SPRINT
SUSTAINABLE PLANT PROTECTION TRANSITION

POLICY BRIEF

Strengthening Pre-Market Pesticide Risk Assessment: Lessons from SPRINT

- **Current EU pre-market pesticide risk assessment does not fully capture real-world risks.** Key gaps include the combined and cumulative effects of pesticide mixtures on ecosystem and human health, aggregate human exposure across dietary and non-dietary pathways, and risks during vulnerable life stages.

- **SPRINT findings show gaps in pre-market risk assessment and indicate approaches for addressing them.** The project measured more than 200 pesticide residues in environmental and human samples across 10 European countries, evaluated the effects of realistic exposures on human health and ecosystems, and developed new toxicological and ecotoxicological indicators that could strengthen existing regulatory approaches.

- **Pre-market risk assessment could be strengthened through more realistic and sensitive testing approaches.** These should account for pesticide mixtures arising from recommended uses across different cropping systems, legacy residues in ecosystems, and potential exposure from indoor dust. They should also expand the use of sensitive (eco)toxicological indicators, strengthen consideration of vulnerable life stages and better integrate assessment of non-dietary exposure.

- **Many of these changes could be implemented within the existing EU regulatory framework.** Updates to EFSA guidance documents and data requirements under Regulations (EU) 283/2013 and 284/2013 could help ensure that risk assessments better reflect real-world conditions of use.

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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Background: Risk Assessment and Approval of Pesticides

The EU has a comprehensive regulatory framework designed to ensure that pesticides do not pose unacceptable risks to human health or the environment before entering the market. Under Regulation (EC) No 1107/2009, approval and authorisation decisions are based on pre-market risk assessments grounded in the precautionary principle. These assessments, conducted according to scientific guidance developed by the European Food Safety Authority (EFSA), combine information on hazard (the intrinsic ability of a substance to cause harm) and exposure (the extent to which humans or the environment come into contact with it). The supporting data and evaluation requirements cover human toxicology, human exposure, ecotoxicology, and environmental fate and behaviour (Regulations (EU) 283/2013, 284/2013 and 546/2011; Table 1).

While the EU pesticide risk assessment is among the most comprehensive in the world, important challenges remain. Pesticides are assessed largely on a substance-by-substance basis, yet humans and ecosystems are exposed to complex and variable mixtures of active substances, metabolites, co-formulants, legacy pesticides, and other environmental contaminants. In addition, the ability of standard testing approaches to capture environmental variability, long-term and cumulative effects, sensitive life stages, and emerging toxicological and ecological endpoints remains an area of active scientific development.

This policy brief summarises key findings and recommendations from the SPRINT project on strengthening the sensitivity, realism, and precautionary basis of EU pesticide pre-market risk assessment. Improvements are suggested for each area of pre-market risk assessment (Table 1).

Table 1: Core components of EU pesticide pre-market risk assessment under Regulations (EU) 283/2013, 284/2013 and the Uniform Principles (Regulation (EU) 546/2011).

	Hazard	**Exposure**
Environmental Risk Assessment (546/2011 – Section 1.5, 2.5)	Ecotoxicological Studies (Reg. (EU) 283/2013 – Section 8, Reg. (EU) 284/2013 – Section 10)	Fate and Behaviour in the Environment (Reg. (EU) 283/2013 – Section 7, Reg. (EU) 284/2013 – Section 9)
Human Health Risk Assessment (546/2011 – Section 1.4, 2.4)	Toxicological Studies (Reg. (EU) 283/2013 – Section 5, Reg. (EU) 284/2013 – Section 7)	Dietary Exposure (Reg. (EU) 283/2013 – Section 6, Reg. (EU) 284/2013 – Section 8) Non-dietary Exposure (Reg. (EU) 284/2013 – Section 7)

Ecotoxicological Studies

Ecotoxicological studies assess the effects of active substances on non-target organisms in environments where pesticides occur. However, ecotoxicological assessments rely primarily on standardised, short-term *lower-tier* laboratory tests using a limited set of indicator species to identify adverse effects, mainly mortality and effects on reproduction. While these approaches provide a harmonised basis for ecotoxicological assessment, they do not fully capture variation in sensitivity among native species, indirect ecological interactions, ecosystem-level effects, long-term impacts or the complexity of real-world pesticide mixtures. *Higher-tier* multispecies and ecosystem studies can improve ecological realism by incorporating more complex biological interactions and ecosystem responses, but they often lack standardised methodologies. Furthermore, higher-tier studies are currently used mainly to overturn indications of toxicity in lower-tier tests, rather than to apply an additional level of precaution.

Key Findings from SPRINT

- **Pesticide mixtures can have ecotoxicological effects even when individual substances occur at low levels.** Realistic mixtures adversely affected terrestrial and aquatic organisms despite individual substances remaining below predicted environmental concentrations (PECs) considered acceptable in current regulatory assessments (Abrantes, Campos, Ré, Muniz-Gonzalez, et al., 2024; Tourinho et al., 2024).

- **Standard test species and endpoints do not adequately capture ecological sensitivity, as shown by testing with new SPRINT indicators.** Native species, including bees and earthworms, and novel endpoints such as soil functional genes and zebrafish swimming behaviour often showed different sensitivities from standard regulatory test systems (Abrantes, Campos, Ré, Muniz-Gonzalez, et al., 2024; Tourinho et al., 2024).

- **Current test durations may underestimate long-term ecological effects.** Effects on soil microbial communities emerged only after 56 days, whereas standard OECD tests often end after 28 days (Mäder et al., 2025).

- **Higher-tier studies reveal ecosystem effects that cannot be captured through standard lower-tier laboratory tests.** Terrestrial mesocosm experiments demonstrated bioaccumulation in earthworms, indicating potential biomagnification, while aquatic systems showed impacts on primary producers that could affect wider ecosystem functioning and food webs (Abrantes, Campos, Ré, Pereira, et al., 2024).

Ecotoxicological Studies: Recommendations

1. **Require more realistic mixture assessments in pre-market testing,** including recommended pesticide application schemes and tank mixtures, and account for pesticide residues already present in soils.

2. **Expand lower-tier ecotoxicological testing to include more sensitive species and endpoints,** including SPRINT indicators such as multispecies tests using native species, assessments of soil microbial functions and functional diversity, behavioural responses of aquatic organisms and early-warning indicators of ecological damage, including changes in gene expression and enzyme activity.

3. **Expand the use of higher-tier ecosystem testing and develop harmonised assessment guidelines** to improve ecological realism, consistency and transparency in regulatory decision-making.

4. **Apply more precautionary safety margins in ecotoxicological risk assessment to account for background environmental mixtures**, including by adjusting Toxicity Exposure Ratio (TER) thresholds.

Fate and Behaviour in the Environment

The goal of assessing the "fate and behaviour in the environment" in pesticide risk assessment is to evaluate how pesticides degrade, move, and persist across environmental compartments, including soil, water, sediment, groundwater, and air. This process establishes predicted environmental concentrations (PECs), which are used to estimate exposure of non-target organisms and determine whether pesticide use is likely to pose unacceptable environmental risks under realistic conditions of use. Because pesticide transport can extend beyond intended application areas, environmental fate assessments also play an important role in understanding off-site contamination and non-dietary human exposure.

Key Findings from SPRINT

- **Mixtures of pesticide residues are widespread in the environment, including compartments and exposure pathways not captured in regulatory assessments.** Mixtures detected in soil, water, sediment and air included residues of hazardous pesticides, comprising both currently approved substances and substances that are no longer approved, highlighting the importance of persistent residues and legacy contamination (Alaoui et al., 2024; Navarro et al., 2023, 2024; Silva et al., 2023).

- **Measured pesticide concentrations in the environment differed from EFSA regulatory predictions.** For example, measured concentration in soil (MECsoil) and surface water (MECsw) were poorly correlated with EFSA-predicted environmental concentrations (PECs), highlighting limitations in current exposure models (Knuth et al., 2024; Suciu et al., 2026).

- **Atmospheric transport and indirect contamination may be more important than regulatory models consider.** Pesticides were detected in 97% of atmospheric samples taken on-farm; 95% contained pesticide mixtures, and 91% contained mixtures considered hazardous to human health (Debler et al., 2024).

- **Wind erosion can drive off-site and potentially long-distance transport of particle-bound pesticides.** In the SPRINT field study, more than half of the measured glyphosate and AMPA was transported in suspension, while atmospheric modelling showed that fine contaminated particles could travel tens to hundreds of kilometres under suitable conditions (Goossens et al., 2026). SPRINT developed the SWIPPE model for wind erosion-related pesticide transport.

- **Local hydrology strongly influences pesticide fate and aquatic exposure.** Streamflow, rainfall, runoff, proximity to water bodies and drainage networks all affected modelled concentrations, underscoring the need for site-specific hydrological information in fate assessments (Suciu et al., 2026).

Fate and Behaviour in the Environment: Recommendations

1. **Account for existing environmental contamination when estimating predicted environmental concentrations (PECs)**, including pesticide mixtures, persistent legacy pesticide residues, and degradation products.

2. **Strengthen the evaluation of pesticide transport by wind erosion in environmental fate assessments** to better capture pesticide transport between treated fields and connected environmental compartments and indoor dust.

3. **Improve the representation and modelling of landscape connectivity and local hydrology in environmental fate assessments** to better capture pesticide transport between treated fields and connected environmental compartments.

4. **Strengthen the pre-market assessment of pesticide fate and degradation in indoor environments,** which are not adequately addressed by tests conducted under outdoor conditions, where degradation may be faster.

Human Exposure

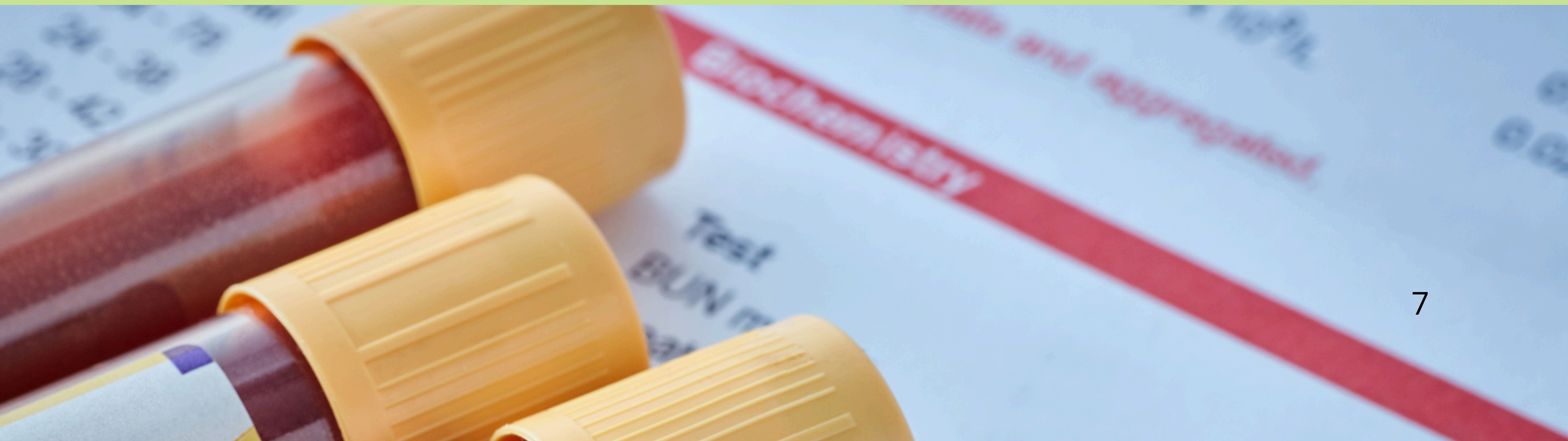
Human exposure assessment estimates pesticide exposure through dietary and non-dietary pathways, including ingestion, inhalation and dermal contact. Regulation focuses primarily on dietary exposure from food residues, using the *Acceptable Daily Intake (ADI)* as the main health-based guidance value. Non-dietary exposure is assessed mainly in relation to pesticide application and only for specified groups, notably operators, workers, residents and bystanders. It therefore does not systematically assess exposure across the wider population or in other everyday settings. Further challenges remain in accounting for aggregate exposure across pathways and cumulative exposure to multiple pesticides, particularly chronic low-dose exposure. The absence of routinely established Biological Guidance Values (BGVs) for pesticide concentrations in human samples also limits the interpretation of biomonitoring data and assessment of real-world exposure.

Key Findings from SPRINT

- **Pesticide mixtures are frequently present in human environments.** Pesticide residue mixtures were detected widely in homes and on personal wristbands, indicating multiple opportunities for non-dietary exposure. More than 100 different pesticide residues were detected in some farmers' homes, while substantial numbers were also found in non-farming households (Navarro et al., 2023; Silva et al., 2023). These potential non-dietary exposure pathways may be particularly relevant 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.** Mixtures of pesticide residues 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 European farmers and residents remains unknown (Scheepers et al., 2025).

- **Non-dietary sources can make an important contribution to total pesticide exposure.** While diet was modelled as the typically 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).



Human Exposure: Recommendations

1. **Better integrate non-dietary exposure into EFSA exposure assessments,** including aggregate exposure (dietary and environmental pathways) and cumulative exposure to multiple pesticides, across all exposed groups. Current non-dietary assessments focus mainly on application-related exposure of operators, workers, residents and bystanders and do not routinely capture chronic exposure through indoor dust or other background pathways.

2. **Apply additional safety factors to lower exposure thresholds (e.g. ADI) where critical toxicological data are lacking,** particularly for vulnerable populations and cumulative and aggregate exposure scenarios.

3. **Require, during pre-market assessment, the toxicokinetic and biomarker data needed to derive Biological Guidance Values (BGVs)** to support the interpretation of human biomonitoring data and post-market surveillance of cumulative and aggregate exposure.

4. **Develop reference values for pesticide residues, including mixtures,** in air and dust to support the assessment and management of non-dietary human exposure.

Human Toxicology Studies

Toxicology studies in pesticide risk assessment identify the intrinsic hazardous properties of pesticide active substances, including acute, chronic, developmental, reproductive, neurological, endocrine, and genotoxic effects. These studies are used to establish toxicological reference values, identify substances of high concern, and evaluate potential cumulative toxic effects of pesticides with similar modes of action. The toxicology work in SPRINT focused on improving the realism and sensitivity of toxicology testing approaches, as well as addressing the effects of mixtures.

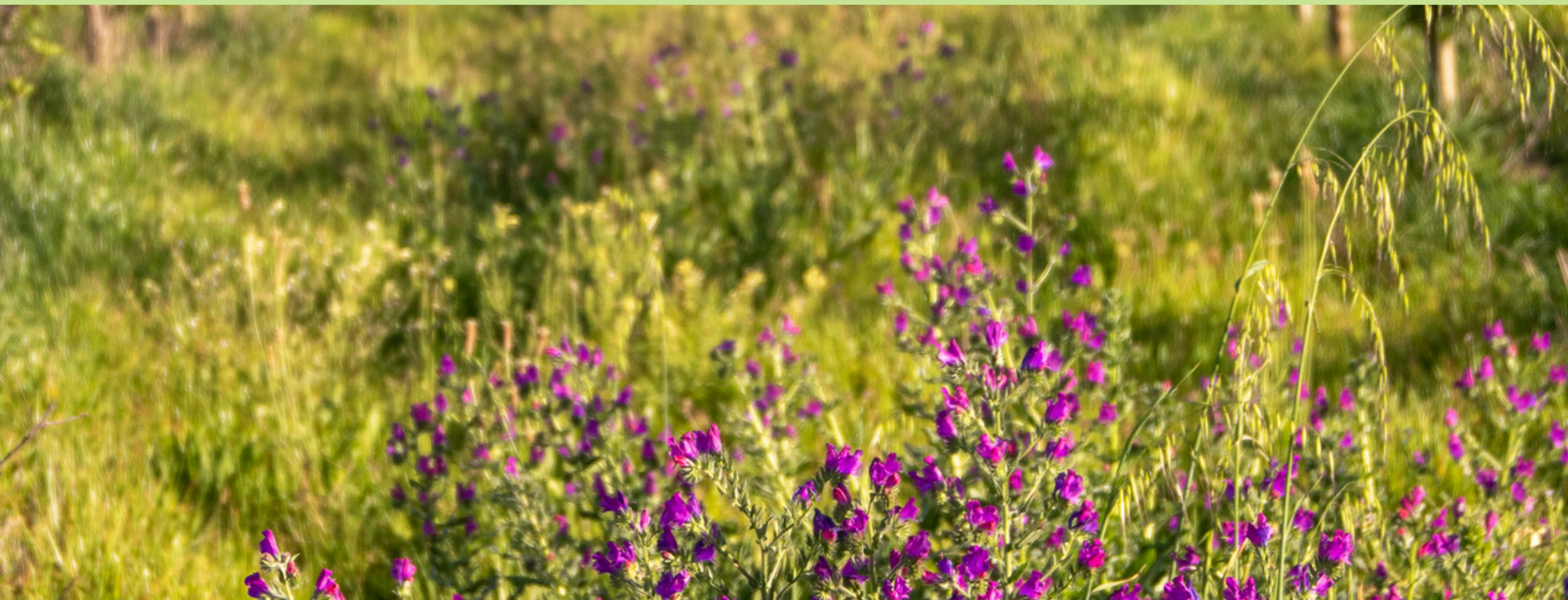
Key Findings from SPRINT

- **Mixture toxicity can exceed the effects of individual substances and can be assessed using appropriate methodologies.** Mixtures were generally more harmful than single substances. However, EFSA's component-based approach successfully predicted effects for known mixtures (Mandrioli et al., 2024, 2025).

- **New toxicological indicators may improve the sensitivity and realism of regulatory testing.** SPRINT developed and evaluated novel in vitro and in vivo indicators that detected effects not always captured by conventional testing approaches, suggesting their potential value for future regulatory assessments (Mandrioli et al., 2024, 2025).

- **Early-life stages may be particularly sensitive to pesticide exposure.** Prenatal and early-life exposures were associated with adverse effects, highlighting the importance of considering vulnerable life stages in toxicological assessments (Mandrioli et al., 2025).

- **Pesticides were associated with effects on the gut microbiome and behaviour.** Exposure to several pesticides, including glyphosate, was associated with changes in human gut microbiome composition, while experimental studies found anxiety-like behavioural changes in mice exposed to glyphosate (Alaoui et al., 2022; Mandrioli et al., 2025).

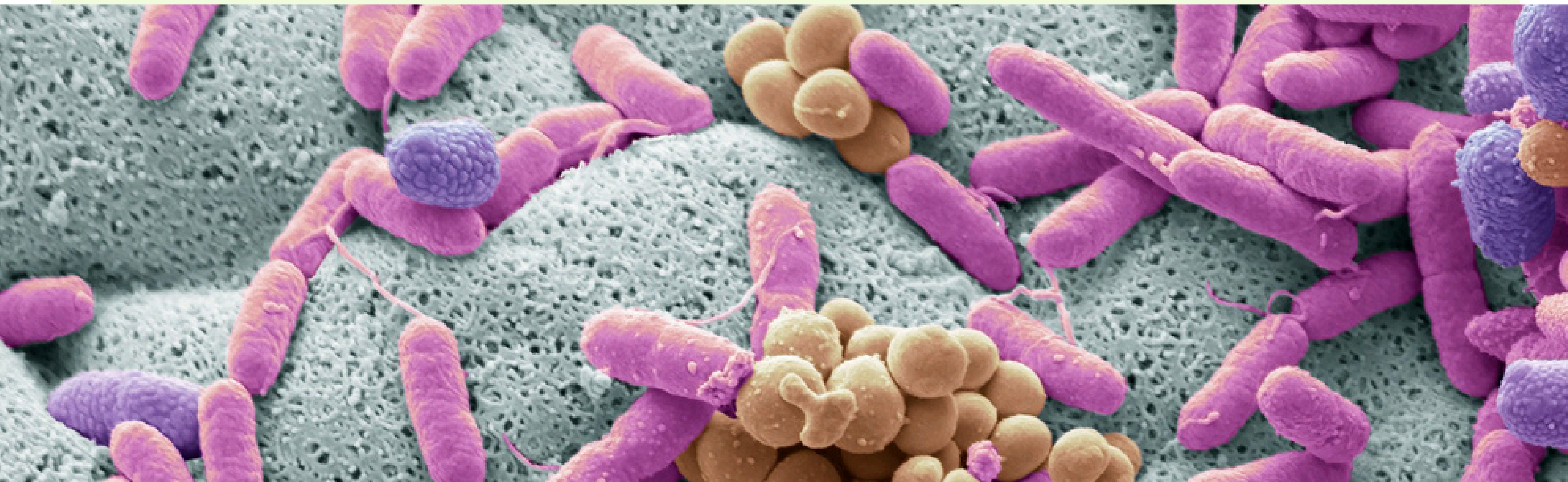


Human Toxicology: Recommendations

1. **Strengthen neurotoxicity and microbiome assessment in pesticide testing requirements,** including behavioural endpoints and microbiome-related indicators, such as the new SPRINT indicators.

2. **Expand testing requirements for early-life and other vulnerable life stages** to better capture developmental sensitivity to pesticide exposure.

3. **Strengthen mixture assessment requirements for commonly co-occurring pesticides,** including crop-specific pesticide combinations and spray tank mixes that may contribute to human exposure.



Conclusions

SPRINT shows that real-world pesticide risks are often more complex than current regulatory approaches assume. Many of the improvements identified by the project could be incorporated through revisions to EFSA guidance documents, testing methodologies, and the data requirements established under Regulations (EU) 283/2013 and 284/2013, improving the sensitivity and realism of both pre-market assessment and post-market surveillance. At the same time, continued research remains essential to address emerging endpoints, mixture effects, environmental variability, and other scientific uncertainties. Together, these efforts can help ensure that pesticide approvals, monitoring systems, and risk-management measures remain responsive to real-world conditions and provide a high level of protection for human health and the environment.

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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