POLICY BRIEF

Strengthening Pesticide Post-Market Surveillance: Lessons from SPRINT

- **Post-market pesticide monitoring is needed to identify real-world risks and effects that pre-market assessment cannot capture.** Current EU programmes remain fragmented, with major gaps for soil, air and indoor dust and limited standards for pesticide mixtures. More coordinated surveillance is needed across environmental media and exposure pathways, supported by benchmarks for pesticide residues and mixtures.

- **Human biomonitoring is needed to measure real-world aggregate and cumulative exposure.** Coordinated EU programmes and harmonised biological guidance values (BGVs) would help identify exposure hotspots and protect vulnerable populations.

- **Spatially explicit pesticide-use data can support more targeted risk reduction.** Combining monitoring results with pesticide-use data and models can identify high-risk pesticide–crop combinations and regions, helping to target substitution, reduced use and alternative management practices.

- **Post-market evidence should play a stronger role in regulatory decision-making.** Surveillance findings should provide a clearer basis for reviewing, restricting or withdrawing pesticide approvals when unacceptable risks are identified.

Further reading

Riedel, A., Hendricks-Franco, L., Bibu, T., Meier, J., Rouillard, J., et al. (2025). Transition pathways and policy recommendations (Deliverable D7.3). SPRINT Project, Horizon 2020, Grant Agreement No. 862568.

This briefing draws on research funded by EU-funded H2020 SPRINT (Grant Agreement No. 862568).

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https://sprint-h2020.eu

Background

The EU has established an extensive framework to assess and manage the risks of plant protection products (PPPs) to human health and the environment. While pre-market authorisation under Regulation (EC) No 1107/2009 aims to prevent unacceptable risks before pesticides enter the market, **post-market surveillance is needed to detect and respond to exposures and impacts arising under real-world conditions of use.**

Significant gaps nevertheless remain. **EU pesticide surveillance is fragmented across policies on food and feed residues, water, drinking water and soil.** Binding monitoring requirements and thresholds exist for food, drinking water, groundwater and surface waters, but most pesticide residues in soil, air and aquatic sediments are not subject to harmonised EU-wide standards. Human biomonitoring is also not systematically implemented, despite its value for understanding exposure among farmworkers, their families and nearby residents. **Links between monitoring results and decisions on pesticide approvals and risk management also remain weak.** Stronger feedback is needed so that evidence on contamination, human exposure and emerging risks leads to timely risk reduction and, where necessary, reassessment of approvals.

This policy brief presents SPRINT findings and recommendations for strengthening post-market pesticide surveillance in the EU. It shows how environmental monitoring, human biomonitoring and risk-prioritisation tools can improve risk detection, support targeted action and **ensure that regulatory decisions respond to new evidence and changing patterns of pesticide use and exposure**.

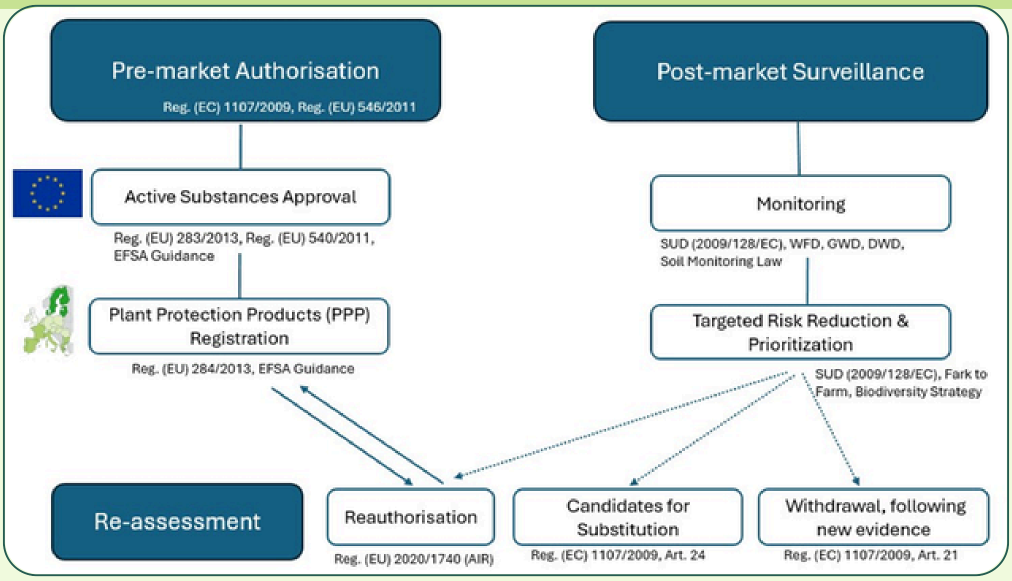


Figure 1: Key policies regulating and supporting pre-market authorisation and post-market surveillance of active substances and plant protection products (PPPs).

Monitoring Pesticides in Food and the Environment

Pesticides can move beyond their intended application area and contaminate air, water, soil, sediment, crops and indoor environments through leaching, runoff, spray drift, volatilisation, wind erosion and household deposition (EFSA, 2014; Goossens et al., 2026). Although pre-market assessments model these pathways, monitoring is needed to detect accumulation and mixture exposures that substance-by-substance assessment may not anticipate. Despite the EU Zero Pollution Action Plan's objective to reduce pesticide pollution, residues remain widespread across environmental compartments and in living organisms (EEA & JRC, 2025; Navarro et al., 2024).

EU pesticide monitoring remains fragmented across environmental compartments, and existing thresholds do not consistently account for pesticide mixtures (Table 2). Monitoring is strongest for food and water but remains limited or absent for soil, air and aquatic sediment. Under the Water Framework Directive and Environmental Quality Standards Directive, only selected priority substances in surface waters are subject to specific standards, while the combined limit applies only to the sum of those listed pesticides. Groundwater and drinking-water rules set limits for individual and total pesticides, but the substances included in monitoring may vary, meaning that not all residues present are necessarily captured. Food maximum residue levels (MRLs) apply to individual substances but not to the total number or quantity of residues in individual food items or across the diet. No harmonised EU pesticide thresholds exist for air or soil.

The Soil Monitoring Directive (2025) creates new opportunities to monitor pesticide contamination but falls short of setting clear thresholds and trigger values for pesticides in soil. It requires Member States to monitor contaminants of concern, including pesticides and their metabolites, and provides for an indicative EU watch list of soil contaminants that may include pesticides. However, it does not set harmonised thresholds, trigger values or assessment criteria for pesticide residues. Risk-based benchmarks and assessment methods will therefore be needed to translate monitoring results into consistent risk assessment and management across the EU.

Table 2: EU Monitoring Requirements for Pesticide Residues

EU policy	Monitoring focus	Scope and mechanisms	Key gaps / limitations
Regulation (EC) No 396/2005 on pesticide MRLs in food and feed	Pesticide residues in or on food and feed (plant and animal).	Harmonised maximum residue levels (MRLs) with default 0.01 mg/kg. EU-coordinated and national control programmes support an annual EFSA report.	No MRLs for total quantity or number of residues. Does not address environmental or non-dietary exposure.
Water Framework Directive (2000/60/EC) - Environmental Quality Standards (EQS) Directive (2008/105/EC)	Select pesticide priority substances and relevant river basin-specific pollutants in surface waters.	Substance-specific EQS apply to listed pesticides. Annual average EQS of 0.2 µg/L for the sum of listed pesticides (in force Dec. 2027).	Only a limited number of pesticides are listed as EU priority substances. Monitored substances can vary by Member State.
Drinking Water Directive (EU) 2020/2184	Pesticide residues and some metabolites in drinking water.	Quality standards: 0.1 µg/L per pesticide and 0.5 µg/L total.	Only pesticides likely to be present in a given water supply must be monitored.
Groundwater Directive (2006/118/EC)	Pesticide active substances and some metabolites in groundwater.	Quality standards: 0.1 µg/L per individual pesticide and 0.5 µg/L total.	The generic total-concentration standard does not account for differences in toxicity among substances.
Ambient Air Quality Directive (2024/2881)	Pesticides not included.	-	No pesticide monitoring requirements or quality standards.
Zero Pollution Action Plan (COM/2021/400)	Monitoring and reporting on pollution trends across air, water and soil.	Non-binding EU-wide pollution reduction targets.	Non-binding and does not establish pesticide monitoring obligations or thresholds.
Natura 2000 (Birds and Habitats Directives)	Pressures and impacts in protected areas, including pesticide pollution where relevant.	Site-specific pesticide monitoring as a pressure in sensitive habitats.	No harmonised requirements or thresholds for monitoring pesticide residues.
Soil Monitoring Directive (2025/2360)	Soil health and selected contaminants, including pesticides.	EU-wide soil monitoring, with pesticides selected by Member States and guided by an indicative EU list.	No harmonised EU thresholds for pesticide residues. No trigger values for action.

Key Findings: Pesticides in the Environment

- **Pesticide mixtures were widespread in the environment.** Mixtures were detected in nearly all samples of air, water, soil, aquatic sediments and indoor dust, with many containing residues hazardous to humans or non-target organisms (Alaoui et al., 2024; Khurshid et al., 2024; Navarro et al., 2023, 2024; Silva et al., 2023).

- **Measured pesticide concentrations in the environment often differed from regulatory predictions.** For example, measured soil concentrations (MEC_{soil}) were poorly correlated with EFSA-predicted environmental concentrations (PEC_{soil}), highlighting limitations in current exposure models (Knuth et al., 2024).

- **Ecotoxicological testing of realistic pesticide mixtures revealed risks to non-target species.** Native aquatic and soil organisms showed sensitivity to pesticide mixtures at concentrations measured in SPRINT monitoring campaigns, highlighting risks that may not be fully captured by standard regulatory testing (Abrantes, Campos, Ré, Muniz-Gonzalez, et al., 2024; Tourinho et al., 2024; Suciu et al., 2026).

- **The SPRINT prioritisation index can help translate monitoring data into action.** By combining pesticide occurrence, distribution and hazard, it identifies substances of greatest concern and supports risk-based prioritisation of monitoring, regulatory review and risk-reduction measures (Silva et al., 2023).

Recommendations

1. **Introduce legally binding, risk-based benchmarks for pesticide residues in soils, aquatic sediments and air,** with clear thresholds and triggers for corrective action when exceedances occur.

2. **Incorporate pesticide mixtures into EQS and MRLs** by setting thresholds for both the concentration and total number of residues, alongside substance-specific limits.

3. **Use the SPRINT prioritisation index to support implementation of the Soil Monitoring Directive.** The index can help interpret monitoring results, identify pesticides that should be prioritised for reduction and inform their possible inclusion in the indicative EU watch list.

4. **In future revisions of the Soil Monitoring Directive, establish stronger trigger values for pesticide residues,** compelling action for remediation, risk reduction and regional land-management responses.

Human Biomonitoring

Humans are exposed to pesticide mixtures through food and drinking water, as well as through non-dietary pathways such as air and dust, with farmers, their families and nearby residents generally facing higher exposure than the wider population (Shekhar et al., 2024). Human biomonitoring (HBM) measures pesticide residues or metabolites in human blood, urine, faeces and hair, capturing real-world aggregate and cumulative exposure across multiple sources and pathways. An HBM survey in five European countries found markers of two or more pesticides in 84% of sampled children and adults (Zero Pollution Dashboard, 2024). **Currently, no EU legislation or programme mandates systematic HBM of exposed groups or the wider population.**

Current exposure assessments only partly addresses this gap. **The Acceptable Daily Intake (ADI) remains the main exposure threshold used across EU pesticide policy**, but it is substance-specific and covers only long-term dietary intake. ADI does not account for exposures from the environment. EFSA and the Dutch National Institute for Public Health and the Environment (RIVM) are developing and applying the Monte Carlo Risk Assessment (MCRA) approach to assess cumulative exposure to pesticide mixtures and aggregate exposure across dietary and non-dietary routes. However, modelling cannot replace HBM or provide a clear threshold for interpreting pesticide concentrations measured in humans.

Interpreting HBM results requires biological guidance values (BGVs) against which measured concentrations can be compared. BGVs have been developed through HBM4EU, PARC and initiatives in Member States including Germany and the Netherlands (Kommission Humanbiomonitoring, 2014; Health Council of the Netherlands, 2025), but are not yet harmonised or consistently applied across the EU. Harmonised EU BGVs are therefore needed to complement the dietary-focused ADI, identify exposure hotspots and support earlier public health action.

Key Findings: Human Biomonitoring

- **Pesticide mixtures are frequently found in human environments.** Residues were detected in homes and on personal wristbands, including more than 100 different pesticides in some farmers' homes and substantial numbers in non-farming households (Navarro et al., 2023; Silva et al., 2023). These findings indicate important non-dietary exposure pathways, particularly for farmers, residents and young children (Debler et al., 2024; Silva et al., 2023; Figueiredo et al., 2025b).
- **Human biomonitoring showed widespread low-level exposure to pesticide mixtures.** Pesticide residue mixtures were detected in faeces, urine and blood samples from most participants. Although exposure varied substantially and most levels were below safe thresholds, the prevalence of threshold exceedances among farmers and residents remains unknown (Scheepers et al., 2025).
- **Non-dietary sources can make an important contribution to total pesticide exposure.** While diet was usually modelled as the dominant exposure pathway, non-dietary sources and pathways may contribute substantially in occupational settings, for certain pesticides and due to dust ingestion (Figueiredo, D. M., Huss, A., et al., 2025; Wieland et al., 2026).

Recommendations

1. **Establish harmonised EU and national human biomonitoring programmes** to measure aggregate pesticide exposure across all routes and sources and identify exposure hotspots.
2. **Adopt harmonised biological guidance values (BGVs)** for pesticides across EU regulatory frameworks and require their development during active substance approval to support interpretation of biomonitoring results and management of aggregate and cumulative exposure. BGVs should account for vulnerable populations, such as children and pregnant women.

Pesticides were frequently detected in homes.

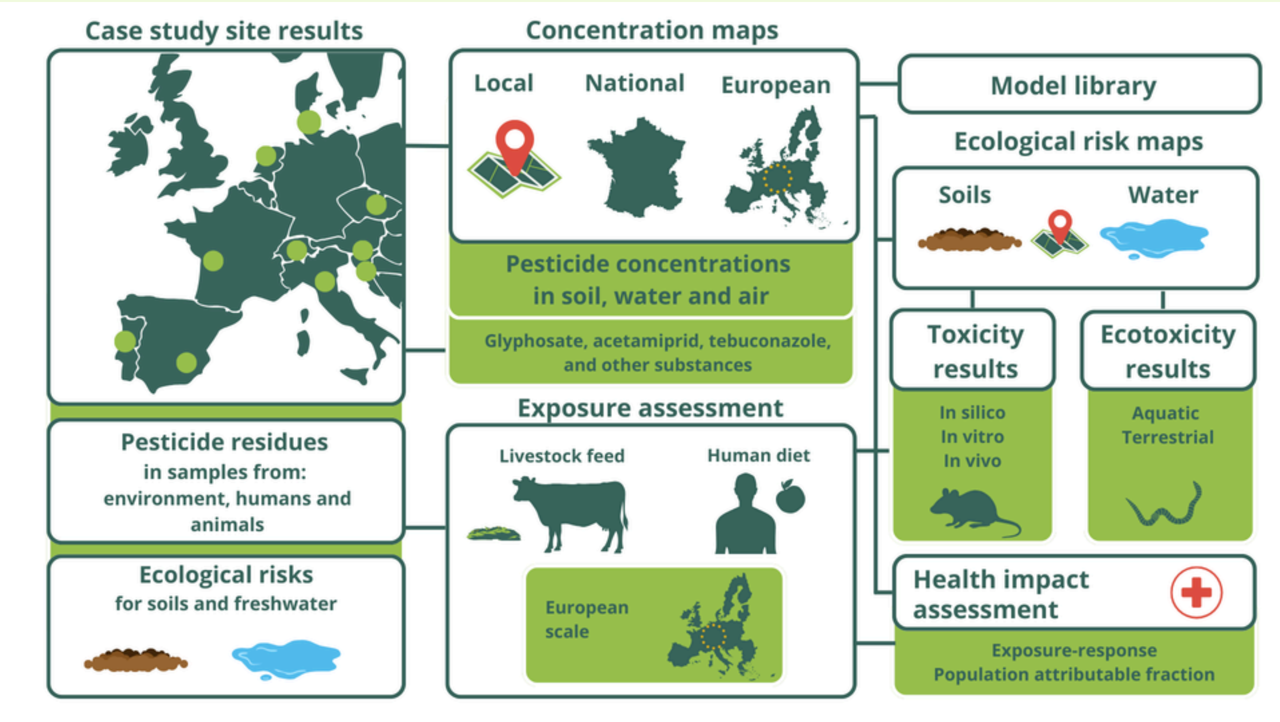
Scaling Up the Impact: Targeting Risk Reduction and Prioritising Action

Pesticide risks depend on where, when and how pesticides are used in practice (European Court of Auditors, 2020). Yet EU indicators such as Harmonised Risk Indicator 1 rely largely on sales data and cannot identify actual use patterns, mixture exposure or geographic hotspots. More detailed data are needed to pinpoint high-risk crops, farming systems and pesticide uses and target action more effectively.

The SPRINT Toolbox addresses this gap by combining pesticide-use, spatial and environmental data to map exposure and risks to humans and ecosystems across Europe. It identifies high-risk pesticide–crop combinations and priority areas for more targeted and cost-effective risk reduction.

However, the necessary data remain fragmented. **Pesticide authorisation registers are not harmonised or centrally compiled at EU level**, and only a few Member States maintain systematic farm-level application records. Although the SAIO Regulation (EU) 2022/2379 should improve reporting from 2028, limited high-resolution use data continue to constrain EU-wide exposure and risk modelling.

The SPRINT toolbox: available here: https://sprint-toolbox.eu/



Scaling Up the Impact: Targeting Risk Reduction and Prioritising Action

Key Findings from SPRINT

- **A small number of pesticides account for a disproportionate share of impacts.** Life-cycle analyses showed that environmental and health damage costs are often driven by a few substances with high toxicity (e.g. emamectin benzoate) or high application rates (e.g. captan) (Fantke et al., 2023a; 2023b).
- **The SPRINT Toolbox supports spatially explicit risk prioritisation.** It integrates PPP use data with spatial and environmental datasets to model spatio-temporal exposure and risk patterns for ecosystems and humans across Europe, helping identify hotspots and high-risk pesticide–crop combinations.
- **Harmonised national use and authorisation data would enable systematic prioritisation.** Currently, national PPP registers, use statistics and Eurostat data lack resolution, harmonisation, and accessibility for robust EU-wide exposure–risk modelling.

Recommendations

1. **Harmonise national PPP usage and authorisation registries across all Member States**, including information on pesticide mixtures, timing, quantity, crop, and application method, to support robust EU-wide exposure and risk assessment.
2. **Adopt tools and maps in the SPRINT Toolbox** to identify and target the pesticides and pesticide–crop combinations posing the greatest risks to human health and the environmen, using exposure models based on actual pesticide usage data.
3. **Complement HRI 1 with indicators based on actual pesticide use**, including annual SPRINT Toolbox risk maps and life-cycle damage cost estimates.
4. **Integrate life-cycle assessment (LCA) into EU pesticide reduction and prioritisation strategies** to identify pesticides with the greatest overall environmental and human health impacts across their full life cycle.

SPRINT TOOLBOX
SUSTAINABLE PLANT PROTECTION TRANSITION

Conclusions

SPRINT shows that real-world pesticide exposure, contamination and mixture effects are more complex than current regulation captures. Stronger post-market surveillance, including environmental monitoring, human biomonitoring and harmonised data, can support earlier risk detection and more targeted action. SPRINT findings should feed systematically into reviews of active substances and pesticide authorisations, as well as into the development of benchmarks and safety factors that better reflect aggregate and cumulative exposure.

Acknowledgements
This briefing draws on research funded by H2020 SPRINT (Grant Agreement No. 862568).

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About SPRINT

SPRINT is a 5-year international research project. It investigates pesticides' risks to health and the environment, and aims to accelerate the transition towards more sustainable plant protection.

The SPRINT project is funded by the EU under Horizon Europe. Project number: 862568.

https://sprint-h2020.eu

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