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Module:	**14: Chemical substances, poisoning and toxicology in agriculture**

14 Module 14: Chemical substances, poisoning and toxicology in agriculture

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14.1 Introduction

This module provides a guide to common occupational toxicants in agriculture and their effects, useful clinical information on poisonings and toxic syndromes, and preventive measures in the workplace. The discussion on chemical substances, in particular those used in Romania, emphasizes the occupational groups at risk, expanding the coverage of all agricultural subsectors. A holistic approach to the subject is given in the last section referring to contaminants, their cycle in natural systems, and their consequences on public health. In addition to the Manual, Module 14 provides a collective exercise based on a case study of non recognized occupational poisoning and the safety data sheet regarding the substance of concern (insecticide).

The aim is to help occupational physicians to understand the health risks associated with chemical substances used or accidentally released in agricultural systems, to recognize, diagnose, treat and prevent poisoning.

Toxic materials are chemical substances or mixture that may cause harm to an individual if it enters the body. It is preferred the less prejudicial term "toxicant" instead of poison which, by popular definition, means fatal, something usually involved with attempted homicide or suicide. Poison is a quantitative concept (harmful at some dose). The route of exposure to occupational toxicants can be inhalation (most common), skin contact (through unprotected skin), and ingestion (e.g., eating food or smoking a cigarette using contaminated hands).

Classification of toxic materials under the Globally Harmonized System includes acute toxicity (e.g., LD50, LC50), skin irritation / skin corrosion, serious eye damage / eye irritation, respiratory or skin sensitization, mutagens, carcinogens, reproductive toxicity, specific target organ toxicity, aspiration hazard, and chemical mixtures.

It is appropriate to mention here other common terms to be distinguished from a toxicant, such as toxin (a toxicant produced by a living organism), and venom (a toxin produced by an animal specifically for the poisoning of other species).

Occupational toxicology is a specific area of environmental toxicology that deals with the work environment and constitutes a significant part of industrial hygiene. For many chemicals there will be a dose called threshold dose bellow which no effect or response is observed in individuals. Workers may be exposed to the following limit values: threshold limit value – ceiling (TLV-C), the concentration that should not be exceeded even momentarily; threshold limit value – short-term exposure limit (TLV-STEL), maximal concentration for a period up to 15 minutes of continuous exposure; and threshold limit value – time-weighted average (TLV-TWA), the concentration for a normal 8-hour workday, repeatedly day after day without adverse effect.

Pathology caused by chemical substances may be translated into:

- Occupational disease (poisoning),
- Signs,

- Symptoms,
- Syndromes.

Pedagogical Objectives

Knowledge objectives:
The trainee should be able to:

- identify chemical agents at the workplace in agriculture,
- nominate the classes to which the identified chemical substances belong,
- give examples of the immediate and long-term health effects due to chemical hazards in agriculture,
- nominate the common toxicants with specific target organ toxicity,
- explain the principles of prevention and medical surveillance.

Aquiring skills and changing the attitude*:*

The trainee should be able to:

- find reliable sources of information on hazard communication,
- take an accurate occupational history,
- recognize and partially diagnose a case of occupational poisoning,
- recognize the adverse health effects of chemical exposure in agricultural workers,
- have a preventive attitude in relationship with workers and employers and to advice them on specific chemical risks in their field.

14.1.1 Glossary

Name	Definition
Carcinogen, genotoxic	agents that exert their carcinogenic effect by a series of events that is initiated by an interaction with DNA, either directly or through an electrophilic metabolite.
Hepatotoxicity	hepatotoxicants are those chemicals causing adverse effects on the liver. The liver may be particularly susceptible to chemical injury because of its high concentration of xenobiotic-metabolizing enzymes.
Intoxication	the morbid condition produced by a poison / systemic effects of toxic materials.
Nephrotoxicity	a pathologic state that can be induced by chemicals (nephrotoxicants) and in which the normal homeostatic functioning of the kidney is impaired.
Neurotoxicity	a general term referring to all toxic effects on the nervous system, including toxic effects measured as behavioral abnormalities. Because the nervous system is complex, both structurally and functionally, the study of neurotoxicity is a many-faceted branch of toxicology, involving electrophysiology, receptor function, pathology, behavior, and other aspects.
Poison (toxicant)	any substance that causes a harmful effect when administered to a living organism. Due to a popular connotation that poisons are, by definition, fatal in their effects and that their administration is usually involved with attempted homicide or suicide, most toxicologists prefer the less prejudicial term toxicant. Poison is a quantitative concept. Almost any substance is harmful at some dose

	and, at the same time, is harmless at a very low dose. There is a range of possible effects, from subtle long-term chronic toxicity to immediate lethality.
Pulmonary toxicity	this term refers to the effects of compounds that exert their toxic effects on the respiratory system, primarily the lungs.
Risk, toxicologic	the probability that some adverse effect will result from a given exposure to a chemical is known as the risk. It is the estimated frequency of occurrence of an event in a population and may be expressed in absolute terms (e.g., 1 in 1 million) or in terms of relative risk (i.e., the ratio of the risk in question to that in an equivalent unexposed population).
Threshold limit value (TLV)	the upper permissive limit of airborne concentrations of substances represents conditions under which it is believed that nearly all workers may be exposed repeatedly, day after day, without adverse effect.
Toxicology	branch of science that deals with poisons (toxicants) and their effects. Occupational toxicology deals with the chemicals found in the workplace.

14.2 Exposure to pesticides

In the Romanian agriculture and horticulture a wide range of chemical substances are used to combat and control pests. They are generally called pesticides, and include insecticides, herbicides, fungicides, bactericides, acaricides, etc., whose toxic mechanisms or long-term side effects are still unknown. Since acute intoxication is rather rare, occurring accidentally or intentionally for criminal or suicidal purposes, discussions are currently focused on the cumulative effect of such substances on human health, especially the threat posed by organophosphates, carbamates and pyrethroids. (1).

The main categories of chemical agents used in Romania are as follows:

- *Organophosphate compounds* (potentially cancerous pC): chlorpyrifos, dichlorvos, disulfoton, tetrachlorvinphos, pirimiphos, dimethoate, which can be found in commercial products such as Pirinex 25 CS, Reldan 22EC, Nurelled 50/500EC, Actellic 50EC, Novadim Progres, etc.; limit value (8 hours) for pirimiphos: 0.50 mg/mc air. (2);
- *Carbamates and dithiocarbamates:* mancozeb, propineb, fenoxycarb, methiocarb (*toxicity class II T), ziram (toxicity class II), thiram, metiram, carbendazim, under the name of Antracol, Dithane, Neotec 75WG, Flowsan, Poliram DF, Manzate 75DF, Vandozeb; limit value (8 hours) for zineb: 0.5 mg/mc air, for thiram: 2 mg/mc air (2);
- *Synthetic pyrethroids:* cypermethrin, alpha-cypermethrin, deltamethrin, lambda cyhalotrhin, gama cyhalotrhin, in products such as Decis, Fastac 10EC, Faster 10EC, Fury 10EC, Karate Zeon, Lamdex 5EC, Zebra, Kaiso Sorbic 5EC, Vantex 60CS etc.; limit value for pyrethrum (8hours): 1 mg/mc air. (2);
- *Urea derivatives:* linuron (toxicity class II), rimsulfuron, as Afalon 50SC (T), Linurex 50SC (T), Titus 25DF, Titus Plus etc.;
- *Phtalimides:* captan (genotoxic), folpet, Captan 80, Captadin 50PU, Folpan 50WP, Folpan 80, Merpan 50WP, Calipso 488SC etc.;
- *Triazoles and imidazoles:* tebuconazole, propiconazole, cyproconazole, difeconazole, iprodione, such as Orius ST 2WS, Sanaprod, Amiral Profi, Arteea, Gat Tessla, Ravral 500SC, Bumper 250EC, Score 250EC, Falcon 460EC etc.;
- *Quinazolines:* proquinazid, quizalofop-P-tefuryl, quizalofop-P-ethyl, propaquizafop, commercialized as Agil, Elegant, Leopard, Targa Super, Pantera, Talenda etc.;

- *Copper and compounds*: Alcupral, Champion, Cupritim, Funguran OH 50WP, Kocde 2000, Curzate Manox, Copac, Champ etc.;
- *Aluminum derivatives:* fosetyl-aluminium, aluminium phosphate (*toxicity class I T+): Aliette, Alletato, Agroxin, Fosforol, Phostoxin etc.;
- *Sulphur products:* Kumulus DF, Thiovit Jet, Critox, Sulphur, Microthiol Special, Sulphamate;
- *2,4-Dichlorophenoxyacetic acid and derivatives* (potentially cancerous pC): Dicopur, Prodate 2,4D, SDMA Super, DMA 6, 2,4D 660SL.

*Acute toxicity: class I (highly toxic), class II (moderately toxic).

The relative acute human toxicity of insecticides classes from most to least toxic is organophosphates > carbamates > organochlorines > pyrethroids > neonicotinoids.

Organophosphates and heavy metals (aluminum) are neurotoxins with selective targets. Aluminum, for instance, is involved in Alzheimer's disease. (3, 4). Acute poisoning may occur in case of exposure to organophosphates, aluminum phosphate and carbamates, while pyrethroids are known to cause respiratory and skin problems. Organs that are the main targets of such pesticides are the skin, the lungs and the central nervous system, and chronic effects are mainly respiratory (bronchial asthma) and neurological diseases, diseases of the reproductive system, as well as cancer. (5).

Organophosphate poisoning includes three clinical syndromes, namely *muscarinic* (tearing, salivation, hypersecretion, miosis), *nicotinic* (muscle twitching), and *central nervous syndrome* (encephalopathy). Neurotoxicity can result from high level exposure to most types of pesticides. (6).

According to the data provided by the National Public Health Institute (7), there are about 12,823 workers exposed, mostly of them working with pesticides, as shown in figure 1.

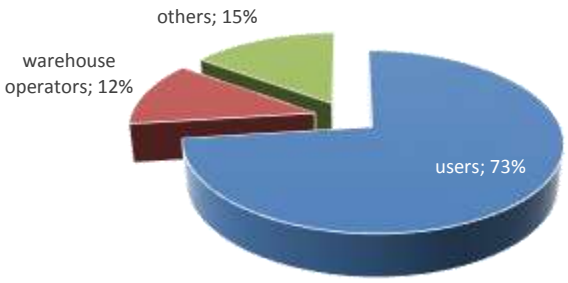

Figure 14-1 Occupational categories at risk (Source: NPHI Bucharest, 2014)

Because pesticides can cause syndromes that are difficult to differentiate from other types of common diseases, the occupational history is essential, as well as identifying the toxic product that the worker has been exposed to, based on a proper recording of all data in the patient's health and safety file. Prevention consists in putting in place regulations regarding the distribution, selling and use of pesticides, a proper recording, certifying and labeling of the products, regulations regarding the tolerable amounts in foodstuffs, a proper occupational risk management (complete personal protective equipment, as shown in figure 2), and access to emergency toxicology units.

The basic principles for treatment of acute poisonings include the following practices: skin and eye decontamination; respiratory function support and airway protection; gastrointestinal tract clearing / vomiting induction; administration of adsorbents and specific antidotes (activated charcoal; atropine as antidote for organophosphate poisoning).

However, identification of pesticide in the blood provides the most objective evidence of poisoning. Medical monitoring of blood acetylcholine esterase has been included in regulatory practices as biomarker for organophosphate and carbamate exposed workers. Sometimes, elevated transaminases occur in liver injury produced by certain pesticides. There are also promising spot tests for urine breakdown products of many pesticides.

Interindividual variations in human susceptibility to pesticide exposure are given by genetic polymorphism of some of the more important families of enzymes involved in xenobiotic metabolism, respectively the cytochrome P450 monooxygenases (CYPs). CYP2B6 has been demonstrated to have a role in the activation of the organophosphate, chlorpyrifos, and in the degradation of the commonly used insecticide repellant diethyl toluamide. (8). Unusual variants of paraoxonase (PON) have recently been associated with genetic risk to organophosphate exposure, while the variant PON1 may detoxify the pesticide poisoning more efficiently. (9).

Figure 14-2 Operators and users handling pesticides safely
(Source: www.wikipedia.org; www.euractiv.com)

14.3 Exposure to organic dust

Powders are inert particle aerosols – excluding microorganisms – which, by origin, can be classified as organic and inorganic; vegetal, animal, and synthetic. Vegetal dust is produced in large quantities in agro-technical sectors (cereals, cotton, flax, tobacco, and soy dust), forestry (wood dust) and animal breeding. Cereal dust is particularly dangerous for workers, because of its complex composition: fragments of grains, small leafs, insect remnants, silica, bacteria, fungi and chemical residues. The farmers who are exposed to moldy cereal dust or to hay, as well as forest workers who are exposed to wood dust, can develop the "organic dust toxic syndrome" - an acute febrile reaction just like flu, but different from hypersensitivity pneumonitis caused by allergens. (10). Working inside livestock buildings and other agricultural structures that allow concentration of exposures are the main risk factors of hazardous respiratory exposures.

Exposing forestry workers to wood dust has been associated with various side effects including dermatitis, conjunctivitis, rhinitis, allergic and non-allergic respiratory diseases, which is subject of discussions to reduce the limit value up to 2.5 mg/mc air. (11). This risk has been recently associated with lung cancer, especially in the case of industrial procedures, where workers are exposed to high concentrations of dust. (12). Risk is posed by both chemical substances in wood, and the substances generated by bacteria, fungi and molds, wood peeling and wood cutting being the common operations of concern. In Romania, the limit values for exposure per 8 hours are 4 mg/mc air for cereal dust, and 5 mg/mc air for wood dust. (13).

Soy and tobacco leaf dust generate hypersensitivity pneumonitis (14), and that is why individual respiratory protection is recommended. Pneumopathy induced *via* hypersensitization (allergic alveolitis) is caused by allergens, which can be proteins or glycoproteins from animals, plants, insects, bacteria, fungi, protozoa or chemical substances with light molecular weight. (14). This pathology can be seen among workers from all areas of agriculture, but especially in agrophyitotechnics and aviculture, farmer's lung being the most

common disease (caused by bacteria and fungi), the poultry farmer's lung (caused by proteins) and the sericulturist's lung (caused by the proteins in silkworms). As it is an occupational allergic pathology, prophylaxis includes avoidance of exposure even changing the job, individual respiratory protection (respirators), and adding fungicides to water-based products or treating hey with buffered propionic acid which reduces the risk of developing farmer's lung. (14).

14.4 Exposure to irritant gases and vapors

Usually, animal care workers and silo fillers are exposed to this occupational hazard and the main toxic substances are represented by:

- *Ammonia:* is released by the organic matter during degradation (animal waste, liquid fertilizer pits, urine of animals kept in enclosed spaces), and that is why animal care workers are mostly exposed to it; limit value (8 hours): 14 mg/mc air (2);
- *Oxides of nitrogen:* occurs in poorly ventilated silos shortly after the storage of fermentable cereals or cereals originated from nitrogen fertilized land (15); limit value (8hours): 5 mg/mc air (2);
- *Hydrogen sulphide:* is released by decomposition of organic matter from wells, drainage channels, pig farms, or from the compost of commonly used edible fungi cultures - genus *Agaricus*; limit value (8 hours): 10 mg/mc air (2). This toxic gas generally results from the fermentation of organic matter in tanks or in enclosed spaces, and accumulation in high concentrations may cause asphyxia in the absence of oxygen;
- *Active chlorine:* releases by the solving of chlorate derivatives (lime chloride, hypochlorite) in aqueous solution. These substances are used as disinfectants in zootechnics and water treatment of wells; limit value (8 hours): 0 mg/mc air. (2).

This category of toxic substances is dangerous depending on solubility: for instance, nitrogen oxides are liposoluble and therefore lungs are the target (silo filler's disease), while irritant gases are hydrosoluble and affect the upper respiratory tract (pharynx, larynx, tracheae, bronchia) and the conjunctiva. Acute intoxication may occur when concentrations are high, while long-term exposure to low concentrations may generate the Reactive Airways Dysfunction Syndrome. The main preventive measures consist of ensuring proper ventilation at the work place, construction of manure pits outside the confinement building, and the use of breathing apparatus.

14.5 Exposure to hydrocarbons, exhaust gases (CO) and mineral oils

This chemical mixture must be taken into account for agricultural mechanics, which perform maintenance work on agricultural equipment. Carbon monoxide (CO) is an asphyxiating gas that affects the transportation of oxygen in the blood, and exposure to low but repeated concentrations can cause cephalea and fatigue. The limit value (8 hours) is 20 mg/mc air. (2). Mineral oils are mixtures of hydrocarbons that can be irritants to the eye, to skin and to respiratory tract. Repeated contact with the skin can cause oil acne, acne-like pustules, hyperkeratosis and skin cancer (basal or spinocellular epithelioma) in particular when the oils are poorly refined or aged through heating, with a high content of polycyclic aromatic hydrocarbons. (16). Risk of inhaling the oil, which can cause chemical pneumonia, is low in this category of workers. The limit value (8 hours) is 5 mg/air. (2). Main protection measures consist of efficient ventilation in workstations and personal protective gloves.

14.6 Exposure to organic solvents

Organic solvents are a bulk of chemical substances having the property to dissolve or dilute other substances such as paints, oils, fats, glues and resins. The main categories of organic solvents include the aliphatic

hydrocarbons (hexane, cyclohexane) and aromatic hydrocarbons (benzene, toluene, xylene); alcohols (methanol); ketones (acetone, methyl ethyl ketone); esters; ethers; organic acids; trichloroethylene and tetrachloroethylene as grease removers from metallic parts. Operations such as degreasing, cleaning, painting or varnishing are quite frequent in maintenance, constructions, and renovation in all sectors of agriculture.

Organic solvents may cause irritation of skin and respiratory tract; neurotoxicity (e.g., n-hexane, tetrachloroethylene, toluene); hepatotoxicity; cancer (e.g., benzene, carbon tetrachloride, trichloroethylene); and mutagenic effects (e.g., 2-ethoxyethanol, 2-methoxyethanol, methyl chloride). (6, 15). The risk of such substances to enter the body is enhanced by the fact that they are highly volatile (inhalable) and liposoluble (penetrate the unprotected skin). Occupational exposure to ethylic alcohol is insignificant. The highest risk is that it may be consumed in large quantities in the rural areas, where the locals are also producers of alcoholic beverages.

In order to prevent exposure, workers should use protective gloves and creams, the working space must be properly ventilated, and those who carry out painting operations by spraying must wear complete personal protective equipment. The order of prevention effectiveness is to first remove the hazard, followed by minimizing risk, both through efforts that eliminate or minimize a human behavioral response. (17).

14.7 Exposure to biocides

Biocides are a wide range of chemical substances used for disinfection, to kill “organisms of concern” e.g., microorganisms, algae, mollusks, and rodents. The risk of exposure to such substances appears usually in zootechnics, but also in animal feed and cereal storage, agriculture settings, buildings, etc.

Representatives for this category are the following chemicals: *formaldehyde* (cancer-causing agent according to the IARC list; limit value/8 hours: 1.20 mg/mc air (2)), and *rodenticides* e.g., K antivitamins, alphachloralose, crimidine, calciferol, cholecalciferol – solid or liquid, as well as gaseous rodenticides (hydrogen cyanide, hydrogen phosphate and chloropicrin), which are suffocating gases, some extremely toxic like chloropicrin, which can cause effects ranging from irritant syndrome to pulmonary edema. Diffuse obliterative bronchiolitis may occur in accidental exposures. (15, 16).

Disinfectants include halogens (e.g., chlorine, hypochlorites, chloramines, and iodine), phenols, aldehydes, quaternary ammonium compounds, and sodium hydroxide. (18).

Disinfectants must be handled according to the instructions on the package. Rodenticides, just similar to pesticides, must be handled only by authorized workers.

In summary, Table 1 shows common chemical substances used in Romanian agriculture, mostly of them designed as biocides.

Tabel 14-1 Chemical substances used in agriculture

No	Chemical substance	Chemical formula	Category to which the substance belongs	Agriculture sector in which the substance is used	Substance is used for
1	Sulphur dioxide	SO2	Fumigant (irritant gas)	Apiculture	for the gasification of backup combs; kills the larvae and butterfly wax
2	Naphthalene	C10H8	Insecticide (toxic)	Apiculture	blocks the biological cycle of the wax moth

No	Chemical substance	Chemical formula	Category to which the substance belongs	Agriculture sector in which the substance is used	Substance is used for
3	Paradichlorobenzene	C6H4Cl2	Fumigant insecticide (toxic)	Apiculture	provides protection against the wax moth
4	Galezon		Preservative	Apiculture	it destroys the wax moth
5	Galerin		Preservative	Apiculture	it destroys the wax moth
6	Glacial acetic acid	CH3COOH	Biocide (corrosive)	Apiculture	destroys both the wax moth and spores of *Nosema apis*
7	Formaldehyde	CH2O	Biocide (toxic)	Sericulture Cattle raising Sheep raising Pigs raising Poultry	for disinfection of rooms and equipment
8	Freshly ground lime suspension (calcium oxide)	CaO	Disinfectant	Sericulture Cattle raising Sheep raising Pigs raising Poultry	for disinfection of rooms and equipment
9	Caustic soda (sodium hydroxide)	NaOH	Cleaning agent (caustic)	Sericulture Aquaculture Heliciculture Cattle raising Sheep raising Pigs raising Poultry	for disinfection of rooms and equipment
10	Lime chloride	Ca(ClO)2	Disinfectant	Sericulture Cattle raising Sheep raising Pigs raising Fish-farming	for disinfection of rooms and equipment; in fish-farming it is given to destroy the low-value fish and to correct the pH of the soil
11	Chloramine	NH2Cl	Biocide (oxidant)	Sericulture	for disinfection of rooms and equipment
12	Cetrimonium bromide	C19H42BrN	Germicide, fungicide, disinfectant	Sericulture	for disinfection of rooms and equipment
13	Copper acetate sulphate	Cu(CH3COO)2	Antiseptic, disinfectant	Sericulture Cattle raising Sheep raising Pigs raising	for disinfection of rooms and equipment; treatment of pododermatitis (cattle raising);

No	Chemical substance	Chemical formula	Category to which the substance belongs	Agriculture sector in which the substance is used	Substance is used for
					treatment of necrobacillosis (pigs raising)
14	Slaked lime (calcium hydroxide)	Ca(OH)2	Disinfectant	Fish-farming	given to destroy the low-value fish and to correct the ph of the soil
15	Sodium chloride solution	NaCl	Disinfectant	Fish-farming Aquaculture	to remove parasites from fish; for disinfection of ponds
16	Superphosphate	P2O5	Synthetic phosphate (fertilizer)	Fish-farming	to enhance the development of natural food
17	Organic nitrogen fertilizers (type 12/12/123)	N	Organic nitrogen (fertilizer)	Heliciculture	fertilizer
18	Malathion	C10H19O6PS2	Insecticide, acaricide	Heliciculture	used to control pests
19	Lime powder		Disinfectant	Cattle raising Sheep raising Pigs raising Poultry	disinfection of rooms and equipment

14.8 Accidental exposures

Veterinary products: these may be drugs or animal feed additives. It is important to be aware of the toxic risk, to avoid self-administration or inadequate contact.

Snakes / insects toxins: can be accidentally transmitted to workers in agrophytotechnics and forestry or to beekeepers when some poisonous species sting or bite. In some geographic areas in Romania (south-west, Dobrogea, and Moldova) where viper lives, medical offices must be equipped with antitoxin.

14.9 Toxicity of plants

Certain plants may cause either chronic systemic toxicity through phytotherapy which is a traditional practice in the rural environment, or skin toxicity. Even if certain plants have therapeutic properties, nevertheless they can be toxic because of their active principles (e.g., alkaloids), impurities or contaminants (such as heavy metals), and they can contaminate harvests by themselves, as it happened in India and Afghanistan, resulting in veno-occlusive disease epidemics. (16).

Regarding marine environment, warm water and nitrogen favor blooms of marine algae including two groups, dinoflagellates and diatoms, that can release toxins. These harmful algal blooms previously called “red tides” can cause acute paralytic, diarrheic, and amnesic poisoning in humans. (6).

Certain plants used in horticulture such as Leander (*Nerium oleander*) or yew (*Taxus genus*) can be toxic by cardiac effects.

Main pathology in horticulture is represented by irritant or allergic dermatitis, in the following two clinical forms:

- Contact eczema in some tulip, narcissus and hyacinth cultivators during harvesting, sorting or packaging bulbs is called "tulip finger". Additional to contact eczema, saponosides in tulips bulb are responsible for the occurrence of conjunctivitis and bronchial asthma.
- Phytophototoxic contact dermatitis by simultaneous exposure to a plant containing photodynamic substances (furocumarin) and to solar radiation. Example: vegetables in the family *Umbelliferae* (carrots, celery, domestic parsnip, fennel, wild parsnip).

In the last few years, a significant risk in Romania has occurred due to increasing the incidence of ambrosia allergy (*Ambrosia artemisiifolia*) reported by family doctors and highlighted by the media channels. Ambrosia species have expanded into grain and sunflower crops, as well as abandoned agricultural land, being considered among invasive and dangerous species for the public health.

Prevention of these illnesses consists of protective clothing, changing to clean clothes and gloves when they become contaminated, and washing exposed areas of the skin before meals and at the end of the workday.

14.10 Contaminants of agricultural systems

Contaminants existing in the agricultural systems that are most commonly studied are pesticides and fertilizers (nitrogen, phosphorus), organic compounds (manure contaminated with pharmaceutical substances), degreasers, toxins, additives to animal feeds (trace elements Na, K, Cu, Zn), and heavy metals (mercury, arsenic, lead, cadmium). Recently, new contaminants have been considered such as pharmaceuticals, steroids, drug-resistant genes, prion proteins, but their environmental impact is yet unknown. (19). These chemical substances are generated by anthropic activities, from animals fed with processed food/hormones/drugs, from plant protection products, and from the cultivation of exotic/invasive species (genetically modified organisms) which destroy natural species and alter the balance of the ecosystem. The threat to human health is the growing concentration of such substances in the drinking water, wastewater and soil. According to the European Environment Agency, some of the highest pesticide loads on arable land are found in Southern France, parts of Spain and Portugal.

In Romania, the main source of drinking water in the rural environment is the drilled well. Given that agriculture is the largest consumer of organic waste, water in the wells that are not deep enough may be contaminated with nitrites and nitrates from fertilizers (nitrogen, manure, mud) or by elutriating septic tanks. Assessments conducted at national level have established that in Romania there are areas that are risk-free from this point of view (Maramures, Sibiu, Timis, Harghita), but also places where more than 75% of the wells have high concentrations of nitrates in the water (Dolj, Mehedinti, Botosani). (20).

The main symptom of nitrate intoxication is cyanosis, and when methemoglobinemia exceeds 80%, asphyxia and even death may occur. Children up to six months are more likely to develop poisoning ("blue baby" syndrome), compared with older children and adults, with the exception of pregnant women and people with glucose-6-phosphate dehydrogenase deficiency or methemoglobin reductase deficiency. (20). Wells-sourced drinking water must have the quality parameters required by the law (see Table 2), and must provide the necessary daily quantity. (20).

Tabel 14-2 List of minimum water quality parameters monitored by public health authorities

Chemical parameters	Accepted value	Microbiological parameters	Accepted value
pH	6.5 ≤ pH ≤ 9.5	Coliform bacteria	0 / 100 ml
Ammonium	0.50 mg / L	*Escherichia coli*	0 / 100 ml
Nitrites	0.50 mg / L	Enterococci	0 / 100 ml
Nitrates	50 mg / L		

Chlorides	250 mg / L		
Organic load CCO-Mn	5 mg O_2 / L		

To be finally used in agriculture, mud from urban waste water treatment must be analyzed by the Office of Pedological and Agrochemical Studies in order to comply with legal regulations regarding the environmental protection. (21).

The ecological reconstruction - restoration of natural biocoenosis - of land that has been seriously degraded or used for economic activities that were subsequently abandoned is a major element of environmental safety and plays a major role in ensuring the progress of society and in using the environmental factors that are favorable to biosphere, in all its diversity.

14.11 Conclusions & Recommendations

As exposure to chemical agents is the most significant risk factor and the most unpredictable with regard to the effects it may have on human life and health, several tools must be used in order to properly control it, respectively: monitoring of exposure, implementing safe and protective measures, ensuring the proper hygiene conditions, monitoring workers' health, and continuous updating of workers' information, skills, training and skills levels.

Chemical substances must be kept in their original containers, stored in ventilated rooms and handled by trained people. Safety Data Sheets (SDS) provide useful information on chemicals, describing the hazards the chemical presents, and giving information on handling, storage and emergency measures in case of an accident.

Raising the awareness of health and safety specialists in the agricultural sector is of great importance in preventing immediate or long-term effects due to harmful chemical agents. It is recommended to follow the European Policy for a sustainable use of pesticides (EU Directives and guidelines); the case studies of the AGRIPROTECT Project which advocates risk management in handling agro-pharmaceutical products (available on the EU-OSHA website, #pesticide); and the expert opinion on the herbicide Glyphosate.

The knowledge and ability of occupational physician to gain an accurate occupational history leads to accurate recognition, diagnosis, treatment, and prevention. Besides the usual procedures and investigations, health surveillance of workers who are exposed to chemical threats in agriculture must consider both biotoxicologic tests for each incriminated substance, and paraclinic tests and investigations.

The health professional should find out what pesticides are used in their community, on what crops, and how and when they are applied in order to assess health risk. Pyrethroids and neonicotinoids are much less toxic to humans, animals and the environment, while organophosphates and carbamates are hypothesized as having chronic toxicity.

Toxicology laboratories are available in the following public health institutions: National Institute of Public Health Bucharest, regional public health centers, public health directorates, and clinical departments. In case of a work-related accident (acute poisoning) forensic toxicology is helpful for a rational diagnostic strategy in relationship with Justice and lethal doses of toxicants.

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