How pesticides impact human health and ecosystems in Europe

Food production systems in Europe rely on chemical pesticides to maintain crop yields. However, widespread pesticide use is a major source of pollution — contaminating water, soil and air, driving biodiversity loss, and leading to pest resistance. Human exposure to chemical pesticides is linked to chronic illnesses such as cancer, and heart, respiratory and neurological diseases. This briefing summarises the latest knowledge on how chemical pesticides impact human health and the environment, and presents good practices to reduce their use and risk across Europe.

Key messages

- European agricultural production relies on high volumes of chemical pesticides to maintain crop yields. From 2011 to 2020, pesticide sales in the EU-27 remained relatively stable at around 350,000 tonnes per year.
- In 2020, one or more pesticides were detected above thresholds of concern at 22% of all monitoring sites in rivers and lakes across Europe. 83% of agricultural soils tested in a 2019 study contained pesticide residues.
- Pesticide pollution drives biodiversity loss in Europe. It causes significant declines in insect populations, threatening the critical role they play in food production.
- A large-scale human biomonitoring study conducted between 2014 and 2021 across five European countries found that at least two pesticides were present in the bodies of 84% of survey participants. Pesticide levels were consistently higher in children than in adults.
- Achieving the pesticide-related targets set in the farm to fork strategy will require significant additional efforts. We could reduce our dependency on chemical pesticides to maintain crop yields and our overall pesticide use volumes by shifting to alternative models of agriculture, such as agroecology.

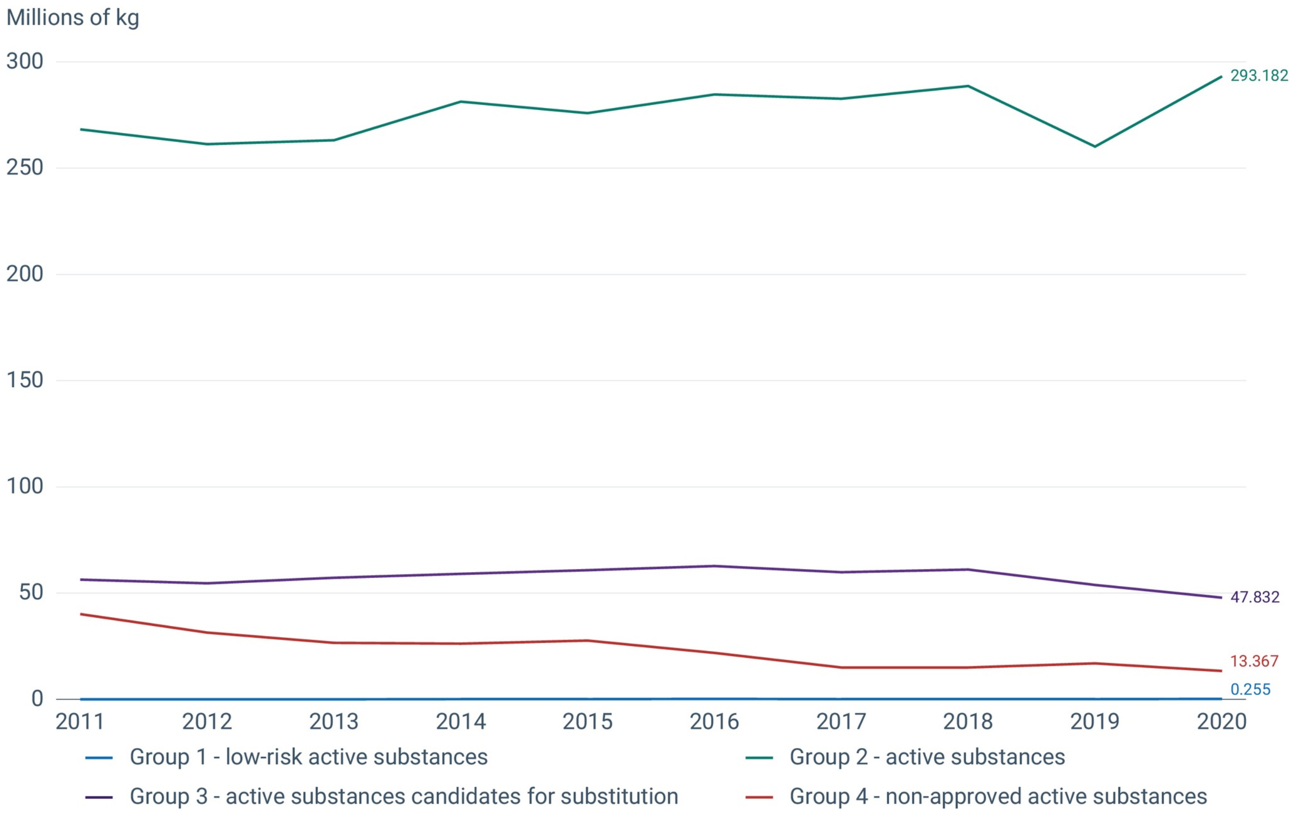
Pesticide use in Europe

Modern food production systems rely on high volumes of chemical pesticides [Box 1] to ensure crop yields' stability and quantity, and maintain food security (EEA, 2017, 2019). Pesticides are also used in non-agricultural settings; for example, in forestry, along roads and railways, and in urban areas such as public parks, playgrounds or gardens. Some of these areas, especially urban green spaces, are widely used by the public — particularly by children and the elderly, whose health is more sensitive to pesticides. The risks pesticides pose to human health and ecosystems depend not only on the intrinsic properties of their components (e.g. active substances, co-formulants, adjuvants), but also on how they are used — including application frequency, volumes and method, and crop and soil type.

Data on pesticide use are not currently available at EU level, but will be mandatory to gather from

2028 onwards according to the Regulation on statistics on agricultural inputs and outputs. At the same time, harmonised, annual data on pesticide sales in the EU have been collected since 2011. In the EU-27, pesticide sales remained relatively stable at around 350,000 tonnes per year from 2011 to 2020 (see Figure 1). In 11 Member States, sales declined over this period, with the sharpest falls in Czechia, Portugal and Denmark. While Latvia and Austria saw the sharpest rates of increase in pesticide sales[1], the largest total increases in volumes sold were in Germany and France. These two countries, together with Spain and Italy, account for the highest volumes sold across most groups of active substances, and are also the top four agricultural producers in the EU (Eurostat, 2022a).

Figure 1. Pesticide sales in the EU-27 by categorisation of active substances



Note: The substance categorisation in the legend mirrors what the European Commission uses to calculate its indicators on pesticide use and risk. Group 2 includes approved active substances that are neither low-risk nor candidates for substitution, which make up around 75% of all approved active substances in the EU according to the EU Pesticides Database. The hazard potential of substances in this group varies significantly.

Source: Eurostat (2022b).

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Box 1. Pesticides, plant protection products and biocides

Pesticides are a large and diverse class of compounds designed to control undesired organisms (e.g. insects, fungus, bacteria, weeds), regulate plant growth or preserve plant products. They include:

- **chemical pesticides** that contain synthetic active substances as well as co-formulants and adjuvants; and
- **non-chemical pesticides** of biological (e.g. micro-organisms, invertebrate macro-organisms, semiochemicals, plant extracts) or mineral (e.g. copper) origin.

Non-chemical pesticides are normally permitted in organic farming. EU legislation usually divides pesticides into:

- **plant protection products**, such as fungicides and herbicides, used to protect crops and plants; and
- **biocides**, such as disinfectants and preservatives, used to control pests that harm human or animal health, or that may damage materials such as wood, plastics or fibres.

Certain groups of substances could be used for both purposes; most notably, insecticides.

In this briefing, the term ‘pesticide’ is used as a synonym for ‘plant protection product’.

Broader global trends affect pesticide use and risk in Europe. Climate change is altering pest distribution and may trigger increased pesticide use. At the same time, pesticide pollution reduces natural pest control and encourages organisms to become resistant to pesticides, leading to a vicious cycle of increased pesticide use (EFSA et al., 2020; Bonato et al., 2023). Regarding the political context, pesticide sales are not expected to be substantially impacted by cost increases resulting from the war in Ukraine. This suggests that policy measures are more crucial than prices for reducing pesticide use (EC, 2023a). Finally, in our interconnected global food system, pesticides banned in the EU are still exported to non-EU countries (ECHA, 2021). This creates the risk that food and feed imports are contaminated with pesticide residues banned within the bloc (Sarkar et al., 2021).

Europe’s push towards sustainable pesticide use

Industrial agriculture's reliance on chemical pesticides is a quintessential 'One Health' challenge: their widespread use impacts human, animal and ecosystem health, as well as food security, in multiple and interacting ways (Destoumieux-Garzón et al., 2018). In Europe, growing awareness about these impacts has sparked transnational advocacy campaigns such as the European Citizens' Initiative 'Save Bees and Farmers!' and the European Research Alliance's declaration 'Towards a chemical pesticide-free agriculture'.

In the context of the European Green Deal, the farm to fork strategy identifies an urgent need to reduce dependency on pesticides. Key policy targets to be achieved by 2030 under the farm to fork strategy, zero pollution action plan and biodiversity strategy for 2030 include:

- a 50% reduction in the use and risk of chemical pesticides;
- a 50% reduction in the use of the more hazardous ones;
- at least 25% of the EU's agricultural land to be under organic farming.

To this end, the European Commission has committed to revising the directive on the sustainable use of pesticides, with a proposed regulation on the sustainable use of plant protection products currently under discussion (see Box 2). It also relies on some of the conditionality rules and financial support offered by the new common agricultural policy 2023-2027.

To measure progress towards the 2030 targets, the Commission further developed two indicators on trends in chemical pesticide use and risk. The indicator on the use and risk of chemical pesticides points to a 14% fall in the combined use and risk of chemical pesticides in 2020 against a baseline average for the period 2015-2017. On the other hand, the Commission's indicator on the use of more hazardous pesticides shows a decrease of 26% from the baseline period (EC, 2022e). However, a lack of EU-wide data on actual pesticide use impacts these indicators' accuracy. Moreover, the methodology underpinning them has been criticised by key actors, such as the European Court of Auditors (ECA) (ECA, 2020)[2] and the German Environment Agency (Bär et al., 2022).

Specifically, the ECA and the German Environment Agency identified that the indicators are limited by the different weighting factors used to calculate the risk of active substances contained in chemical pesticides, which are assigned depending on their regulatory status (e.g. 'low-risk', 'approved', 'candidates for substitution' and 'not approved') rather than on scientific evidence of harm. As a result, both organisations made suggestions to increase the indicators' accuracy and reliability, and the Commission recently committed to improve them as part of its new deal for pollinators.

Pesticide authorisation and risk assessment

In the EU, active substances used in plant protection products and biocides must be approved according to the regulation concerning the placing of plant protection products on the market. Then, individual Member States authorise placing products with those active substances on their national markets. For some biocides, EU-level authorisation is also possible.

An active substance can be approved if it is safe for people's health and does not have unacceptable effects on the environment. However, limitations in testing methods, data availability and obligations to communicate approved pesticides' adverse effects (i.e. post-marketing surveillance) imply that such effects may only be recognised after many years (SAPEA, 2018). Active substances in the process of having their approval renewed remain on the market while a new risk assessment is conducted. Historically, this dynamic has led to the continued use of substances that were later proposed for a ban, as in the recent case of the fungicide dimoxystrobin.

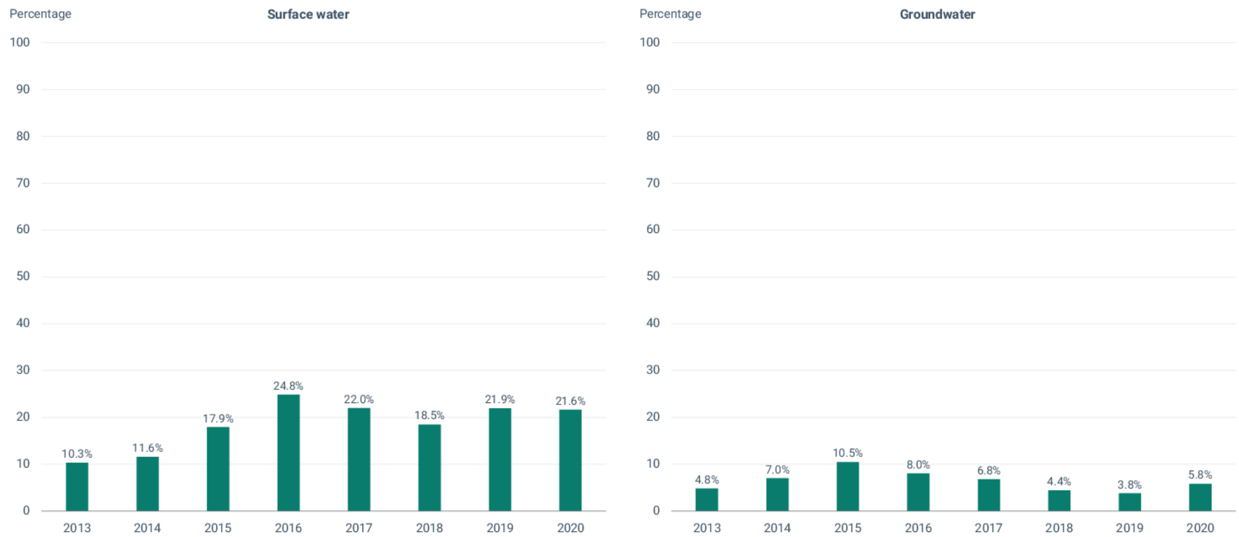
In general, the current risk assessment paradigm is fragmented and fails to capture cumulative and combined exposure to pesticides, and the resulting impacts on human health and ecosystems (Bopp et al., 2019; Devos et al., 2022; Sousa et al., 2022). This paradigm is also limited in terms of assessing risks from other potentially toxic substances contained in pesticides, such as co-formulants and adjuvants (Mesnage and Antoniou, 2018; SAPEA, 2018).

Currently, Member States can also grant emergency authorisations to use non-approved active substances and active substances approved at EU level but not yet authorised at Member State level. This can happen for a wide range of reasons, including plant health issues and minor uses. In 2020, over 13,000 tonnes of non-approved active substances were sold in the EU (Eurostat, 2022b). A Commission indicator calculated that the risk associated with emergency authorisations increased by 38% from the baseline period 2011-2013 up to 2020 (EC, 2022f). Most notably, some countries granted repeated emergency authorisations to the neonicotinoid insecticides thiamethoxam, clothianidin and imidacloprid, which are no longer approved in the EU because they are toxic to bees. A recent judgment by the Court of Justice of the European Union may prevent this possibility in the future, but its full legal implications are still unclear.

Pesticides in water and soils

Once a pesticide has been authorised for use, environmental monitoring provides an important 'warning system' to complement risk assessment. In 2020, based on country data reported to the EEA, one or more pesticides were detected above effect or quality thresholds at 22% of reported surface water monitoring sites in Europe, including rivers and lakes. Between 2013 and 2020, the lowest percentage of exceedances was 10% and the highest 25%. Exceedances were also detected at between 4-11% of groundwater monitoring sites between 2013 and 2020 (see Figure 2).

Figure 2. Percentage of reported monitoring sites with pesticides exceeding thresholds in a) surface waters and b) groundwater in Europe, weighted by country area



Source: EEA (2021).

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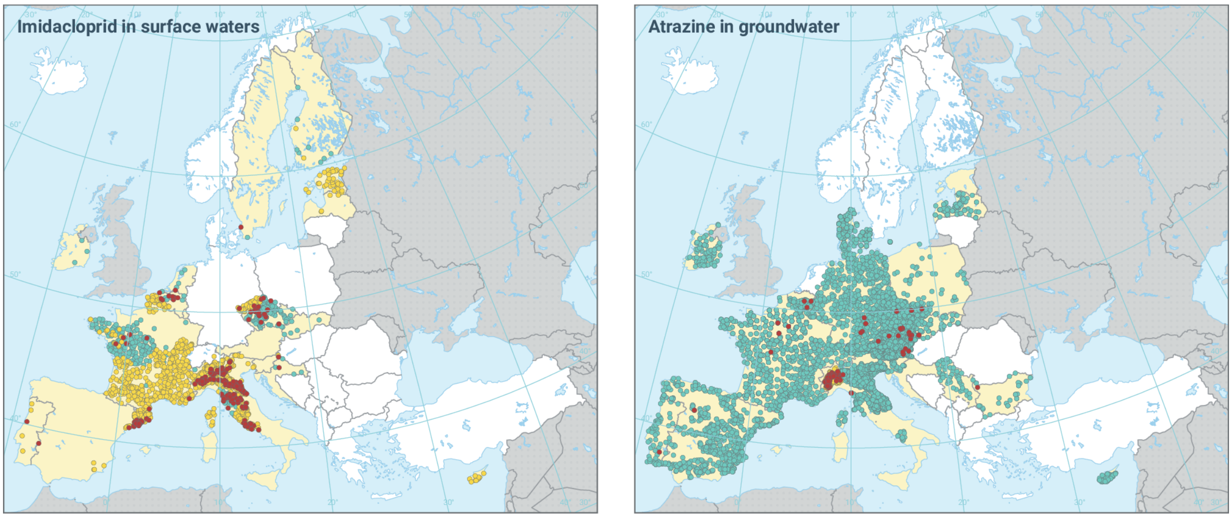
Although the pesticides causing exceedances vary across countries, in 2020 the insecticide imidacloprid (see Figure 3) and the herbicide metolachlor showed the highest absolute number of exceedances across Europe. In groundwater, the highly persistent herbicide atrazine and its metabolites caused the most exceedances — even though atrazine has been banned since 2007 (see Figure 3).

Figure 3. Exceedances of a) effect thresholds in Europe's surface waters for the pesticide imidacloprid in 2020; and b) quality standards in Europe's groundwater for the pesticide atrazine in 2020



Reference data: © EuroGeographics, © FAO (UN), © TurkStat Source: European Commission - Eurostat/GISCO

Exceedances of (left) effect thresholds in Europe's surface waters for the pesticide imidacloprid in 2020; and (right) quality standards in Europe's groundwater for the pesticide atrazine in 2020

Yes
Unknown
No
Delivered data
No data delivered
Outside coverage

0 500 1,000 1,500 km

Note: 'Unknown' means that the substance was detected but the concentration was below the limit of quantification (LoQ) and the LoQ was higher than the assessment threshold. This means that it is impossible to determine whether there was an exceedance or not. The data reported for imidacloprid in surface waters cover 16 countries. The data reported for atrazine cover 18 countries. For the methodology, see ETC/ICM (2020).

Source: EEA (2022b).

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In fact, most substances for which high numbers of exceedances are seen across Europe are no longer approved in the EU. This points to the long-term impacts of pesticide use and possible emergency uses. At the same time, Europe-wide monitoring data on recently approved pesticides, as well as data on co-formulants and adjuvants, are generally not available. The proposed revision of the EU's water legislation partly seeks to address this gap. It proposes to monitor additional pesticides and pesticide degradation products as priority substances; it also aims to set a standard for total pesticides in surface waters to address the combined effects of mixtures.

With respect to terrestrial ecosystems, there are currently no EU quality standards for pesticides in soils. The planned European soil health law, announced in the EU soil strategy for 2030, may address this gap by specifying the conditions for ‘healthy’ soil and determining options for EU-wide soil monitoring (Pieper et al., 2023). At the same time, the Joint Research Centre’s (JRC) Land Use and Coverage Area frame (LUCAS) database includes data on pesticide residues in EU agricultural soils (Orgiazzi et al., 2022). A study based on data from the LUCAS 2015 survey found that 83% of topsoil samples contained one or more pesticide residues, while 58% contained mixtures of two or more pesticides. The most common mixture detected was the herbicide glyphosate and its metabolite aminomethylphosphonic acid (AMPA), representing 25% of all pesticide combinations in soil (Silva et al., 2019). In a separate study in three EU countries, soils from organic farms were found to contain significantly fewer residues than those from conventional farms (Geissen et al., 2021).

How pesticides impact ecosystems

Pesticides are intrinsically harmful to living organisms. When used outdoors, they can impact ecosystems even when they are intended to exclusively target a specific pest. If pesticide levels exceed critical thresholds, individually or as mixtures, they affect ecological processes and make ecosystems less diverse and resistant to disturbances. Importantly, pesticides have also become increasingly effective, meaning that they may have the same negative impact even when applied in lesser volumes (Schulz et al., 2021).

Although there is no EU-wide system to monitor species’ exposure to pesticides, residues in crops, wild plants, soils, air and water possibly expose a wide range of terrestrial and aquatic organisms, including microbes. For example, pesticide residues are routinely found in bee colonies, nectar and pollen (Zioga et al., 2020; Murcia-Morales et al., 2021). Many studies document the exposure of other non-target organisms (Corcellas et al., 2015; Lennon et al., 2020; Fritsch et al., 2022), including inside nature conservation areas (Brühl et al., 2021).

Recent assessments show that pesticide exposure is linked to a wide range of direct (both lethal and non-lethal) and indirect effects on biodiversity, contributing to declines in populations of insects, birds, bats, earthworms, aquatic plants, fish and amphibians, among others (Mamy et al., 2022). In many cases, impacts are linked to banned substances, such as neonicotinoid insecticides for pollinators, terrestrial mammals and birds (Pisa et al., 2021), or the insecticide chlorpyrifos for bats (Eidels et al., 2016). At the same time, there is also evidence of adverse effects from approved substances. For example, cypermethrin impacts fish (Ullah et al., 2018) and glyphosate may affect food webs (Russo et al., 2020; Iwasaki and Hogendoorn, 2021). The synergistic effects of pesticide mixtures on various organisms have also been documented (Siviter et al., 2021; Cedergreen, 2014).

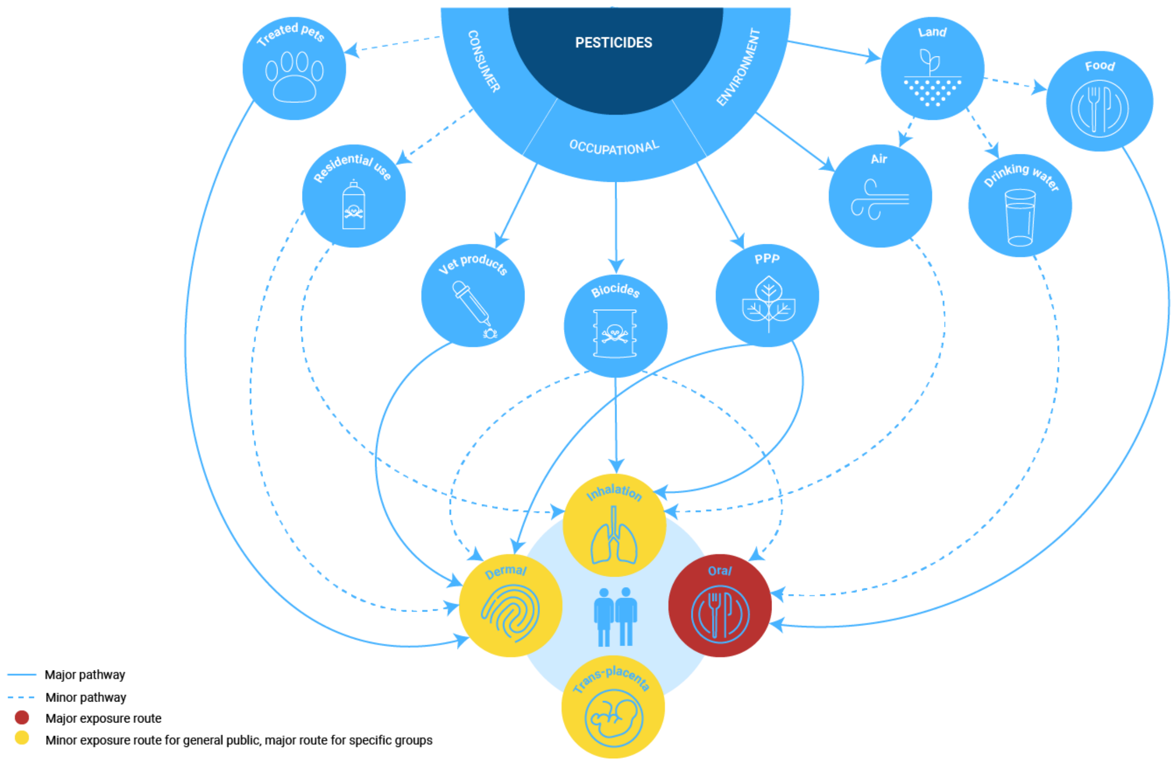
Insects and other invertebrates are the most directly impacted by pesticides. There are drastic rates of insect decline across the globe (Wagner, 2020). In Europe, various studies from across the region demonstrate significant reductions in insect abundance, diversity and biomass (van der Zee et al., 2014; Dennis et al., 2019; Fox et al., 2023). A German study documented a 76% decline in flying insects in protected areas over 27 years and identified pesticides as a driver (Hallmann et al., 2017). Similarly, a report on 576 butterfly species in Europe found that fertilisers and pesticides negatively affected 80% of them (Sánchez-Bayo and Wyckhuys, 2019). This also indirectly affects insect-eating birds and farmland birds: the extensive use of pesticides is one of the primary factor responsible for their decline in Europe and beyond (Mineau and Whiteside, 2013; EEA, 2020).

The new deal for pollinators specifically acknowledges pesticides such as neonicotinoids as a major driver of pollinator decline, alongside the need to improve pollinator conservation to protect their contribution to food security. Crops that depend on pollinators are a major dietary source of many key nutrients such as dietary lipids, vitamins A, C, and E and some minerals. (Eilers et al., 2011). Future crop losses linked to pollinator decline may reduce human intake of certain food groups such as fruits, vegetables and nuts. This could lead to an increase in non-communicable diseases such as strokes, cardiovascular disease and cancer (Smith et al., 2022).

How pesticides impact human health

People can be exposed to pesticides through diet, in areas where pesticides are applied and at work. Diet is the main source of exposure to pesticides in the general population due to pesticide residues on food, in particular fruits and vegetables but also food products of animal origin (HBM4EU, 2022b). They can also contaminate drinking water. Occupational exposure may occur when workers in farms, forests or urban areas apply pesticides, as well as while maintaining spraying machinery or using materials treated with pesticides. Agricultural workers have been found to carry pesticides home on their clothing, exposing their families (Hernández et al., 2019), while people living near fields where pesticides are applied can be exposed through pesticide drift and volatilisation (Teysseire et al., 2021).

Figure 4. Overview of human exposure routes and pathways for pesticides



Note: Bold line denotes a major exposure pathway, whereas dotted line denotes a minor pathway. Red circles denote a major exposure route. Yellow circles denote a minor exposure route for the general population which may nevertheless be a major route for specific groups.

Source: adapted from HBM4EU (2022b).

Recent monitoring data on pesticide residues in food, held by the European Food Safety Authority (EFSA), suggest that dietary exposure to individual pesticides is unlikely to pose a risk to consumer health. However, the methodology did not account for possible mixture effects. In 2020, maximum residue levels were exceeded in only 1.7% of samples from the most consumed food commodities in Europe. Yet the exceedance rates for some of these commodities — for example, rice (6.7%) and dried beans (4.9%) — increased between 2017 and 2020. The figures for other food groups (e.g. grape leaves, cumin seeds, mate or wild terrestrial animals such as deer and boar) can be significantly higher (EFSA et al., 2022a).

Moreover, various studies at the national level identified pesticides in drinking water. A Dutch study focused on recently-authorised pesticides excluded from routine monitoring and found seven at levels above the drinking water quality standard (Sjerps et al., 2019). A Danish study estimated that

41% of Danish households were potentially exposed to pesticides in drinking water between 2015 and 2019 (Voutchkova et al., 2021). In Ireland, 4.5% of drinking water supplies exceeded the standard for pesticides (EPA, 2021).

Regarding pesticides in air, concentrations can rise significantly during spraying periods and are usually higher in agricultural areas (Marliere et al., 2020; Figueiredo et al., 2021). A recent review suggests that people living close to these areas may be more exposed than the general population (Dereumeaux et al., 2020).

To better understand human exposure to pesticides in Europe, the European Human Biomonitoring Initiative (HBM4EU) conducted a large-scale human biomonitoring survey in adults and children across five European countries between 2014 and 2021. In total, at least 46 pesticides and their metabolites were identified (Huber et al., 2022), with at least two pesticides detected in 84% of the samples collected (Ottenbros et al., 2023).

The specific substances the HBM4EU studies focused on were widespread in the samples, with detection rates of over 90% for pyrethroids and the now-banned chlorpyrifos. For glyphosate and AMPA, exposure was similarly wide across the EU but at low concentrations. Worryingly, all of the pesticides monitored under HBM4EU were detected in higher concentrations in children than in adults (HBM4EU, 2022b; Govarts et al., 2023). Compared to their body weight, children tend to consume more food than adults. High fruit and vegetable consumption in particular, which tends to be associated with higher socio-economic status, has been linked to higher exposure to organophosphate pesticides in both pregnant women and children (Montazeri et al., 2019; Papadopoulou et al., 2019). In contrast, organic fruit and vegetable consumption has been linked to lower pesticide levels in the human body, both in children and adults (Papadopoulou et al., 2019) (see also the case study from Cyprus).

It is not yet possible to derive estimates of the burden of disease from pesticides in Europe, either for the general population or for specific groups. However, strong or suspected links have been established between exposure to pesticides and increased risk of several chronic diseases, including:

- various types of cancers (e.g. Non-Hodgkin lymphoma, multiple myeloma, ovarian, breast, brain and prostate cancers);
- neurological disorders such as Parkinson’s and Alzheimer’s diseases;
- cardiovascular diseases;
- developmental delays in children;
- effects on reproductive capacity and male and female infertility;
- cognitive impairments;
- impaired respiratory health.

While it is not always possible to identify the active substances involved, certain groups of pesticides have sometimes been associated with increased risk of certain types of health effects. These include ‘legacy’ pesticides such as organochlorines (e.g. DDT and lindane) as well as organophosphates and pyrethroids in relation to neurodevelopmental disorders and prostate cancer; or glyphosate for Non-Hodgkin lymphoma[3] , among others (see Figure 5).

Importantly, even when exposure to individual pesticides may be low, mixtures of pesticides and other chemicals can cause effects (Rizzati et al., 2016; Kortenkamp et al., 2021). In addition, some pesticides are endocrine-disrupting chemicals, potentially affecting health even at low doses (Leemans et al., 2019). Lastly, some potential toxicological effects connected to exposure to active substances in pesticides may not be adequately detected by existing test methods. These include diabetes, Parkinsonian disorders, childhood leukaemia, immunotoxicity, mental illnesses and other neuropsychological effects (SAPEA, 2018).

Some groups, including pregnant and lactating women, children and the elderly, are particularly susceptible to pesticides’ harmful effects. There are windows of vulnerability when developing body systems are particularly sensitive to certain chemicals. For example, early life exposure to organophosphate pesticides has been linked to cognitive and behavioural deficits and neurodevelopmental disorders (Hertz-Picciotto et al., 2018), and respiratory symptoms such as asthma (Raanan et al., 2015).

Evidence also suggests that the association between pesticide exposure and many of these diseases is generally stronger in occupationally-exposed groups such as agricultural and forestry workers (EU-OSHA, 2020). There is also a strong link between the children of those exposed occupationally and diseases such as childhood leukaemia and central nervous system tumours (Inserm, 2022).

Figure 5. Overview of health effects associated with exposure to HBM4EU priority pesticides

Target organ of the body	Effects	Relevant substances	Adults (men)	Adults (women)	Infants/foetuses
Brain/Neurological system	Disturbance of neurodevelopment e.g. cognitive deficits	Pyrethroids	Not applicable	Not applicable	Suspected
		Glyphosate-based herbicides	Not applicable	Not applicable	More evidence needed
		Organophosphates (Chlorpyrifos/Dimethoate)	Not applicable	Not applicable	Strong evidence
	Behavioural disorders	Pyrethroids	Not applicable	Not applicable	Strong evidence
		Organophosphates (as a group)	Not applicable	Not applicable	Suspected
Blood system	Childhood leukemia	Pyrethroids/Chlorpyrifos	Not applicable	Not applicable	Suspected
Endocrine system	Endocrine disrupting effects	Pyrethroids/Organophosphates (as a group)	Suspected	Suspected	Suspected
		Glyphosate-based herbicides	More evidence needed	More evidence needed	More evidence needed
Immune system	Immunotoxic effects	Pyrethroids	More evidence needed	More evidence needed	More evidence needed
		Organophosphates (as a group)	Suspected	Suspected	Suspected
Reproductive system	Reproductive effects	Organophosphates (as a group)	More evidence needed	More evidence needed	More evidence needed
		Pyrethroids	Suspected	Suspected	Suspected
		Glyphosate-based herbicides	More evidence needed	More evidence needed	More evidence needed
Non-organ specific	Carcinogenic	Organophosphates (Chlorpyrifos/Dimethoate)	Suspected	Suspected	Suspected
		Pyrethroids	Suspected	Suspected	Suspected
		Glyphosate-based herbicides	Suspected	Suspected	Suspected

Key:
- Strong evidence
- Suspected
- More evidence needed
- Not applicable

Note: The approach used to categorise evidence strength for each substance is based on HBM4EU (2022b). For some effects, the categorisation itself has been updated to reflect new evidence, based on expert judgement. Specifically for glyphosate's suspected carcinogenic effects, the strength of evidence was assessed in HBM4EU based on the evaluation conducted by the International Agency for Research on Cancer. Of note, this evaluation diverges from the conclusions of other authorities, most notably the European Chemicals Agency and the EFSA[3].

Source: adapted from HBM4EU (2022b).

Reducing pesticide use and risk

Despite progress in many Member States, pesticide pollution and its associated impacts on health and the environment have either remained unchanged or worsened since the directive on the sustainable use of pesticides was adopted (EC, 2022a). Achieving the targets set in the farm to fork strategy will thus require additional efforts on the part of EU policymakers and Member States alike. These efforts should not only aim to reduce the current use of pesticides and associated risks: they should also prevent new risks at the stage of risk assessment and market authorisation.

As a first step, current risk assessment procedures should be improved to better capture pesticide impacts at the ecosystem level and address scientific uncertainty, in line with the precautionary principle that underpins the regulation on plant protection products. This includes, among other things:

- developing more integrated risk assessment methodologies to better assess risks to health and the environment, as currently attempted by the EFSA (EFSA et al., 2022b, 2022c), and the interaction of pesticides with other stressors such as climate change;
- taking into account combined exposure to mixtures of different chemicals (Drakvik et al., 2020; HBM4EU, 2022a);
- accelerating test method development to determine pesticides' toxicity to pollinators, as proposed in the new deal for pollinators;
- improving the risk assessment of co-formulants, adjuvants and novel biopesticides (SAPEA, 2018);
- simplifying risk assessment procedures and moving towards generic risk assessment to reduce the risk of regrettable substitutions, in line with the chemical strategy for sustainability.

Improving EU-level information on pesticide use is also essential to understanding and managing risks. This can include requiring more systematic post-marketing surveillance, strengthening farm-level data collection on pesticide use (as suggested under the proposed regulation on sustainable use), and expanding human biomonitoring and environmental monitoring. Regarding the latter, monitoring should cover newly-approved active substances and other substances such as co-formulants and adjuvants, with a broader range of indicator species. The upcoming proposal for a soil health law can provide an important opportunity to introduce requirements to systematically monitor pesticides in soils.

When an active substance is withdrawn from the market due to new evidence, emergency authorisations should be subjected to greater scrutiny. When Member States repeatedly grant these kinds of authorisations, efforts to eliminate harmful pesticides are compromised.

In terms of reducing current pesticide use and risks, the proposed regulation on the sustainable use of plant protection products and the new common agricultural policy (CAP) also offer several instruments.

Setting binding national targets to reduce pesticide use and risk, and clear rules for the application of integrated pest management (IPM), as mandated in the proposed regulation, will be key to achieving the farm to fork targets. However, evaluations demonstrate that Member States have unevenly implemented IPM and national action plans to reduce pesticide use under the current directive on the sustainable use of pesticides (ECA, 2020; EC, 2022b). There is thus a need to adopt more effective measures ensure compliance by Member States and implementation by pesticide users[4].

Policy measures to reduce pesticide use and manage risks at the farm level include providing training and information to professional users (see the case study from Sweden) and advisors; incentives for the transition to organic farming (see the first case study from France) and precision farming; support to implement IPM (see the case study from Malta); and introducing higher taxes for more hazardous pesticides (Nielsen et al., 2023). The new CAP may support the implementation of such measures by setting mandatory requirements for crop rotation, and non-productive areas and features on arable land to support biodiversity. It also offers Member States the possibility to financially supports practices going beyond this baseline. Currently, 26% of EU agricultural land stands to receive support explicitly to reduce pesticide use and risk through IPM or pesticide management. The size of the EU agricultural area receiving CAP support for organic production is also foreseen to come close to 10% by 2027 (EC, 2022c).

To mitigate impacts on human health and ecosystems, it is important to restrict or ban pesticide use in public spaces, areas used for drinking water abstraction, and, where possible, ecologically sensitive areas. Such restrictions on use, which are included in the proposed regulation on the sustainable use of plant protection products and in some of the CAP strategic plans adopted by Member States, also require appropriately-sized buffer strips around sensitive areas in which spraying is banned (Aguiar et al., 2015). Banning or restricting pesticide use in public spaces is an increasingly popular measure at national and sub-national levels, as demonstrated by the ‘Pesticide Free Towns’ initiative (Pesticide Action Network Europe, 2022) (see the second case study from France). Achieving the same objective in all ecologically sensitive areas will be more difficult, considering that more than 30% of the EU terrestrial area covered by protected areas[5] is currently agricultural land. Where some pesticide use remains unavoidable, authorised uses could be limited to low-risk, active substances and substances allowed in organic farming (Bär et al., 2022). This would support efforts to improve pollinator populations under the new deal for pollinators.

Final reflections

It has been suggested that reducing chemical pesticide use in Europe will negatively impact some crop yields and net exports in the short-and-medium term (Barreiro-Hurle et al., 2021a). However, existing models do not necessarily consider the medium-long-term positive impacts that will result from other policies under the European Green Deal (e.g. food waste reduction, shifts towards plant-based diets, measures to improve organic farming efficiency and increase biodiversity in agricultural areas) (Barreiro-Hurle et al., 2021b). They also do not consider that EU research and innovation could possibly increase access to alternatives to synthetic pesticides, such as novel biopesticides and plants obtained through new genomic techniques.

Food supply is not at stake in the EU today. The EU is largely self-sufficient for key agricultural products, is a main wheat and barley exporter, and is largely able to cover its consumption of staple crops such as maize and sugar (EC, 2022d). Yet if pesticide use is not sufficiently curbed, pesticides will continue to reduce natural pest control (Bonato et al., 2023), impact pollinator populations (Sponsler et al., 2019), and harm microorganisms that support plant growth (Edlinger et al., 2022). This means that over the medium- to long-term, excessive pesticide use is likely to negatively affect food security.

Industrial agriculture’s heavy reliance on chemical pesticides is increasingly being challenged in light of alternative agricultural models (IPES-Food, 2016). We could reduce our dependency on pesticides to maintain crop yields by shifting towards agroecology, intercropping, soil conservation management and crop diversification (EEA, 2022a). In addition to their benefits for biodiversity and soil quality, these practices have increasingly been shown to preserve crop productivity and farm profitability (Lechenet et al., 2017; Rega et al., 2019; Tibi et al., 2022). Together with ambitious policies addressing the other components of the food system, they could help us achieve chemical pesticide-free agriculture in Europe (Mora et al., 2023).

Case studies

The case studies listed below present examples of good practice at farm, city and national levels in reducing the use and risk of chemical pesticides. They have been prepared based on information reported by the Eionet Group on Food Systems. The National Research Institute for Agriculture, Food and Environment (INRAE) contributed to the two case studies from France.

- Project Vemmenhög: helping farmers reduce pesticide concentrations in Vemmenhög, Sweden with information
- AgriHub Project for integrated pest management in Malta
- **Reducing children’s exposure to pesticides by providing organic food in Cypriot schools**
- **Organic sugar beet production and robotics use in France**
- **Banning pesticide use in French cemeteries**

Notes

[1] In Austria, the volume of pesticide sales is partly inflated by the use of inert gases such as carbon dioxide and sulphur in the storage of agricultural products.

[2] The ECA did not comment directly on the indicators included in the farm to fork strategy, which did not exist at the time. Their report focused on an earlier indicator developed by the European Commission to measure progress against the directive on the sustainable use of pesticides. Since these indicators partly share their methodologies, some of the observations made by the ECA apply to the new indicators, as well.

[3] The evaluation of glyphosate’s potential carcinogenic effects as part of the regulatory process for

pesticides has attracted increasing attention, particularly following the decision of the International Agency for Research on Cancer to classify it as probably carcinogenic. In Europe, the current risk assessment for glyphosate conducted by the European Chemicals Agency holds that classifying glyphosate as a carcinogen is not justified in light of available scientific evidence, although it finds that glyphosate causes serious eye damage and is toxic to aquatic life. As EFSA is expected to conclude a peer review of its own, separate assessment in July 2023, the current approval for using glyphosate in the EU has been extended until 15 December 2023. The use of different approaches and available data in these assessments may help explain their diverging conclusions.

[4] Of note, an ‘IPM Toolbox’ to support farmers in the transition to IPM has recently been developed by the European Commission, following a request from the European Parliament (EC, 2023b).

[5] This includes both Natura 2000 and nationally-designated areas (CDDA).

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