

7. EUROPEAN LEGISLATION AND MAXIMUM RESIDUE LEVELS

The European Union has one of the world's most elaborate systems for assessing, authorising and monitoring pesticides. It operates through scientific assessments, regulatory procedures, maximum residue levels and monitoring programmes designed to protect consumers' health and the environment.

The European Food Safety Authority (EFSA) plays a central role by examining available scientific studies, assessing risks and helping establish the conditions under which active substances may be used. This is an enormously complex task, requiring multidisciplinary expertise and continual updating of knowledge.

However, the quality of the scientific work carried out by public institutions must not be confused with the completeness of available knowledge, or with an ability to test individually every food placed on the market. Regulation must address an immense range of products, chemicals, agricultural practices and potential exposure pathways. The system therefore relies on risk assessment, prioritisation, sampling-based monitoring and targeted inspections. These tools are indispensable, but they are not equivalent to comprehensive chemical knowledge about every food product.

Another distinction deserves attention: maximum residue levels are not simply concentrations below which a substance becomes harmless. They are regulatory values established in consideration of agricultural practices and subjected to scientific risk assessments.

To understand what European legislation actually guarantees, we must distinguish between what the rules require, what is actually monitored, and what remains unknown to the consumer.

7.1 The principal European rules governing pesticides

EU pesticide regulation is based primarily on two regulations. Regulation (EC) No 1107/2009 governs approval of active substances and authorisation of plant protection products for agricultural use. Regulation (EC) No 396/2005 lays down rules for establishing and applying maximum pesticide residue levels in food and feed of plant and animal origin.

The two regulations serve different purposes. The former determines which substances may be approved and under what conditions plant protection products may be used. The latter establishes the maximum concentrations of residues allowed in food products.

Regulation (EU) 2017/625 additionally governs official controls along the agri-food chain. The European framework also contains provisions concerning sustainable pesticide use, water protection, agricultural worker safety and the prevention of environmental risks.

Its overall objective is to ensure a high level of protection for human health and the environment. Nevertheless, legislation cannot eliminate every possibility of exposure or contamination. Its role is to identify, assess and manage risks in light of the scientific knowledge available.

7.2 How a pesticide is authorised



Overview of the European regulatory framework (simplified schematic)

Before an active substance may be used in plant protection products, it must undergo an assessment procedure. Applicant companies submit dossiers containing chemical and physical properties, toxicological studies, environmental data and findings on possible effects on living organisms.

The assessment covers many issues: acute and chronic toxicity, possible carcinogenic effects, reproductive effects, environmental fate and risks to non-target organisms. The dossiers are examined by the competent scientific authorities in accordance with legally prescribed procedures.

EFSA participates in the scientific peer review of assessments, whereas decisions on approval of active substances are taken by the competent European institutions. Individual plant protection products must subsequently be authorised by Member States through the prescribed procedures. Authorisations specify eligible crops, application methods, doses and restrictions.

Approval of an active substance therefore does not constitute unrestricted authorisation of every possible use.

The system enables many risks to be evaluated in advance, but inevitably has a limitation: decisions are based on the studies and knowledge available when an assessment is performed. New research may reveal previously unknown effects, change risk estimates or require conditions of use to be revised.

Chemical safety is not definitively settled knowledge; it is the outcome of an evolving scientific process.

7.3 What maximum residue levels are

Maximum residue levels (MRLs) are the highest concentrations of pesticide residues legally permitted in food and feed. They are generally expressed in milligrams per kilogram of product (mg/kg). One milligram equals one-thousandth of a gram. A concentration of 0.1 mg/kg therefore means that a kilogram of food contains 0.1 milligrams of the substance concerned.

There is no single limit applicable to all pesticides and foods. Each pesticide–food combination may have a specific value established according to regulatory procedures. A particular substance may therefore have different limits in apples, wheat, rice and other agricultural products.

These differences reflect substance characteristics, conditions of use, expected residues and the assessment of dietary exposure. This is important for interpreting the regulatory limit: an MRL does not necessarily represent the concentration at which a pesticide begins to cause adverse health effects.

It is a compliance value established in consideration of agricultural practices and after verification that expected exposure is compatible with consumer-protection criteria. Compliance with an MRL therefore indicates regulatory compliance, not the absence of pesticides from food.

7.4 How a maximum residue level is established

The establishment of an MRL takes into account good agricultural practices (GAPs), including the prescribed application methods, quantities applied, number of treatments and interval between the last application and harvest.

Experimental crop trials determine the residue concentrations that may arise when the product is used under the conditions under consideration. Trial results are then used to propose a maximum residue level. Next, the dietary exposure that might result from the substance being present in different foods is assessed using toxicological data, consumption information and scientific models.

The procedure is intended to verify that the proposed limit is compatible with consumer protection. Yet an important distinction emerges: a limit is also constructed from agricultural needs and practices considered acceptable, rather than solely by identifying a toxicological threshold.

This does not mean the value is arbitrarily chosen. Its determination combines agronomic considerations, scientific assessments and regulatory decisions. The question addressed is not exclusively the lowest concentration technically achievable; rather, it is which concentration may result from the agricultural practices considered and be acceptable under risk assessment.

An MRL is therefore a meeting point between agricultural production, scientific assessment and market regulation. Understanding that distinction allows us to interpret the limit without attributing to it characteristics it does not possess.

7.5 Acceptable daily intake and acute reference dose

Toxicological reference parameters are used to assess risks associated with pesticide ingestion. Two of the most important are the ADI and ARfD.

The acceptable daily intake (ADI) represents the amount of a substance that can be ingested daily over a lifetime without appreciable health risk, according to available knowledge and with appropriate safety factors. The acute reference dose (ARfD) represents the amount that can be ingested over a short period, normally no more than 24 hours, without appreciable risk.

Both parameters are normally expressed as milligrams of substance per kilogram of body weight. They are determined from toxicological studies, with factors intended to address scientific uncertainties and differences in individual sensitivity.

ADI and ARfD differ from MRLs. The former concern doses taken into the body through food; the latter concern permitted concentrations in a particular food. This distinction helps explain why different foods can have very different MRLs for the same pesticide. Assessment must also consider how much of a food is consumed and its contribution to overall exposure.

It is important, however, that toxicological reference parameters are based on available knowledge. New evidence can lead to their revision. Acetamiprid offers a concrete example: in 2024 EFSA proposed a substantial reduction in toxicological reference values in response to uncertainties concerning developmental neurotoxicity.

Science can improve its capacity to assess risk, but cannot guarantee that every assessment made today will remain unchanged in the future.

7.6 How dietary exposure is assessed

To assess whether established limits adequately protect health, EFSA uses scientific tools that combine residue data with food-consumption information. One of the main tools is PRIMo, the Pesticide Residue Intake Model.

The model estimates exposure from consumption of different foods across European populations. It considers both chronic exposure, repeated over time, and acute exposure associated with consumption during a short period. Different dietary habits and population groups, including children, are taken into account.

A food containing a given pesticide concentration can contribute differently to total exposure depending on how much of it is eaten. Body weight also matters: ingesting the same amount of a substance results in a higher dose per kilogram of body weight for a child than for a heavier adult.

These models are essential scientific instruments, but necessarily rely on data, assumptions and statistical distributions of consumption. They do not reconstruct every substance ingested by every consumer throughout their lifetime. Their purpose is to estimate and manage population risk, not to establish each individual's personal chemical-exposure history.

7.7 The general default value of 0.01 mg/kg and its exceptions

As a general rule, Regulation (EC) No 396/2005 provides for a value of 0.01 mg/kg when no specific MRL has been set for a particular pesticide-food combination, subject to the applicable exceptions. This corresponds to 10 micrograms per kilogram.

It is not a universal limit applicable indiscriminately to every substance. EU legislation includes many specific values, sometimes much higher or lower than 0.01 mg/kg. Some substances do not require an MRL; others are subject to particular values.

It is also essential to distinguish a regulatory limit from a laboratory method's limit of quantification (LOQ). The LOQ is the lowest concentration at which the laboratory can measure a substance with adequate analytical performance. For some substances, a suitably equipped laboratory can quantify concentrations below the legal limit.

A residue may therefore be perfectly measurable while fully complying with legislation. Once again, compliance with a limit and the absence of quantifiable residues are not equivalent concepts.

7.8 Glyphosate: science, agriculture and regulatory decisions

Glyphosate illustrates the complexity of the European pesticide-authorisation system. It is a widely used herbicide worldwide, and its safety has been assessed repeatedly amid intense public debate.

In 2015, the International Agency for Research on Cancer (IARC) classified glyphosate as probably carcinogenic to humans (Group 2A). Subsequent assessments by European authorities reached different conclusions concerning carcinogenic classification and risk under the conditions of use considered.

In 2023, EFSA did not identify critical areas of concern that would prevent renewal of approval, while highlighting outstanding issues and data gaps. In November of that year, the EU renewed glyphosate's approval until 15 December 2033. The European Commission adopted the decision after Member States had failed to reach a qualified majority either for or against renewal.

This illustrates an important distinction. Scientific assessments identify hazards and estimate risks. Regulatory decisions are taken by competent institutions through procedures that also define permitted conditions of use. Such decisions exist in a context of agricultural needs, economic implications and industrial interests.

The presence of these interests does not in itself show that a decision is scientifically incorrect or resulted from improper pressure. But an authorisation decision is not the same thing as a scientific experiment demonstrating that a substance is absolutely harmless.

Glyphosate in wheat

A particularly significant example is the maximum glyphosate residue level in wheat, historically set at 10 mg/kg for this combination. That is 1,000 times the general default reference value of 0.01 mg/kg applicable where no specific MRL exists.

The comparison does not prove that glyphosate is more dangerous than other substances or that this MRL is necessarily inadequate. Limits for different pesticides cannot be compared as if they represented a common scale of toxicity.

Nevertheless, the figure raises a legitimate question. Does the fact that a concentration higher than many other MRLs is legally permitted mean it is the minimum residue level achievable in an agricultural product? And why should consumers not be able to know the amount actually present in the wheat used to make their food?

Compliance with the limit does not provide this information. A product may contain residues far below the limit or quantities close to the maximum permitted value, without consumers normally being informed of the difference.

Glyphosate thus illustrates why it matters to distinguish legal limits from verified analytical quality.

7.9 Pesticides not authorised in the European Union

Another issue concerns substances not approved for agricultural use in the EU. Non-approval does not automatically mean that every measurable presence in food is prohibited.

In certain circumstances, legislation may establish MRLs even for substances not authorised for European agricultural use. Import tolerances are one example. Subject to regulatory conditions, they allow agricultural products from countries using different practices to be marketed when the consumer risk assessment is favourable.

Imported foods must still comply with the limits applicable on the EU market. The distinction is therefore between authorisation to use a substance in European agriculture and the lawful presence of its residues in marketed foods.

A substance not authorised in EU fields may, in certain circumstances, be present within regulatory limits in imported food. Understanding this distinction helps clarify what legal compliance actually guarantees.

7.10 Official controls: how sampling works

EU Member States conduct monitoring programmes to verify food compliance with MRLs. These include national programmes, an EU-coordinated programme and enhanced checks on certain imports.

The EU-coordinated programme is designed to provide representative information about pesticide residues in selected food categories. National programmes may focus more heavily on products, origins and situations with higher probabilities of irregularities.

Such controls are scientifically grounded and indispensable for understanding market conditions. Nevertheless, they are based on sampling. They do not entail comprehensive testing for all pesticides in every individual batch placed on the market.

Official controls are not the only form of verification: food business operators are responsible for product compliance and must adopt risk-management and control procedures. Even so, the overall system is not equivalent to the individual analysis of every package or food batch.

Statistical monitoring can provide reliable information about the market as a whole without proving that every product has been analysed. This is a fundamental distinction. Monitoring results estimate contamination and non-compliance rates, identify problematic situations and guide future inspections. They cannot automatically tell us the chemical composition of a product that was not sampled.

7.11 What European monitoring actually shows

EFSA's report published in May 2026, based on samples collected in 2024, illustrates several important points. The EU-coordinated programme analysed 9,842 samples from 12 food categories.

Of these, 43.1% had no quantifiable residues of the pesticides tested; 54.5% contained one or more quantifiable residues within regulatory limits; 2.4% exceeded an MRL; and 1.2% were deemed non-compliant after analytical uncertainty was considered.

Another notable figure is that 34.9% of samples contained more than one quantifiable pesticide. One sweet-pepper sample from a non-European country contained 17 different pesticides, all below their respective limits.

These findings show that regulatory compliance can coexist with multiple residues in one food. Most samples complied with the rules, and EFSA's evaluations generally indicated low dietary risk in the scenarios examined. This is an important outcome demonstrating the value of monitoring.

But the data should be read in full. More than half the samples in the coordinated programme contained at least one quantifiable residue. That does not mean that more than half the foods were dangerous. It does mean that measurable residues are common in the examined food categories.

It also explains why a compliance percentage alone does not exhaust the information that might interest consumers. A person may wish not only to buy compliant food, but also to know which residues it contains and in what amounts. These are different criteria.

7.12 The gap between rules and their implementation

The existence of legislation does not automatically mean that every economic operator complies with it. Farming takes place in complex production settings influenced by weather, pest pressure, economic constraints and operational difficulties.

Most operators have an interest in obeying the rules and selling compliant products. Nevertheless, misuse, errors, unauthorised treatments and fraud can occur. Detecting them depends on effective controls, traceability and the availability of information.

European institutions have documented implementation weaknesses. In Special Report 05/2020, the European Court of Auditors identified limited progress in measuring and reducing risks associated with plant protection products. It also highlighted shortcomings in implementing and verifying integrated pest management (IPM).

IPM combines agronomic and biological methods and gives priority, where feasible, to alternatives to chemical treatments. The Court observed that available instruments did not adequately measure the success of EU policies promoting sustainable pesticide use.

These observations do not establish that the system is ineffective overall. They do show that a meaningful gap may exist between legislative objectives and their real-world achievement.

Controls detect some irregularities, but we cannot assume that every violation will be discovered. Nor would it be correct to extrapolate arbitrarily from detected cases to estimate how many remain hidden. The actual scale of undetected irregularities requires specific evidence and assessment methods.

7.13 Substances not routinely tested: the example of PFAS

Pesticide control is only one part of evaluating chemical contamination in food. Many other families of potentially undesirable substances can be found in the environment. Among them are per- and polyfluoroalkyl substances (PFAS), a large group of compounds many of which are highly persistent.

PFAS may reach soil and water from various sources and, under certain conditions, can be absorbed by crops and transferred into the food chain. PFAS are not, as a general category, pesticides. They nevertheless provide an important example of the limits of regulatory coverage of food contaminants.

Regulation (EU) 2023/915 sets maximum levels for four PFAS and their sum in certain food categories, including meat, fish and eggs. It does not lay down harmonised specific maximum levels for those PFAS in many plant-based matrices, such as fruits, vegetables and cereals.

That does not mean contamination of these foods is impossible or that scientific authorities are uninterested in PFAS occurrence. In 2022, the European Commission adopted a recommendation on PFAS monitoring in several food categories, including fruits, vegetables and other plant-based products.

The drinking-water framework is different. From 12 January 2026, new EU monitoring requirements and parametric values apply to PFAS in water intended for human consumption. The rules specify 0.10 micrograms per litre for the sum of 20 PFAS and 0.50 micrograms per litre for total PFAS, according to their respective regulatory definitions.

Different regulations for drinking water and plant foods do not automatically constitute a scientific contradiction. Exposure routes, consumption patterns, available data and regulatory procedures differ. Yet the example raises a concrete question: if we recognise the importance of monitoring PFAS in water, how much do we know about their possible transfer to food through agricultural soils and irrigation water?

The absence of a specific limit for a given matrix does not demonstrate that the contaminant is absent. Nor does the absence of analytical testing justify concluding that the product contains none of the substance.

This distinction extends beyond PFAS. For numerous contaminants, limits, monitoring programmes and scientific knowledge vary according to the substance and food matrix. Regulation necessarily relies on priorities and assessments of known or reasonably foreseeable risks; it is not a complete inventory of

every undesirable substance that might occur in food.

7.14 Regulatory compliance and analytical excellence

A central distinction now becomes clear. The European food-safety system protects populations by regulating risks and monitoring compliance. It is not designed to certify that every marketed food contains the lowest technically measurable amount of every possible contaminant.

Regulation operates on a vast scale, setting priorities and rules that apply across the market. This essential task necessarily differs from an in-depth analytical selection of an individual food batch.

A product can comply with the law while containing pesticide residues below applicable limits. It may contain several residues simultaneously. It may also never have been tested for contaminants for which no specific testing obligation applies to that food matrix.

Compliance does not necessarily provide a complete description of the product's chemical composition. This does not mean that the food is dangerous. It simply means that obeying the rules and possessing detailed analytical knowledge answer different questions.

Regulatory compliance is the minimum requirement for legally marketing food; it is not automatic certification of excellence in chemical composition.

A voluntary selection system may choose broader testing programmes, searching for more substances and applying stricter criteria than regulatory limits. For example, it may exclude batches in which certain contaminants are quantifiable, even at levels fully compliant with the law.

It is essential, however, to specify which substances were tested, which methods were used and the relevant limits of quantification. The absence of quantifiable residues is not the same as the absolute absence of every contaminant molecule.

Broader analytical knowledge does not eliminate all uncertainty, but it can reduce some uncertainties and provide consumers with information that is normally unavailable.

A compliant food meets applicable requirements. Food selected through a more restrictive analytical protocol also meets additional, declared and verifiable quality criteria. This difference can underpin a concept of food excellence based on measurable information.

7.15 The value of science and the areas still unexplored

European food safety has made extraordinary progress thanks to scientific research, institutional activity and advances in analytical techniques. The work carried out by EFSA and the competent authorities is essential to consumer protection.

The complexity of the problems is immense: thousands of substances, numerous food matrices, different exposure conditions and possible health effects must be assessed. The system must therefore proceed through priorities, gradual updates and the ongoing acquisition of knowledge.

This should not be interpreted as evidence of carelessness or bad faith. It is a consequence of the sheer scale of the scientific challenge. Precisely for this reason, however, we must not confuse the value of the work already done with the completeness of the results achieved.

Some contaminants are still not routinely tested in particular food matrices; some combined effects remain incompletely understood; chronic exposure is difficult to reconstruct; and products reach the market without detailed testing of each individual batch.

New knowledge may also require earlier assessments and limits once considered adequate to be revised. Food safety is not an absolute, unchanging state: it results from an ongoing process of knowledge acquisition, assessment and risk management.

Recognising the limits of that process does not mean questioning science. It means understanding its nature. Scientific progress also depends on identifying what we do not yet know.

Knowledge of food contaminants can advance not only through public regulation but also through research programmes, independent monitoring and wider voluntary analytical protocols. These activities need not replace one another. They can serve different purposes while increasing the information available about food.

Regulatory compliance is the starting point. Knowledge is the next step.

Chapter 7 conclusions

The European pesticide regulatory system is a fundamental tool for protecting consumers' health. Active substances are scientifically assessed, agricultural uses require authorisation and food must comply with MRLs established through regulatory and toxicological procedures.

Official controls identify numerous irregularities and help describe conditions across the food market. Yet the size and complexity of the supply chain make it impossible to equate these controls with comprehensive analysis of every marketed product.

Furthermore, legal limits do not necessarily cover all potential contaminants, and scientific assessments of combined effects continue to evolve. These considerations do not diminish the value of the work undertaken by European institutions. Rather, they show how complex food-safety protection is and how much remains to be understood.

The law specifies the conditions under which food may be marketed. It does not automatically certify that a particular food represents the highest attainable standard of chemical quality. Nor does it necessarily provide consumers with a complete list of the substances actually present in the product they buy.

It is therefore legitimate to seek more extensive information, broader analytical testing and selection criteria stricter than those required by law. Not because every residue is necessarily dangerous, but because the opportunity to know what we eat is a value in itself.

Food safety has advanced greatly thanks to science and public institutions. But current knowledge does not exhaust everything that needs to be known. Large areas of uncertainty remain, which research and improving analytical techniques may progressively illuminate.

Understanding these limits is not a reason for mistrust. It means acknowledging that knowledge is a continuous process and that consumers have a right to participate through increasingly complete information. This awareness leads directly to the distinction explored in the next chapter: compliance with legal limits versus the absence of detectable residues.

Scientific and regulatory sources

Regulation (EC) No 1107/2009 — Placing plant protection products on the market.

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European Commission — EU Pesticides Database.

https://food.ec.europa.eu/plants/pesticides/eu-pesticides-database_en

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