SPRINT - risks and impacts of pesticides on the environment and human health

This case study is an example of the Soil Science cluster working beyond the traditional context of soil science, linking directly to human as well as environmental health. It illustrates the kind of wide collaboration the Soil Science cluster can organize - within and beyond WUR - for novel research that is highly relevant and contributes significantly to both science and society.

Abstract / summary

The EU-funded SPRINT project (https://sprint-h2020.eu/, 15 M€, 2020-2025) will develop and validate a Global Health Risk Assessment Toolbox to integrate assessments of the impacts of plant protection products (PPP) on ecosystem, plant, animal and human (EPAH) health, using three main attributes for health status: resilience, reproduction/productivity and manifestation of diseases. The goal is integrated risk assessment at the local, regional, national and European level, focusing on different PPP use patterns and detected residue mixtures in contrasting farming systems (conventional, integrated, organic). PPP distribution and impacts on EPAH health will be evaluated at 11 case study sites (CSS). Environmental pathways, and direct (food/feed ingestion) and indirect (air/dust inhalation and dermal uptake) animal and human exposure routes will be assessed to improve current fate, exposure, and toxicokinetic models (e.g. EFSA-FOCUS, BROWSE, BREAM). (Eco)toxicological assays will be performed based on CCS findings, using existing and improved procedures, including alternative testing criteria and new target organisms. The assays will cover direct and indirect exposure to multiple residues, realistic ranges of PPP concentrations, multi-species scenarios, and short- and long-term time horizons. Modelling of sustainability and cost-benefit analysis at the farm and macroeconomic level will be conducted to derive recommendations for sustainable transition pathways, and a research agenda on PPPs. SPRINT is based on a multi-actor approach with CCS platforms to engage stakeholders and identify respective needs, improve farmer and citizen awareness, jointly develop novel management strategies for reduced reliance on PPP use, and create an enabling environment for adoption and change.

Case Description

Background

Most farmers rely on plant protection products (PPPs) to maximise crop yields. However, some PPPs are potentially harmful to environmental, animal and human health. Data on the risks and impacts associated with PPPs' are, at present, fragmented and incomplete. There is, therefore, a need to deliver an integrated approach to fill this data gap. To address this, the WUR Soil Science cluster group, Soil Physics and Land management, conceived and is coordinator of the SPRINT project which will develop and test an integrated global health approach to assessing the risks and impacts of PPPs on environmental, crop, livestock and human health. SPRINT entails a transdisciplinary consortium, including medical and (eco)toxicological research partners, and close involvement of all relevant stakeholders to collaborate in establishing the global one health approach and effectively (co-)developing transition pathways away from reliance on PPP use, and improve farmer and citizen awareness. The project consists of 25 partner organizations in Europe and Argentina with a total project budget of 15 million €.

Research objectives

Main objectives of the SPRINT project are to i) engage with stakeholders to identify their knowledge needs and improve awareness of and trust in integrated risk assessments of pesticides, ii) assess PPP component mixtures & distribution in the environment (soil, water, air), crops, livestock and humans and the related health state of organisms & humans in different farming systems, iii) estimate direct & indirect PPP residue exposure levels for selected organisms, crops, livestock and humans in the case studies, iv) develop laboratory tests for measuring the effects of PPP mixtures on environmental, crop, livestock and human health, v) develop a Global Health Risk Assessment Toolbox for risk and

impact assessment of PPP residue mixtures on the environment, crops, livestock and human health, linking exposure to PPP residue mixtures to health impacts, vi) assess integrated risks, costs and benefits of PPP use in different farming systems at micro and macroeconomic level, including internal and external costs of PPP use, and vii) propose transition pathways towards more sustainable plant protection, provide policy recommendations and develop a research agenda on sustainable plant protection.

Research approach

The main concept of SPRINT (Fig. 1) is as an innovative, integrated global health approach that leverages transdisciplinary expertise, multi-actor involvement and representative case studies. Coverage of the main cropping systems and varied European landscapes, with differentiation of conventional, integrated and organic farming scenarios, significantly contribute to advancing the assessment of the effects of different application patterns on PPP distribution, exposure, and EPAH health. The development of a Global Health Risk Assessment Toolbox within SPRINT is underpinned by holistic attributes/indicators to characterize health status (Figure 1).

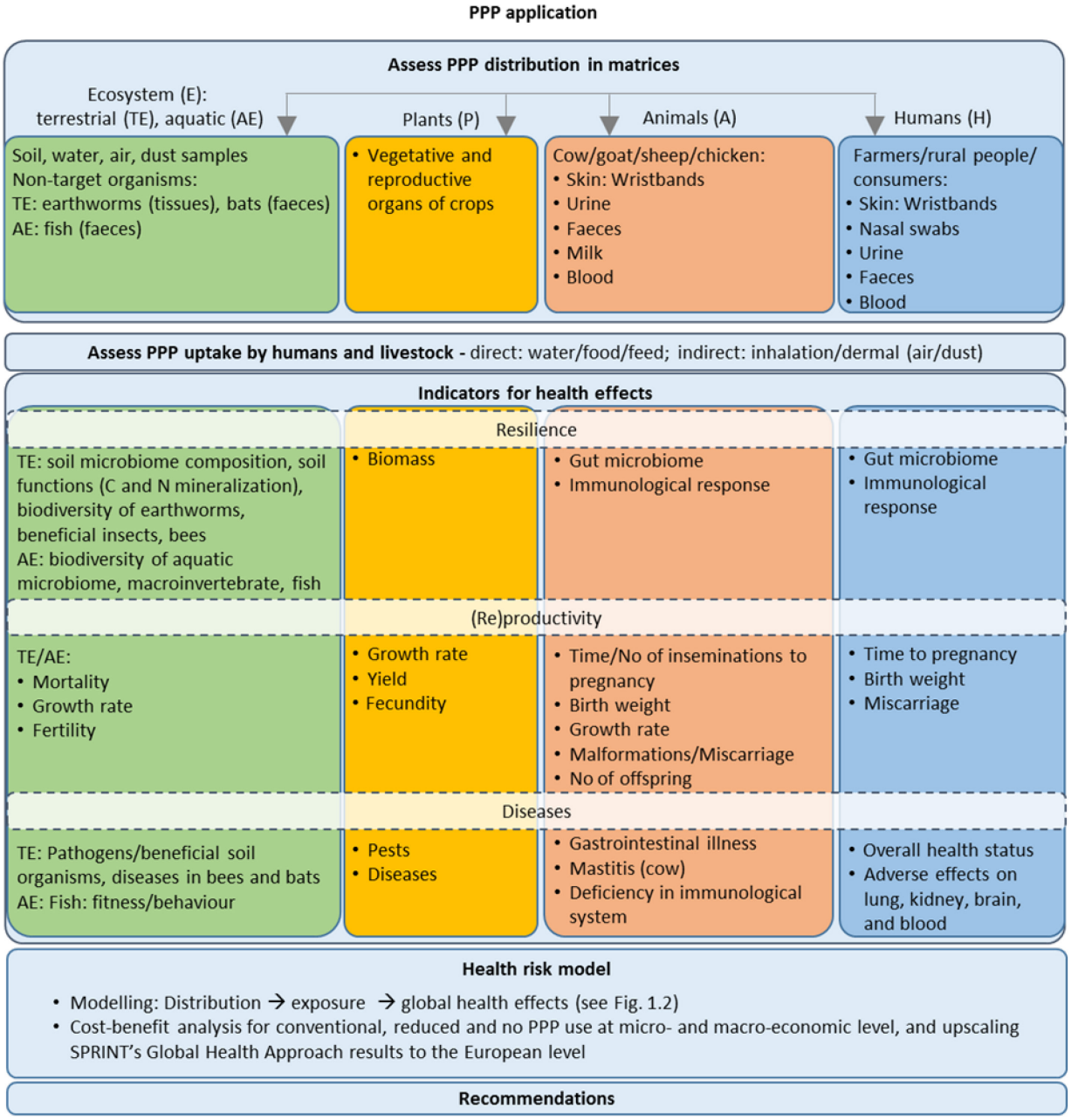

Figure 1: SPRINT's approach with regard to the overall assessment of PPP residue distribution in different matrices, and related EPAH health impacts

The distribution and impacts of mixtures of PPPs on EPAH health will be evaluated across 11 CSS with contrasting farming systems (conventional, integrated, organic), covering the main European crops, and soy production for feed in Argentina destined for the European market (see Figure 2). PPP mixture, environmental fluxes, and both direct (by water/food/feed ingestion) and indirect (by air/dust inhalation and dermal uptake) animal and human exposure routes will be quantified to improve fate (FOCUS), exposure (BROWSE, BREAM), and toxicokinetic/toxicodynamic (TK/TD) models. Relationships between PPP distribution and health indicators for the ecosystem, animals and humans assessed across the CSS will be collated, with a view to providing a clear consensus on cause and effect.

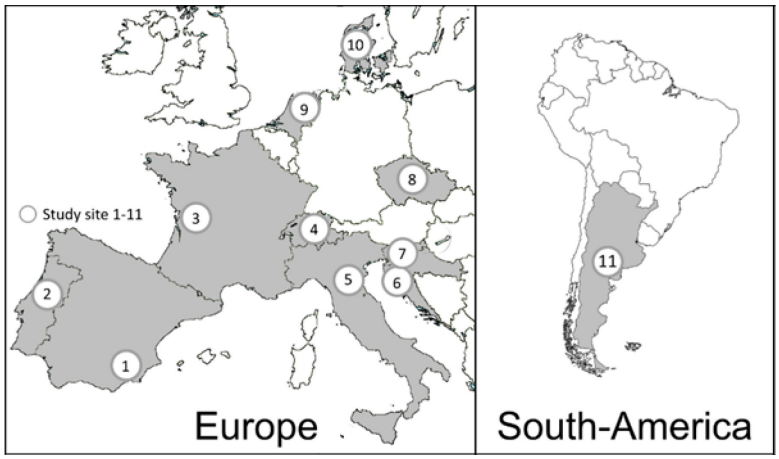

Figure 2: SPRINT Case Study Sites (CSS)

SPRINT will rely on the recently published EFSA guidance for risk assessment of combined exposure to multiple chemicals (EFSA, 2019) and extend the approach to multiple species. Improved (eco)toxicological assays will be performed by WUR and 3 other universities based on findings from the CSS and existing databases such as the LUCAS survey. Data published by Silva et al. (2019) and from 3 of the CSSs (Geissen et al, 2021) show that mixtures of up to 13 PPP residues are present in soils. The assays will cover direct and indirect exposure to multiple PPP residues, realistic ranges of PPP concentrations, multi-species scenarios, and acute and chronic exposures. The risk from exposure to chemical mixtures can be assessed as a whole (whole-mixture approach), or based on the individual components of the mixture (components-based approach). Since we will test known mixtures from the CSS, we will apply the component based approach (EFSA, 2019) with consideration of potential interactions.

SPRINT will be developed for integrated risk assessments at local, regional, national and European levels, focusing on conventional, integrated and organic farming systems, as well as different environmental and socioeconomic conditions. Modelling of sustainability and cost-benefits at micro- and macro-economic scale will be included to derive recommendations for sustainable transition pathways and a research agenda on PPPs. Stakeholders will be involved throughout the project, and overseen by an independently chaired Project Stakeholder Advisory Group (PSAG).

Stakeholder involvement

Stakeholder platforms will use different mechanisms to engage with stakeholders. A detailed stakeholder engagement plan was prepared at the beginning of the project, including mapping of stakeholders to ensure representation of all key actors (e.g. farmers, farm advisory services, EFSA, industry, consumers, NGOs, public authorities, policy makers, and civil society actors). Farmers, rural residents and consumers will be involved using crowd sourced research. Stakeholder networks have been established in all case study sites (Table 1). In addition, training events will be organized for case study partners on the monitoring activities, interviews, workshops and exposure assessment to ensure both quality and consistency in approaches to stakeholder involvement and thus collected evidence. In different work packages of the project, specific training and analysis of activities related to gathering EHAP evidence, and on socio-economics and policy, will be provided. The Project Stakeholder Advisory Group (PSAG) comprises representatives of stakeholder perspectives from a range of EU and non-EU countries, providing objective advice, supporting dissemination, and engaging with the case study sites to assure consistency in evidence gathering.

Link to education

SPRINT is closely aligned with a range of educational activities, providing opportunities for BSc and MSc theses and internships, PhD student involvement, educational oriented field visits to case study sites, and student exchanges between SPRINT partner organizations. In addition, results of the project are used in different courses to provide students with state-of-the-art knowledge, insights and information about the project.

Research Highlights

Geissen, V., V. Silva, E.H. Lwanga, N. Beriot, K. Oostindie, Z. Bin, E. Pyne, S. Busink, P.l Zomer, H. Mol, C.J. Ritsema 2021: Cocktails of pesticide residues in conventional and organic farming systems in Europe – Legacy of the past and turning point for the future. Environmental Pollution, 278, 116827.

Bhandari, G., Atreya, K. Scheepers, P.T.J., Geissen, V. 2020: Concentration and distribution of pesticide residues in soil: Non-dietary human health risk assessment. Chemosphere 253. 126594.

Beriot, N., Zomer, P., Zornoza, R., Geissen, V. 2020: A laboratory comparison of the interactions between three plastic mulch types and 38 active substances found in pesticides. PeerJ 8 e9876.

Silva, V., Mol, H.G., Zomer, P., Tienstra, M., Ritsema, C.J., Geissen, V. 2019. Pesticide residues in European agricultural soils – A hidden reality unfolded. Science of The Total Environment 653: 1432-1545.

Bento, C.P., van der Hoeven, S., Yang, X., Riksen, M.M., Mol, H.G., Ritsema, C.J., Geissen, V., 2019. Dynamics of glyphosate and AMPA in the soil surface layer of glyphosate-resistant crop cultivations in the loess Pampas of Argentina. Environmental Pollution 244, 323-331.

Silva, V., Montanarella, L., Jones, A., Fernández-Ugalde, O., Mol, H.G., Ritsema, C.J., Geissen, V., 2018. Distribution of glyphosate and aminomethylphosphonic acid (AMPA) in agricultural topsoils of the European Union. Science of the Total Environment 621, 1352-1359.

Impact

Besides SPRINT's academic impact, the project will support several EU policies, from broad overarching strategies to pesticide regulations and policy evaluations. In particular: i) REFIT (the regulatory fitness and performance programme) - an ongoing evaluation programme which checks that EU legislation is 'fit for purpose'. SPRINT will address some of the key areas REFIT identified as needing improvement, namely cumulative risk assessment, using green diplomacy to promote our green agenda for pesticides, and better enforcement of the Maximum Residue Level Regulation; ii) the European Green Deal – which aims to overcome environmental decline and the threat of climate change by making the EU's economy more sustainable. A significant part of making the EU's economy sustainable will require a transformation of the food system. SPRINT will contribute to this through one of the key strategies of the green deal, 'Farm to Fork'; iii) the Farm to Fork (F2F) strategy - a central part of the European Green Deal. The strategy has several aims which SPRINT can feed into. Most importantly, the project will contribute to the goal of reducing PPP use by 50% by 2030. In addition, SPRINT contributes to the F2F aim of a sustainable food system which has a neutral or positive impact, reverses biodiversity loss, and ensures food is safe for everyone; and iv) the Sustainable Use of Pesticides Directive (2009/128/EC) – which aims to achieve sustainable use of PPPs in the EU by promoting the use of integrated pest management and alternative approaches for controlling pests. SPRINT will contribute to the success of this directive by identifying transition pathways towards reducing reliance on PPPs.