

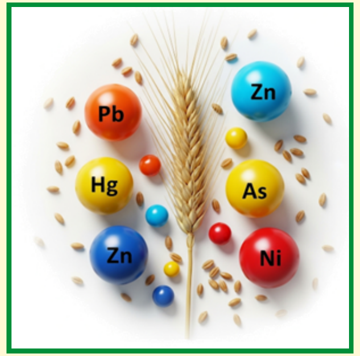


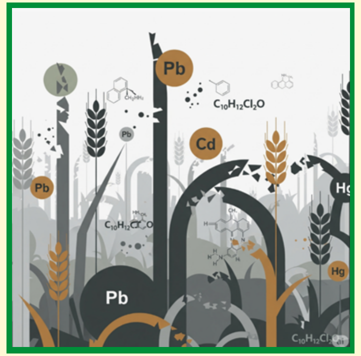

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GUIDE REGARDING THE MEASURES TO PREVENT AND REDUCE THE CONTAMINATION OF CEREALS AND RELATED PRODUCTS

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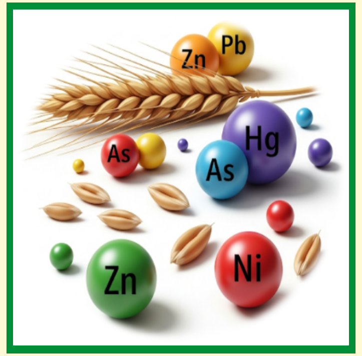

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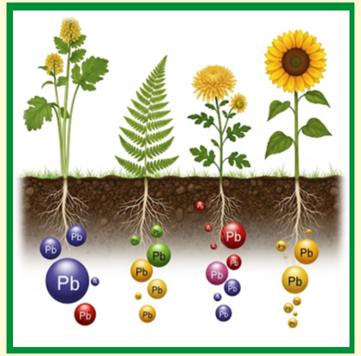


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GUIDE

REGARDING THE MEASURES TO PREVENT AND REDUCE THE CONTAMINATION OF CEREALS AND RELATED PRODUCTS

Material edited within the project

„ I eat to live or I live to eat - OPEN EAT"

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II. Avram, Dana
III. Arsene, Ioana-Adina

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Timişoara - Str. Maior Titus Mureșan
Nr. 8, Cam. 2, Tel.: 0744.515.656
e-mail: eurobit91@yahoo.com
www.edituraeurobit.ro

Project coordinator:

ROMPAN - THE ROMANIAN EMPLOYERS' ASSOCIATION OF THE MILLING, BAKERY AND FLOUR BASED PRODUCTS INDUSTRY

Ec. Aurel POPESCU - ROMPAN President

PhD. Eng. Daniela Victorita VOICA - Vicepresident - Guide Development Coordinator

Partners:

- **P1 - ANSES - AGENCE NATIONALE DE LA SECURITE SANITAIRE DE L'ALIMENTATION DE L'ENVIRONNEMENT ET DU TRAVAIL FRANCE**

  Prof. Benoît VALLET - General Manager

  Petru JITARU, PhD - Guide Development Coordinator

- **P2 - FINS - Institute of Food Technology UNIVERZITET U NOVOM SADU Serbia**

  Prof. Dejan MADIĆ, PhD - Rector

  Aleksandra TORBICA, PhD - Guide Development Coordinator

- **P3 - ULST - UNIVERSITY OF LIFE SCIENCES "KING MICHAEL I" Timisoara, Romania**

  Prof. Cosmin-Alin POPESCU - Rector

  Prof. Ersilia ALEXA - Guide Development Coordinator

- **P4 - UNIBA - UNIVERSITÀ DEGLI STUDI DI BARI ALDO MORO Italy**
  Prof. Roberto BELLOTTI - Rector
  Prof. Maria DE ANGELIS - Rector delegate
  Prof. Pasquale FILANNINO - Guide Development Coordinator

- **P5 - ICSANAAS - INSTITUTE OF CLIMATESMART AGRICULTURE OF THE NATIONAL ACADEMY OF AGRARIAN SCIENCES OF UKRAINE**
  Prof. acad. Dr. Sci. Rayisa VOZHEHOVA - Director
  Iryna ANTONIK, PhD - Guide Development Coordinator

The authors of the guide:

ROMPAN - THE ROMANIAN EMPLOYERS' ASSOCIATION OF THE MILLING, BAKERY AND FLOUR BASED PRODUCTS INDUSTRY

PhD. Eng. Daniela Victorița VOICA - Vice-president ROMPAN
Eng. Dana AVRAM
Eng. Ioana-Adina ARSENE

Partner 1 - **ANSES - AGENCE NATIONALE DE LA SECURITE SANITAIRE DE L'ALIMENTATION DE L'ENVIRONNEMENT ET DU TRAVAIL FRANCE**

PhD. Petru Jitaru
Rachida Chekri
PhD. Yassine Makni

Partner 2 - **FINS – Institute of Food Technology UNIVERZITET U NOVOM SADU Serbia**

PhD. Aleksandra Torbica - Principal Research Fellow
PhD. Bojana Filipčev - Principal Research Fellow
PhD. Olivera Šimurina - Principal Research Fellow

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Partner 3 - **ULST - UNIVERSITY OF LIFE SCIENCES "KING MICHAEL I" Timisoara, Romania**

Prof. Ersilia Alexa
Lecturer Delia Dumbrava
Lecturer Camelia Moldovan
As.Prof. Corina Misca
Prof. Diana Raba
Lecturer Mirela Popa

Partner 4 - **UNIBA - UNIVERSITÀ DEGLI STUDI DI BARI ALDO MORO**

Prof. Pasquale Filannino
Dr. Donato Gerin
Prof. Stefania Pollastro

Partner 5 - **Institute of climatesmart agriculture of the National Academy of Agrarian Sciences of Ukraine**

PhD. Iryna Antonik - Leading researcher fellow
PhD. Oleksandr Shablia - Senior researcher
PhD. Taras Zhygailo - Senior researcher
PhD. Nataliia Valentiuk - Senior research fellow
Dr.Sci. (Biol.) Natalia Volkova - Chief researcher fellow
Prof. Acad. of the NAAS Rayisa Vozhehova - Director

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GUIDE 1.

MEASURES TO PREVENT AND REDUCE CONTAMINATION OF CEREALS AND RELATED PRODUCTS

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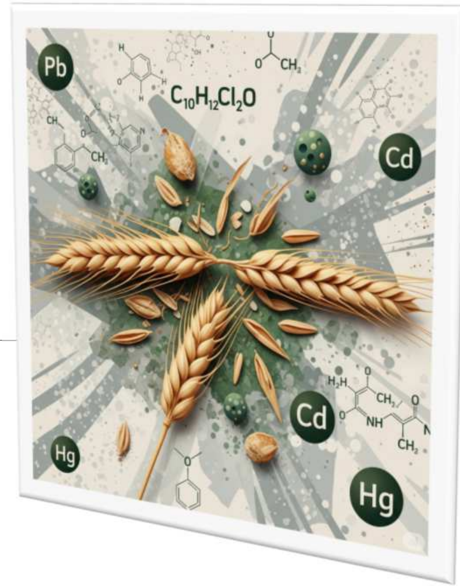
CHAPTER 1.

INTRODUCTION



1.1. Definition of contaminants

In toxicology, the term contaminant is defined as a substance with toxic potential which, following entry into the body – either in a relatively high dose (administered once or repeatedly at short intervals) or in small doses (but administered repeatedly over a long period) – induces, immediately or after a certain latency period, transient or persistent alterations in one or more physiological functions of the body, which can ultimately lead to death.

In ecological systems, contaminants are defined as toxic agents, of a chemical or biological nature, present in the environment. These constituents have the ability to induce adverse effects at the level of ecosystems and material property, and may also diminish the benefits derived from ecosystem services or obstruct the legitimate uses of biological systems. From a terminological point of view, contamination is considered synonymous with pollution and environmental alteration.

1.2. Classification of contaminants

The human being has always been exposed to the action of chemical compounds, either those naturally present in the environment or those introduced with industrial development. In addition to these, military activities can also release a wide range of contaminants into the environment, affecting the soil and, implicitly, agricultural crops.

The classification of contaminants is carried out according to the following criteria:

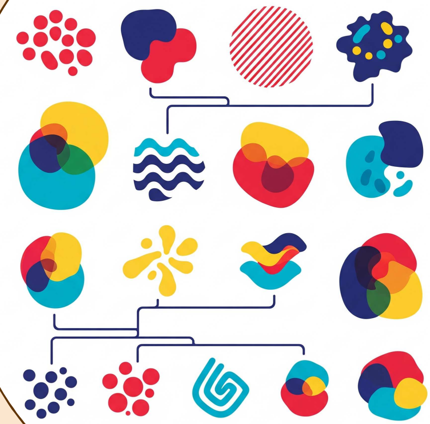
- **by origin:** minerals, plants, animals, synthetics;

- **by chemical composition:** organic and inorganic, acids, bases, oxidizing substances;

- **by the state of aggregation:** gaseous, liquid, solid;

- **according to the pathophysiological behavior:** with action on the central nervous system, the vegetative nervous system, the respiratory system, the cardiovascular system, the blood, etc.

- **by origin:** medicines, industrial toxins, toxic plants, pesticides, etc.



1.3. Types of contaminants specific to cereals and related products

Contamination of cereals and related products is a major concern for global food security. It can occur at various stages, from cultivation and harvesting, to transportation, storage, and processing. The war in Ukraine, a key player in the global grain market, has exacerbated certain risks and introduced new types of contamination, having a profound impact on supply chains and product quality.

These contaminants can be broadly classified as:

I. Chemical contaminants:

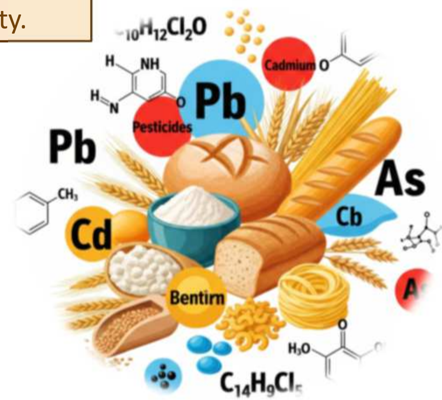
- pesticides and pesticide residues,

- heavy metals,

- persistent organic contaminants (dioxins, furans, polychlorinated biphenyls),

- veterinary and drug contaminants,

- migratory chemicals in packaging/storage materials



1.3. Types of contaminants specific to cereals and related products

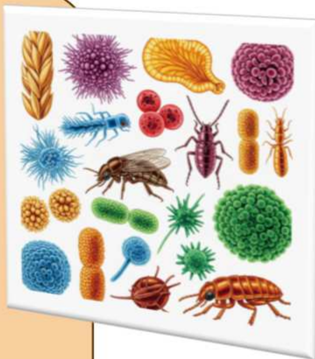
II. Biological contaminants:

- mycotoxin,
- pathogenic bacteria,
- viruses and parasites,

-pests (insects and rodents).

III. Physical contaminants:

- fragments of glass, metal, plastic, stone,
- hair, fibers, clothing components,
- earth, sand, dust, dead insects/rodents



IV. Radiological contaminants: e.g. cesium-137, strontium-90.

V. Contaminants specific to armed conflicts (Amplification of existing risks and introduction of new types):

- explosives residues,
- contamination with fuels and lubricants,
- war waste

1.4. Toxic doses. Lethal doses. Maximum permissible concentrations

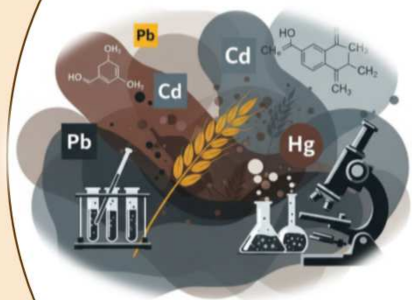
The toxic action of various contaminants is quantified by means of specific quantities of the substance, called doses, which, once introduced into the biological system, generate a series of adverse effects.

Dose is defined as that amount of exogenous substance which, when administered to a living organism, induces a specific and reproducible biological effect. The expression of this amount may vary depending on the methodological context and the purpose of the assessment, including, but not limited to, the reference to individual body mass (dose/kg body weight) or total body mass (dose per overall body mass), among other relevant units of measurement.

Toxic dose is defined as the amount of substance capable of inducing harmful effects on an organism.

The primary assessment of the toxicity of contaminants is mainly carried out by determining the lethal dose (LD). It quantifies the acute toxicity of a substance after entering the body.

The determination of LD is performed experimentally and is expressed in milligrams per kilogram body weight (mg/kg body). The scoring is done by DL followed by a numerical index (from 1 to 100), which indicates the percentage of mortality of the tested population in a specified time interval



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1.4. Toxic doses. Lethal doses. Maximum permissible concentrations

The main categories of DL are the following:

LD5 (DLM) – minimum lethal dose

LD50 – the average lethal dose that causes the death of 50% of experimental animals.

(LD75) – fatal dose;

(LD100) – absolute lethal dose

DL 50 is the most common term according to which the toxicity of a substance is assessed

1.4. Toxic doses. Lethal doses. Maximum permissible concentrations

In relation to the degree of toxicity, expressed by LD50 (mg/kg), orally, in rats, toxic substances are classified into:

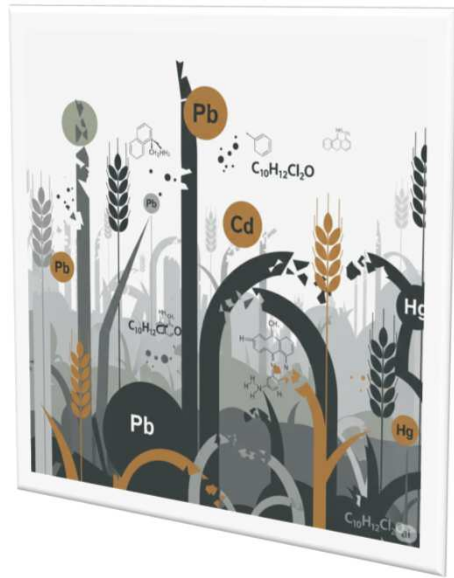
group I – highly toxic (LD50 less than 1 mg/kg) – alkaloids;

group II – very toxic (LD50 1-50 mg/kg) – organophosphate, organomercuric;

group II – toxic (LD50 50-500 mg/kg) heavy metals;

group III – moderately toxic (LD50 500-5000 mg/kg) food additives;

group IV – non-toxic (LD 50 over 5000 mg/kg) compounds of plant origin



1.4. Toxic doses. Lethal doses. Maximum permissible concentrations

For the purpose of assessing the toxicity of contaminants, the following terms have been established:

- **the dose without effect**, i.e. the amount of substance (mg/kg animal body) which, administered in food continuously, for at least two years and absorbed by experimental animals (at least two species) does not produce any harmful effects;

- **the acceptable daily intake** for the human species (ADI) is the amount of the substance absorbed daily throughout life and which does not pose any foreseeable risk, based on all known toxicological data (the ADI is calculated as 1/100 of the no-effect dose and is expressed in mg/kg body weight);

- **the acceptable daily dose** for the individual is given by the ADI x the individual weight;

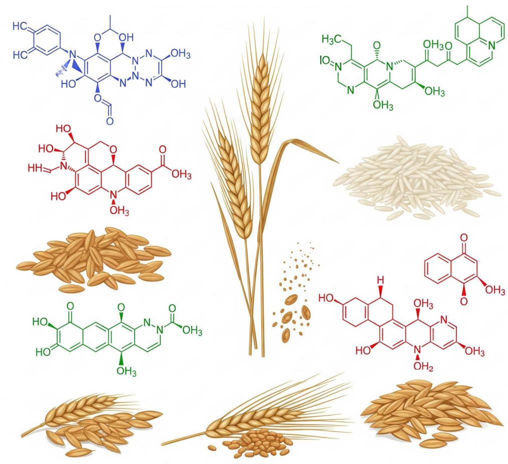
- **acceptable or tolerable residues**, represents the amount of toxic substance (including its stable metabolites) in a food product and which can be ingested with it daily, throughout life, without danger, represents the ADI x body weight in kg / food consumed in kg;

- **the practical residue limit**, represents the maximum level of residues authorized in a certain food product (the maximum limit is established depending on the ADI, the amount ingested and the importance of the food);

- **the maximum permissible limit** (MAL) is objectively established on the basis of toxicological data, but in practice it is also taken into account considerations regarding the sensitivity of the analytical means available to ensure the effectiveness of the control

1.5. Primary contaminants: pesticides, nitrogen compounds and heavy metals

Cereals, as staple foods of global importance, are intrinsically vulnerable to various sources of contamination, which generates substantial risks to human health. In this context, pesticides, nitrogen compounds and heavy metals are primary contaminants of major concern, given their extensive use, persistence in the environment and potential adverse health effects.



Pesticides

Pesticides, chemical agents used in the management of agricultural pests and disease vectors, are indispensable for ensuring global food security. However, the presence of pesticide residues in cereals is a major concern, posing a significant threat to public health.

1.5. Primary contaminants: pesticides, nitrogen compounds and heavy metals

Classification of pesticides according to the type of organism combated

Herbicides: These are pesticides used to control weeds (unwanted plants) that compete with plants grown for resources. They are among the most widely used pesticides.

Insecticides: They are intended to combat harmful insects that attack plants, food stores or transmit diseases.

Fungicides: These are used to prevent and control diseases caused by fungi (fungi) in plants.

Acaricides: They specialize in combating mites, small spider-like organisms that can damage crops.

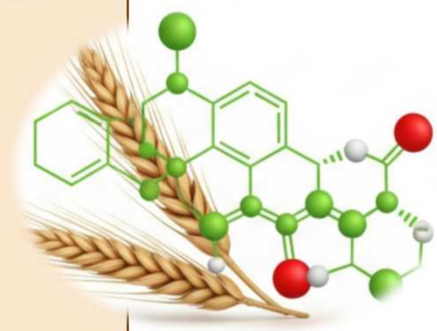
Nematocidae: Targets nematodes, microscopic worms that live in the soil and can affect plant roots.

Rodenticides: They are used to control rodents (mice, rats) that can destroy crops or deposits.

Mollusks: Fights mollusks, such as snails and slugs, that can harm plants.

Bactericides: These are used to combat pathogenic bacteria that cause disease in plants.

Virulicides (or virulostats): They are intended for the control of viruses that affect plants.



1.5. Primary contaminants: pesticides, nitrogen compounds and heavy metals

Sources of pesticide contamination:

Agriculture is the predominant economic sector in which chlorinated pesticides have been used, the residual effects of which persist to this day. The impact of the use of these pesticides in an agricultural context on water resources manifests itself in the form of diffuse pollution, the concentrations of which are currently monitored in both groundwater and surface water.

Emissions of Persistent Organic Pollutants (POPs), generated by activities in the agricultural sector and released into the atmosphere, come from stationary sources – including the direct application of pesticides on the soil and combustion processes – as well as from mobile sources, mainly associated with motorized agricultural equipment (e.g. tractors) and other means of road transport

1.5. Primary contaminants: pesticides, nitrogen compounds and heavy metals

Effects of pesticides on soil

The responsible management of pesticides and the adoption of ecological alternatives become imperative for maintaining soil health and sustainability due to the serious ecological consequences of intensive use in agriculture:

- it affects the soil by altering the microbiome;
- it affects the biogeochemical cycles of nutrients;
- It can compromise soil fertility in the long term, including by changing substrate availability and physicochemical conditions.

1.5. Primary contaminants: pesticides, nitrogen compounds and heavy metals

Nitrogen compounds

Nitrogen compounds as primary contaminants are nitrogen-containing chemicals that are released directly into the environment (atmosphere, hydrosphere or lithosphere) from anthropogenic or natural sources, exceeding the assimilation capacity of ecosystems and causing harmful effects. They are "primary" because they are emitted in their polluting form, unlike "secondary contaminants" that are formed by chemical reactions in the environment from precursors.

Nitrogen fertilizers are substances, usually of chemical or organic origin, that are added to the soil to provide plants with nitrogen, an essential nutrient for their growth and development.

1.5. Primary contaminants: pesticides, nitrogen compounds and heavy metals

Classification

Nitrogen compounds can be classified according to the environment in which they predominantly act and their chemical form:

1. Nitrogen compounds in the atmosphere (air pollutants):

- nitrogen oxides (NO_x):

nitrogen monoxide (NO): colorless and odorless gas, formed at high temperatures in combustion processes.

nitrogen dioxide (NO_2): reddish-brown gas, with a pungent odor, formed by the oxidation of NO in the atmosphere. It is responsible for the color of smog and is irritating to the respiratory system.

- ammonia (NH_3): colorless, strong-smelling, pungent gas. It is an alkaline gas that can react with other air pollutants to form fine particles.

2. Nitrogen compounds in water (water pollutants):

- nitrates (NO_3^-): stable ions, highly soluble in water. They are the main form of nitrogen that causes eutrophication and are a major concern for drinking water quality.

- ammonium (NH_4^+) / ammonia (dissolved NH_3): ammonium is the ionized form, predominant in waters with neutral or acidic pH, while molecular ammonia is more toxic and prevalent at high pHs.

- nitrites (NO_2^-): ions intermediate in the nitrogen cycle, unstable in the presence of oxygen, but can be toxic in high concentrations.

- organic nitrogen (organic N): nitrogen compounds incorporated into dissolved or particulate organic matter; it is released by the decomposition of organic matter.

3. Nitrogen compounds in soil (soil pollutants):

- nitrates (NO_3^-): they are highly mobile in the soil and can be washed (leached) into groundwater or surface water; Excess can lead to losses of nutrients from the soil.

- ammonium (NH_4^+): binds to soil particles, but can be converted by nitrification into nitrates.

- organic nitrogen: excessive amounts of organic nitrogen from certain sources (e.g. sewage sludge, manure) can lead to accumulations or the release of other pollutants.

1.5. Primary contaminants: pesticides, nitrogen compounds and heavy metals

Sources of pollution

1. Anthropogenic sources (the main sources of pollution):

Agriculture: one of the most significant sources of nitrogen pollution.

Excessive use of nitrogen fertilisers: nitrates and ammonia in fertilisers (synthetic or organic, e.g. manure) can wash away in water or volatilise into the atmosphere.

Manure: Large livestock farms produce considerable amounts of nitrogen-rich manure, which can contaminate soil and water.

Burning fossil fuels

Transport: NO_x emissions from the engines of cars, planes, ships (combustion of gasoline, diesel).

Energy industry: coal, natural gas, oil thermal power plants, which release NO_x by burning at high temperatures.

Manufacturing: industrial processes involving the combustion of fuels or chemical reactions at high temperatures.

Wastewater treatment

Domestic and industrial wastewater contains significant amounts of organic nitrogen, ammonium, nitrites and nitrates, which, if not properly treated, are discharged into water bodies.

Sewage sludge: can be used as fertilizer, but can also contain large amounts of nitrogen.

Solid waste: landfills can release ammonia and other forms of nitrogen by breaking down organic matter.

Industrial Processes: The production of nitric acid, fertilizers, explosives, and other chemicals can release nitrogen compounds into the atmosphere or liquid effluents.

2. Natural sources

Electrical discharges (lightning): they can form small amounts of nitrogen oxides in the atmosphere.

Volcanic eruptions: they can emit nitrogen gases.

Natural forest fires: releases NO_x and ammonia.

Decomposition of organic matter in soil and water: natural biological processes (nitrification, denitrification) can release nitrogen compounds, but on a slower and more controlled scale than anthropogenic sources, without normally exceeding the assimilation capacity of the ecosystem.

Microbial activity in the soil: Certain bacteria in the soil can produce N_2O (nitrogen oxide, a powerful greenhouse gas).

1.5. Primary contaminants: pesticides, nitrogen compounds and heavy metals

Effects of excessive use of nitrogen fertilizers on soil and water

Although fundamental to agriculture, the excessive use of nitrogen fertilizers in modern agriculture has profound ecological consequences on soil health and functionality:

significantly alters microbial communities in the soil, inhibiting nitrogen-fixing bacteria and favoring other microbial groups;

accelerates the decomposition of organic matter and humus, crucial elements for soil fertility and structure;

causes nutritional imbalances, affecting the assimilation of other essential elements by plants

causes acidification of the soil, degrading its physicochemical properties; the decline of organic matter and pH changes directly influence soil aggregation, resulting in a more fragile structure, poor aeration and increased susceptibility to erosion.

1.5. Primary contaminants: pesticides, nitrogen compounds and heavy metals

Effects of excessive use of nitrogen fertilizers on soil and water

The excessive use or poor management of fertilizers also generates severe effects on water quality and aquatic environments. In this context, the implementation of sustainable agricultural practices becomes imperative to mitigate this negative impact. Fertilizers are a major source of pollution of water bodies, by leaching nutrients from the soil. Nitrogen and phosphorus, essential for plant growth, become pollutants in excessive concentrations. Rainfall and irrigation facilitate the transfer of these nutrients from agricultural areas to aquatic ecosystems.

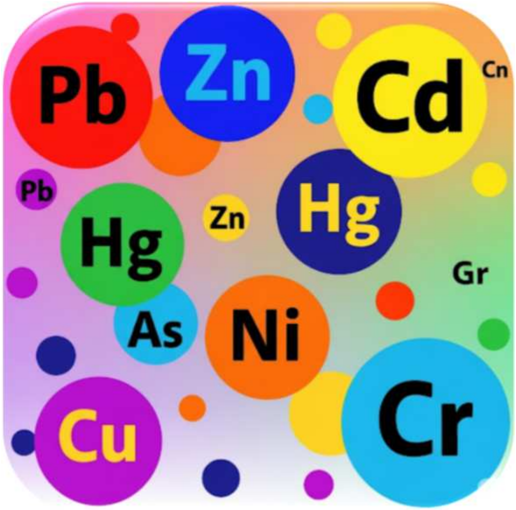
This nutritional overload leads to eutrophication, a phenomenon characterized by massive algal proliferation, which by decomposition depletes the oxygen dissolved in the water, generating hypoxic or anoxic zones (known as "dead zones") incompatible with supporting aquatic life.

Nitrates from fertilizers can contaminate groundwater supplies, a crucial resource for human consumption, posing significant health risks. Alterations in water quality parameters, such as pH fluctuations and oxygen depletion, destabilise the fragile balance of aquatic ecosystems, negatively impacting biodiversity.

1.5. Primary contaminants: pesticides, nitrogen compounds and heavy metals

Heavy metals

Heavy metals are a group of relatively high-density metal elements that are of major interest in toxicology and ecology due to their potential to be toxic and accumulate in the environment and living organisms. From a toxicological point of view, any metal that exhibits toxicity at low concentrations can be considered "heavy" in the given context. Many heavy metals are toxic to plants, animals and humans, and can cause various ailments and dysfunctions. This toxicity can occur even at very low concentrations, as they tend to bioaccumulate (accumulate in the tissues of organisms) and biomagnify (concentrations increase along the food chain).



1.5. Primary contaminants: pesticides, nitrogen compounds and heavy metals

Classification

The classification of "heavy" metals is most often done either on the basis of their density or on the basis of their biological impact (essential vs. toxic).

1. By density: non-ferrous metals with a density greater than 5 kg/dm³ (e.g. Pb, Hg, Cd, As - although arsenic is a metalloid, it is often included due to its toxicity).

2. By toxicity and biological role:

Essential metals (trace elements): These are necessary for the normal functioning of the body in small quantities. However, in excess, they can become toxic (e.g.: Cu, Fe, Zn, Mn, Ni, Co, Cr - in certain forms).

Toxic metals (with no known biological role): They have no beneficial role in the body and are dangerous even in small quantities (e.g.: Pb, Hg, Cd, As, Tl).

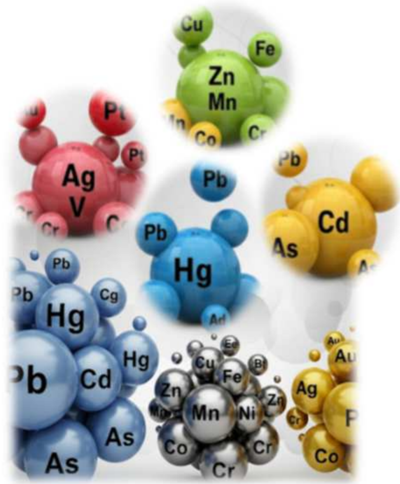
Metals of variable toxicity: Some metals, such as aluminum (Al), can be toxic in certain forms or at high concentrations, although they are not always strictly classified as "heavy metals" in the sense of density.

3. By their usefulness (in an industrial context):

Metals for the manufacture of machinery and plants: copper, tin (tin), zinc, nickel, lead and their alloys.

Metals used in alloys: chromium, vanadium, cobalt.

Precious (noble) metals: gold, silver, platinum (some of these can be considered "heavy" by density, but are distinguished by their value and chemical stability).



1.5. Primary contaminants: pesticides, nitrogen compounds and heavy metals

Sources of pollution

1. Industrial sources:

Mining and metallurgical industry: The extraction, processing and smelting of metals can release significant amounts of heavy metals into the air, water and soil (e.g. lead, cadmium, copper, zinc).

Burning fossil fuels: Power plants that burn coal or oil can release Hg, As, and other heavy metals into the atmosphere.

Cement production: heavy metals can be released.

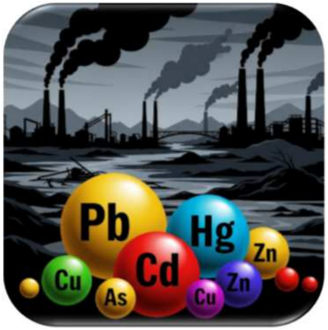
Chemical industry: the manufacture of paints, pigments, batteries, pesticides, and other chemicals uses and releases heavy metals.

Waste gas treatment plants: the waste resulting from these processes may contain heavy metals.

2. Agricultural activities:

Use of pesticides and fertilizers: some pesticides and fertilizers may contain heavy metals (e.g., Cd, As), which accumulate in the soil and can end up in crops and waters.

Irrigation with polluted water: the use of water contaminated with heavy metals for irrigation leads to their accumulation in the soil and plants.



1.5. Primary contaminants: pesticides, nitrogen compounds and heavy metals

Sources of pollution

3. Landfilling and waste management:

Landfills: Industrial and municipal waste, especially electronic waste (e-waste) or batteries, contain heavy metals that can seep into soil and groundwater.

Waste incineration: Burning waste can release heavy metals into the atmosphere.

4. Car traffic:

Emissions from cars: leaded gasoline was a major source of lead pollution; Wear and tear on tires and brake pads can release heavy metals.

5. Consumer and household products:

Batteries often contain lead, cadmium, and mercury.

Old lead-based paints, used in the past, are a source of exposure, especially in old buildings.

Cosmetics and personal hygiene products: Some products may contain traces of heavy metals.

Medications and supplements: Certain medications or herbal supplements can be contaminated.

Food containers: Some containers or packaging may contain heavy metals that migrate into food.

6. Natural Sources:

Volcanic eruptions: Volcanoes release heavy metals into the atmosphere.

Natural rock weathering: Rock erosion can release heavy metals into the soil and water.

1.5. Primary contaminants: pesticides, nitrogen compounds and heavy metals

Sources of pollution

7. Armed conflicts:

Ammunition and explosives:

Lead (Pb): Bullets often contain lead, which, once released into soil and water, can become reactive and toxic.

Depleted uranium: certain types of munitions (armor-piercing projectiles) use depleted uranium, which, on impact, fragments and releases radioactive particles and heavy metals into the environment.

Other metals: explosives and ammunition fragments may also contain other heavy metals such as chromium (Cr), arsenic (As), mercury (Hg), nickel (Ni), zinc (Zn), and cadmium (Cd), which disperse in soil and water.

Destroyed military equipment: destroyed tanks, armored vehicles, aircraft, and other military equipment contain a variety of heavy metals and other toxic substances that are released into the environment as they degrade.

Destruction of industrial infrastructure: the bombing or destruction of factories, chemical plants, industrial waste landfills or other industrial facilities can directly release large stocks of heavy metals and other hazardous substances into the environment.

Fires: caused by military actions (e.g. forest fires, fires at fuel depots) release fine particles and pollutants, including heavy metals, into the atmosphere, which can later be deposited on the ground and in water.

Soil and water contamination: mined territories, remnants of explosives and petroleum products, as well as substances released during shelling, all cause long-term soil degradation. Heavy metals seep into the soil, contaminating agricultural crops and reaching groundwater and surface water.

Military and medical waste: conflicts generate considerable amounts of military and medical waste, many of them toxic (e.g. medical waste, asbestos construction debris, PCBs, heavy metals), which require special management and, if disposed of improperly, contribute to pollution.

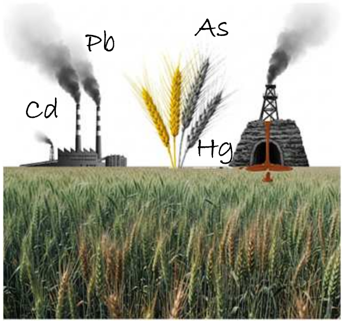
1.5. Primary contaminants: pesticides, nitrogen compounds and heavy metals

Effects of heavy metals on soil and water

Soil and water pollution with heavy metals is a major global problem, with serious effects on ecosystems and human health. Although elements such as lead (Pb), cadmium (Cd), mercury (Hg), arsenic (As) and chromium (Cr) occur naturally in the earth's crust, human activities have greatly increased their concentrations in the environment. Among the main causes are rapid industrialization, mining, intensive agriculture (with fertilizers and pesticides), poor waste management and emissions from transport. Once in the soil, heavy metals can be immobilized by adsorption to clay and organic matter particles, or they can remain mobile, being taken up by plants. The impact on plants is varied and includes:

- growth inhibition,
- reduction of photosynthesis,
- damage to cell membranes and accumulation in tissues, which can lead to severe toxicity and even plant death.

The consumption of plants contaminated with heavy metals by animals and humans is an important route of transfer of these pollutants in the food chain, with negative effects on health. For example, lead can affect the nervous system, cadmium is associated with kidney and bone disease, and mercury can cause neurological disorders.



1.5. Primary contaminants: pesticides, nitrogen compounds and heavy metals

Effects of heavy metals on soil and water

Heavy metals can enter water sources (rivers, lakes, groundwater) through surface runoff, washing from contaminated soils and direct industrial discharges. Once in the water, they persist for a long time, accumulating in sediments and aquatic organisms. The process of biopeating, i.e. the mixing of sediment by aquatic organisms, can redistribute heavy metals back into the water, increasing exposure. The toxicity of these metals in water is influenced by the type of metal, its chemical form and the characteristics of the water (pH, hardness and organic matter). Aquatic organisms, especially fish and invertebrates, accumulate heavy metals in their tissues (bioaccumulation). These concentrations increase along the food chain, which means that top predators can have much higher concentrations. This phenomenon increases the risk to human health if contaminated fish is consumed.

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CHAPTER 2.

LEGISLATION AT NATIONAL AND EUROPEAN LEVEL ON MEASURES TO REDUCE CONTAMINATION OF CEREALS AND RELATED PRODUCTS

2.1. Argument

♦ Legislation plays a crucial role in reducing grain contamination, as it sets clear standards and maximum permissible limits for various contaminants, from mycotoxins to pesticide residues.

♦ By imposing strict rules on good agricultural practices, hygiene and monitoring, the legislation ensures a safe food chain from producer to consumer.

♦ Without these regulations, the risk of contaminated grains reaching the market would increase significantly, endangering public health and affecting trust in food.

2.2. National and European Legislation to Reduce Grain Contamination

◊ Food safety is a key priority, and cereals and related products are a fundamental component of the human diet.
◊ That is why there is a complex legislative framework, both at national and European level, designed to reduce and control the contamination of these products.
◊ The main purpose is to protect the health of consumers.

European framework: a unified approach

At the level of the European Union, the legislation in the field is extensive and harmonized, ensuring a high standard of safety in all member states. This includes a number of regulations and directives addressing various types of contaminants, such as mycotoxins (toxins produced by moulds), pesticide residues, heavy metals, nitrates and genetically modified organisms (GMOs).

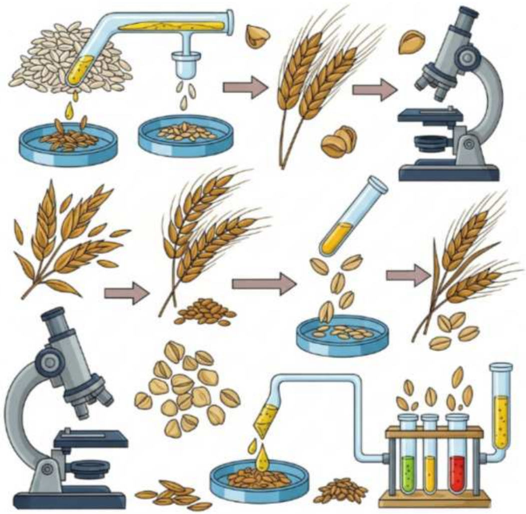
2.2. National and European Legislation to Reduce Grain Contamination

- European legislation sets maximum permissible limits for these contaminants, requiring strict monitoring and regular controls throughout the production chain, from farm to plate.

- By Regulation (EC) no. 178/2002, the principle of traceability is established, allowing the rapid identification of the source of any contamination.

- Also, Regulation (EC) no. Regulation (EC) No 1881/2006 is a key example, as it defines maximum limits for certain contaminants in foodstuffs, including cereals.

2.3. National Legislation: Adaptation and Implementation



□ Each EU member state, including Romania, transposes and details European legislation into its own national normative acts. This means that, in addition to the directly applicable European regulations, there are also specific laws and orders that adapt the requirements to the national context.

□ National authorities, such as the National Sanitary Veterinary and Food Safety Authority (ANSVSA) in Romania, are responsible for implementing and enforcing these rules. They carry out inspections, take samples and carry out analyses to ensure that cereals and derived products comply with safety standards.

2.3. Key Measures to Reduce Contamination

The legislation requires a series of preventive and control measures:

Good Agricultural Practices (GAP): Growers are obliged to apply practices that minimize the risk of contamination from the production phase (e.g. crop rotation, moisture management, responsible use of pesticides).

Good Hygiene Practices (GHP): During storage, transport and processing, strict hygiene conditions are imposed to prevent the development of mould and other contaminants.

2.3. Key Measures to Reduce Contamination

- Food Safety Management Systems: Food industry operators must implement systems based on HACCP (Hazard Analysis and Critical Control Points) principles to identify, assess and control risks.
- Monitoring and Testing: Regular analyses of cereals and related products are carried out to verify compliance with the maximum permissible limits of contaminants.
- Product Recalls: If limits are exceeded or a risk is identified, the legislation requires the immediate withdrawal of products from the market to protect consumers.

2.4. Initiatives and analyses against the backdrop of the Ukrainian conflict

The current conflict in Ukraine has generated dysfunctions in global trade in agricultural products and induced significant vulnerabilities in food supply chains.

Although the fundamental regulatory framework of the European Union (EU) on food safety, transposed into import regulations, remains valid for all products placed on the EU market, the supranational entity was forced to implement specific protocols and manage complex challenges generated by grain flows of Ukrainian origin, namely: "**Solidarity Corridors**" and **Autonomous Trade Measures** (CSFs)

In response to the escalation of the Russian invasion, the EU has operationalised "solidarity corridors", facilitating the export of Ukrainian agricultural products via alternative land and river routes. Complementary to these logistical measures, Autonomous Trade Measures (MCAs) have been established. They involve the unilateral suspension of customs tariffs and quotas for agricultural products imported from Ukraine. The primary objectives of these interventions are to support Ukraine's economic resilience and contribute to global food security, by ensuring the continuity of essential product flows on international markets (Source: European Commission; CSIS analysis – Center for Strategic and International Studies).

2.4. Initiatives and analyses against the backdrop of the Ukrainian conflict

- **Concerns about market disruption and unilateral bans**

The significant influx of grain from Ukraine, which is essential to sustain the country's economy, has caused considerable disruption to agricultural markets in neighbouring EU Member States, including Poland, Hungary, Slovakia, Bulgaria and Romania.
Farmers in these nations have expressed their protest, citing unfair competition and, in certain situations, concerns about quality standards, such as the use of pesticides banned on EU territory. In response to these tensions, some Member States have imposed unilateral import bans. The European Commission initially criticised these measures, considering them a violation of the EU's competence in the field of the common commercial policy (Sources: CSIS reports, Hungary Today).

- **Exceptional and temporary preventive measures**

To manage the tensions generated and facilitate a compromise solution, the European Union implemented "exceptional and temporary preventive measures" in May 2023. They imposed a restrictive ban on the domestic trade of certain Ukrainian agricultural products – wheat, maize, rapeseed and sunflower seeds – on the territory of the 'five frontline Member States'.

2.4. Initiatives and analyses against the backdrop of the Ukrainian conflict

- **Assessment of Ukraine's food security as a candidate country**

In the context of its status as a candidate country for the European Union, the European Commission has carried out a detailed assessment of Ukraine's readiness to fulfil the acquis communitaire in various sectors, including food safety. Reports indicate that Ukraine has a certain level of preparedness in terms of consumer and health protection, having a public health law partially aligned with that of the EU. However, the assessment also highlights areas that need to be strengthened, such as:

♦ administrative capacities of food safety institutions

♦ coordination and full alignment of the official food and feed control system with EU standards.

Ukrainian laboratories are generally well-equipped and accredited, but capacity could be increased. Ukraine is active in the Food and Feed Rapid Alert System (SARAF) network, but is not a member (Sources: European Commission assessments, reported by institutions such as UGA.ua).

2.4. Initiatives and analyses against the backdrop of the Ukrainian conflict

● The European Union's legislative framework on grain contaminants is rigorous and applies universally to all imports, including those from Ukraine. The armed conflict has significantly altered trade dynamics and required the adoption of temporary measures to manage Ukrainian agricultural product flows. These interventions have been complementary to ongoing efforts to support Ukraine in aligning its food safety systems with European standards.

Regardless of the geopolitical context, the fundamental principles of food safety, including compliance with maximum permissible levels for contaminants, remain of paramount importance.

2.5. Legislative regulations on the import of cereals into the European Union and Romania

- Regulations at the European Union level:

The European and national legislation regarding cereal imports into the European Union and, implicitly, into Romania, is complex and encompasses a wide spectrum of regulations, targeting both food and phytosanitary safety, as well as customs and market aspects.

EU legislation is the foundation for grain imports from non-EU countries. The main regulated areas are:

1. Food and Phytosanitary Safety:

● **Regulation (EU) 2017/625** on official controls carried out by the competent authorities of the Member States to verify compliance with EU food and feed legislation. Imported cereals must comply with EU food safety standards, including maximum residue limits of pesticides, mycotoxins (e.g. aflatoxins, ochratoxin), heavy metals and other contaminants.

● **Regulation (EU) 2016/2031** on protective measures against plant pests regulates phytosanitary requirements for the import of plants, plant products and other objects, including cereals, in order to prevent the introduction and spread of pests into the EU. Imported cereals may require phytosanitary certificates from the country of origin.

● **Specific rules for specific products or origins:** There are specific regulations for certain cereals or from certain third countries, which may require enhanced border controls (e.g. for certain mycotoxins).

Co-funded by the European Union

2.5. Legislative regulations on the import of cereals into the European Union and Romania

- Regulations at the European Union Level

2. Common organisation of the markets in agricultural products (CMO):
Regulation (EU) No 1308/2013 establishes a common organisation of the markets in agricultural products, including cereals. It includes provisions on:

- **Import tariffs:** The EU applies customs duties on the import of cereals from third countries, which can vary depending on the type of cereal and the EU's trade agreements with that country (e.g. tariff quotas, tariff exemptions for certain countries). The EU TARIC database provides detailed information on the applicable tariffs.
- **Tariff rate quotas:** The EU can open tariff quotas (limited quantities of products that can be imported at reduced or zero tariffs) for certain types of cereals from third countries.
- **Import/export licences:** For certain categories of cereals or in certain circumstances, import or export licences, governed by Implementing Regulation (EU) 2016/1239, may be required.

2.5. Legislative regulations on the import of cereals into the European Union and Romania

- European Union (EU) Regulations

3. Union Customs Rules:

● **The Union Customs Code (Regulation (EU) No 952/2013) lays** down the general rules and procedures for customs clearance of goods upon entry into the EU, including customs declarations, determination of customs value, origin of goods and customs status.

● **VAT on the amount**

For products imported from non-EU countries, VAT is generally due at customs. However, there are also VAT deferral mechanisms for economic operators holding specific certificates (reverse charge).

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2.5. Legislative regulations on the import of cereals into the European Union and Romania

- National Regulations in Romania

1. Emergency Ordinance no. 84/2023 (and possible extensions/subsequent amendments) on the establishment of measures to regulate imports of agricultural products from Ukraine or the Republic of Moldova: It imposed, for example, that imports of wheat, corn, rapeseed and sunflower from these countries can only be carried out on the basis of an import authorization by economic operators in Romania. This measure was introduced to protect the internal market and ensure national food security in the context of the war in Ukraine. (Note: This Ukraine-specific regulation is temporary and may be amended or extended.)

2. Normative acts on food safety and sanitary-veterinary control:

● **Rules for the safety of food of non-animal origin:** There are orders of the National Sanitary Veterinary and Food Safety Authority (ANSVSA), such as the Rule of July 18, 2022 (Order no. 120/4.724/2022), which establishes the conditions for carrying out import operations for food products of non-animal origin (including cereals). They detail the official control procedures at border inspection points (BIPs) and the requirements for the health certificate issued by the exporting country.

● **Border Inspection Points (BIPs):** Imports of cereals from third countries must pass through designated FIPs, where physical, documentary and identity checks are carried out.

Co-funded by the European Union

2.5. Legislative regulations on the import of cereals into the European Union and Romania

- National Regulations in Romania

3. Legislation on the quality and marketing of agricultural products

● **Romanian Standards (SR) and ISO:** The National Institute for Standardization (ASRO) develops national standards (e.g. SR EN 15587:2019 for the determination of impurities in cereals), which may be relevant for the quality of imported cereals. Although they are not mandatory in themselves unless they are referred to in a legal regulation, they define good practices and can be used in commercial contracts.

● **Law no. 321/2009** on the marketing of food products, with subsequent amendments, which regulates general aspects of food trade, including imports.

4. Normative acts on food safety and sanitary-veterinary control

Emergency Ordinance 43/2007 on the deliberate release into the environment of genetically modified organisms, which regulates the import and use of GMO cereals.

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2.5. Legislative regulations on the import of cereals into the European Union and Romania

- General Process of Importing Cereals from Third Countries (Non-EU) into Romania

1. Compliance with EU requirements: The economic operator must ensure that the cereals comply with all EU food safety, phytosanitary and quality standards.

2. Documentatio. The following documents are required:

- ● Commercial invoice
- ● Packing list
- ● Certificate of origin
- ● Phytosanitary certificate (if applicable) issued by the competent authority of the exporting country.
- ● Health certificate/analysis, attesting to compliance with food safety standards (e.g. mycotoxin content).
- ● Import license (if required according to GEO 84/2023 or other specific regulations).

2.5. Legislative regulations on the import of cereals into the European Union and Romania

- General Process of Importing Cereals from Third Countries (Non-EU) into Romania

3. Customs clearance and border controls

The goods arrive at an approved Border Inspection Point (BIP).

Documentary, identity and physical checks are carried out by the competent authorities (ANSVSA, Romanian Customs Authority).

The import customs declaration is submitted.

Customs duties (if applicable) and VAT are paid.

4. Release for free circulation: Once controls have been completed and tax obligations have been paid, cereals are released for free circulation within the EU.

It is crucial for importers to consult the updated specific legislation and work with customs and veterinary experts to ensure full compliance.

Co-funded by the European Union

2.6. Limits of contaminant levels allowed by Romanian legislation

In Romania, the maximum limits of the level of nitrates and nitrites in horticultural products are legislated by ORDER No. 293/640/2001-1/2002 regarding the safety and quality conditions for fresh vegetables and fruits intended for human consumption issued by the Order of the MINISTRY OF AGRICULTURE, FOOD AND FORESTRY No. 293 of August 2, 2001, Order of the MINISTRY OF HEALTH AND FAMILY No. 640 of September 19, 2001, approved by the NATIONAL AUTHORITY FOR CONSUMER PROTECTION on January 3, 2002 and published in the OFFICIAL GAZETTE NO. 173 of March 13, 2002.

Chemical substances used in the agricultural sector are allowed on the basis of a Certificate signed by the Interministerial Commission for the Certification of Phytosanitary Products. A new CODEX - a list of certified plant protection products classifies substances into four toxicity groups - according to the legal provision published on 5 June 2004. The new CODEX (similar to a register) of plant protection products used in Romania has been published by MAAP. This catalog is updated every 2 - 3 years.

By Directives 86/469 and 86/363, the Commission of the European Community established the control of residues in foodstuffs of animal and plant origin. The two directives cover all categories of residues (pesticides, PCBs, hormones, heavy metals, etc.). Directive 83/363 refers to pesticide residues and is also included in Order 825/23.05.1994 for the approval of hygiene norms regarding food and its sanitary protection and completed by Order 611/3.04.1995. These limits were revised in Order 356/2001 of the Ministry of Agriculture.

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CHAPTER 3.

MEASURES TO PREVENT AND REDUCE CONTAMINATION OF CEREALS AND RELATED PRODUCTS WITH PESTICIDES

3.1. Argumentum

The contamination of cereals and derived products with pesticide residues is a major concern for public health and food safety. In order to effectively address this problem, it is essential to implement a comprehensive set of preventive and mitigation measures. Firstly, compliance with Good Agricultural Practices (GAP) is fundamental; This includes using pesticides according to label directions, adhering to recommended doses, and applying at the optimal time to minimize residue buildup in the final product. The choice of pesticides with low persistence in the environment and in the agricultural product is another key strategy, favoring active substances that degrade rapidly. Crop rotation can also help reduce pest and disease pressure, thus decreasing the need for intensive pesticide application.

Constant monitoring of residue levels in soil, water and growing plants is crucial to identify possible problems early and adjust intervention strategies. The use of biological control methods and the integration of pest control methods (PMI), which combines the responsible use of pesticides with biological, cultural and physical methods, is a sustainable approach that reduces dependence on chemicals.

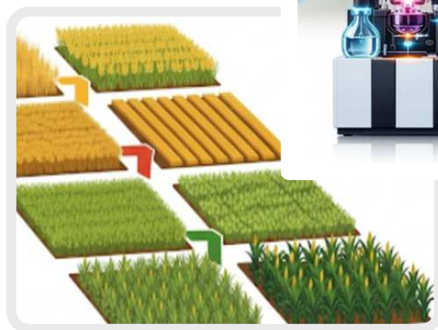
3.2. Measures to prevent and reduce pesticide contamination cereals and related products at the production stage

Preventing and reducing pesticide contamination of cereals is a process that begins well before the harvesting stage. These steps imply the consistent implementation of a set of preventive measures, fundamental to guarantee the safety of cereals intended for human consumption and to ensure the protection of the environment:

- **Good Agricultural Practices (GAP):**
    - **choice of pesticides:** preferably low-persistence pesticides that degrade quickly in the environment and in the plant;
    - **strict application of pesticides** according to the label, compliance with dosages and optimal application time to minimize residues;

3.2. Measures to prevent and reduce pesticide contamination cereals and related products at the production stage

- **crop rotation:** a smart agronomic strategy that naturally reduces pests and diseases, decreasing the need for pesticide interventions;
- **soil and water analysis:** to identify any pre-existing contamination that could be picked up by cereals.



3.2. Measures to prevent and reduce pesticide contamination cereals and related products at the production stage

- **Integrated pest control**: reducing dependence on pesticides by combining biological, cultural, physical and chemical methods, applied only when strictly necessary and in minimum effective doses;

- **constant monitoring of pests and crop health:** allows precise interventions, reducing unnecessary treatments and the risk of residues.

3.3. Measures to prevent and reduce pesticide contamination cereals and related products at the harvesting stage

Measures to prevent and reduce the contamination of cereals with pesticides transcend the harvesting stage. To achieve this goal, several measures are recommended:

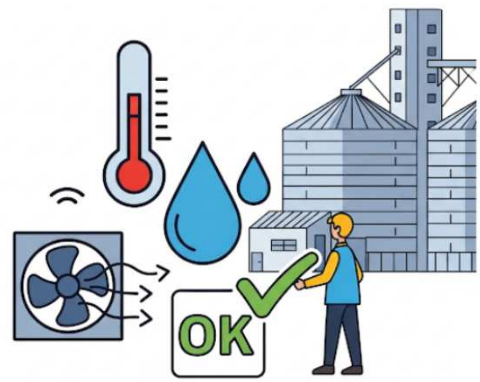
- **knowing the duration of pesticide retention and observing the break time**: strict adherence to the interval between the last pesticide application and harvesting, allowing residues to degrade to safe levels;

3.4. Measures to prevent and reduce pesticide contamination cereals and related products at the post-harvesting conditioning stage

The conditioning phase is critical to guarantee the safety of the final products and requires some measures:

- **Optimal storage conditions**: Temperature, humidity and ventilation control prevents the development of pests and molds in warehouses, eliminating the need for additional pesticides;

- **Constant monitoring**: sampling and laboratory analysis throughout the entire post-harvest flow are indispensable to verify compliance with the Maximum Residue Limits (MRLs) and to quickly identify any problems.



3.5. Measures to prevent and reduce pesticide contamination cereals and related products at the processing stage

The grain processing phase offers significant opportunities for further reduction of pesticide residue levels, even after field and post-harvest measures have been applied. Various industrial processes can help reduce these contaminants:

- **mechanical washing and cleaning:** are crucial for the effective removal of residues from the surface of cereals;

- **hulling and grinding**: They substantially reduce residues by removing bran and outer layers where pesticides are often concentrated. Subsequent grinding reduces residues remaining in the product mass;

3.5. Measures to prevent and reduce pesticide contamination cereals and related products at the processing stage

- **heat treatment**: cooking, baking or frying can thermally degrade certain pesticides, reducing their level in the final product, the effectiveness depending on the type of pesticide and the thermal regime;

- **continuous monitoring**: Laboratory analyses during processing are essential to verify the effectiveness of the measures and to ensure compliance with legally established maximum residue limits (MRLs).

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CHAPTER 4.

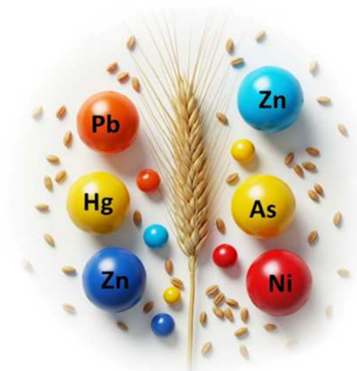
MEASURES TO PREVENT AND REDUCE CONTAMINATION OF CEREALS AND RELATED PRODUCTS WITH HEAVY METALS

Co-funded by the European Union

4.1. Argument

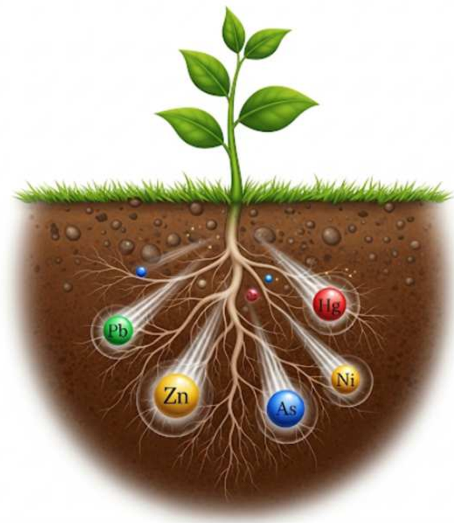
The contamination of cereals and derived products with heavy metals represents a serious threat, requiring the urgent and rigorous adoption of prevention and reduction measures. The arguments in favor of such an approach are structured on essential pillars: public health, food safety, economic impact and environmental sustainability. The level of heavy metals in plants depends on several factors:

- the cultivated species;
- the influence of land traffic and industrial activities carried out in the urban environment;
- conventional or organic cultivation technology;
- the influence of the use of contaminated wastewater in irrigation;
- the analyzed part of the plant, the concentration of heavy metals of the soil;
- cultivated varieties and morphological structure;
- heavy metal content in soil.



4.2. Preventive measures in the stage of soil preparation for cultivation

- **Phytoremediation** (can take from several years to decades): in the case of soils with a high level of contamination, phytoremediation techniques (using hyperaccumulator plants to extract metals from the soil) can be considered as long-term solutions, although they are not directly measures to prevent grain contamination in the current production cycle, but to remediate the soil.
- Phytoremediation often involves the use of hyperaccumulative or tolerant plants, which are not intended for human consumption, but are specifically cultivated to extract metals from the soil. After the remediation process is completed, the contaminated biomass is safely disposed of and the soil becomes safer for growing grains.

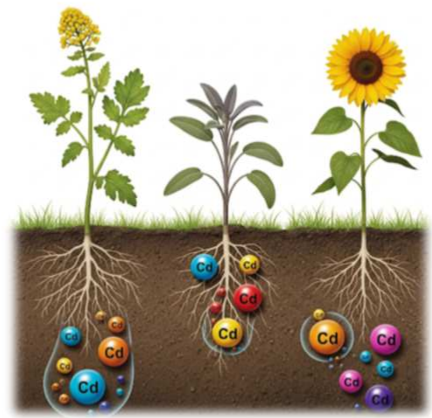


4.2. Preventive measures in the stage of soil preparation for cultivation

Hyperaccumulative plants for:

Cadmium (Cd):

- *Thlaspi caerulescens* (*Noccaea caerulescens*) - a cruciferous plant, recognized as one of the best hyperaccumulators of Cd and Zn.
- *Brassica juncea* (indian mustard) - it has a large biomass and a good ability to accumulate Cd, Pb, Cu and other metals.
- some species of *Helianthus annuus* (sunflower) – can accumulate Cd and Pb.
- *Salvia officinalis* (sage) and *Ocimum basilicum* (basil) - have been studied for their potential for Cd accumulation
- *Hypericum perforatum* - effective in absorbing Pb and Cd.

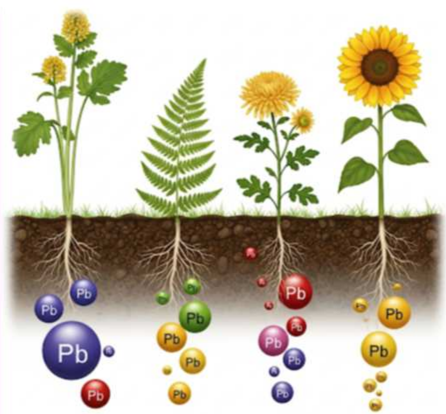


4.2. Preventive measures in the stage of soil preparation for cultivation

Hyperaccumulative plants for:

Lead (Pb):

- *Brassica juncea* (indian mustard) - it has a large biomass and a good ability to accumulate Pb, Cu, Cd and other metals.
- *Helianthus annuus* (Sunflower) - shows potential for Pb phytoextraction.
- *Pteris vittata* (arsenic fern) - although better known for arsenic, it also has some potential for Pb.
- Chrysanthemum - can absorb Pb and other heavy metals.
- some species of *Morus* (mulberry) - have been studied for the phytoremediation of soils contaminated with lead.



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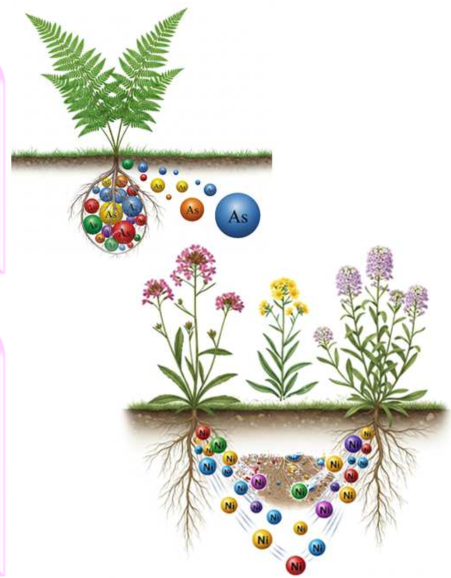
4.2. Preventive measures in the stage of soil preparation for cultivation

Hyperaccumulative plants for:

Arsen (As):

- *Pteris vittata* (arsenic fern or Chinese fern) - It is one of the best known and most effective arsenic hyperaccumulators. It can accumulate arsenic in the leaves at concentrations of thousands of mg/kg.



Nickel (Ni):

- some species of Alyssum (ex. *Alyssum bertolonii*) - are recognized as Ni hyperaccumulators.

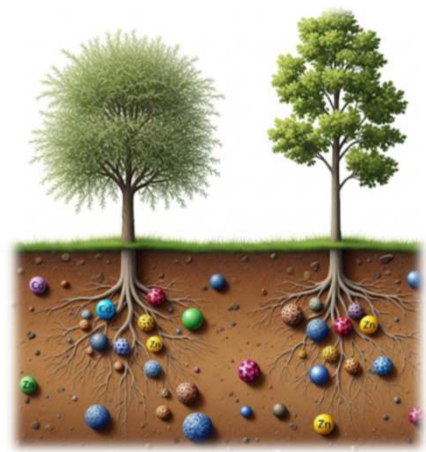
- *Aurinia saxatilis* (golden-mustache) - known for its ability to accumulate nickel.

4.2. Preventive measures in the stage of soil preparation for cultivation

Tolerant and phytostabilizing plants:

These plants do not necessarily accumulate large amounts of metals in aerial biomass, but they can tolerate high levels of metals in the soil and immobilize them in the roots or in the soil around the roots (rhizosphere), thus reducing their mobility and bioavailability. This technique is useful for preventing the spread of heavy metals into groundwater and stabilizing eroded soils.

- *Salix spp.* and *Populus spp.* - fast-growing trees, used for phytostabilization and phytoextraction in the case of some metals (*Salix spp*. can accumulate Cd, Zn).
- *Zea mays* - although it is a cereal, it can be used in phytostabilization or rotations to help improve the soil, but pay attention to the accumulation in grains.
- *Chrysopogon zizanioides* - resistant to harsh conditions and is used to stabilize eroded and contaminated soils.
- *Equisetum arvense* - tolerant to heavy and contaminating soils, often used for soil stabilization.
- *Artemisia annua* - hardy plant known for its ability to survive in difficult soils.
- *Medicago sativa L.* (alfaalfa) - phytoremediation of soils polluted with heavy metals, including lead and copper.

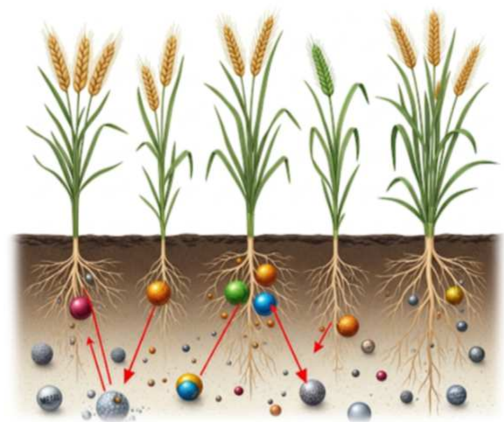


4.3. Preventive measures at the production stage

Preventing and reducing contamination of cereals in the field is essential to ensure safe and quality agricultural products. To minimize the absorption of heavy metals by cereals, a number of agronomic and soil management measures can be implemented:

Selection of cereal varieties:

- Choosing varieties with a low capacity to accumulate heavy metals ("excluder plants") is an effective strategy. There are significant differences between varieties in terms of the absorption and translocation of heavy metals.



4.3. Preventive measures at the production stage

- **Soil monitoring and analysis:** Performing regular soil tests to determine the level of heavy metals is crucial. This allows for the identification of contaminated areas and the adaptation of agricultural practices.

- **Soil pH adjustment:** Soil pH significantly influences the mobility and bioavailability of heavy metals. Increasing pH through calcareous amendments (e.g. calcium carbonate) can reduce the solubility and, implicitly, the absorption of many heavy metals, such as cadmium and lead.

4.3. Preventive measures at the production stage

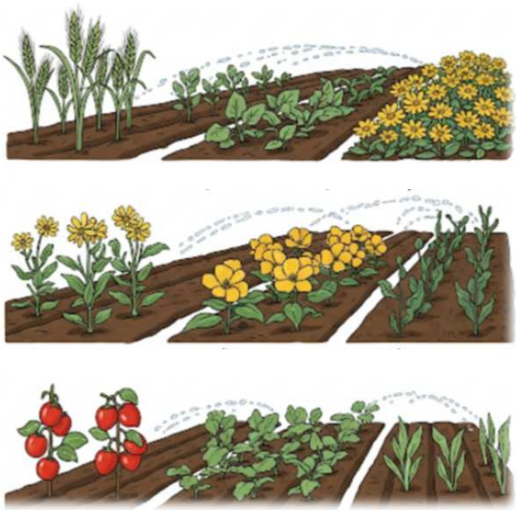
- **Improving soil organic matter content:** The addition of organic matter (compost, manure, plant residues) can reduce the bioavailability of heavy metals by forming stable complexes, thus limiting their uptake by plants.

- **Use of low-heavy metal fertilizers:** It is essential to use phosphate fertilizers with a certified and low content of cadmium and other heavy metals. Verification of labels and origin of fertilizers is mandatory.

4.3. Preventive measures at the production stage

- **Crop rotation:** The inclusion in rotation of crops that accumulate less heavy metals or crops that can contribute to phytoextraction (in the case of heavily contaminated soils and for remediation purposes) can be beneficial.

- **Irrigation practices:** The use of quality irrigation water with a low content of heavy metals is fundamental. Periodic analysis of water sources is recommended.



4.4. Preventive measures in the harvesting phase

Proper adjustment and maintenance of harvesting equipment:

- **Setting the cutting height:** Optimal adjustment of the cutting height of the combine harvester to avoid contact with the soil and minimize its embedding in the harvested mass. This is a fundamental measure to reduce soil particle contamination.
- **Regular checking and cleaning:** Before and during the harvesting campaign, the combine harvesters must be thoroughly inspected and cleaned of plant debris, accumulated dust and potential sources of leakage (lubricants, fluids).
- **Use of food grade lubricants:** As far as technically and economically feasible, the use of specialized, food-grade lubricants in critical systems can reduce the risk in the event of a leak.
- **Verification of the integrity of metal components:** Periodic inspection of parts that come into direct contact with grain to identify excessive wear and replace them in time, preventing the release of metal fragments.

4.4. Preventive measures in the harvesting phase

Soil and field management:

- **Preparing the ground:** Ensuring a level land surface with no steep ditches or bumps that could force the combine to cut too low.
- **Avoiding harvesting in adverse conditions:** As much as possible, harvest in excessively wet or muddy soil conditions, which favor soil adhesion to plants and machinery, should be avoided. Also, harvesting in strong winds, especially in areas with powdery soils, should be avoided or carried out with additional precautions.
- **Physical barriers:** In the case of fields adjacent to heavily trafficked roads or sources of industrial pollution, the opportunity of planting forest curtains or other plant barriers, which can reduce the deposition of dust particles on the crop, can be assessed.

4.4. Preventive measures in the harvesting phase

Quality control at the point of harvest:

- **Visual inspection:** Combine operators and harvesting personnel should conduct visual inspections of harvested grains to identify the presence of excessive amounts of impurities, soil or unusual residues.
- **Avoiding contamination in trailers/containers:** Trailers and containers used to transport grain from the field must be clean, dry and have not previously been used to transport contaminated materials.

4.4. Preventive measures in the harvesting phase

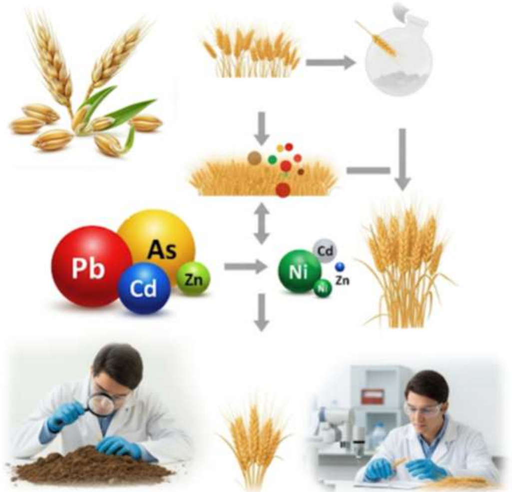
Risk map and harvest planning:

- **Identification of risk areas:** In the case of large farms or areas with a history of contamination, high-risk areas (e.g. plots adjacent to roads, factories) can be mapped and harvested separately or with increased precautions.

- **Pre-harvest analyses:** If contamination is suspected, grain samples can be taken from the field before harvesting for preliminary analysis to decide on the harvesting strategy and subsequent management.

4.5. Preventive measures in the post-harvest and conditioning stages

The risk of persistence or even intensification of heavy metal contamination is strongly manifested in the post-harvest stages and during the conditioning processes. Therefore, guaranteeing the quality and safety of cereals requires the rigorous implementation of control measures throughout the value chain, from the initial source in the field to the final product destined for the consumer. At these stages, grains can be exposed to various sources of heavy metals.



4.5. Preventive measures in the post-harvest and conditioning stages

Rigorous cleaning and sanitation of equipment and spaces:

- All transport, storage and processing equipment (trailers, conveyor belts, silos, mills, sieves) must be cleaned regularly and thoroughly to remove dust, debris and any potential sources of contamination.
- cleaning materials and solutions that do not add new contaminants will be used.

4.5. Preventive measures in the post-harvest and conditioning stages

Verification of building materials and equipment:

- New equipment must be made of inert, non-toxic materials that do not release heavy metals (e.g. food-grade stainless steel).
- Old equipment should be inspected to identify areas with potential for metal release (e.g. lead paint, metal wear).

4.5. Preventive measures in the post-harvest and conditioning stages

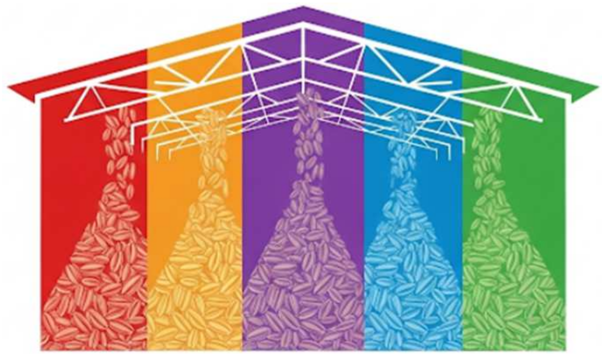
Dust control:

- Ventilation and air filtration systems in warehouses and processing units must be efficient to minimize the accumulation and spread of dust.
- Loading/unloading and processing areas should be as isolated as possible from external sources of air pollution.

4.5. Preventive measures in the post-harvest and conditioning stages

Preventing cross-contamination:

- Physical separation of grain consignments of different origins or qualities (especially those suspected of contamination).
- Thorough cleaning of equipment between processing different batches or types of grain.
- Storage of cereals in dedicated, clean and dry spaces, away from potential sources of contamination (e.g. chemicals, industrial waste).



4.5. Preventive measures in the post-harvest and conditioning stages

Use of quality controlled water:

- The water used to wash, humidify or cool grain must come from a safe source and be regularly tested for the absence of heavy metals. The quality of drinking water is often an acceptable standard.

4.5. Preventive measures in the post-harvest and conditioning stages

Secure packages:

- Packaging materials (bags, containers) must be food-grade, new or properly cleaned and sanitized, and must not contain or release heavy metals.
- Packaging should be stored in hygienic conditions to prevent contamination before use.

4.5. Preventive measures in the post-harvest and conditioning stages

Monitoring and testing of the finished product:

- Although preventive measures are fundamental, regular testing of grain batches (and derived products) for heavy metals is essential to verify the effectiveness of the measures implemented and to ensure compliance with legal limits.

- Samples can be taken from various points in the processing flow to identify potential critical points of contamination.

4.5. Preventive measures in the post-harvest and conditioning stages

Staff training:

- All employees involved in the post-harvest and conditioning stages must be trained on good hygiene practices, cleaning procedures, prevention of cross-contamination and the importance of food safety.

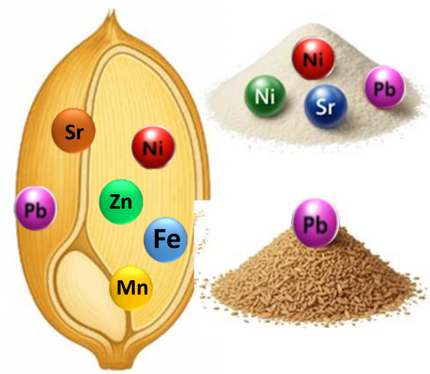
4.6. Preventive measures at the processing stage

The molecular mechanisms of metal transport and their distribution in various cereal shells is not yet fully understood, but studies show that some heavy metals accumulate predominantly in various morphological structures of cereals. Knowledge of these aspects allows the optimal processing of cereals and the efficient use of the raw materials obtained in order to reduce the impact of heavy metals on consumers.

Elemental micro-analyses of cereal grain sections seem to indicate that **phosphate, potassium, calcium, manganese, iron and zinc** appear to be distributed in a similar way: the highest concentrations are found in the aleurone and the embryo – especially in the scutellum – and the lowest concentrations are found in the endosperm.

Lead accumulated predominantly in the outer layer (pericarp and seed shell) of the grain; this finding is consistent with the results of the grain grinding test, in which bran (which mainly includes the pericarp and seed shell) contained significantly more Pb than whole wheat flour.

Heavy metals such as **nickel, strontium, antimony, and lead**, are found in higher concentrations in whole wheat flour compared to white wheat flour.



4.6. Preventive measures at the processing stage

Even if the raw material was initially of good quality, improper processing practices can introduce or concentrate heavy metals, affecting the quality and safety of derived products (flour, semolina, flakes, etc.). To minimize heavy metal contamination during grain processing, it is recommended:

- **Raw material quality control:** Accepting only batches of cereals that have been tested and confirmed as having levels of heavy metals below the maximum permissible limits (MAL) according to national and international regulations (e.g. Regulation (EC) No. 1881/2006 of the European Commission on maximum levels of certain contaminants in foodstuffs).
- **Water quality control:** The water used in washing, conditioning or humidification processes must be of drinkable quality and periodically tested for the absence of heavy metals. Water filtration systems can be useful.

4.6. Preventive measures at the processing stage

Equipment maintenance and sanitation:

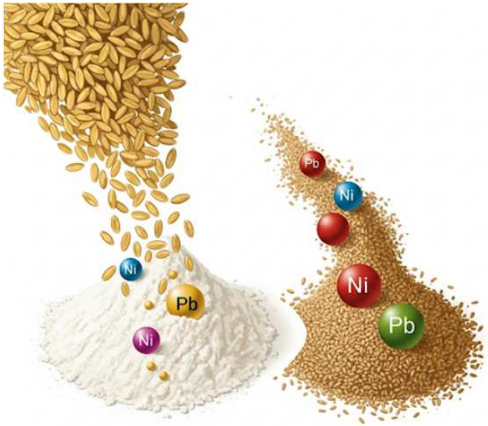
- **Thorough cleaning:** All machinery and surfaces that come into contact with grain (degerminators, mills, sieves, conveyor belts, pipelines) must be cleaned and sanitized regularly, according to a HACCP program, to remove residues and prevent the accumulation of contaminants.
- **Inspection and replacement:** Periodic inspection of wear parts (rollers, sieves, hammers) and their replacement before they reach an advanced degree of damage that could release metal particles. Inert, food-grade, abrasion-resistant materials (e.g. high-quality stainless steel) will be preferred.
- **Safe lubricants:** Exclusive use of food-grade lubricants in all lubrication points of machinery that may come into contact with grain.

4.6. Preventive measures at the processing stage

Optimization of the grinding process:

- **Separarea fracțiunilor:** Recunoașterea faptului că metalele grele se concentrează în tărâțe și alte subproduse. Prin urmare, o măcinare eficientă care separă cât mai bine endospermul de straturile exterioare poate reduce conținutul de metale grele în făina albă.

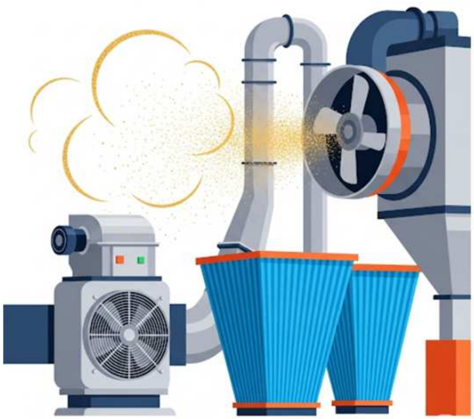
- **Monitorizarea subproduselor:** Subprodusele cu conținut ridicat de metale grele trebuie gestionate corespunzător și nu trebuie reintroduse în lanțul alimentar uman sau animal fără o evaluare riguroasă a riscului.



4.6. Preventive measures at the processing stage

Dust and environmental control:

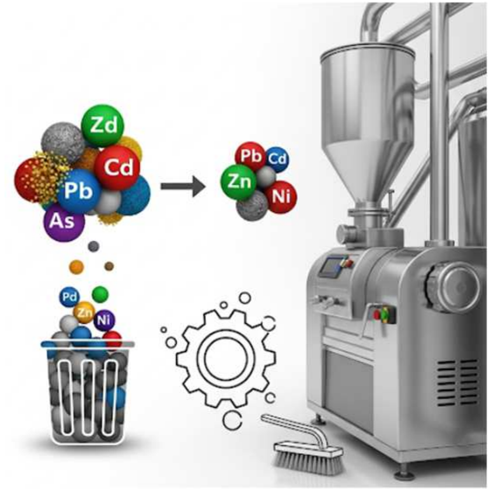
- Efficient air suction and filtration systems in processing units to minimise suspended dust, which can contain heavy metals and settle on products.
- Maintaining positive pressure in critical processing areas to prevent contaminated air from entering from outside.



4.6. Preventive measures at the processing stage

Preventing cross-contamination:

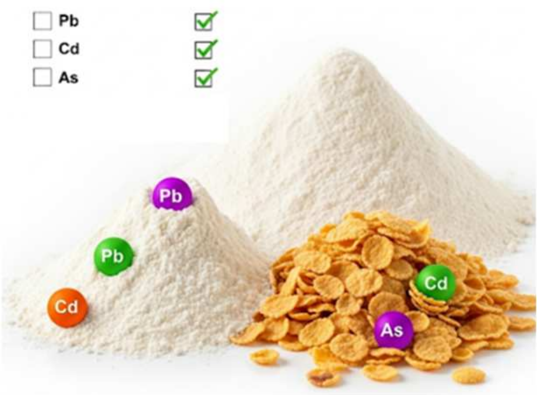
- Implementation of strict procedures to prevent mixing batches of cereals with different levels of contamination.
- Complete cleaning of processing lines between batch changes or grain types.



4.6. Preventive measures at the processing stage

Continuous monitoring of the processed product:

- **Periodic Analysis:** Carrying out regular analyses of intermediates (e.g. semolina, bran) and the finished product (flour) to verify compliance with the LMA for heavy metals. These analyses may include techniques such as atomic absorption spectrometry (AAS) or inductively coupled plasma mass spectrometry (ICP-MS).
- **Critical Control Points (CCPs):** Identifying the points in the process where the risk of heavy metal contamination is highest and establishing CCPs with critical limits and monitoring procedures.



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CHAPTER 5.

MEASURES TO PREVENT AND REDUCE CONTAMINATION OF CEREALS AND RELATED PRODUCTS WITH NITROGEN COMPOUNDS

5.1. General notions

The ubiquitous presence of nitrogen compounds in cereals is a direct consequence of their indispensable role in plant growth and development. Nevertheless, the imprudent or excessive application and mismanagement of nitrogen, particularly in agricultural systems, can precipitate diverse forms of contamination. These contaminants, which include nitrates, nitrites, and N-nitrosamines, pose significant deleterious effects on both environmental integrity and human health.

Consequently, the mitigation and prevention of such contamination necessitate a comprehensive, multi-faceted strategy. This approach must encompass the entire value chain, ranging from meticulously managed field practices to sophisticated post-harvest handling and processing methodologies

5.2. Agronomic practices (pre-harvest)

Soil Nutrient Diagnostics

Regular and precise soil testing constitutes a foundational practice for effective nitrogen management. This diagnostic approach facilitates the accurate quantification of extant soil nitrogen reserves and the precise determination of crop-specific nutritional demands. Such granular data are instrumental in mitigating the risk of excessive nitrogen application, thereby preventing potential nutrient loss and environmental burden.

Advanced Spatial Nutrient Management

The integration of Precision Agriculture (PA) methodologies, specifically Site-Specific Nutrient Management (SSNM), leverages advanced technological tools. The utilization of Global Positioning Systems (GPS), remote sensing, and variable-rate applicators enables the highly accurate deployment of nitrogen fertilizers. This precision is informed by real-time data pertaining to spatial variability in soil fertility and crop nutrient requirements across heterogeneous field zones. The implementation of these technologies consequently minimizes localized over-application and significantly augments Nitrogen Use Efficiency (NUE).

5.2. Agronomic practices (pre-harvest)

Holistic Nutrient Stewardship Principles

Adherence to the 4R Nutrient Stewardship framework is pivotal for sustainable nitrogen management. This framework advocates for the judicious application of fertilizers based on four core principles: employing the Right Source, at the Right Rate, at the Right Time, and in the Right Place. Conscientious adoption of these principles substantially curtails nutrient losses to the environment while simultaneously maximizing the assimilation and utilization of nitrogen by the cultivated crop.

Optimized Nitrogen Delivery Strategies

Split application of nitrogen fertilizers represents a refined approach to nutrient management, involving the division of the total nitrogen requirement into multiple, smaller doses applied at critical growth stages throughout the cropping season. This strategy is precisely calibrated to synchronize nitrogen availability with the crop's dynamic uptake curve, thereby significantly mitigating losses attributable to leaching and volatilization

5.2. Agronomic practices (pre-harvest)

Integrated Soil Fertility and Crop Management

The strategic enhancement of soil organic matter (SOM) content through practices such as the incorporation of crop residues and the judicious application of organic manures (e.g., farmyard manure, compost) is paramount for fostering soil health and augmenting its nitrogen retention capacity. This approach consequently diminishes the dependency on synthetic nitrogen inputs. Nevertheless, it is imperative that manure application be meticulously managed to preclude the introduction of supra-optimal nitrogen levels.

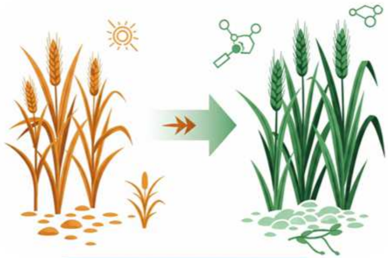
Precision Water Management

The implementation of optimized irrigation practices, including precise scheduling and the adoption of efficient methodologies such as drip irrigation, is critical for preventing waterlogging. This condition can otherwise promote denitrification and lead to substantial nitrogen loss. Furthermore, over-irrigation directly contributes to increased nitrate leaching, underscoring the necessity for calibrated water delivery

5.2. Agronomic practices (pre-harvest)

Genetic Enhancement for Nitrogen Use Efficiency

The ongoing development and deployment of cereal varieties exhibiting enhanced nitrogen use efficiency (NUE) represent a significant advancement in sustainable agriculture. These genetically improved cultivars are capable of achieving optimal growth and yield with reduced nitrogen inputs, thereby contributing to both economic and environmental sustainability.



Competitive Exclusion and Resource Allocation

Effective weed control and integrated pest management strategies are indispensable for minimizing plant physiological stress. By mitigating competition from undesirable flora and limiting biotic damage, these practices ensure that applied nitrogen resources are predominantly assimilated by the target cereal crop, rather than being diverted to competing organisms

5.3. Harvesting and Post-harvest Practices

Optimizing Post-Harvest Practices for Cereal Quality

Timely Harvesting is a critical factor in mitigating the risk of fungal proliferation and subsequent mycotoxin contamination in cereal crops. Harvesting at optimal physiological maturity and with a low moisture content directly reduces the susceptibility of the grain to fungal colonization. This is particularly important given the potential link between fungal nitrogen metabolism and mycotoxin biosynthesis.

Equipment Sanitation for Contamination Prevention

Maintaining rigorous hygiene protocols for all harvesting, transport, and storage equipment is paramount. Ensuring that all machinery is thoroughly cleaned, dried, and free from residual organic matter or debris before and after use is essential to prevent cross-contamination and minimize the introduction of spoilage microorganisms to the harvested crop

5.3. Harvesting and Post-harvest Practices

Optimizing Cereal Grain Storage for Quality Preservation

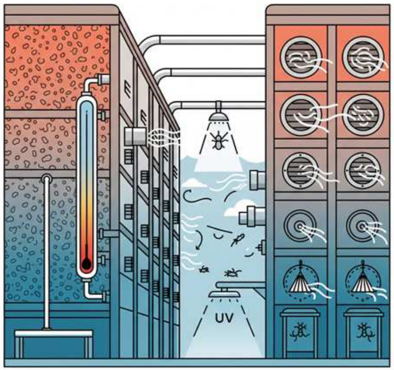
Effective cereal grain storage is paramount for preserving quality and preventing spoilage. This involves a multi-faceted approach focused on controlling environmental factors and mitigating biological threats

- ***Moisture and Temperature Regulation***

Moisture control is critical, with grain moisture content typically maintained below 13-14%. This threshold effectively inhibits the proliferation of microorganisms, including mycotoxin-producing molds, which can indirectly impact nitrogen compound levels within the grain. Concurrently, temperature control, ideally below 7°C, further suppresses microbial activity and reduces the rate of metabolic processes that contribute to spoilage.

- Aeration and Pest Management

Adequate aeration is essential to prevent the formation of localized "hot spots" and moisture accumulation within the grain mass. Such conditions can create conducive environments for microbial growth and spoilage. Furthermore, rigorous pest control measures are indispensable to manage insect and rodent infestations. These pests not only directly consume or damage grains but also create entry points and favorable conditions for subsequent microbial contamination, compromising overall grain quality and safety



5.3. Harvesting and Post-harvest Practices

Post-Harvest Cleaning and Processing for Cereal Quality Enhancement

Optimizing post-harvest cleaning and processing stages is crucial for enhancing cereal grain quality and safety. This multi-step approach focuses on contaminant reduction and controlled transformation of the grain

- Initial Cleaning and Separation

Sorting and initial cleaning are fundamental steps. The meticulous removal of foreign matter, damaged kernels, and dust at this early stage significantly diminishes potential sources of contamination. For certain grain types, a washing step can further reduce surface contaminants.

- Targeted Contaminant Reduction in Milling

During milling processes, precise control can facilitate the separation of contaminated grain fractions, thereby improving the overall quality of the end product.

- Considerations for Thermal Processing

While thermal processing can be effective in reducing certain contaminants, careful consideration is warranted. High temperatures carry the risk of promoting the formation of undesirable nitrogen compounds, such as N-nitrosamines. This is particularly relevant when precursors like nitrates and amines are present, especially in processed cereal products. Therefore, a balanced approach is necessary to maximize contaminant reduction while minimizing the formation of detrimental byproducts

5.4. Monitoring and Analysis

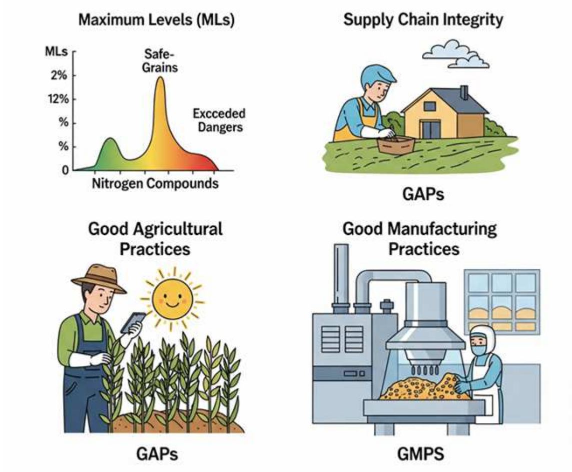
Routine Analysis of Raw Materials and Finished Products: The implementation of robust analytical protocols for detecting nitrate, nitrite, and N-nitrosamine levels in both raw cereal grains and their processed derivatives is paramount. This practice not only ensures adherence to established food safety standards but also facilitates the proactive identification of potential contaminants.

Enhanced Traceability Systems: Establishing and maintaining highly effective traceability systems is critical. Such systems enable the swift and accurate identification, isolation, and recall of any compromised product batches, thereby mitigating widespread public health risks and preserving supply chain integrity

5.5. Regulatory Framework and Standards

Establishing Maximum Levels (MLs): National and international food safety authorities are responsible for stipulating the maximum permissible concentrations of nitrogenous compounds, such as nitrates and nitrites, across a spectrum of food products, including cereals and infant formulas. Strict adherence to these prescribed limits is paramount for ensuring consumer safety.

Good Agricultural Practices (GAPs) and Good Manufacturing Practices (GMPs): The vigorous promotion and rigorous enforcement of Good Agricultural Practices (GAPs) at the primary production level and Good Manufacturing Practices (GMPs) throughout the processing stages are indispensable. These measures collectively contribute to minimizing contamination risks across the entire food supply chain.



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