and determining the PPE and RPE required at each phase.

#### **Fig. 19. Wearing gloves when cleaning and brushing nozzles**



Source: Dobson et al, 2003

Finally, PPE should never be used again in other activities, such as for cleaning the house or cooking.

## **1.6. Cleaning, maintenance and storage of PPE**

### ***1.6.1. Cleaning***

When application has been completed and before returning home, workers must remove the PPE used while handling and applying pesticides. This prevents residues from being taken home. As mentioned in section 1.1.4, users should wash themselves thoroughly and/or shower in an area that does not contaminate family clothes and outside play and work areas or drinking-and washing water supplies.

Work clothing, including footwear, must be washed after each day's use with soap or other detergent, if available. It must be washed separately from other, non-pesticide contaminated, clothing and kept in a separate place. Similarly, boots should be washed and not worn to return to a residence to avoid exposing family members to pesticide residues. PPE should be washed at the end of each day's operations, separately from other clothing, before returning it to the store. Spray operators who use pesticides on consecutive days should have two sets of coveralls and alternate their use, such that clean, dry overalls are worn each day. Most modern pesticide formulations mix or disperse in water, but soap or detergent helps to remove chemical deposits that have dried on PPE. This implies that soap or detergent and a supply of clean water should be available at the site at which pesticides are applied. This may necessitate taking additional containers of water to the site. Some larger application equipment has extra tanks to carry water for washing hands or gloves if they are contaminated.

In all cleaning operations, producing large quantities of rinsate should be avoided, and washing should not be done near or in drinking-water sources or rivers.

### ***1.6.2. Maintenance***

PPE must not be allowed to become badly worn or torn, as this can allow pesticides to penetrate more easily and counters the benefit of wearing it. PPE must be inspected regularly, and if it becomes too worn, it should be replaced. Footwear must also be repaired or replaced accordingly.

### ***1.6.3. Storage***

PPE should not be stored near non-work clothes or near food, and should not be kept at home. It should be stored separately from pesticides and application equipment to prevent contamination.

Pesticide shops must be clean, well lit, ventilated, secured with a lock and designed to contain any spillages and leakage from pesticide containers (Fig. 20). To avoid contamination, PPE should be stored separately from pesticide products. In small farms and household gardens, separation may be possible only by having a separate container to store PPE away from pesticides. Storage of HHPs centrally in a small community can help prevent unauthorized access, if it is socially appropriate.

**Fig. 20. Small, lockable store for pesticide containers**



Source: Dobson et al, 2003

## **1.7. Disposal of PPE**

Any PPE deemed to be insufficiently clean and/or too worn to be re-used should be collected in large plastic bags and disposed of in accordance with national requirements, if any. If no system is in place, it is recommended that used PPE be returned to the retailer for return to the manufacturer. If recycling schemes exist in the country, the material of used PPE can be recycled.

## 2. Personal protection and PPE: policy considerations

It is recommended that governments analyse actual use of PPE before deciding to register a product and subsequently decide to allow continued registration of the product. If a gap is identified between the recommendation on the label and actual use, it is important to identify the reasons for the gap and the associated risks and develop policy to address the situation.

Typical reasons for not using PPE, or using it inappropriately, include those listed below.



- PPE is not available; often it is not available where pesticides are bought or is not provided by the employer.
- PPE is too expensive.
- PPE is too uncomfortable, particularly in hot, humid climates (see Article 3.6 of the Code of Conduct).
- PPE is not used or incorrectly used, or the wrong type is used, due to lack of knowledge or understanding of the risk and exposure, lack of experience or inadequate training.
- PPE is not used, or the wrong type is used, because the required type is not available.
- PPE is not cleaned, maintained or stored as required and therefore becomes inappropriate.
- PPE is not “accepted” by pesticide operators.
- PPE actual use is not controlled or enforced, and therefore users may decide not to wear it.

Once the reasons have been identified, policy can be developed to promote measures to improve the situation. Examples of policy measures are listed below.

### 2.1. Awareness-raising, risk communication and training

- *Pesticide users:* Guidance on the selection and use of PPE should be included in farmer and public health training programmes by extension or advisory services. Training should also include use of non-chemical methods of pest management as the first option or selection of less hazardous products (such as biological pesticides) that require less PPE, in particular if access to or wearing PPE is not realistic.
- *Pesticide retailers:* Pesticide retailers should have adequate knowledge about the selection and use of PPE to be able to advise their customers. Such knowledge can be obtained by including modules on PPE in the training that is mandatory to obtain a license to sell pesticides.
- The reasons for using PPE, its selection and correct use can be further explained in campaigns on television, radio, brochures and posters in local languages. The reasons should be associated with information about possible routes of exposure to pesticides. Pictograms

showing acute and chronic pesticide hazards and coloured bands should be made available to all pesticide handlers. Training should be given in interpreting pictograms and colour bands and should be adapted to illiterate farmers.

- Governments should ensure that pesticide risk communication in their countries complies with certain standards. Pesticide advertising in relation to PPE should include understanding of the risks; children or animals should not be used in such advertising (FAO/WHO, 2010)

## 2.2. Availability

*Art 5.1.8 Governments should, with the cooperation of the pesticides industry, limit the availability of pesticides that are sold to the general public through non-specialized outlets, to low hazard products (WHO Class U) or low risk and ready to use products that require no dilution or other preparation, and can be applied with limited need for personal protective equipment;*

- Pesticide retailers must offer for sale the appropriate PPE required for the pesticides they sell. Such a requirement can be made mandatory by making it a condition for holding a license to sell pesticides.
- Governments should withdraw or restrict use of a pesticide if PPE cannot be made available to the pesticide handler or if the conditions of use are such that appropriate PPE is not worn.
- In some cases, the pesticide registration authority may decide that a certain product may be sold only in combination with specified PPE.
- In order to increase the availability of PPE, governments and industry could encourage local manufacture of appropriate PPE and develop markets.
- Large-scale operations in which pesticide applicators are employed, such as plant protection services, vector control services, plantations and pesticide application providers, could be legally obliged to provide staff with appropriate PPE in appropriate quantities and conditions that take into account recommended replacement schedules.

## 2.3. Quality and affordability

*Art 5.1: In establishing pesticide production facilities of a suitable standard in developing countries, manufacturers and governments should cooperate to:*

*Art 5.5.1 adopt engineering standards and operating practices appropriate to the nature of the manufacturing operations and the hazards involved, and ensure the availability of appropriate protective equipment;*

*Art 6.1 Governments should:*

*Art 6.1.12 permit pesticide application equipment and personal protective equipment to be marketed only if they comply with established standards.*

*Government and industry should cooperate in further reducing risks.*

*Art 5.3.1: by promoting the use of personal protective equipment which is suitable for the tasks to be carried out, appropriate to the prevailing climatic conditions and affordable.*

- The available PPE should be of adequate quality. Governments could issue regulations and guidelines for minimum PPE standards or refer to international standards for PPE (some are listed in Annex 5). These might, for instance, be linked to the sale and/or importation of PPE. Industry should comply with the standards set by the authorities.
- Good-quality PPE should be available at an affordable cost. Governments could encourage research to develop more affordable PPE. They could also consider reducing or cancelling import taxes on PPE.
- Quality requirements for application equipment also help to reduce exposure risk and the necessity for extensive PPE. Guidance is provided in the FAO set of guidelines on application equipment (FAO, 2001a, 2001b, 2001c, 2001d, 2001e).

## **2.4. Monitoring**

- Governments should establish continuous monitoring to determine the effectiveness of measures to reduce pesticide exposure through correct use of appropriate PPE. If it is found that such measures have limited effect or are difficult to implement throughout the country, regulatory action may be required to restrict the availability of the pesticides concerned or to cancel their registration. (See also Code of Conduct Articles 3.6 and 7.5 in Box 1 and the guidelines on HHPs (FAO/WHO, 2016)).
- Governments should monitor not only the actual use and effectiveness of PPE but also its quality, in particular that of locally available PPE, for commercial and small-scale farmers.
- Governments and PPE manufacturers should put in place a mechanism to collect feedback on issues with PPE and suggestions for improvement.
- Industry and NGOs are invited to monitor and report to the authorities on the use and acceptance of PPE.

## **2.5. Stakeholder involvement**

- It is recommended that regulatory authorities establish stakeholder platforms or working groups to exchange information on personal protection and PPE as part of information exchange on pesticide risk reduction and training on IPM and IVM. Such groups should regularly review whether PPE adequately mitigates risk; if not, they should seek and recommend alternatives.

- National pesticide industry associations should play a role in training pesticide retailers through extended stewardship and in ensuring that correct PPE is made available with those of their products that are sold in the country.
- Industry and NGOs are invited to provide information on use of appropriate PPE to pesticide handlers.

## 2.6. Registration



*Art 3.6 Pesticides whose handling and application require the use of personal protective equipment that is uncomfortable, expensive or not readily available should be avoided, especially in the case of small-scale users and farm workers in hot climates.*

- The capacity of countries to legislate on PPE varies, as does the availability of PPE. Therefore, countries should take these aspects into consideration when registering pesticides for use. At the time of registration, or review of registration, regulatory authorities should consider the hazard and the associated risk under common use circumstances in the country and then decide on the necessary PPE for each pesticide product and use. Where the availability or use of PPE in the country of use is limited or local personal protection practice, particularly in LMIC, is a factor, requirements may be established to protect health or the environment under the conditions of use in the country, such as by restricting use to license-holders.
- As it may be difficult to enforce the use of PPE, particularly in small-holder farming, when use of PPE is a condition to reduce occupational risk to acceptable levels, registrars may consider combining wearing of PPE with other mitigation measures, such as restricting the use or availability of the pesticide. It tends to be easier to enforce use of PPE for restricted uses, e.g. only by licensed PCOs.
- Industry should indicate in the registration application dossier where the required PPE can be purchased in the country of use. When PPE is not available, the required PPE is not commonly used in the country or the available PPE is not effective under the use conditions in the country, the product should not be registered, and the government should encourage use of alternative cultivation or working practices (IPM, IVM or agro-ecological approaches), or alternative products.

## 2.7. Risk mitigation

- A requirement for PPE is one of many measures for mitigating the risk of occupational exposure of handlers and workers, but is considered one of the least effective strategies. The

conditions for effective application of this measure are that PPE be available to users at an affordable cost and wearing PPE be feasible and comfortable under local climatic conditions.

- The risk reduction potential of PPE depends on the type of equipment, its quality, its maintenance and whether it is correctly used. Examples of exposure reduction with PPE are given in section 1.3 and Table 2.
- PPE cannot be used to mitigate the pesticide risk of bystanders and residents. Ensuring their personal protection is, however, important. This can be achieved by better communication from applicators and operators and the establishment of buffer zones around sprayed areas; this is particularly recommended for schools (see section 1.1.7).
- Another risk mitigation measure is to require and enforce a minimum or restricted entry interval before workers can go into treated areas. A re-entry interval can allow the pesticide to degrade to levels that do not pose an unacceptable risk. An important condition for the effectiveness of this measure is enforcement of intervals by government before worker re-entry. In addition, a re-entry interval may not be feasible for certain crops because agronomic practices such as picking, pruning, weeding or pest inspection must be conducted before the end of the interval. Some countries have therefore established “early entry” PPE requirements.

## Summary of considerations to reduce risks when handling and applying pesticides and technical considerations in use of PPE

Steps (#) in the [FAO/WHO tiered approach in pesticide risk reduction \(FAO, 2010\)](#) are shown in the table below, which is relevant for the individuals/companies responsible for application and for operators. [Regulatory](#), [evaluation](#) and [policy](#) aspects are not directly addressed.

<b>Considerations</b>	
<b>#1</b>	<b>Reduce reliance on pesticides</b>
1.	<p>Consider whether the envisaged pesticide applications are actually required and are done in the context of an IPM, IVM or other agroecological approaches.</p> <ul style="list-style-type: none"> <li>- Are alternative, non-toxic pest management approaches available?</li> <li>- Can the number of applications or the volumes be reduced (e.g. by eliminating calendar applications and replacing them by pest scouting, spot applications, better calibration, etc.)?</li> </ul>
<b>#2</b>	<b>Select pesticides with the lowest hazard</b>
2.	<p>Select the least hazardous pesticides for a particular pest problem and/or a formulation that poses the least risk and therefore generally requires less comprehensive PPE.</p> <ul style="list-style-type: none"> <li>- Are less toxic products available that are effective against the pest?</li> <li>- Is a different chemical compound or a different formulation of the same compound available?</li> </ul>
<b>#3</b>	<b>Ensure proper use of the selected products for approved applications and in compliance with international standards</b> during three phases of pesticide exposure: <ol style="list-style-type: none"> <li>i. Handling the concentrated pesticide formulation, which involves mixing and loading into sprayers or aeroplane tanks;</li> <li>ii. Applying the diluted product; and</li> <li>iii. Rinsing or cleaning contaminated PPE and application equipment and disposing of the rinsate.</li> </ol>
3.	<p><b>Know the risks in your environment</b></p> <ul style="list-style-type: none"> <li>- Are you familiar with the <a href="#">pesticide risks in relation to personal protection</a>?</li> <li>- Are you well aware of the <a href="#">routes of exposure</a> to pesticides?</li> <li>- Review means <a href="#">for limiting pesticide exposure</a> to human health and the environment.</li> <li>- Are you in a <a href="#">low- and middle-income country</a>?</li> <li>- Are you living and working in a <a href="#">tropical climate</a>?</li> </ul>
4.	<p><b>Read and understand the <a href="#">label</a></b></p> <ul style="list-style-type: none"> <li>- Are you familiar with the signal words and pictograms on hazards? With the safety directions for PPE?</li> </ul>
5.	<p><b>Ensure the correct choice and <a href="#">correct use</a> of appropriate PPE for each pesticide</b></p> <ul style="list-style-type: none"> <li>- Decide which PPE is required according to factors such as hazards, formulation type and packaging. Check <a href="#">Table 1</a>.</li> <li>- Do you have the correct PPE and RPE required for use of the pesticide? To protect your <a href="#">body</a>? <a href="#">Feet</a>? <a href="#">Hands</a>? <a href="#">Head and face</a>? <a href="#">Eyes</a>? <a href="#">Ears</a>? <a href="#">Lungs</a>?</li> <li>- Do the pieces of PPE <a href="#">fit well</a>?</li> </ul> <p><i>Remember: Pesticides whose handling and application require the use of personal protective equipment that is uncomfortable, expensive or not readily available should be avoided, especially in the case of small-scale users and farm workers in hot climates.</i></p>

<b>Considerations</b>	
6.	<p>Use well-maintained <a href="#">application equipment</a> that prevents spray drift</p> <ul style="list-style-type: none"> <li>- Has the application equipment been checked to ensure there are no leaks?</li> <li>- Do you have a planned procedure for maintaining equipment?</li> <li>- Are the spray applicators trained?</li> </ul>
7.	<p>Ensure responsible <a href="#">cleaning, maintenance, storage</a> and <a href="#">disposal</a> of PPE</p> <ul style="list-style-type: none"> <li>- Do you have adequate separate storage space for pesticides, application equipment and PPE? Keep clean PPE separate from used PPE that has not been cleaned.</li> <li>- Do you have facilities for disposal of waste water and materials as well as recycling or disposal of rinsed containers?</li> <li>- Ensure that cleaning of PPE, equipment and disposal of containers do not cause contamination.</li> </ul>
8.	<p><a href="#">Personal hygiene</a></p> <ul style="list-style-type: none"> <li>- Is water for drinking and washing hands readily available before and after spray operations?</li> <li>- Users must not eat or drink unless they have washed their hands and face and are not near pesticides.</li> <li>- Do applicators wash their full bodies after spraying?</li> </ul>
9.	<p><a href="#">First aid</a></p> <ul style="list-style-type: none"> <li>- Is a first aid kit readily available?</li> <li>- Are there medical facilities close to the site? Do they have the appropriate antidotes for highly toxic compounds?</li> <li>- Are the pesticide users trained in giving correct first aid?</li> </ul>
10.	<p>Ensure protection of other people</p> <ul style="list-style-type: none"> <li>- <a href="#">Other farm workers</a></li> <li>- <a href="#">Vulnerable groups</a></li> <li>- <a href="#">Bystanders and residents.</a></li> </ul>
11.	<p><b>Monitoring</b></p> <ul style="list-style-type: none"> <li>- Do you keep records of which pesticides have been used, the application rate, when applied and where?</li> <li>- Do you keep records of incidents and accidents?</li> <li>- Do you analyse monitoring data and draw lessons for better pesticide risk management?</li> <li>- Reduce take-home residues and contamination at home.</li> <li>- Report to the relevant authorities</li> </ul>

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## Annex 1: Classifications of acute hazard in the GHS and by WHO

Depending on the acute hazard classification system used in a country, the responsible authority should assign colour bands to either the GHS or the WHO classification, but should not mix them.

### GHS – Acute toxicity

	Hazard category					
	Category 1	Category 2	Category 3	Category 4	Category 5	Not classified
<b>Pictogram</b>					<i>No symbol</i>	<i>No symbol</i>
<b>Signal Word</b>	Danger	Danger	Danger	Warning	Warning	<i>No signal word</i>
<b>Hazard Statement</b>						
<b>- oral</b>	Fatal if swallowed	Fatal if swallowed	Toxic if swallowed	Harmful if swallowed	May be harmful if swallowed	
<b>- dermal</b>	Fatal in contact with skin	Fatal in contact with skin	Toxic in contact with skin	Harmful in contact with skin	May be harmful in contact with skin	
<b>- inhalation</b>	Fatal if inhaled	Fatal if inhaled	Toxic if inhaled	Harmful if inhaled	May be harmful if inhaled	
<b>Colour band</b>	PMS red 199 C	PMS red 199 C	PMS Yellow C	PMS Blue 293 C	PMS Blue 293 C	PMS Green 347 C

### WHO – Acute toxicity (and for a limited number of pesticides also chronic toxicity)

	Hazard class				
	Class Ia <i>Extremely hazardous</i>	Class Ib <i>Highly hazardous</i>	Class II <i>Moderately hazardous</i>	Class III <i>Slightly hazardous</i>	Class U <i>Unlikely to present acute hazard in normal use</i>
<b>Hazard symbol</b>				<i>No symbol</i>	<i>No symbol</i>
<b>Signal word</b>	Very toxic	Toxic	Harmful	Caution	<i>No signal word</i>
<b>Colour band</b>	PMS red 199 C	PMS red 199 C	PMS Yellow C	PMS Blue 293 C	PMS Green 347 C

Source: FAO/WHO, 2015 (under revision)

## Annex 2: PPE for applying public health pesticides

The suggested basic minimum requirements are shown in the table below.

Always read the label and follow the manufacturers' instructions for each pesticide.

Activity	Coveralls	Gloves	Boots	Hood or hat	RPE	Face shield	Apron	Ear protection
Indoor residual spraying	√	√	√	√	√	3	3	
Manual thermal fogging or cold fogging	√	√	√	√	√	3	3	√
Truck cold fogging or thermal fogging	√	1	√		1	3	3	4
Applying larvicide	√	√	√	√		3	3	5

RPE, respiratory protective equipment

Notes:

1. Gloves are required only when preparing the spray and may be removed before entering a truck cab.
2. A mask or RPE is not recommended, as the operator is protected in the truck cab.
3. A face shield and apron should be used only when preparing the spray to prevent splashes of concentrated pesticide on the face.
4. Ear protection is required only when testing equipment and for maintenance workers when they near stationary equipment that emits > 85 dB. Once the operators are in the truck cab, ear protection is no longer required.
5. Ear protection is required if motorized equipment is used > 85 dB. The requirement for ear protection depends on the equipment used to apply larvicide.

## Annex 3: PPE for applying agricultural pesticides

The suggested basic minimum requirements are shown in the table below.

*Always read label and follow the manufacturers' instructions for each pesticide.*

Activity	Coveralls and boots	Gloves	Face-shield or goggles	Apron	Hood or hat	RPE*	Ear protection	Notes
Handling unopened packs	√	√	O					
Mixing and filling spray tank Unclassified pesticides	√	√	√	O	√			1
Mixing and filling spray tank. Harmful and irritating pesticides	√	√	√	√	√			1
Mixing and filling spray tank. WHO class I and II pesticides	√	√	√	√	√	√		2
Spraying downwards with hand-held lance	√	√			√			3
Spraying upwards with hand-held lance	√	√	√		√	O		4
Operator in cab	√							5
Tractor but no cab	√	√			√			
Mist blowers	√	√	√		√		√	4
Fogging in greenhouses and stores	√	√	√		√	√	√	4
Applying granules	√	√						2, 6
Applying treated seed	√	√				O		3
Changing nozzles	√	√		O				
Cleaning sprayers	√	√	O	√				
Cleaning PPE and RPE	√	√	O					
Disposing of waste	√	√						

\*RPE (respiratory protective equipment) is used primarily when the majority of spray droplets are < 30 µm. It may be required in other circumstances, such as during use of dusts, especially in a confined space.

Notes:

1. Use induction hopper on tractor-mounted or larger sprayers or equivalent.
  2. Use closed transfer system, if available, especially for highly toxic insecticides.
  3. Hat required when walking in fields to protect from sunlight.
  4. Endeavour to remain upwind of spray.
  5. A cab should have a well-filtered air ventilation system, and cab windows should be closed.
  6. Avoid applying dusts, and ensure that granules are not fractured into smaller dust particles by setting the applicator properly.
- O Optional

## Annex 4: The FAO Pesticide Registration Toolkit

The [FAO Pesticide Registration Toolkit](http://www.fao.org/pesticide-registration-toolkit) is a decision support system for pesticide registrars in LMIC to assist them in the evaluation for authorization of pesticides and review of registered pesticides.

The Toolkit is best considered a web-based registration handbook for day-to-day use by pesticide registrars. It supports and facilitates informed decision-making by registrars but is not an automated system that suggests decisions. Registrars can use the Toolkit in several regular tasks.

The Toolkit consists of three types of tool.

1. The first tool provides technical advice on procedures that apply **to all pesticides** undergoing registration, such as data requirements, testing guidelines, assessment methods, decision-making steps and risk mitigation measures. For instance, it provides methods and resources for:
  - **Conducting risk assessments**, for both human health and environmental effects, using broadly accepted methods or existing assessments by reputable registration authorities [see the *Assessment Methods* tool in the left column of the screen shot below]. It provides assessment methods of varying complexity, ranging from relatively simple assessment methods that require limited human resources, to methods that require more staff and technical capacity, to complex evaluation methods that often require local risk assessment models, a wide range of data and specialized staff. Pesticide regulatory authorities can choose a method according to their national priorities, technical capacity and time available for evaluations. The strengths and weaknesses of each method are outlined to allow an informed choice by the regulatory authority.
  - **Decision making on risk mitigation options**, including practical guidance on how to consider local conditions.
2. The second type of tool consists of information sources **on individual pesticides**, such as registrations elsewhere, restrictions and bans, approved labels, maximum residue limits, pesticide properties and scientific reviews.
3. The third tool provides links to “Special Topics” such as HHPs or public health pesticides.

The FAO Pesticide Registration Toolkit can be accessed at: <http://www.fao.org/pesticide-registration-toolkit> and is available in English, French and Spanish, and partially in Arabic, Chinese and Russian.

## Annex 5: Standards for PPE and RPE

### Standards for protective clothing

International (ISO), European (CEN) and national specifications for protective clothing should be consulted when purchasing equipment to ensure that manufacturers and suppliers conform to them. The following list indicates some of the product requirement standards, but users should check for the latest update.

- [www.iso.ch](http://www.iso.ch)
- [www.cen.eu](http://www.cen.eu)
- [www.cenelec.eu](http://www.cenelec.eu)
- [http://www.iso.org/iso/home/store/catalogue\\_tc/catalogue\\_tc\\_browse.htm?commid=506](http://www.iso.org/iso/home/store/catalogue_tc/catalogue_tc_browse.htm?commid=506)

General performance requirements for protective clothing	ISO 13688:2012 This standard is only intended to be used in combination with other standards containing requirements for specific protective performance and not on a stand-alone basis.
<b>Body</b> protection Partial- and whole-body protection for operators applying liquid pesticides and for re-entry workers	EN ISO 27065:2017 Amd A1; ISO 16602 ( <a href="#">link</a> )
<b>Body</b> protection <b>Types 3-6</b>	ISO 16602:2007 This includes requirements for the following types: <ul style="list-style-type: none"> <li>· Type 3: “Liquid-tight” chemical protective clothing</li> <li>· Type 4: “Spray-tight” chemical protective clothing</li> <li>· Type 5: Chemical protective clothing providing protection against airborne solid chemicals</li> <li>· Type 6: Chemical protective clothing with “limited protective performance against liquid chemicals”</li> </ul> Partial body (“PB”) designation added for Type 3, Type 4, or Type 6 if the protective clothing covers only part of the body e.g. apron.
<b>Hand</b> protection Protective gloves for pesticide operators and re-entry workers	ISO 18889; EN ISO 374-1:2016/Amd.1:2018 ( <a href="#">link</a> )
<b>Footwear</b> protection against chemicals	EN 13832-2:2018; EN 13832-3: 2018 and ISO 20345:2011
<b>Eye</b> protection	EN 166:2002
<b>Ear</b> protection	EN 352
<b>Respiratory</b> protection – Full face respirators	EN 136:1998; EN 14387:2004+A1:2008
<b>Respiratory</b> protection - Half masks and quarter masks	EN 140:1999; EN 143:2000; EN 149:2001+A1:2009

## **RPE: Standards for particulate air filters**

In the USA, the National Institute for Occupational Safety and Health (NIOSH) standards state efficiencies of 95%, 99% and 99.7% (considered 100%). Masks are rated N (not resistant to oil), R (resistant to oil for 8 h) and P (oil proof). The designations are thus N95, N99, N100, R95, R99, R100, etc. Large packs of masks are widely available and are relatively inexpensive.

Similarly, the European EN 149:2001 norm (“Filtering Half masks to protect against particles”) designates three mask ratings for particles (solid or liquid): FFP1, FFP2 and FFP3, which are suitable for outdoor uses.

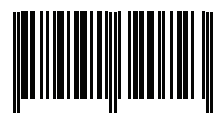
- FFP1 particle filtering masks protect against low levels of dust, as well as solid and liquid aerosols. It protects against materials in concentrations up to 4 times the occupational exposure limit (OEL).
- FFP2 particle filtering masks protect against moderate levels of dust, as well as solid and liquid aerosols. They have a higher level of protection than FFP1. FFP2 masks protect against materials in concentrations up to 12 times the OEL.
- FFP3 particle filtering masks protect against higher levels of dust. They also protect against solid and liquid aerosols. FFP3 masks protect against materials in concentrations up to 50 times the OEL. FFP3 masks are suitable for handling hazardous powders, such as those in the pharmaceutical industry.

## **European Commission websites relevant to PPE**

- [https://ec.europa.eu/growth/sectors/mechanical-engineering/personal-protective-equipment\\_en](https://ec.europa.eu/growth/sectors/mechanical-engineering/personal-protective-equipment_en)
- Regulation (EU) 2016/425 of the European Parliament and of the Council of 9 March 2016 on personal protective equipment and repealing Council Directive 89/686/EEC (available in all EU official languages)  
<https://publications.europa.eu/en/publication-detail/-/publication/eb5411ef-f714-11e5-abb1-01aa75ed71a1/language-en>  
  
[Corrigendum](#) to Commission communication in the framework of the implementation of Regulation (EU) 2016/425 of the European Parliament and of the Council on personal protective equipment and repealing Council Directive 89/686/EEC - OJ C 222 of 26/06/2018
- Guidelines on EU Regulation 2016/425  
<https://ec.europa.eu/docsroom/documents/29201>



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