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Managing chemical risk in the agriculture sector

Application booklet

Chemical risk management in the agricultural sector

Application booklet



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Acronyms and abbreviations

LC50 Mean lethal concentration

DDT Dichloro-diphenyl-trichloroethane

LD50 Mean lethal dose

PPE Personal protective equipment

FAO Food and Agriculture Organization of the United Nations

SDS Safety data sheet

a.i. Active ingredient

WHO World Health Organization

ILO International Labour Organization

PQUA Chemical pesticides for agricultural use

GHS Globally Harmonized System of Classification and Labeling of Chemicals



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It was drafted by the ILO team: Rodrigo Mogrovejo, Chief Technical Adviser of the Vision Zero Fund, Schneider Guataqui Cervera, National Project Coordinator of the Vision Zero Fund; and the Colombian Safety Council team: Yezid Niño Barrero, Technical Manager, Bibiana Acero Technical Adviser. It was reviewed by Halshka Graczyk of LABADMIN/OSH of the ILO.



Definitions

Acute toxicity: serious adverse effects occurring after a single oral or dermal exposure to a toxic substance or multiple exposures over 24 hours, or after inhalation exposure for four hours (United Nations 2015).

Exposure: contact with a substance by ingestion, inhalation or direct contact (e.g. through the skin or eyes); exposure can be short-term (acute exposure) or of intermediate or prolonged duration (chronic exposure) (ATSDR 2021).

Hazard: anything that can cause harm or damage (e.g. dust, chemical products, noise, working at heights, physical labour, unguarded machinery, long or unpredictable working hours) (ILO 2018).

Hazard category: division of criteria within each hazard class of the Globally Harmonized System (GHS). Categories allow comparison of the severity of hazards within a hazard class (United Nations 2015).

Hazard class: nature of the physical, health or environmental hazard in the GHS (United Nations 2015).

Label: an appropriate group of written, printed or graphic information elements concerning a hazardous product, selected as relevant to the target sector(s) concerned, that is affixed to, printed on, or attached to the immediate container of a hazardous product, or to the outside packaging of a hazardous product (United Nations 2015).

LC50: concentration of a chemical in air or of a chemical in water which causes the death of 50% (one half) of a group of test animals (United Nations 2015).

LD50: amount of a chemical, given all at once, which results in the death of 50 % (one half) of a group of test animals (United Nations 2015).

Persistence: characteristic that measures the chemical stability of a substance in the abiotic and biotic environment; environmental persistence is an important property that can increase the potential of a chemical to cause adverse effects and to be transported to remote environments (Boethling et al. 2009).

Pesticide: substance or mixture of substances intended to repel, destroy or control pests, including vectors of human or animal disease (FAO 2003).

Pictogram: graphical composition that may include a symbol plus other graphic elements, such as a border, background pattern or colour that is intended to convey specific information (United Nations 2015).

Re-entry time: number of days after the last pesticide application when the crop can be replanted (Pacheco and Barbona 2017).

Risk: combination of (a) the likelihood of a hazardous event occurring and (b) the severity of the harm that may occur, including the consequences that may manifest themselves in the long term (ILO 2018).

Safety data sheet (SDS): source of comprehensive information on the hazards and safety measures concerning a substance or mixture for the purpose of its management in the workplace (United Nations 2015).

Toxicity: inherent capacity of a chemical to produce adverse effects in living organisms (De la Cruz, Bravo and Ramírez 2015).

Waiting period: number of days after the last pesticide application when crops can be harvested or animals grazed (Pacheco and Barbona 2017).

Chronic toxicity: capacity of a substance to cause long-term damage; chronic effects occur after prolonged exposure (months, years, decades) and/or persist after exposure has ceased (ILO 2001b).

Globally Harmonized System of Classification and Labeling of Chemicals (GHS): United Nations initiative with harmonized criteria for classifying substances and mixtures according to their environmental, physical and health hazards; it establishes harmonized hazard communication elements, with requirements for labels and safety data

sheets (United Nations 2015).

Half-life of a pesticide: time required for half of the pesticide to degrade in the environment; half-lives are only estimates and may vary according to environmental conditions (FAO 1997).



Introduction

The agricultural sector is recognized as the first link in the food production chain; it is achieved through organized cultivation that requires a range of chemical products to optimize plant fertility and growth, as well as to ensure the control of pests that may attack crops. Although pesticides allow the elimination of certain undesirable elements, they can cause damage to human health, animal health and the environment, which leads to the need to find a balance between the rational use of pesticides and the minimum impacts of their use. On the other hand, the use of other chemical products in the agricultural sector that are associated with the maintenance and operation of equipment and machinery, as well as cleaning and disinfection processes, also require adequate management and should not be neglected.

Rigorous control is therefore necessary to prevent major health risks to employers, workers and the general public (ILO 2011). Managing chemical risk starts with communicating hazards to provide adequate and timely information to workers in the field. In this regard, the Globally Harmonized System of Classification and Labelling of Chemicals (GHS)

has emerged as a key element for protecting workers, through the classification of chemical products, communication and training, which helps to ensure safety (ILO 2021d).

Despite the progressive adoption of the GHS by governments in different countries around the world, dissemination strategies must be considered that allow for a correct understanding of the system and lead to a proper interpretation of the hazards associated with the chemical products used in the workplace. In particular, the high degree of heterogeneity of workers in the agricultural sector must be taken into account, which implies a great challenge for employers and for occupational health authorities in general.

Therefore, this booklet provides general guidelines for GHS implementation and practical guidance to the agriculture sector for effectively managing chemical risk, which should be aligned with the guidelines provided in the legislation of the country in which the user resides.



1. Chemical products in agriculture

Farmers and farm workers are exposed to different agricultural chemicals, which are grouped into three categories: pesticides, fertilizers and animal health products (ILO 2001a). However, there are other chemical inputs that are used for the maintenance and operation of spraying equipment, such as fuels, lubricants and cleaning agents.

Of all these toxic agents, pesticides are of particular importance due to their frequent use, the different kinds of active ingredients they contain, their toxicological characteristics, their wide dissemination in the environment and human exposure to them.



1.1 Classification of pesticides

Pesticides are classified according to their main characteristics, such as the use and type of active ingredients, the presentation and method of application, and their persistency and half-life in the environment.

Use and type of active ingredient: according to their chemical structure, pesticides are classified into several families, ranging from organophosphorus compounds, carbamates, pyrethroids and organochlorines to inorganic compounds, among others.

Cuadro 1. Classification of pesticides by use and active ingredients

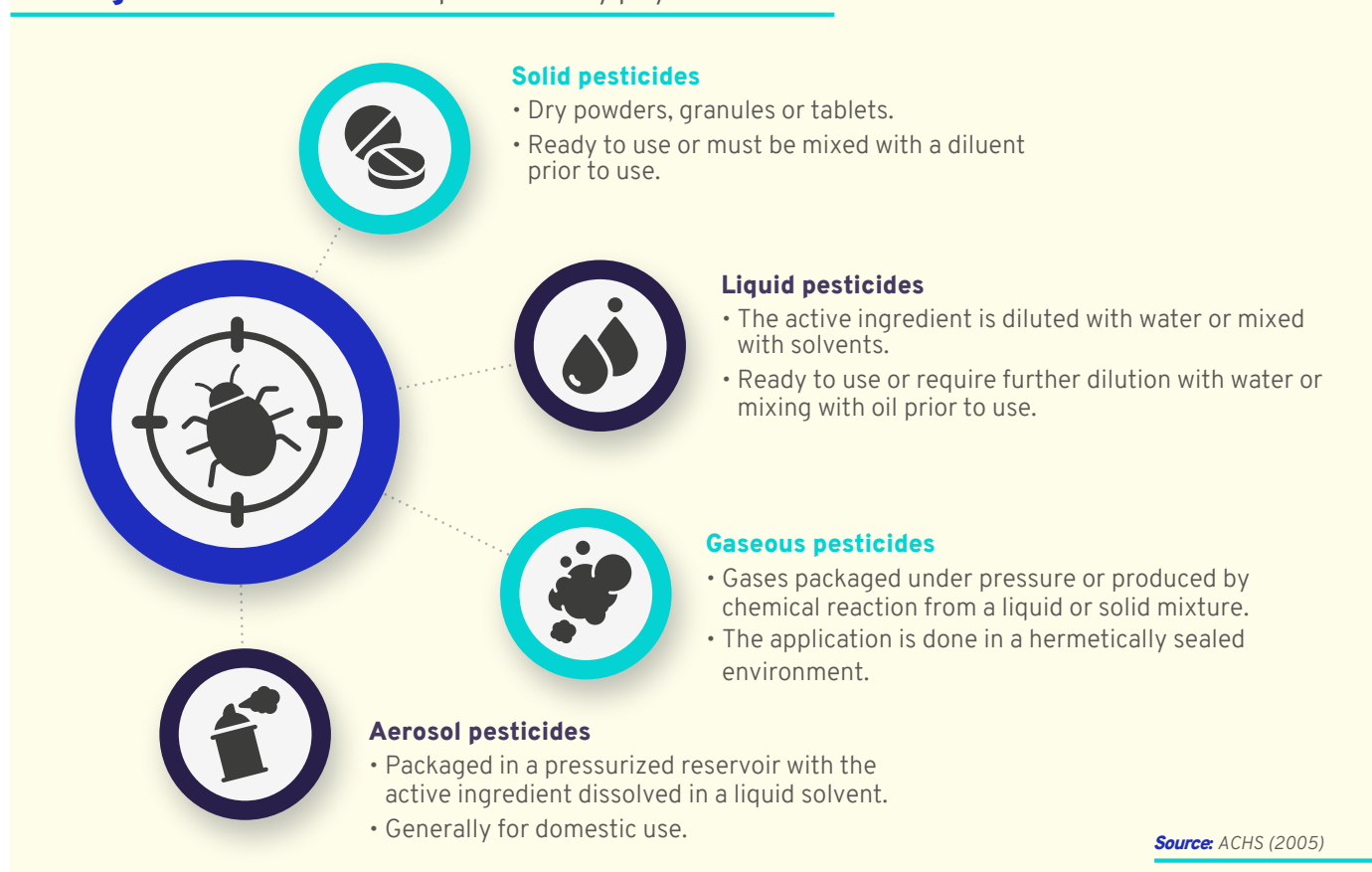
Pesticide	Use/pest controlled	Mode of action on the pest	Type of active ingredient	Examples
Insecticides/ acaricides	Insects, mites	Alter excitability of nervous system	Organophosphates	Chlorpyrifos, methyl azinphos,
			Carbamates	Carbaryl, propoxur
			Pyrethroids	Deltamethrin, cypermethrin, lamdacyhalothrin, beta-cyfluthrin
			Organochlorines	DDT, lindane, endosulfan, dieldrin
Nematicides	Nematodes (worms)	Inhibit enzymes and metabolic processes	Carbamates	Aldicarb
			Natural	Neem oil
Fungicides	Moulds	Disrupt cellular structures or functions essential for survival	Dithiocarbamates, imidazoles, dicarboximides, pyrimidines, piperazines, triazoles, carbamates, aryl amides, methyl bromide	Mancozeb, metalaxyl, vinclozolin, triadimefon, chlorothalonil, tebuconazole, carbendazim, sulphur
Herbicides	Weeds	Inhibit synthesis of amino acids essential for plant life	Inhibitors of biomolecular synthesis	Glyphosate, glufosinate, atrazine, linuron, 2,4-D amine, dicamba, paraquat, metsulfuron- methyl
Agricultural bactericides	Weeds	Disrupt cytoplasmic membrane and interfere with DNA metabolism for control of bacterial diseases	Antibiotics, plant extracts	Gentamicin sulphate, oxytetracycline hydrochloride
Molluscicides	Molluscs (snails, slugs)	Interfere with metabolism and nervous system	Carbamates, inorganic compounds	Carbaryl, isolan, ferric phosphate, metaldehyde
Ovicides	Insect or mite eggs	Eliminate insects and mites at egg stage	Carboxamides	Carboxamides
Rodenticides	Rodents	Inhibit hepatic synthesis of blood clotting factors	Coumarins, indandiones	Brodifacoum, coumatetralyl, warfarin, chlorphacinone

Source: Oerke (2006); Ramírez and Lacasaña (2001).

In addition to the types of pesticides described above, there are also seed treatments, which are plant protection products that protect seeds and plants in their earliest stages from attack by insects and diseases, which act as growth regulators because they modify insect development.

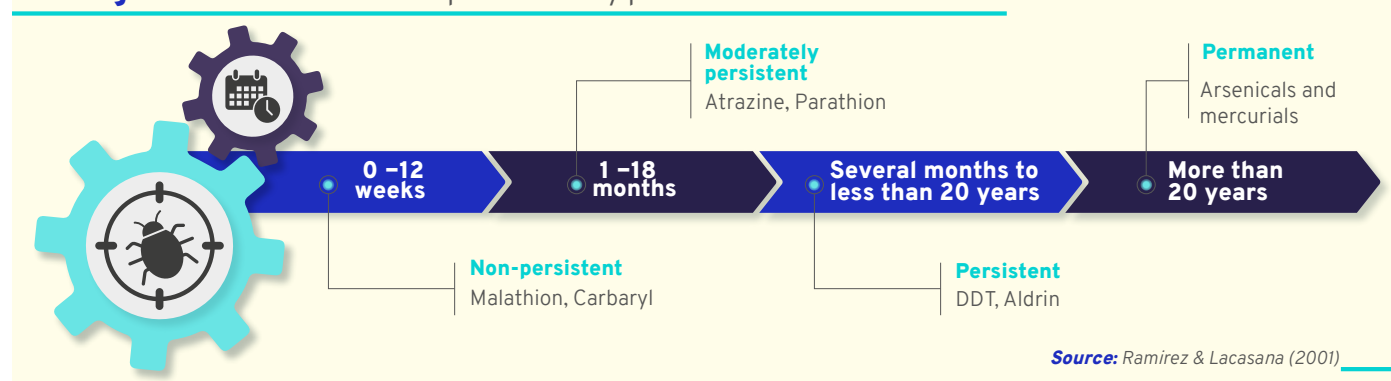
Presentation and method of application: this second class of products depends on its formulation. Persistence and half-life in the environment: Pesticides are classified according to their half-life as permanent, persistent, moderately persistent or non-persistent (Ramírez and Lacasaña 2001).

Figure 1. Classification of pesticides by physical state



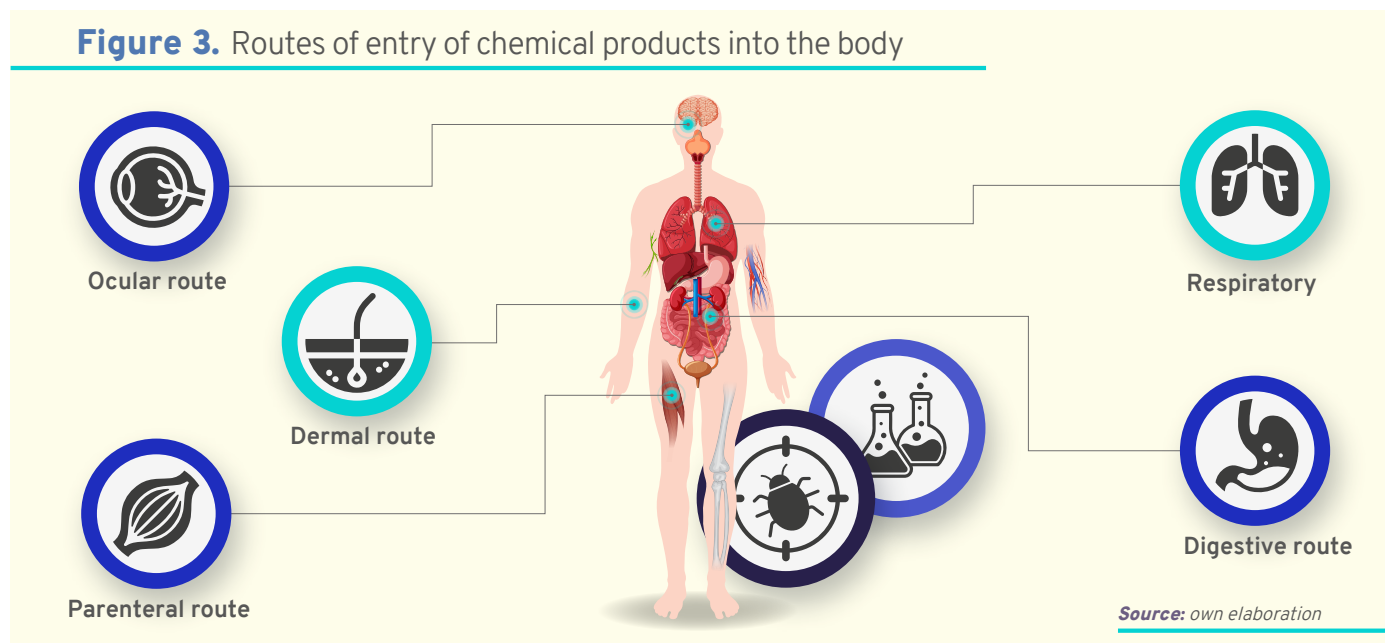
Persistence and half-life in the environment: Pesticides are classified according to their half-life as permanent, persistent, moderately persistent or non-persistent (Ramírez and Lacasaña 2001).

Figure 2. Classification of pesticides by persistence and half-life



1.2 Routes of entry into the body

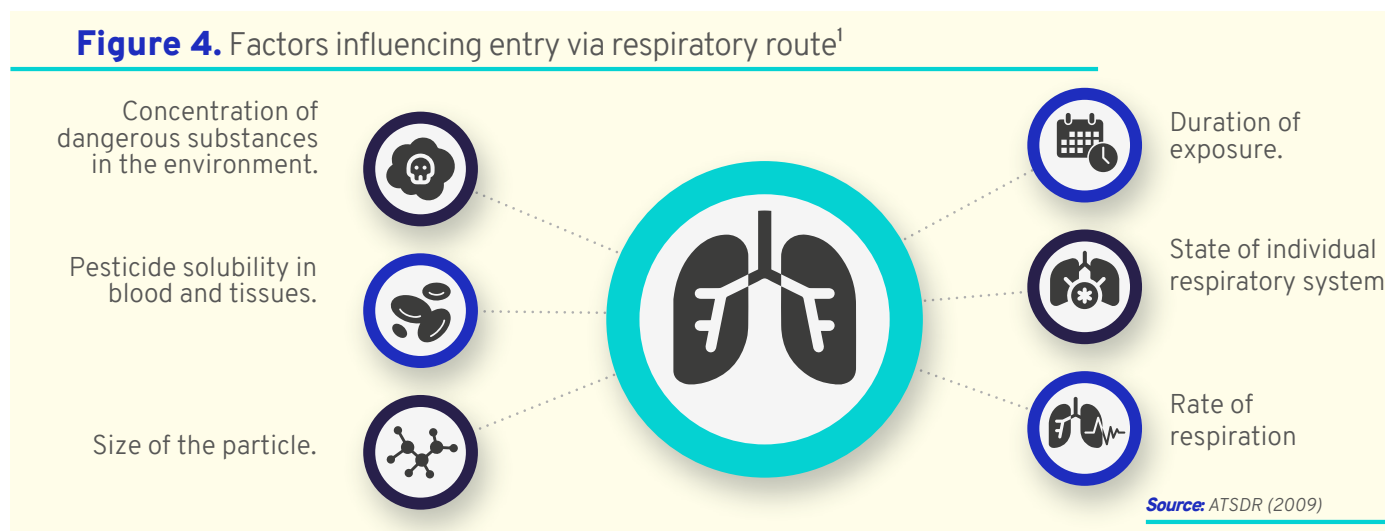
The five routes of entry of chemical products into the body are: respiratory, dermal, digestive, ocular and parenteral.



Respiratory route

The lungs can quickly absorb the products into the bloodstream and if any of them are inhaled in sufficient quantity they can cause serious damage to the nose, throat and lungs (Pacheco and Barbona 2017).

The magnitude and consequences of these products entering the system by this route is subject to a number of factors, including:



¹ Concentration of hazardous substances in the environment: quantity of hazardous substances per unit volume of polluted air.
Solubility of the pesticide in blood and tissues: ability of the substance to be dissolved or mixed.
Rate of respiration: number of breaths per unit of time.

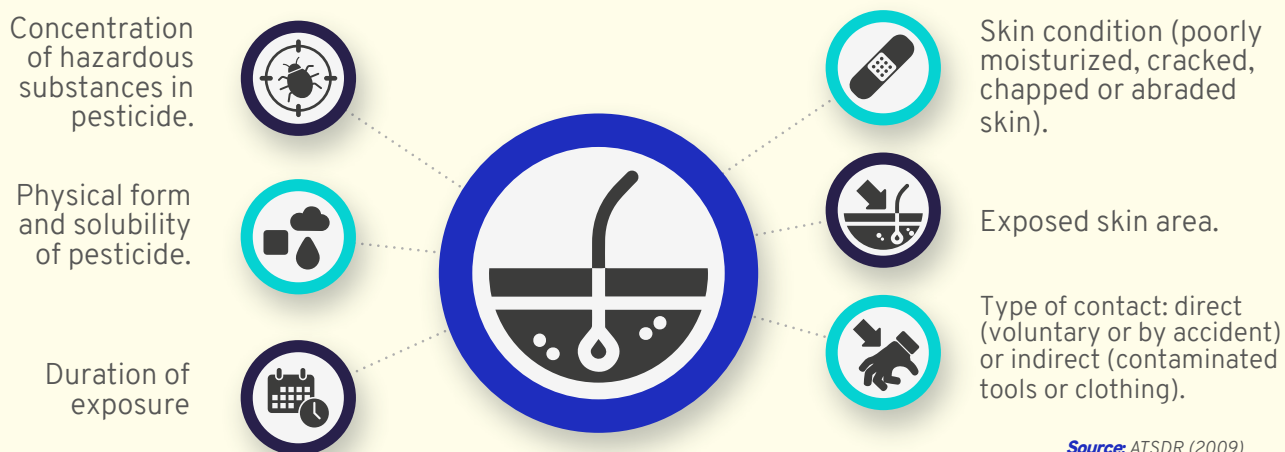
Dermal route

Pesticides can be absorbed immediately after skin contact and this action will continue as long as the substance remains in contact, leading to systemic damage. This is the case for agents that cause

injuries to specific organs or systems that are far away from the contact area, such as the brain, liver, kidneys, lungs, etc. (INSHT 2021).

Factors influencing dermal absorption are the following:

Figure 5. Factors influencing entry via dermal route ²



Digestive route

Hazardous agents can be ingested usually by accident or intentionally, through the consumption of contaminated food and drink or by swallowing particles³ that have entered the respiratory tract (INSHT 2021). The effects caused by the absorption of these agents depend on different factors, such as their concentration in the affected organs, their chemical and physical form and the time they remain inside the organism.

Ocular route

Because most pesticides are applied by spraying, the eyes are a common point of contact for toxic substances and the primary point of contact is the cornea (ATSDR 2009).

Parenteral route

Another point of penetration is through open wounds or skin lesions.



² **Concentration of hazardous substances in the pesticide:** quantity of hazardous substances per unit volume of pesticide.

Solubility of the pesticide: ability of the substance to be dissolved or mixed.

³ Passage of particles from the mouth to the stomach.

2. Health risks

Exposure to chemical products can cause adverse health effects, such as pesticide poisoning. These range from mild to severe and life-threatening, and in some cases may have long-term consequences.

Pesticides are recognized as a hazard because they are potentially associated with high levels of acute or chronic danger to human health or the environment. Serious and systemic effects can result from the unsafe handling of these substances, as well as from their intentional or accidental ingestion (WHO 2019b).

Acute poisoning: adverse effects occur after a single oral or dermal exposure to such a substance, multiple exposures over 24 hours or inhalation exposure for four hours (United Nations 2015). Signs and symptoms appear rapidly and may include systemic or localized effects.

The clinical manifestations of acute pesticide poisoning can be grouped according to the nervous, cardiovascular, respiratory, gastrointestinal and hepatic, urinary, circulatory, dermal, ocular and reproductive systems.

Table 2. Common signs and symptoms of acute pesticide poisoning

Nervous system	Cardiovascular system	Respiratory system
<ul style="list-style-type: none"> • Headache • Behavioural disturbances (confusion, excitement, disorientation) • Depression • Stupor • Vertigo • Lack of coordination • Tingling • Muscle spasms • Paralysis • Hearing loss • Shock • Coma 	<ul style="list-style-type: none"> • Cardiac arrhythmia • Tachycardia and hypertension • Bradycardia and hypotension 	<ul style="list-style-type: none"> • Upper respiratory tract irritation • Rhinitis • Cough • Sneezing • Hoarse voice • Lack of air • Respiratory distress • Pulmonary oedema
Gastrointestinal and hepatic system	Urinary system	Circulatory system
<ul style="list-style-type: none"> • Nausea • Vomiting • Diarrhoea • Abdominal pain • Stomatitis (inflammation and redness inside the mouth) • Salivation 	<ul style="list-style-type: none"> • Proteinuria (protein in urine) • Haematuria (blood in urine) • Oliguria (abnormally low urine output) • Acute renal failure • Cloudy urine • Dark reddish urine 	<ul style="list-style-type: none"> • Anemia (deficiency of healthy red blood cells) • Haemolysis (disintegration of red blood cells) • Leukopenia (white blood cell deficiency)

Dermal system	Ocular system	Reproductive system
<ul style="list-style-type: none"> • Irritation and redness • Rashes (blisters) • Lesions • Pallor • Cyanosis (bluish discolouration) • Jaundice (yellowing) • Accumulation of blood under the skin • Sweating 	<ul style="list-style-type: none"> • Conjunctivitis • Tearing • Yellow sclera • Double vision • Blurred vision • Pupil constriction • Pupil dilation • Non-reactive pupils • Keratitis (inflammation of the cornea) 	<ul style="list-style-type: none"> • Low sperm count • Disruption of menstrual cycle

Source: Bolivia (2008).

Because of their lower body mass, children are the most vulnerable to acute pesticide exposure (ILO 2021a).

Chronic poisoning: this is the clinical picture that presents after repeated exposure to low doses of a

toxic substance for prolonged periods of time.

Unlike acute poisoning, the risk of a single contact is not quantified in chronic poisoning. Signs of intoxication occur as a result of the accumulation of the poison in the body after repeated exposures.

Table 3. Effects of chronic pesticide poisoning

Effect	Specific effects
Respiratory sensitization	<ul style="list-style-type: none"> • Hypersensitivity in the airways (asthma)
Skin sensitization	<ul style="list-style-type: none"> • Allergic skin reactions
Carcinogenicity	<p>Some pesticides are classified as "probable carcinogens" and are associated with a risk of cancer:</p> <ul style="list-style-type: none"> • Lung cancer • Leukaemia • Lymphoma • Prostate cancer • Breast cancer • Stomach cancer
Mutagenicity	<ul style="list-style-type: none"> • Chromosomal changes • Congenital malformations
Reproductive toxicity	<ul style="list-style-type: none"> • Male infertility • Reduced sperm quantity, quality and motility • Spontaneous abortions • Premature births • Malformations • Low birth weight • Contamination of breast milk
Specific "target organ" toxicity after repeated exposure	Mainly in the nervous system, lungs, liver, kidneys and bladder

Source: ILO (2011); Cruz et al. (2015).

3. Hazard communication based on the Globally Harmonized System

Farmers and farm workers are exposed to different agricultural chemicals, mainly pesticides, so it is of vital importance that they be kept adequately informed about such hazards.

The Globally Harmonized System of Classification and Labeling of Chemicals (GHS) is a United Nations initiative that standardizes internationally the classification of chemical products and allows for establishing whether they are hazardous or non-hazardous. The GHS uses labels and safety data sheets

(SDSs), as appropriate, to identify the associated hazards and communicate information about them.

The availability of information on the hazard characteristics of products and recommended control measures enables the management of chemical risk during their transport, use and disposal. Such management is directed at all those who may be exposed, including workers, consumers, emergency services personnel and the general public (United Nations 2015).

Figure 6. Benefits of GHS implementation



Hazard classification

Hazard classification considers only the characteristics of chemical substances or their mixtures, in the following sequence:

Figure 7. Stages of hazard classification



The GHS, according to the nature of the hazard (physical, health or environmental), classifies chemical products into hazard classes and categories (INSHT 2006). In the GHS, hazard categories are generally marked with numbers ranging from 1 to 5, with category 1 always being the most severe. A category can also be further subdivided using letters, with the letter A being the most severe. An example of such a classification is given in table 4.

Labelling










The label of agrochemical products is the main source of information for the user. The label is attached to or printed on the container containing the hazardous product or on its outer packaging. Based on the GHS, the minimum elements of a label are given in table 5.



Table 4. Example of hazard class and categories

Ranking	
Hazard class	Hazard categories
Aerosols	1
	2
	3
Spontaneously reacting (self-reactive) substances and mixtures	Type A
	Type B
	Types C y D
	Types E y F
	Type G

Source: United Nations (2015).

Table 5. Label elements based on GHS

Labelling element	Criteria				
Product identification	Chemical identity of product or chemical identities of components in the case of mixtures				
Danger pictograms	They consist of a black symbol on a white background with a red border. The GHS uses nine pictograms to represent the hazards of chemical products:				
	Physical hazards				
					
	Explosive	Flammable	Fuel	Pressurized gas	Corrosive to metals
	Health hazards				
					
	Lethal/ acutely toxic (by ingestion, contact with skin or inhalation)	Corrosive to skin/serious eye damage	Carcinogenic/ mutagenic/ respiratory sensitizer/ respiratory hazard/toxic for reproduction/toxic to target organs	Harmful if swallowed/ skin contact or inhalation/irritant to skin, eyes or respiratory system/skin sensitizer/ narcotic	





Labelling element	Criteria	
Danger pictograms	Environmental hazards	
		
	Hazardous to the aquatic environment (acutely toxic or chronically toxic)	PHazardous to the ozone layer (destroys ozone in the upper atmosphere)
Signal words	Indicates the greater or lesser severity of the hazard and alerts the reader of the label to a potential hazard. The signal words used in the GHS are "Danger" and "Warning". The former is used for the most serious categories of hazard, while the latter is reserved for less serious categories.	
Hazard statements (with H codes)	Statements assigned to a hazard class and category describing the dangerous product, e.g.: H330.	
Precautionary statements (with P codes) and precautionary pictograms	Statement describing the recommended measures that should be taken to minimize or prevent adverse effects caused by exposure to a hazardous product, such as: P271: Use only outdoors or in a well-ventilated area.	
Supplier identification	The label should indicate the name, address and telephone number of the manufacturer or supplier of the substance or mixture.	

Source: United Nations(2015).

The degree of toxicity of a pesticide distinguishes the most hazardous pesticides from the less hazardous ones. This classification is oriented to the acute effect⁴ on the health of any person handling a product (WHO 2019a) and is calculated using the median lethal dose – LD50 – or the median lethal concentration – LC50.

Therefore, according to the acute toxicity category into which the pesticides are classified, labels must be printed with the corresponding pictogram, together with the signal word and hazard statements, as shown in the following example.

Table 6. Label elements for acute toxicity category

	Category 1	Category 2	Category 3	Category 4	Category 5	Not classified
Pictogram					No symbol	No symbol
Signal word	Danger	Danger	Danger	Warning	Warning	No signal word
Indications of danger	Fatal if swallowed	Fatal if swallowed	Toxic if swallowed	Harmful in contact with skin	May be harmful if swallowed	
	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	
	Fatal if inhaled	Fatal if inhaled	Toxic if inhaled	Harmful if inhaled	May be harmful if inhaled	
Band colour	Red	Red	Yellow	Blue	Blue	Green

Source: United Nations (2015); FAO (2015).

⁴ Resulting from a single exposure or one that is repeated over a relatively short period of time.

⁵ The LD50 and LC50 vary according to multiple factors, such as function, product presentation, route of entry into the body, temperature, diet, age, sex, etc.




For the classification of pesticides according to their acute toxicity, in each country the regulations and provisions of the competent authority related to toxicological categories and ranges should be consulted.

Depending on the nature of any other health hazards,

physical hazards or environmental hazards of the product, this information must be supplemented by other pictograms and hazard statements.

The following table provides a sample pesticide label based on GHS elements.

Table 7. Pesticide label template based on GHS elements

Auxiliary side	Main side	Auxiliary side															
<p>Cautionary advice:</p> <p>"Do not consume food or drink or smoke while using this product"</p> <ul style="list-style-type: none">• Precautions and warnings for use and application• First aid and emergency care instructions• Storage instructions• Conditions for handling and disposal of waste and empty containers• Environmental protection measures <p>Emergency hotline</p>	<p>Product name</p> <ul style="list-style-type: none">• Common name, a.i. concentration• and formulation• Registration number <div><p>"Read the label (and the information sheet) carefully before using the product"</p><p>"Keep locked up and out of reach of children"</p></div> <div><div></div><p>Indications of danger</p></div> <div><div><p>Registration holder: Manufacturer: Importer and distributor: Made in:</p></div><div><p>Date of manufacture: Batch No.: Net contents: Expiry date:</p></div></div>	<ul style="list-style-type: none">• Instructions for use and handling• Mode and mechanism of action• Instructions for use• Indications on the use of required PPE <p>"Consult an agronomist"</p> <table><tr><td>Cultivo</td><td>Plaga</td><td>Dosis</td><td>PC*</td><td>LMR**</td></tr><tr><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td></tr></table> <ul style="list-style-type: none">• Frequency and time of application• Re-entry period (replanting)• Compatibility• Phytotoxicity• Liability <p>Toxicological category</p> <p>*GP: grace period</p> <p>**MRL: maximum residue level</p>	Cultivo	Plaga	Dosis	PC*	LMR**										
Cultivo	Plaga	Dosis	PC*	LMR**													
<p>Colour band based on toxicological category of pesticide</p> <div><div>Precautionary pictograms</div><div>Signal words</div><div>Precautionary pictograms</div></div>																	

Source: own elaboration based on United Nations (2015); FAO and WHO (2015).

Note: You can find any of the GHS pictograms displayed on the model label for pesticides, based on the hazards associated with the nature of the product and the rules established by the GHS.

Safety data sheets (SDS)

The **SDS is a document that describes the hazards of a chemical** providing information on its safe handling, use and storage in the workplace. The SDS must be prepared for all chemical substances and mixtures that meet the

harmonized criteria for health, physical and environmental hazards, in the framework of the GHS.

The manufacturer, importer or distributor is responsible for preparing and submitting the SDS for each of the chemical products it supplies. It consists of 16 sections, as set out in table 8.

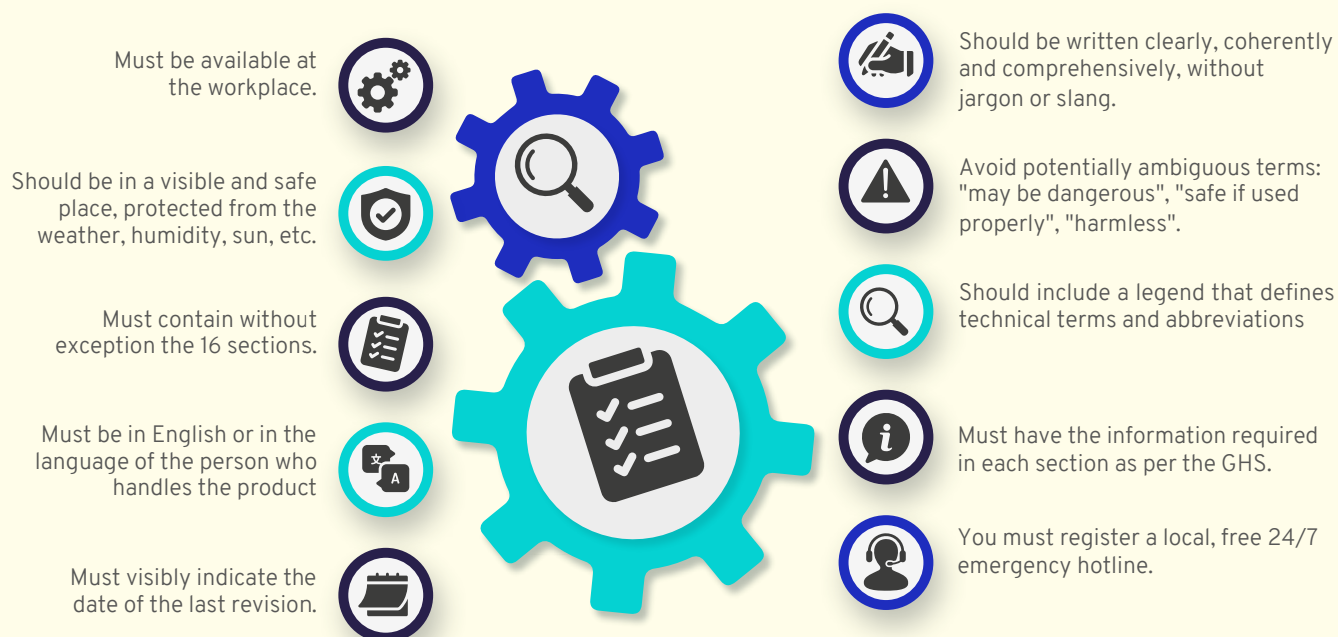
Table 8. Safety data sheet (SDS) sections

Section	Description
1. Product identification	<ul style="list-style-type: none"> a) GHS product identifier b) Other means of identification c) Recommended chemical use and restrictions on use;d) Supplier's details (name, address, telephone number, etc.) e) Emergency phone number
2. Identification of hazard(s)	<ul style="list-style-type: none"> a) GHS classification of the substance/mixture and any national or regional information b) GHS label elements, including precautionary statements c) Other hazards which do not result in classification (e.g. dust explosion hazard) or are not covered by GHS.
3. Composition/ information on ingredients	<p><u>Substance:</u></p> <ul style="list-style-type: none"> a) Chemical identity b) Common name, synonyms, etc. c) CAS number and other unique identifiers d) Impurities and stabilizing additives which are themselves classified and which contribute to the classification of the substance <p><u>Mixture:</u></p> <p>The chemical identity and concentration or concentration ranges of all components which are hazardous within the meaning of the GHS criteria and are present above their cut-off levels/concentration limits.</p>
4. First aid	<ul style="list-style-type: none"> a) Description of necessary measures, subdivided according to the different routes of exposure, i.e. inhalation, skin and eye contact, and ingestion b) Most important symptoms/effects, acute and delayed c) Indication of immediate medical attention and special treatment needed, if necessary
5. Firefighting measures	<ul style="list-style-type: none"> a) Suitable (or unsuitable) extinguishing media b) Specific hazards arising from the chemical (e.g. nature of any hazardous combustible products) c) Special protective equipment and precautions for fire-fighters.
6. Measures to be taken in the event of accidental spillage	<ul style="list-style-type: none"> a) Personal precautions, protective equipment and emergency procedures b) Environmental precautions c) Methods and materials for containment and cleaning up
7. Handling and storage	<ul style="list-style-type: none"> a) Precautions for safe handling b) Conditions for safe storage, including any incompatibilities.
8. Controlling exposure/personal protection	<ul style="list-style-type: none"> a) Control parameters, e.g. occupational exposure limit values or biological limit values; b) Appropriate engineering controls c) Individual protection measures, such as personal protective equipment (PPE).

Section	Description
9. Physical and chemical properties	Physical state; colour; odour; melting point/freezing point; boiling point or initial boiling point and boiling range; flammability limit; lower and upper explosion limit/flammability limit; flash point; auto-ignition temperature; decomposition temperature; pH; kinematic viscosity; solubility; partition coefficient: n-octanol/water partition coefficient; vapour pressure; density and/or relative density; relative vapour density; particle characteristics; explosive properties; oxidizing properties; reactivity with container material.
10. Stability and reactivity	a) Reactivity; b) Chemical stability; c) Possibility of dangerous reactions; d) Conditions to avoid (e.g. static discharge, shock or vibration); e) Incompatible materials; f) Hazardous decomposition products.
11. Toxicological information	Concise but complete and comprehensible description of the various toxicological (health) effects and the available data used to identify those effects, including: a) Information on the likely routes of exposure (inhalation, ingestion, skin and eye contact); b) Symptoms related to the physical, chemical and toxicological characteristics; c) Delayed and immediate and effects and also chronic effects from short- and long-term exposure; d) Numerical measures of toxicity (such as acute toxicity estimates).
12. Ecotoxicological information	a) Ecotoxicity (aquatic and terrestrial, where available); b) Persistence and degradability; c) Bioaccumulation potential; d) Mobility on the ground; e) Other adverse effects.
13. Information on disposal of products	Description of waste residues and information on their safe handling and methods of disposal, including the disposal of any contaminated packaging.
14. Information related to transportation	a) UN number; b) UN proper shipping name; c) Transport hazard class(es); d) Packing group, if applicable; e) Environmental hazards (e.g. Marine pollutant (Yes/No); f) Carriage in bulk (according to Annex II of MARPOL 73/78 and the IBC Code); g) Special precautions which a user needs to be aware of, or needs to comply with transport or conveyance either within or outside their premises.
15. Regulatory information	Specific safety, health and environmental regulations for the product in question.
16. Other information	Additional information considered relevant. Date of last revision, abbreviations, references of documents consulted.

Source: United Nations (2015).

Figure 8. Safety data sheet requirements



Source: own elaboration based on United Nations (2015)

4. Activities with potential exposure to chemical products and pesticides

The following are some of the main activities associated with the use of chemical products:

Figure 9. Activities with potential exposure to chemical products

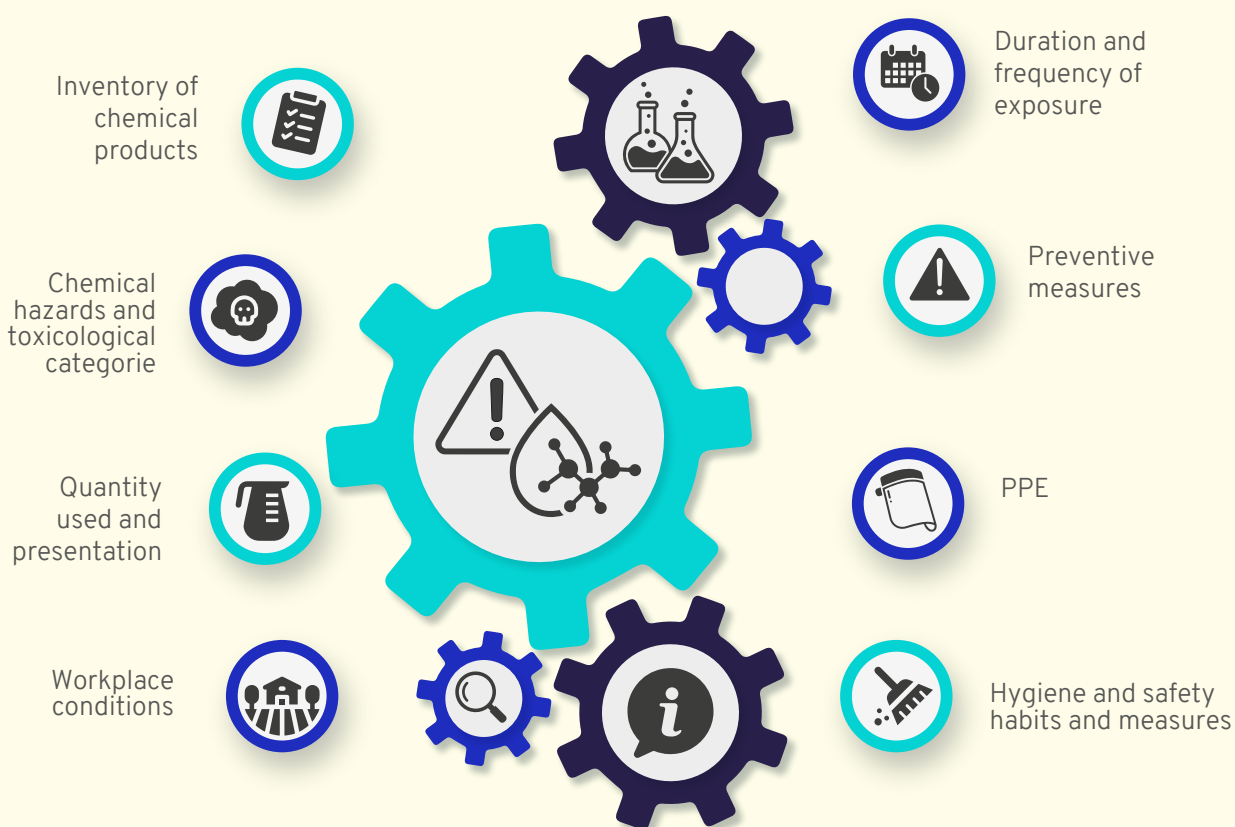


Source: own elaboration

5. Environmental monitoring

Environmental monitoring covers the identification, assessment and control of the risk to which workers are exposed in relation to the type of chemical product, the process and the protective measures employed. Exposure assessment can be carried out through environmental concentration measurements of chemical compounds at the workplace. There are also methods for assessing the risks of chemical products in a preliminary way through observation and without measurement, which allow the exposure to be classified as high-, medium- or low-risk. For such an assessment, it is essential to collect information on: Los resultados de la vigilancia ambiental permiten mantener el riesgo del trabajador en niveles aceptables a través de la implementación de estrategias de control, para que sea posible priorizar intervenciones según su efectividad. The results of environmental monitoring allow the risk to workers to be kept at acceptable levels through the implementation of control strategies, so that interventions can be prioritized according to their effectiveness.

Figure 10. Information required to assess the risks of using chemical products

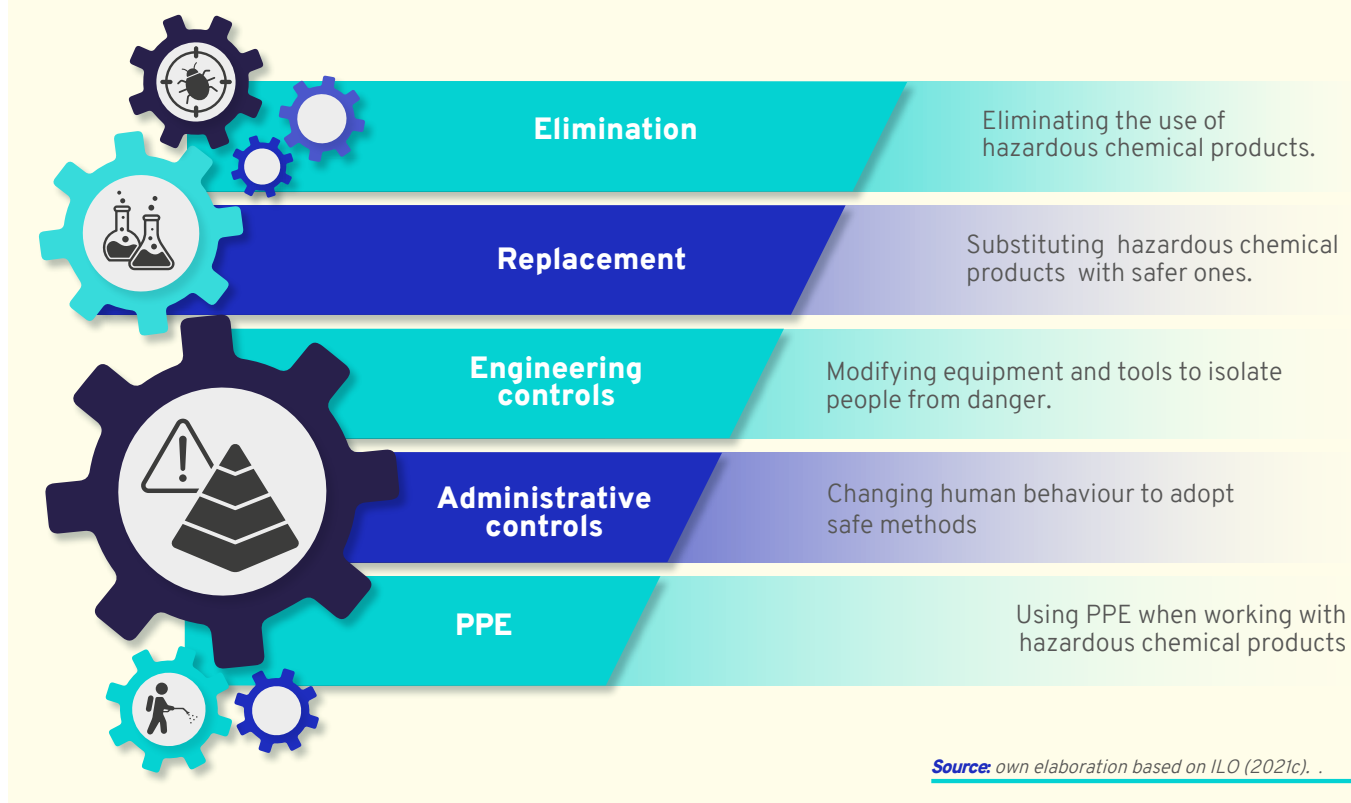


Source: own elaboration

6. Hierarchy of controls

ILO guidance on occupational safety and health follows the principles of the hierarchy of controls for the prevention of hazards:

Figure 11. Hierarchy of controls for reducing exposure to hazardous agrochemicals



It is important to consider this hierarchy of controls throughout the life cycle of the chemical substance, through the implementation of practical measures such as:

- safe handling and use of pesticides;
- use of PPE;
- safe storage of pesticides; and
- pesticide phase-out (ILO 2021c).

7. Safe handling and use of pesticides

Proper pesticide selection and quality control

- Correctly identify the pest or disease causing the problem in order to request support from agricultural technicians.
- Before opting to use a pesticide, evaluate all pest control possibilities (biological, mechanical, genetic, etc.).
- Know which agrochemicals are recommended for the identified pest or disease, as each product has been developed, approved and registered for specific uses (Pacheco and Barbona 2017).
- Choose the pesticide that offers the least risk to health and the environment.
- Accept products only in their original packaging, in good condition and in good working order.
- Verify that the product has a registration licence issued by the competent authority in the country of distribution. The registration number should be verified on the label. Do not purchase products close to their expiry date unless immediate use is considered.
- Confirm that the pesticide is labelled and has a safety data sheet.

Preparing mixtures

- Read the label and safety documentation in order to determine the required elements, dosages, dilutions, preventive measures and protective elements. Do not use higher concentrations than those indicated.
- Maintain the necessary tools and instruments in good condition and for exclusive use (dosing device, hand shovels, funnels, stirrers, stands, etc.), preferably marked and stored in a designated location. Under no circumstances should household utensils be used.
- Use clearly gauged and calibrated dosing devices (balances, test tubes, graduated containers).
- Provide a dedicated area for the preparation of mixtures. It should be signposted, well lit, far away from water sources, well ventilated and far away from the general population and animals.
- Place the pesticide container on a flat surface and open it carefully. Use a sharp knife or scissors to cut paper and cardboard containers in order to prevent dust from spreading and contaminating the environment. Under no circumstances should the mouth be used as a tool to open containers (ILO 2011).
- When mixing, use closed containers and mechanical means for transferring and stirring as far as possible, avoiding splashing and spillage.
- Prepare only the quantity that will be used.
- Do not mix different pesticides.
- Use clean water for mixing.
- Do not eat, drink, smoke or chew gum during the operation.



Loading equipment

- Load the product inside the facility and with your back to the wind.
- Drain the containers completely into the tank of the spray equipment.
- When adding the mixture to the spray tank, keep the hose above the liquid level to prevent the pesticide mixture from flowing back through the hose. Do not under any circumstances suck on the hose to make the product start to flow (WHO 2004).



When preparing the mixture and loading the application equipment, the risk of poisoning may be high because the concentrated product is being.

Before application

- Train the staff responsible for application.
- Place signs in the area of application with warning legends in order to prevent people from entering.
- Consult label information and other technical and product safety documentation, written instructions, application equipment manual, etc.
- Check the applicator pump and make sure there are no leaks in the hose, connections or cap, and fix any that are found.
- Calibrate application equipment according to the crop, pest, field conditions, nozzles and product to be used.
- Change nozzles frequently as their wear may change the dosage or dispersion pattern of the product (WHO 2004).
- Check that the weather conditions are satisfactory in order to prevent excessive wind speeds from causing the applied product to drift.
- Remove people and domestic animals from the crop area before starting the application. Do not allow them to enter the area during the procedure.



During application

- Use PPE according to the recommendations of the pesticide manufacturer.
- Avoid applying pesticides on days with strong wind or when there is a threat of rain. These conditions may reduce the effectiveness of the pesticide and/or cause carry-over of the pesticide, with possible negative impacts on the environment.
- Avoid working inside the spray cloud. Always work downwind and aim the droplets at the biological target.
- Take special care with areas that should not be sprayed, such as already sprayed crops, farms, bodies or reservoirs of water, pollinator habitats or organic crops (ILO 2011).
- If the nozzle becomes blocked, never clean it by inserting it into the mouth. Use water or a soft probe or brush.
- The duration of the application should be as short as possible.
- One risk-control measure is to rotate staff to reduce exposure.
- Do not eat, drink, smoke or chew gum while agrochemicals are being applied.



After application

- One good management practice is to keep a register with information about the agrochemicals used, the date and the place of use and the name of the user.
- Re-entry periods must be respected. If re-entry is necessary, PPE must be used. In the case of a mixture, the longest period should be considered (ACHS 2005).
- Remove warning signs when they are no longer required.
- Establish routines for personal hygiene and for hygiene of equipment, tools and utensils (ILO 2011).

After application, pesticide residues may persist for a long time on plant and soil surfaces, which may come into contact with skin or be inhaled by workers re-entering treated areas after application (ILO 2011).

This is why the ideal re-entry time may range from 4 hours to 30 days, depending on the crop, the pesticide used and the location. This decision is based on an assessment of the risk to workers that should take into account the toxicity of the pesticide, its application rate, its rate of dissipation from the crop and the crop density/structure, as well as work practices (FAO 2021). Such re-entry time should be reported on pesticide labels (FAO 2018).

8. Use of personal protective equipment (PPE)

PPE reduces the possibility of contact and the entry of chemical products into the body. Personnel who handle, mix or apply pesticides are required to wear the PPE indicated on the label and in section 8, “Controlling exposure /personal protection”, of the SDS, and should be trained in its correct use (ILO 2021b).

Figure 12. Clean-up activities after work with chemical products and pesticides



PPE must be clean and free of tears, holes or other defects or signs of excessive wear.

They should be sized to fit the wearer or be adjustable and comfortable.












They must not impede the wearer's vision, breathing or hearing.

They should be inspected periodically and replaced when they are damaged or do not adequately protect the worker.

The service life of each element must be taken into account.

The selection of PPE depends on the hazard class of the substance, the route of exposure or form of contact, the concentration and the working conditions. It is therefore necessary to carry out a risk analysis to determine whether the PPE selected is appropriate.

Table 9. PPE elements

PPE	Description	Example
Respirator	<p>Protects the mouth, the nose and in some cases the eyes from small particles and vapours. Respirators can be classified into disposable or maintenance-free respirators, respirators with a filter and respirators with air supply.</p> <p>If the respirator is fitted with filters, it should be changed if breathing is difficult, any irritation or odour is detected, if they are broken or if required by the chemical product label or item label.</p> <p>Similarly, filters should be selected according to the type of pesticide or chemical to be used and according to the information in the SDS</p>	 Maintenance-free respirator  Respirator with filter  Respirator with air supply
Gloves	<p>Gloves are the most commonly used items to protect the hands and arms against the possibility of risks from skin contact.</p> <p>Some of the gloves used are made of nitrile, PVC or neoprene material with a long cuff and should be at least 0.4 mm thick, comfortable and flexible enough to be able to grip pesticide containers and other equipment.</p>	 Nitrile gloves  Neoprene
Goggles and masks	<p>Intended to protect the face and eyes against the risks caused by vapours, aerosols, projections of solid particles and liquids.</p>	 Goggles  Mask
Coverall, protective suit, apron, hood	<p>In order to isolate the body from hazardous products and pesticides, it is necessary to use coveralls, as well as protective clothing, aprons and hoods, made of resistant materials such as rubber, PVC and high-density polyethylene.</p> <p>Protective suits are resistant to chemical products under normal conditions of use, while aprons protect against splashes and spills.</p> <p>For tasks such as spraying tall crops, hoods of impermeable material should be worn for neck and head protection.</p>	 Protective suit  Apron  Hood
Boots	<p>Unlined rubber boots protect feet and prevent liquid absorption. Boots protect against spills, splashes and sprays, as well as during walking after application when the substance that has been dispersed is not yet dry.</p>	 Rubber footwear

Source: own elaboration

⁶ Including plants that are taller than the average height of a person, e.g. trees.

Figure 13. Order of putting on and taking off PPE



*Before starting to take off PPE, gloves should be washed to reduce the risk of exposure.

Source: Ministry of Agriculture and Rural Development, Government of Mexico (2019).

Cleaning PPE

Cleaning and disinfection of PPE should be carried out according to the manufacturer's instructions (INSHT 2012). Gloves should be worn to protect hands from exposure to chemical products, as well as a respirator for protection against possible vapours or particulate matter that may be generated during this process.

After cleaning, the gloves should be kept in a ventilated, clean, cool, dry place intended only for this purpose,

separate from other clothing. Respirators should be stored in closed plastic bags

Training in the use of PPE

Training of workers should provide guidance on the risks of exposure to pesticides, the function and limitations of PPE, the correct way to put it on and take it off and ensure a proper fit, and its safe cleaning and disposal (ILO 2021c).

9. Safe storage of pesticides

In the agricultural sector, substances such as ammonium nitrate, sulphur, sodium hypochlorite, gasoline and propane gas, among other substances, represent risks of emergency events during storage, and it is common to find that inventories include substances with a risk of explosion or fire, for which the specifications of the space allocated for storage and the safety conditions must be strictly maintained.

Specifications of storage facilities

Location: far away from offices, rest areas, housing, food collection centres, animals and water sources.

Construction materials: non-combustible and impermeable materials, smooth non-porous floors, anchored metal or similar shelves.

General requirements: ventilation, lighting, hazard and precautionary signs, restricted access, pallets (not wooden), fire extinguishers, spill kits,⁷ spill containment dikes,⁸ drains without connection to sewage systems, eye-wash showers and published emergency telephone numbers.

Safe storage practices:

- Always store products in their original containers with their respective labels, closed and in an upright position.
- Keep SDSs Available for consultation.
- Place larger-volume and liquid products at the bottom of the shelves.
- Use stored products on a "first in, first out" basis.
- Do not store incompatible products together and check the manufacturer's instructions.
- Wash hands after storage work.



10. Disposal of pesticides

Agricultural activities may give rise to hazardous chemical wastes, such as empty containers, expired or deteriorated products, residues of mixtures, and waste water

from the washing of equipment and utensils. Other less common forms of waste may be generated, such as damaged PPE or material used to collect accidental spills.

⁷ **Spill kit:** a set of tools, supplies and personal protection items that will help any trained person respond to a spill in a safe and efficient manner

⁸ **Spill containment dike:** a containment barrier that restricts the flow of spilled liquids, protecting facilities and the environment.

Empty containers

Empty containers should be discarded in accordance with the information on the label and the safety data sheet, ensuring that the product is completely discharged from the application equipment. The recommended procedure is a triple wash, which ensures that the entire product is used and that empty containers are completely safe to handle and transport, as it removes 99 per cent of product residues in the container (ILO 2021c). To perform a triple wash, the steps shown in figure 14 should be followed.

Once destroyed, the containers should be drained, placed in plastic bags and stored in the collection centre, a place specially designed for the safe storage of this type of containers until their final disposal, where they do not pose a risk of contamination to people or the environment. Depending on the regulations in each country, it is likely that a post-consumer pesticide product return management plan will be required, which also covers empty containers and their return to the manufacturer or transfer to the nearest collection centre.

Figure 14. Procedure for triple washing pesticide containers



Consult your pesticide supplier or local authorities about campaigns and the location of the nearest collection centres for the delivery of pesticide containers, packaging and wrapping for all types of material (plastic, metal, glass, etc.).

Residues of mixtures

Depending on the area to be treated, the correct calculation of the amount of mixture to be used is essential to ensure that there is no excess. However, if residues do occur, while also following the manufacturer's instructions, they should be applied in another area of the crop or reapplied in areas where pest outbreaks are occurring.

Wash water

This originates from the washing of applicator equipment, protection elements, other equipment, utensils and tools. This wastewater must be managed with a management plan that considers alternatives, such as by piping it to an agrochemical trap or pit where it is neutralized, treated or biologically degraded for subsequent discharge.

Never discharge untreated wash water into domestic water drains, lakes, lagoons, rivers or other surface or ground water courses.

Expired or spoiled products

Products that have expired or do not meet their technical specifications should be returned to the manufacturer or importer, a process that should be managed through the supply chain.

Solid waste

Materials contaminated with chemical products, such as used PPE or absorbent material that has been contaminated by chemical spills, should be handed over to hazardous waste managers with environmental permits issued by the competent authorities.

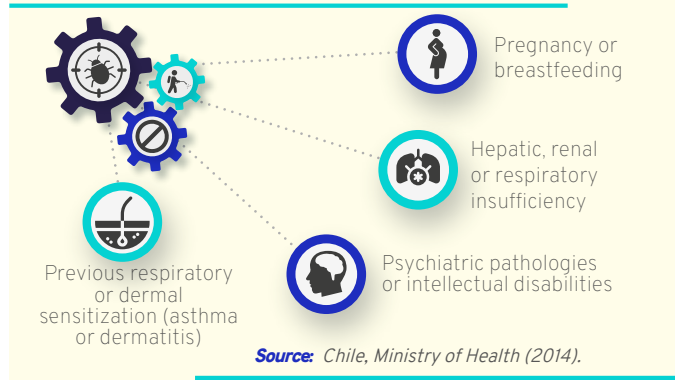
11. Health surveillance

Workers' health surveillance has a preventive function, which is carried out through medical examinations and serves to (ACHS 2005) (Ministry of Health 2019):

- determine the early effects of overexposure;
- identify sick workers so that immediate action can be taken in response;
- verify whether preventive measures effectively avert adverse impacts on workers' health.

While both women and men are at risk of exposure to pesticides in the agricultural sector, the impacts on their health may differ. For pregnant women, low doses of chemical products can cause dramatic effects on a developing foetus; in particular, endocrine-disrupting chemicals (EDCs) are capable of inducing hormonal effects that affect fertility, fecundity and development (ILO 2021f).

Figure 15. Conditions that restrict working with pesticides



Medical examinations should be performed at the start of the work activity, while the activity is ongoing, whenever there are changes to work assignments and upon completion of such work. It is recommended that such examinations include biological tests based on blood sampling that allow the monitoring of the effects of exposure to certain pesticides and, if necessary, the temporary suspension of activities involving exposure to pesticides for medical reasons.

Table 10. Biological tests according to pesticide class

Pesticide class based on active ingredient(s)	Biological test	Remarks
Organophosphates and carbamates	Plasma acetylcholinesterase	A pre-exposure baseline assessment is required as a benchmark against which subsequent controls can be compared (ILO 2011).
Methyl bromide	Level of bromide ions in blood	
Coumarins	Prothrombin time	Results are compared with normal ranges.

Source: Chile, Ministry of Health (2014).



Always conduct routine medical check-ups and inform the doctor about the activities performed and the chemical products to which the person is exposed at

12. Emergency procedures

Spill response

Chemical spills must be absorbed and cleaned up immediately to avoid undesirable outcomes, such as exposure of personnel, generation of hazardous vapours, leakage of waste through the soil and

drainage into sewers or water sources. Please consult section 6, “Measures to be taken in the event of accidental spillage”, of the SDS.

The procedure to be followed should include:

- Use PPE according to the chemical manufacturer's instructions (gloves, respirators, goggles, etc.).
- Check for spillage. If the container has been dropped, it should be picked up and placed in an upright position, ensuring that it is tightly closed and cannot be overturned.
- Determine the limits of the spill and mark it with a caution sign so that people do not approach it.
- Contain spillage with a barrier of earth, sand or other material to prevent its further spread.
- Use absorbent material (cloths, sponges, sand), soil or clay) to collect the spilled product.
- Clean the spill area after collection of the product to remove any product residue.
- Dispose of the hazardous waste generated from the spill response.

Figure 16. Objectives of first aid



First aid

First aid involves practices to treat any poisoning or injury until the person is seen by a doctor. While administering first aid, the label of the chemical product and section 4, “First aid”, of the SDS should be consulted.

Prompt treatment can mean the difference between life and death.

Figure 17. First aid in case of chemical poisoning or lesions



Call a doctor immediately and if necessary request transfer of the patient to the nearest medical facility.

Provide information about the brand name of the chemical, its composition, the time of poisoning and the symptoms presented by the person affected. If possible, take a photo of the label and show it to the attending physician.

Firefighting

All possible measures should be taken to avoid a fire caused by agrochemical products, including the following:

- No smoking near chemical products.
- Keep flammable products away from heat sources or direct sunlight.
- Store chemical products away from combustible materials such as hay or straw.
- Regularly review electrical installations.

The SDS in section 5, “Firefighting measures”, describe the proper way to fight a fire, as well as the type of extinguisher to be used. These may be of class A,B or C:

A = common combustible materials, such as wood, cloth, paper, rubber and many plastics.

B = flammable liquids, combustible liquids, petroleum oils, tar, oils, oil-based paints, solvents, lacquers, alcohols and flammable gases.

C = electrical equipment.

There may also be class D fires involving combustible metals, such as magnesium, titanium, zirconium, sodium, lithium and potassium, or class K fires involving cooking fuels (vegetable or animal oils and fats) (ICONTEC 2009). Do not forget to locate fire extinguishers in visible and easily accessible places, and regularly check their capacity and expiry dates.

It is important to follow these steps when using a fire extinguisher:

Figure 18. Steps to take in the event of a fire



Remove the pin



Hold with one hand and grasp the nozzle with the other hand.



After testing the extinguisher's operation, **aim the nozzle at the source of the fire** at a distance of 2 or 3 metres.



Squeeze the trigger, aiming downwind, until the fire is extinguished.



Make 100 % sure that the fire is out.

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