December 2020

Report

Pollinator conservation in EU Member States' national action plans for the sustainable use of pesticides [Subject]

Institute for European Environmental Policy

European Commission

The Institute for European Environmental Policy (IEEP) is a sustainability think tank. Working with stakeholders across EU institutions, international bodies, academia, civil society and industry, our team of economists, scientists and lawyers produce evidence-based research and policy insight.

Our work spans nine research areas and covers both short-term policy issues and long-term strategic studies. As a not-for-profit organisation with over 40 years of experience, we are committed to advancing impact-driven sustainability policy across the EU and the world.

For more information about IEEP, visit www.ieep.eu or follow us on Twitter @IEEP_eu and LinkedIn.

THE REPORT SHOULD BE CITED AS FOLLOWS

Underwood, E (2020) Pollinator conservation in Member States' national action plans for the sustainable use of pesticides. Report for European Commission under contract for technical support related to the implementation of the EU Pollinators Initiative. Institute for European Environmental Policy, Brussels.

CORRESPONDING AUTHORS

Evelyn Underwood (eunderwood@ieep.eu)

ACKNOWLEDGEMENTS

We gratefully acknowledge helpful reviews and comments from Carsten Brühl1, Henriette Christensen2, Martin Dermine2, Paule Yacoub2, Zsófia Varga3, and the consulted experts4.

[1] University of Landau, Germany [2] Pesticide Action Network Europe [3] IUCN [4] Susanna D'Antoni (ISPRA, IT), Simona Benčaťová (Research Institute for Animal Production Nitra, SK), Danilo Bevk (Institute of Biology, SI), Guillaume Fried (ANSES, FR), Charlott Gissén (Jordbruksverket, SE), Denis Godeaux (Service public de Wallonie, BE), Wolfram Güthler (Bayerisches Staatsministerium für Umwelt und Verbraucherschutz, DE), Marja Jalli (Luke, FI), Reet Karise and Marika Mänd (EMU Estonian University of Life Sciences, EE), Per Kudsk (Aarhus University, DK), Pauliina Laitinen (Tukes - Finnish Safety and Chemicals Agency, FI), Chris Lambert (Departement Omgeving, Flanders, BE), Alberto Masci (Ministero delle politiche agricole alimentari e forestali, IT), Julien Ruelle (Environment Brussels, BE), Noelia Vallejo Pedregal & colleague (Subdirección General de Biodiversidad Terrestre y Marina, ES), Felix Wäckers (BioBest, BE)

This report was commissioned and funded by the European Commission.

IEEP main office
Rue Joseph II 36-38,
1000 Brussels, Belgium
Tel: +32 (0) 2738 7482
Fax: +32 (0) 2732 4004

London office
11 Belgrave Road
IEEP Offices, Floor 3
London, SW1V 1RB
Tel: +44 (0) 20 7799 2244

Contents

1. PREFACE

Due to the Covid-19 restrictions during 2020, it was not possible to carry out the planned workshop with Member State representatives and experts to discuss and review the draft findings and recommendations of this report. It was also not possible to present the draft report at the SUD working group meeting in March 2020 and then allow for a long consultation period with Member State representatives. The following provided written comments to the draft report in November 2020: Austria, Denmark, Finland, Germany, Ireland, Italy, Luxembourg, Slovenia, Spain, Sweden. A key recommendation is that there should be a follow up process to this report to allow for more discussion and exchange of good practices. This report should not be regarded as a contribution to the refit of Directive 2009/128/EC.

2. SUMMARY

This report assesses the integration of pollinator conservation into Member States' National Action Plans (NAPs) on the sustainable use of pesticides under Directive 2009/128/EC of the European Parliament and of the Council of 21 October 2009 establishing a framework for Community action to achieve the sustainable use of pesticides, known as the Sustainable Use of Pesticides Directive (SUD), and provides good practices and recommendations on how pollinator conservation can be integrated into the NAPs. It supports the implementation of Action 7A of the EU Pollinators Initiative, the first-ever comprehensive EU action to address the decline of wild pollinators in the EU[1]. Wild pollinators include bumblebees and solitary bees, hoverflies, butterflies and moths, other flies, beetles, and wasps, but not honeybees. Pesticides (also known as plant protection products) have been identified as a significant pressure on wild pollinators.

The SUD (Article 4) requires Member States to adopt NAPs that set out quantitative objectives, targets, measures and timetables to reduce risks and impacts of pesticide use and to encourage the development and introduction of integrated pest management (IPM) and of alternative approaches or techniques in order to reduce dependency on the use of pesticides. Whilst there are no specific legal requirements for Member States to include objectives, targets and actions in their NAPs to reduce the pressures and risks of pesticide use on pollinators, Member States may include such objectives, targets and actions.

The report reviewed 19 revised NAPs (published between 2017 and 2020) and 8 initial NAPs (published in 2012 or 2013)[2]. Many of the revised NAPs mention bees or pollinators in their targets or objectives, but most of them lack detail and do not clearly distinguish wild pollinators from honeybees, and there is little evidence of monitoring of impacts to improve knowledge and target measures. Five NAPs mention limitations or prohibitions of pesticide use in the Natura 2000 network and other sites important for biodiversity protection. Most NAPs mention pollinators or bees in connection with training and awareness raising, with more specific plans in 8 NAPs, but it is often not clear if the training addresses wild pollinators. Three NAPs mention pollinators in connection with promotion and implementation of IPM and alternatives, whilst other NAPs plan to promote alternatives to pesticides but do not say how they will deliver for pollinator conservation.

[1] https://ec.europa.eu/environment/nature/conservation/species/pollinators/policy_en.htm

[2] All NAPs were reviewed in the final English language versions published on the DG SANTE website. If further clarity was needed the original language version was also consulted. The UK NAP was not reviewed.

Section 2 reviews the evidence for the effectiveness of actions and highlights good practices in Member States, and Section 3 makes recommendations for future NAPs and accompanying actions at the EU and Member State levels.

Several initiatives are underway to establish indicators of pesticide risk to pollinators and to improve the knowledge base to better assess the risk and target measures. The Danish pesticide load indicator takes account of toxicity of pesticide active substances to bees, as far as the current EU wide risk assessments have identified effects. It is used to calculate the Danish pesticide tax and so incentivises the use of less harmful products. The Swedish government is assembling an inventory of knowledge about the risks of pesticides to pollinating insects and using this to harmonise pesticide labelling messages and create better information tools for farmers. There is a common need amongst Member States for compiled information on pesticide impacts on wild pollinators, and for an improved compilation of statistics on pesticide use to assess exposure.

- The recommendation is to pool expert knowledge in EU research projects to produce an inventory of the current ecotoxicity information on pesticides and pollinators. There is also a need for continued research funding and EU wide exchanges of current knowledge and discussions of the issues. Wild pollinator protection needs research to identify the most sensitive species and to get realistic exposure data, since wild pollinators are exposed during their lifetime to multiple pesticide formulations and potential synergistic effects need to be accounted for. Furthermore, an assessment of the potential to extrapolate the available toxicological information from one pollinator species to another should be carried out.

Whilst the declarations in the revised NAPs about developing monitoring and indicators relevant to wild pollinators promise improvements in future, the current situation is that very little monitoring of impacts of pesticides on pollinators is being carried out. The few pesticide residue surveys in wild bees carried out so far reveal exposure to multiple chemicals through a combination of exposure routes. Methods are available to set up residue studies, and several projects are setting up long-term residue monitoring in honeybee-collected pollen, but long-term programmes to monitor residues in wild pollinators are expensive and practically challenging. The French biovigilance programme has demonstrated how long-term observations of on-farm biodiversity can be linked to records of farming practices, including pesticide use, to reveal the impacts of changes in practices. However, pollinators react at the landscape scale so disentangling the effects of changes in pesticide use from other influencing factors requires careful design and large data sets.

- A recommendation is to encourage the insertion of targets for pollinator population recovery in both NAPs and CAP strategic plans, and to integrate pesticide impact monitoring with the European Pollinator Monitoring Scheme, which is being rolled out on a network of sites across the EU. This will require the implementation of methods to gather more information on pollinator populations, as there is currently no desired reference value that could serve as a basis for recovery and there are no validated recording methods.

Specific measures to control impacts of pesticide use on pollinators and to ensure compliance with the measures mentioned in NAPs include aims to strengthen regulatory provisions informed by research and expert groups, to catalogue toxicity of pesticides to pollinators and improve labelling of risks and make adoption of drift reduction techniques mandatory. Harmonisation of approaches should be in line with efforts to harmonize risk assessment procedures under Regulation (EC) No 1107/2009 and in accordance with Commission Regulation (EU) 547/2011.

- Recommendations include the development of a more unified approach to pesticide labelling of risks to bees, through harmonization between Member States, and to broaden the warning to cover all pollinators; to promote drift reduction techniques; and to raise awareness and regulatory controls on pesticides and their mixtures that have higher toxicity to pollinators.

The SUD gives scope for Member States to take regulatory or other measures to reduce pesticide use in specific areas including Natura 2000 sites and other protected areas, thus minimising the risk arising from pesticide use. Little information is available on how pesticides are used in Natura 2000 sites and other nature protected areas and what impact is that having on biodiversity conservation. However, Italy and Spain illustrate how pesticide risks to the Natura 2000 network have been mapped, to facilitate targeted measures. In Spain, a set of voluntary guidelines for IPM are being targeted at farming systems within Natura 2000 and other areas with sensitive protected species and habitats, and in Italy, research is ongoing to identify alternative farming systems that can be promoted within the Natura 2000 network as being compatible with protection of species and habitats.

- A recommendation is that national and regional authorities responsible for the sustainable use of pesticides and for the Natura 2000 network (as well as other protected areas such as national and regional parks) to collaborate to improve the information database and develop targeted incentives and regulatory measures to minimise or prohibit pesticide use in protected areas. It is also important to target measures at farms in the buffer zones around protected sites.

Integrated Pest Management is mandatory under the SUD since 2014, including giving priority to non-chemical alternatives, use of crop rotation, resistant cultivars, and avoiding prophylactic uses such as spraying based on crop development stage and seed treatments.

- Member States should ensure the development of farm advisory services, as planned by the SUD, to help farmers achieve such a change in practice, to reduce the overall use of pesticides and therefore to achieve a better protection of wild pollinators.
- NAPs can be used to strengthen training and awareness raising on the risks and impacts of pesticides on pollinators and ways to reduce pesticide use, through the obligatory training of professional users, and information and awareness raising targeted to non-professional pesticide users. National Action Plans could promote non-chemical alternatives for non-professional users. France and Belgium have taken the approach of phasing out the sale of synthetic pesticides to non-professional users altogether.
- Member States can use their NAP to take measures to prioritise non-chemical methods of pest control in agriculture with a view to protecting pollinators, by enforcing the uptake of IPM approaches, by promoting organic agriculture, and by controlling and verifying the implementation of IPM general principles at farm level. Although farmers are obliged to keep records of the application of plant protection products, and to implement the IPM principles, it is not possible to confirm, based on the spray records, whether farmers have implemented IPM or not. There are some voluntary initiatives to incentivise farmers to record their IPM decisions, which could in future be used to check how the IPM principles are being implemented. For example, Denmark has set up an IPM record system for each farm to fill out a form annually with a points system for IPM themes such as crop rotation, the choice of resistant crop varieties, the choice of pesticides with the lowest load.

The European Commission has stated that it expects Member States to support the objectives of the EU Farm to Fork Strategy and the EU Biodiversity Strategy 2030, including the goal to reverse the decline of pollinator populations[3]. Overall, the NAPs should deliver substantially more positive action to reduce the pressures of pesticides on wild pollinators. An overarching recommendation is to set up mechanisms to share and exchange good practices between countries.

[3] 'Brussels confronts EU countries over pesticides and animal welfare'. Eddy Wax, Sep 24, 2020, 6:00 AM, Politico Pro

3. AIM OF THIS REPORT

This report assesses the integration of pollinator conservation into Member States' National Action Plans (NAPs) on the sustainable use of pesticides[4] (also known as plant protection products) under Directive 2009/128/EC of the European Parliament and of the Council of 21 October 2009 establishing a framework for Community action to achieve the sustainable use of pesticides, known as the Sustainable Use Directive (SUD). It provides good practices and recommendations on how pollinator conservation can be integrated into the NAPs. The report supports the implementation of Action 7A of the EU Pollinators Initiative, the first-ever comprehensive EU action to address the decline of wild pollinators in the EU[5]. It focuses on wild pollinators, which include bumblebees, solitary bees, hoverflies, butterflies, moths, other flies, beetles, and wasps, but not honeybees. Pesticides have been identified as a significant pressure on wild pollinators.

This report is aimed at the Member State managing authorities who are designing and implementing the SUD NAPs, but should also be of interest to research and agronomy institutes, NGOs, farming organisations including organic farming representatives, farm advisors and other organisations involved in the implementation of Integrated Pest Management (IPM) and other pesticide risk reduction programmes. The EU pollinators initiative emphasises the need to tackle the causes of pollinator decline, but the issue of reducing pesticide risk to pollinators has been given greater political priority since the new EU Farm to Fork Strategy and the EU Biodiversity Strategy to 2030[6] set the targets to *Reverse the decline of pollinators by 2030* and to *reduce by 50% the overall use of – and risk from – chemical pesticides by 2030 and reduce by 50% the use of more hazardous pesticides by 2030*, combined with further targets for biodiversity protection on agricultural land.

The SUD (Article 4) requires Member States to adopt NAPs that set out quantitative objectives, targets, measures, and timetables to reduce risks and impacts of pesticide use and to encourage the development and introduction of IPM and of alternative approaches or techniques to reduce dependency on the use of pesticides. Whilst there are no specific legal requirements for Member States to include objectives, targets, and actions in their NAPs to reduce the pressures and risks of pesticide use on pollinators, Member States may include such objectives,

---

[4] Recital 3 states that at present, Directive 2009/128/EC should apply to pesticides which are plant protection products. However, it is anticipated that the scope of this Directive will be extended to cover biocidal products.

[5] https://ec.europa.eu/environment/nature/conservation/species/pollinators/policy_en.htm

[6] COM(2020) 381 final and COM(2020) 380 final

targets, and actions to support pollinator conservation. This report reviewed 19 revised NAPs (published between 2017 and 2020) and 8 initial NAPs (adopted and published between 2012 and 2014), except the UK, plus 10 supporting documents[7].

This report: 1) reviews NAPs for evidence of actions targeted to or benefiting wild pollinators; 2) reviews the effectiveness of actions and highlights good practices; and 3) makes recommendations for future NAPs.

[7] All NAPs were reviewed in the final English language versions published on the SUD web portal. If further clarity was needed the original language version was also consulted. The UK NAP was not reviewed. The draft Italian NAP for 2019-2024 submitted to public consultation was reviewed in Italian for examples in section 2 only. The revised Hungarian NAP published December 2019 and the Bulgarian NAP published August 2020 could not be reviewed.

4. SECTION 1. HOW ARE MEMBER STATES USING THEIR NATIONAL ACTION PLANS FOR WILD POLLINATORS?

This section introduces the Sustainable Use Directive (SUD) and the analysis of NAPs undertaken for this report. Then the section examines the scope for action under the SUD and the actual measures planned by Member States NAPs under five headings: a) National targets or objectives to reduce pesticide use aimed at pollinator conservation and monitoring of impacts; b) Specific measures to control impacts of pesticide use on pollinators and to ensure compliance with the measures; c) Limitations or prohibitions on pesticide use in sensitive areas – public spaces and Natura 2000 sites; d) Training and awareness raising on pesticides and pollinators; e) Promotion and implementation of IPM and alternative approaches to protect pollinators.

4.1 Introduction to the Sustainable Use Directive

The SUD aims to achieve a sustainable use of pesticides in the EU, by reducing the risks and impacts of pesticide use on human health and the environment, reducing dependency on pesticides, and promoting the use of IPM and of alternative approaches or techniques[8].

The SUD (Article 4) requires Member States to adopt NAPs that set out quantitative objectives, targets, measures, and timetables to reduce risks and impacts of pesticide use and to encourage the development and introduction of IPM and of alternative approaches or techniques to reduce dependency on the use of pesticides.

Whilst there are no specific legal requirements for Member States to include objectives, targets, and actions in their NAPs to reduce the pressures and risks of pesticide use on pollinators, Member States may include such objectives, targets and actions. Aspects of the Directive that are particularly relevant to reducing impacts on pollinators include the need for indicators and monitoring, requirements of IPM, advice and training, and broader information and awareness raising (Box 1).

[8] according to the general principles in Annex III of the SUD

Box 1: Sustainable Use Directive requirements

- The NAP should include indicators to monitor the risks and impacts of pesticide use on the environment, and to monitor the use of pesticides containing active substances of particular concern, especially if alternatives are available (Recital 5[9] and Article 15b[10]).

- The SUD foresees the following measures applying to all professional users of pesticides, including farmers, foresters, and other land managers:

  - All professional users shall implement Integrated Pest Management (as from 2014), with article 14.1 stating: "professional users of pesticides [ought to] switch to practices and products with the lowest risk to human health and the environment among those available for the same pest problem.".

  - Member States shall assist this change by encouraging farmers and others to use non-chemical alternatives, with article 14.1 stating: "Member States shall take all necessary measures to promote low pesticide-input pest management, giving wherever possible priority to non-chemical methods". From 2015 the national Farm Advisory Service must be able to inform farmers about alternatives to pesticides[11]. As per article 14.5 of the SUD, "Member States shall establish appropriate incentives to encourage professional users to

[9] Recital 5: National Action Plans aimed at setting quantitative objectives, targets, measures, timetables and indicators to reduce risks and impacts of pesticide use on human health and the environment and at encouraging the development and introduction of integrated pest management and of alternative approaches or techniques in order to reduce dependency on the use of pesticides should be used by Member States in order to facilitate the implementation of this Directive.

[10] Article 15.2(b) Member States shall: (a) calculate harmonised risk indicators as referred to in paragraph 1 by using statistical data collected in accordance with the Community legislation concerning statistics on plant protection products together with other relevant data; (b) identify trends in the use of certain active substances; (c) identify priority items, such as active substances, crops, regions or practices, that require particular attention or good practices that can be used as examples in order to achieve the objectives of this Directive to reduce the risks and impacts of pesticide use on human health and the environment and to encourage the development and introduction of integrated pest management and of alternative approaches or techniques in order to reduce dependency on the use of pesticides.

[11] As required by the Common Agricultural Policy - Regulation (EU) No 1306/2013 on the financing, management and monitoring of the common agricultural policy states in article 12.2 (e) that the farm advisory system shall cover as mandatory: requirements at the level of beneficiaries as defined by Member States for implementing Article 55 of Regulation (EC) No 1107/2009, in particular the requirement referred to in Article 14 of Directive 2009/128/EC.

implement crop or sector-specific guidelines for integrated pest management on a voluntary basis".

- Annex III of the SUD lists the eight IPM general principles, including point 8: Professional pesticide users should check the success of the applied plant protection measures based on the records on the use of pesticides and on the monitoring of harmful organisms.
- Member States shall minimise or prohibit pesticide use in specific areas (Article 12). The specific areas include public spaces and Natura 2000 sites.
- Member States shall establish appropriately sized buffer zones to protect non-target aquatic organisms and safeguard zones for surface and groundwater used for the abstraction of drinking water (Article 11).

• Member States' measures to reduce risks and impacts of pesticide use shall also include:

- training of professional users, distributors and advisors. including identification and control of risks to non-target plants, beneficial insects, wildlife, biodiversity, and the environment in general[12;]
- inspection of pesticide application equipment[13;]
- the prohibition of aerial spraying, although derogations may be allowed[14;]
- information and awareness-raising about pesticide risks directed to the general public, in particular regarding the risks and the po-

12 According to SUD Annex I "Training subjects referred to in Article 5", point 3 "The hazards and risks associated with pesticides, and how to identify and control them, in particular: (c) risks to non-target plants, beneficial insects, wildlife, biodiversity and the environment in general.

13 Inspection of pesticide application equipment became compulsory in November 2016, as the last deadline to come into force. Since that date Member States have had to fulfil all requirements of the SUD.

14 According to SUD Article 9, aerial spraying may only be allowed in special cases provided the conditions listed in the article are met.

tential acute and chronic effects for human health, non-target organisms and the environment arising from their use, and the use of non-chemical alternatives[15].

Regulation (EC) No 1107/2009 of the European Parliament and of the Council of 21 October 2009 concerning the placing of plant protection products on the market and repealing Council Directives 79/117/EEC and 91/414/EEC (referred to as the pesticides regulation) foresaw that IPM becomes part of the conditionality rules of the Common Agricultural Policy (CAP)[16]. The CAP regulation for the 2014 to 2020 period (Regulation (EU) No 1307/2013 of the European Parliament and of the Council of 17 December 2013 establishing rules for direct payments to farmers under support schemes within the framework of the common agricultural policy and repealing Council Regulation (EC) No 637/2008 and Council Regulation (EC) No 73/2009) did not include the SUD in the statutory management requirements for farmers.

The report from the Commission to the European Parliament and the Council on Member State NAPs and on progress in the implementation of Directive 2009/128/EC on the sustainable use of pesticides[17] of 10 October 2017[18], hereinafter referred to as the first Commission report, stated that the Commission

---

[15] According to SUD Article 7.1, Member States shall take measures to inform the general public and to promote and facilitate information and awareness raising programmes and the availability of accurate and balanced information relating to pesticides for the general public, in particular regarding the risks and the potential acute and chronic effects for human health, non-target organisms and the environment arising from their use, and the use of non-chemical alternatives.

[16] According to recital (35) of the EU Pesticide Regulation 1107/2009, the Council of the EU is requested to include integrated pest management in the statutory management requirements of the CAP: 'The Council should include in the statutory management requirement referred to in Annex III to Council Regulation (EC) No 1782/2003 of 29 September 2003 establishing common rules for direct support schemes under the common agricultural policy and establishing certain support schemes for farmers (1), the principles of integrated pest management, including good plant protection practice and non-chemical methods of plant protection and pest and crop management'.

[17] https://ec.europa.eu/food/sites/food/files/plant/docs/pesticides_sup_report-overview_en.pdf

[18] The first Commission report on the NAPs in 2017 (COM(2017) 587 final) states that: 'Once this Directive has been implemented in all Member States and the obligations directly applicable to farmers have been identified, the Commission will be addressing the Joint Statement by the European Parliament and the Council in Regulation (EU) No 1306/2013 which invites the Commission to include the relevant parts of the Directive in the system of cross-compliance. Moreover, in the meantime, the Commission will support the Member States in the development of methodologies to assess compliance with the eight IPM principles, taking into account the diversity of EU agriculture and the principle of subsidiarity.'

would address the issue once the Directive has been implemented in all Member States and the obligations directly applicable to farmers have been identified[19].

The deadline for Member States to publish their first NAPs was 26 November 2012. These initial NAPs were adopted and published between 2012 and 2014. Following Article 4 of the SUD stating that Member States should revise their plan at least every five years, they published revised NAPs from 2017 onwards. Some Member States have published several updates, such as France, Denmark, and Lithuania. Eight Member States had not published revised NAPs at the time of our assessment[20]. At least six of the NAPs were published by Member States after the publication of the EU Pollinators Initiative, and therefore had the possibility of referring to this EU policy and its objectives.

The Commission published its second report to the European Parliament and the Council on the experience gained by Member States on the implementation of national targets established in their NAPs and on progress in the implementation of Directive 2009/128/EC on the sustainable use of pesticides in May 2020[21]. With regard to NAPs, the report concluded that less than one third of Member States completed the review of their NAPs within the five-year legal deadline. Of those that reviewed their NAPs, most failed to address the weaknesses identified by the Commission in their initial NAPs, with just 20% of revised NAPs setting high-level, outcome-based targets, as part of a longer-term strategy to reduce the risks and impacts of pesticide use.

In 2017, the Commission carried out fact-finding missions on SUD implementation with a focus on gathering information and identifying good practices in Denmark, Germany, Italy, Netherlands, Poland, and Sweden. As of 2018, the Commission initiated a new audit series, switching to checking compliance in this area. In 2018, audits were performed in Bulgaria, France, Hungary, Spain, and seven further Member States were visited in 2019, including Austria, Cyprus, Greece, Ireland, Lithuania, Portugal, and Romania[22]. In addition, the European Parliament and the European Court of Auditors recently published reports that addressed the implementation of EU pesticide legislation and made recommendations. These documents were considered in this analysis.

---

[19] First Commission Report, Chapter 4.2, third paragraph; page 18.

[20] The revised Hungarian NAP dated December 2019 and the Bulgarian NAP dated August 2020 were not reviewed. Germany reviewed its NAP and judged that it did not need to be changed. Five Member States had still not published revised NAPs in November 2020: Croatia, Greece, Italy, Netherlands, Slovakia.

[21] https://ec.europa.eu/food/sites/food/files/plant/docs/pesticides_sud_report-act_2020_en.pdf

[22] Fact-finding mission reports and audits reports are published on the DG Health and Food Safety website at https://ec.europa.eu/food/audits-analysis/audit_reports/index.cfm

4.2 Analysis of the NAPs

Approach to the NAP analysis

We analysed the NAPs available in English on DG SANTE's webpage[i] to identify planned measures related to biodiversity and pollinators. We also considered Commission audits of SUD implementation where relevant to biodiversity and pollinators, and Member State's implementation reviews[23]. All the documents analysed were published in English[24]. We reviewed 19 revised NAPs and 8 initial NAPs, plus 10 supporting documents, as follows[25]:

Initial NAPs (2012-2013)	Revised NAPs (2017-2020)	Implementation reports, further NAP updates, etc (2018-2020)
BG (2012), DE (2013), EL (2013), HR (2013), HU (2012), IT (2014), NL (2012), SK (2012)	AT (2018), BE (2018), CY (2019), CZ (2018), DK (2018), EE (2019), ES (2018), FI (2018), FR (2019), IE (2019), LT (2017), LU (2017), LV (2020), MT (2019), PL (2018), PT (2019), RO (2019), SE (2019), SI (2018)	BE (2020), DE (2019 implementation report), DK (2019 addendum), FI (2018), FR (2020), LT (2019, 2020), NL (2019), PT (2018), SI (2018)

To search for pollinator-related measures in the NAPs, we used the following keywords: biodiversity, bees, insects, pollinators, non-target (organisms), beneficial (organisms). The measures contained in national law outside of the SUD NAP were left out of the scope of this report[26]. The screening picked out all references to pollinators and pollinator conservation, including any of the following:

- Objective and/or target directly relevant to pollinators, monitoring programmes that measure impacts of pesticides on pollinators
- Objectives and/or targets that could provide pollinators with additional resources and/or habitat
- Measures for reduction of pesticide use or risk in specific areas that mention pollinators

[23] Finland, France, Slovenia, and Portugal have published implementation reports on their NAPs, and these are available on the SUD web portal. Other reports may be available at national level, but they have not been translated or transmitted to the Commission yet and were outside the scope of this review.
[24] If any aspects were unclear, the original language version was consulted. The draft Italian NAP for 2019-2024 in Italian was reviewed for examples in section 2, but not included in section 1 as it has not yet been approved. The revised Hungarian NAP dated December 2019 and the Bulgarian NAP dated August 2020 were not reviewed.
[25] The dates correspond to the date of submission to the European Commission, which may differ from the date on the document.
[26] However, national regulations may contain interesting measures that would warrant further investigation.

- Mention of pollinators in descriptions of training or guidance related provisions
- Mention of reducing risks to pollinators in the context of IPM implementation
- Mention of promoting organic farming or other alternative methods of production as a means to reduce pesticide use

4.2.1 National targets or objectives to reduce pesticide use aimed at pollinator conservation and monitoring of impacts

Scope for action under SUD - setting targets or objectives

The SUD states that Member States' NAPs should set out quantitative objectives, targets, measures, and timetables to reduce risks and impacts of pesticide use on the environment[27]. This could include a focus on pollinators as a specific group at risk from pesticide use. The NAP should also include indicators to monitor the use of pesticides containing active substances of particular concern[28]. Member States could therefore identify and target monitoring at priority active substances, crops, regions, or practices that require particular attention to reduce the impacts of pesticide use on pollinators.

The NAPs should take account of plans under other Community legislation on the use of pesticides according to the SUD[29]. Plans under EU policy instruments that are relevant to the use of pesticides include Rural Development programmes and aspects of Pillar 1 implementation and farm advisory services under the CAP, and river basin management plans and programmes of measures under the Water Framework Directive. In addition, NAPs could refer to national or regional strategies or action plans for pollinators, and Member States national biodiversity strategies and sustainable forest management plans. Currently, Ireland, France, the Netherlands, and Spain have national pollinator strategies, and many parts of Germany have regional or local pollinator strategies or plans.

Objectives or targets aimed at pollinators in the NAPs

None of the current NAPs feature a quantifiable target to reduce risks of pesticides to pollinators. However, Sweden's 2019 revised NAP stands out from all the others as it sets a specific objective for pollinators and defines targeted actions

[27] SUD Article 4
[28] SUD Recital 5 and Article 15b
[29] SUD Article 4.1

and an indicator to measure progress, linked to the national non-toxic environment strategy launched in 2014.

The NAPs of the Netherlands, Belgium and France also contain objectives targeted at reducing risks to wild pollinators and other insects. The Netherlands NAP was published before the Netherlands national pollinator conservation policy[ii] was launched in 2018, but it includes measures to reduce risks to non-target insects including pollinators. The French NAP has been repeatedly revised in the framework of the French government's policy objective to reduce pesticide use, and the most recent revision in 2019 includes specific priorities for pollinators. The Belgian NAP from 2018 sets a national objective related to the consideration of pollinators in the pesticide authorization process, which is managed by the federal government, and a specific objective for pollinators in the Brussels region.

The NAPs of the Netherlands and France are coherent with their national pollinator strategies, but the Irish one is not. The recently revised Ireland NAP makes a link to the national pollinator strategy but does not define any specific actions or indicators for pollinators, or the actions defined in the national pollinator strategy, even though the pollinator strategy was launched before the NAP was revised[30]. The agriculture ministry (DAFM) stated that representatives from the Pollinator Plan stakeholder group were consulted in the development of the new NAP[iii]. In Spain, the national pollinator strategy is more recent than the revised NAP.

Several NAPs mention an objective of reducing the impact of pesticide use on bees or pollinator populations, but the actions lack detail and do not clearly distinguish wild pollinators from honeybees, e.g. the NAPs of Bulgaria, Hungary, Romania, Poland, and Croatia.

Several other NAPs mention general biodiversity objectives, but do not include any specific objectives or actions targeted at wild pollinators. For example, the Austria NAP (2017-2021) has no specific objective to reduce risk to pollinators. The NAP was criticised by the Austrian beekeeper organisationiv, which highlighted that despite the engagement of most Austrian farms in agri-environmental programmes, the amount of pesticides used on the territory did not decrease between 2013 and 2015. The organisation recommended that the NAP should include a chapter of measures dedicated to pollinators, following IPBES recommendations. They propose that data on pesticide use by farmers in Austria is published in an online-database accessible to all and categorized (category of pesticides, regions, cultures, etc.), and that better indicators are developed to measure

[30] The Department of Agriculture, Food and the Marine has endorsed the All-Ireland Pollinator plan and it is funded by the Government of Ireland.

impacts on pollinators. Table 1 lists the NAP extracts that refer to objectives or targets relevant to pollinators.

Table 1: Objectives or targets aimed at pollinators in the NAPs

Sweden NAP (2019)	The NAP revised in 2019 sets an objective to limit the use of plant protection products which are harmful to pollinating insects to minimise the risks by 2022. The objective is to be achieved by actions on training, information and advice, and better product and user information (see the following section for details).
Netherlands NAP (2013)	The national strategy on crop protection[v] includes the objective to strive to minimise any risks and effects of the use of plant protection products on non-target flora and fauna as much as possible, with incentives through the CAP and guidance and advice (see the following section for details). The Netherlands also commits to support the EFSA guidance for the assessment of the risks of plant protection products to bees and other pollinators.
France Ecophyto+ (2019)	The most recent revision to the NAP (Ecophyto+) makes a link to the National Plan for Actions for Bees and Wild Pollinators, which was published in 2016. The NAP defined four strategic priorities for national research funding by the national food safety authority ANSES for the 2018-2020 period, with one specifically targeting bees and other pollinators. The NAP also states intentions to step up legislative provisions to protect pollinators and improve monitoring (see Table 3).
Belgium NAPAN (2018)	The NAP published in 2018 sets an objective to protect pollinators in the context of the plant protection products authorization procedure through the second Federal Action Plan for bees. The Brussels region sets an objective to protect pollinating insects by promotion of awareness of wild pollinators and their lifestyles and nesting areas. This will be carried out through the adoption of a bees and wild pollinators action plan (a requirement of the Brussels Regional Nature Plan), and a mapping of the 'operational sites' and identification of terricolous (ground-

	nesting) bee communities. The NAP also states that the adoption of new regulatory measures may be studied with a view to reducing the use of products that are most problematic to pollinating insects.
Luxembourg NAP (2017)	Measure 2-2 of the revised NAP sets the objective to protect insect pollinators and foresees several measures for pollinators (see below) including a restrictive position to neonicotinoids in general and a general positive attitude to the protection of insect pollinators both nationally and at EU level.
Bulgaria NAP (2012)	The NAP published in 2012 included the objective of avoiding and/or reducing the impact of pesticides on biodiversity, with special attention being devoted to bees and other non-target organisms.
Croatia NAP (2013)	The NAP published in 2013 states that it is imperative that the application of pesticides does not impact pollinator populations, and to know pesticides' chemical, physical and biological properties and their influences on bees and other pollinators.
Hungary NAP (2012)	The NAP published in 2021 contains the target area: Protection of non-target organisms (particularly the pollinators and the protected animal species) and mitigation of the related risks.
Romania NAP (2019)	Objective to reduce the impact on pollinating insects, through preserving biodiversity and protecting the environment by reducing the risks of water, soil, and air pollution by plant protection products.
Poland NAP (2018)	States that pollinators, in particular honeybees, play an extremely important role in agriculture, as well as in natural ecosystems. The activities of the State Plant Health and Seed Inspection Service will be primarily focused on protection of pollinating insects during plant protection treatments (together with protection of the aquatic environment).
Ireland	The revised NAP published in 2019 references the All-Ireland Pollinator Plan 2015-2020[vi] to set the goal of making

NAP (2019-2024)	information relevant to pollinator protection available on the DAFM/PCS website, by providing a link to the information on the webpages of the Pollinator Plan. However, the Pollinator Plan is much more specific and ambitious. It sets a target to encourage the sustainable use of agricultural pesticides by 2020, and a target to reduce the use of pesticides (insecticides, herbicides, fungicides) on public land, which includes actions by various government authorities and local authorities to produce best-practice guidelines and better online resources, and to collect and maintain better data on use of pesticides (see details in the next section).

Four NAPs specify an overall quantified pesticide risk reduction target. Only Denmark and Germany link this to a measure of environmental risk (see Table 2). Denmark's NAP does not mention bees or pollinators as a focus or objective, but the revised NAP confirms that the differentiated pesticide tax system is an important instrument to reduce the overall pesticide load on nature, the environment, and health. The tax forms part of Denmark's implementation of the SUD since the differentiated pesticide tax incentivises users of pesticides to use the least harmful pesticides and to reduce the use of pesticides31.

The first Commission report already highlighted the lack of precise and measurable targets in the NAPs. The second report from the Commission to the European Parliament and the Council on the experience gained by Member States on the implementation of national targets established in their National Action Plans and on progress in the implementation of Directive 2009/128/EC on the sustainable use of pesticides, published on 20 May 2020 reiterates this conclusion, and points out that most revised NAPs lack ambition. In both reports, the Commission asked Member States to upgrade their NAPs regarding biodiversity objectives.

Table 2: Quantified targets for reduction of pesticide use and/or risk

France Ecophyto+ (2019)	The 2008 Ecophyto plan set a target for a 50% reduction in pesticide use by 2018, which was delayed until 2025 in

[31] Comments from Denmark regarding protection of pollinators submitted to DG ENV by Department of pesticides and biocides (Pesticider og Biocider) in the environment ministry (Miljøstyrelsen), 1 October 2020

	two subsequent revisions of the plan (2015 and 2018)[32]. The most recent revision acknowledged the failure to effectively reduce pesticide use, since sales increased over the plan period and sharply in 2018[vii]. The target is measured by the Number of Dose Units (NODU) indicator, which is calculated using annual sales data and recommended dosage to estimate an average number of treatments per hectare.
Denmark NAP (2018)	The first NAP had a 40% pesticide load reduction target by the end of 2015 compared with 2011, corresponding to a PBI (national pesticide impact indicator) of 1.96 based on pesticides sales figures. This objective was not reached. The objective remains the same in the 2017-2021 NAP, now to be achieved by 2021. The target is measured using the PBI index made up of the human health, ecotoxicology, and environmental fate sub-indices[33] (Kudsk, Jørgensen and Ørum, 2018). The NAP published in 2017 confirms that the differentiated pesticide tax system is an important instrument to reduce the overall pesticide load on nature, the environment, and health.
Germany NAP (2013)	The NAP establishes a target of a 30% reduction in the risks that using plant protection products entails for the environment by 2023 compared to a baseline of the average value for 1996 – 2005. The risk is measured using the SYNOPS indicator, which includes a risk index for terrestrial non-target organisms[34].
Luxembourg NAP (2017)	The revised NAP added a new objective of "*reducing the use of plant protection products by 50 % (reduction in*

[32] In 2014, France passed the Labbé law prohibiting pesticide use in public areas and the sale of pesticides to non-professional users, based on Article 12 (a) of the SUD. The ban on sales of pesticides to amateur users came into force in January 2019. LOI n° 2014-110 du 6 février 2014 visant à mieux encadrer l'utilisation des produits phytosanitaires sur le territoire national. https://www.legifrance.gouv.fr/jorf/id/JORFTEXT000028571536/

[33] The ecotoxicology index is calculated on basis of the LC/LD/EC50 values of the active ingredients for acute toxicity to mammals, birds, fish, daphnia, algae, aquatic plants, earthworms and bees and NOEC values for chronic toxicity to fish, daphnia and earthworms.

[34] Calculated using representative test organisms for each environmental compartment. Field margin test organisms are honeybees, mites and parasitic wasps (Braconidae). https://www.nap-pflanzenschutz.de/indikatorenforschung/indikatoren-und-deutscher-pflanzenschutzindex/deutscher-pflanzenschutzindex/synops-risikoindex-fuer-terrestrische-nichtzielorganismen/?L=0

	tonnes applied) by 2030" and aims at a reduction of 30% until 2025 of active substances qualified as "big movers".

Scope for action under SUD – Indicators and monitoring of pesticide use and/or of risks of pesticides to pollinators

Member States are required to calculate the Harmonised Risk Indicators[35], identify trends in the use of certain active substances[36], identify priority items, such as active substances, crops, regions, or practices that require particular attention, or good practices[37], communicate the results of these evaluations to the Commission and to other Member States and to make this information available to the public[38]. The pesticides regulation requires Member States to control and verify that plant protection products are used in accordance with the conditions of authorisation and the labelling specifications[39].

The Commission reports the trend in pesticide use by weight, with different weightings applied for different risk categories[viii]. However, this does not provide any indication of the trend in risk to biodiversity in particular, including insect pollinators, as pesticide risk to insects is not related to the weighting of the pesticide used, nor the quantity in weight used, nor to the relative risks to human health and the environment more broadly.

The European Commission guidance document on monitoring and surveying of impacts of pesticide use on human health and the environment recommends that Member States further develop pesticide statistics with the aim of improving the availability of data on pesticide use at regional level, as the geographical location is important information for assessing risk (European Commission, 2017). It is also important to ensure that pesticide use statistics can be linked to complementary data such as land use data, biodiversity monitoring, protected areas distribution and other environmental data.

NAP action on indicators and monitoring of risks of pesticides to pollinators

Seven NAPs contain statements that aim to measure, monitor, or otherwise assess risks of pesticide use to pollinators (see Table 3). Three specifically mention wild

---

[35] SUD Article 15(2)(a) and Commission Directive (E) 2019/782 establishing harmonised risk indicators to estimate the trends in risk from pesticide use

[36] SUD Article 15(2)(b)

[37] SUD Article 15(2)(c)

[38] SUD Article 15(3)

[39] Regulation (EC) No 1107/2009 Articles 68 in conjunction with Article 55

pollinators, but the indicators of success in Portugal, for example, refer to the risk to honeybees rather than wild pollinator populations. Whilst these declarations in the revised NAPs promise improvements in future, the current situation is that very little monitoring of impacts of pesticides on pollinators is being carried out. The European Parliament review of the SUD pointed to the limited monitoring of the reduction of the impacts of pesticides on the environment and human health in its SUD implementation assessment in 2018 (Remáč et al, 2018). The European Court of Auditors audit on the implementation of the SUD published in February 2020 also highlighted the limited progress in measuring and reducing the risks of the use of pesticides (European Court of Auditors, 2020).

Table 3: NAP action on indicators and monitoring relevant to measuring risks of pesticides to pollinators

Sweden NAP (2019)	Defines the indicator to monitor progress on the objective as the proportion of crop plants in flower which are treated with plant protection products which are toxic to pollinating insects (see Section 2).
France Ecophyto plan (2019)	Sets the goal to establish a "phytopharmacovigilance mechanism" to monitor "the adverse effects of plant protection products on humans, livestock, including the honeybee, crops, biodiversity, wildlife, water and soil" (see Section 2). The 2018 revised plan states that particular efforts will be made to monitor the sublethal effects of active substances on wild pollinators, specifically of the neonicotinoid family. National research networks will be mobilized to further investigate the impacts of products on target and non-target organisms (including pollinators) and ecosystems, and the solutions centred on ecological infrastructure to reduce transfers and impacts. The NAP also states the intention to launch discussion to evaluate the relevance of currently used indicators of environmental impacts and possibly develop new indicators.
Estonia NAP (2019)	Refers to a plan to use structural changes in the communities of bumblebees (proportion of bumblebee species which are more sensitive to environmental conditions) as an indicator for measuring the performance of the general objectives of the Action Plan.

Portugal NAP (2019)	Sets objective to monitor the effects of plant protection products on pollinators, and the risks of such products to pollinators for the 2018-2023 period. The proposal is for the adoption (in cross-compliance checks) of indicators of pesticide use in relation to the legal requirements on managing biodiversity. Indicators are defined as: proportion of pesticides hazardous to bees (compared to total number of pesticides in the market), number of recorded pesticide poisonings of honeybees, and pesticide residues detected in honey.
Croatia NAP (2013)	Objective to establish a system to monitor the exposure of bees to pesticides in real conditions of use in Croatia, to research the adverse impacts of pesticides on bees and the overall bee colony.
Finland NAP (2018)	Assigns support for research to increase understanding of pollinator exposure to pesticides (see Section 2).
Italy NAP (2014)	NAP indicator of impacts on wildlife was defined in a decree in 2015[ix]: Populations of birds sensitive to pesticides[x]
Luxembourg NAP (2017)	The revised NAP foresees continuation of the research project BEEFIRST which monitors the pesticide residues present in pollen collected by honeybees (see section 2).

Several documents point to weaknesses in Member States pesticide monitoring as laid out in their NAPs and therefore their inability to assess whether implemented policy measures are effective for pollinator protection (see Table 4).

Table 4: Evidence of weaknesses in NAPs re monitoring of impacts of pesticides on pollinators

Austria	The revised NAP was criticised by the Austrian beekeeper organisation[xi] for its failure to use appropriate indicators to monitor pesticide risk for flora and fauna and especially for pollinators. They consider the indicators used to monitor pesticide risk for flora and fauna and especially for pollinators as inappropriate and stated that as well as taking into account the Farmland Bird Index, Grassland Butterfly Index, and High Nature Value farmland index, the

	NAP should finance and develop a dedicated pollinators indicator based on measures of cases of intoxication of honeybees and pesticide residues found in bee products.
Ireland	The 2019 NAP makes no mention of pollinators, whilst the All-Ireland Pollinator Plan 2015-2020[xii] defines the need for action (led by AFBI and DAFM) to maintain data on the pesticides that are used in Ireland, where they are used, and what for, in order to assess risks to pollinators.
Netherlands	The mid-term evaluation of the Netherlands NAP in 2019 (Verschoor and et al, 2019) concluded that to see whether the implemented policy measures help to stop the decline of biodiversity, biodiversity in the Netherlands has to be monitored for a longer period of time.

4.2.2 Specific measures to control impacts on pollinators and to ensure compliance

Scope for action under the SUD

Member States are required to identify priority items, such as active substances, crops, regions, or practices that require particular attention, or good practices[40], communicate the results of these evaluations to the Commission and to other Member States and to make this information available to the public[41]. Therefore, it is the responsibility of Member States to define measures to prioritise non-chemical methods of pest control. This can include measures for protection of pollinators, and measures targeting priority active substances which present a high risk to pollinators. The NAP can reinforce or amplify actions regulated by the EU Pesticides Regulation. Pollinator protection can be integrated into the national code of conduct on pesticide use that must be followed by all professional users and in the label specifications and rules tied to use of specific pesticide products. The EU Pesticides Regulation requires Member States to carry out official controls

[40] SUD Article 15(2)(c)
[41] SUD Article 15(3)

in order to enforce compliance[42] with the proper use of plant protection products[43]. According to the pesticide labelling regulation[44], the labels of plant protection products must contain standard indications for special risks to animal health or to the environment, including standard phrases to highlight risks to bees.

Restrictions on pesticide use to reduce exposure of wild pollinators could include:

- bans on spraying during sunny periods or during the flowering period of crops that are particularly attractive to pollinators (though it is important to note that some pollinators fly at night or in cloudy conditions);
- bans or restrictions on use of certain pesticides on certain crops to reduce exposure of pollinators;
- establishment of buffer strips to decrease pesticide exposure in off field habitats;
- promotion or requirement for use of pesticide spray techniques and technologies that reduce exposure.

NAPs with specific measures to control impacts on pollinators and to ensure compliance

Seven NAPs contain specific measures to reduce risks of pesticides to wild pollinators as well as honeybees (see Table 5). For example, the Swedish Board of Agriculture has published a list of pesticides that are particularly toxic to pollinators (see section 2). Most other NAPs refer to specific measures to reduce pesti-

[42] Article 68 of Regulation (EC) No 1107/2009

[43] As per Article 55 of the EU pesticides regulation (Regulation (EC) No 1107/2009), proper use includes the application of the principles of good plant protection practice and compliance with the authorisation conditions and specified on the labelling. It shall also comply with the provisions of the SUD and, in particular, with general principles of integrated pest management, as referred to in Article 14 of and Annex III to that Directive, which shall apply at the latest by 1 January 2014.

[44] Commission Regulation (EU) 547/2011 of 8 June 2011 implementing Regulation (EC) No 1107/2009 of the European Parliament and of the Council as regards labelling requirements for plant protection products. Annex II lists standard label phrases for risks to bees (SPe8) as '*Dangerous to bees/To protect bees and pollinating insects do not apply to crop plants when in flower/Do not use where bees are actively foraging/Remove or cover beehives during application and for (state time) after treatment/Do not apply when flowering weeds are present/Remove weeds before flowering/Do not apply before (state time).* The phrase shall be assigned to plant-protection products for which an evaluation according to the uniform principles shows for one or more of the labelled uses that risk-mitigation measures must be applied to protect bees or other pollinating insects. Depending on the use pattern of the plant-protection product, and other relevant national regulatory provisions, Member States may select the appropriate phrasing to mitigate the risk to bees and other pollinating insects and their brood.'

cide risk to honeybees without mentioning wild pollinators; for example, the Finland NAP specifies that pesticides dangerous to honeybees must not be used within 60 m distance from beehives. Most Member States specify that farmers need to inform beekeepers well in advance before spraying but provide no specific mechanism for this, nor do they implement any means of controlling compliance. The Austria NAP was criticised by the Austrian beekeeper organisation[xiii] for its failure to promote new technology measures to reduce pesticide exposure.

The second Commission report on the NAPs pointed out that only five Member States identified any priority active substances to target action, and no revised NAP explicitly identified priority regions or good practices.

Table 5: Specific measures for pollinators in NAPs

Sweden NAP (2019)	The Government has tasked the Swedish Environmental Protection Agency with proposing further measures capable of reversing a negative trend in biodiversity. The Swedish Board of Agriculture and Swedish Chemicals Agency have initiated efforts to review the impacts of pesticide use on biodiversity, which includes through collating information about the rules and use of these products and making it easily accessible, including an up-to-date list of all the plant protection products which are harmful to pollinating insects and possible actions.
France Ecophyto+ (2019)	ANSES[45] (the French national agency for safety of food, environment and workplace), was asked to identify, in the light of new scientific data, the strengthening of all components of the regulatory provisions in force to improve protection of bees and other pollinating insects, by revising the legislative scope and targeting the periods for derogations. The protection of bees is currently regulated by three decrees[46], which complement the conditions of use specific to each product, such as the maximum dose or the maximum number of applications, which are specified in the marketing authorization issued at the end of

[45] Agence nationale de sécurité sanitaire de l'alimentation, de l'environnement et du travail
[46] Inter-ministerial Order of 28 November 2003 on the conditions for the use of plant protection products, with a view to protecting domestic and wild pollinating bees during the flowering season, and the Order of 7 April 2010 on the use of tank mixes.

	the product risk assessment, including the risk assessment for bees. In its opinion published on February 5, 2019, ANSES makes several recommendations, such as the extension to all products of the restrictions that now apply only to insecticides (République Française, 2020). A working group was set up in 2019[xiv] to follow up on these recommendations and propose an action plan including regulatory changes[47].
Belgium NAPAN (2018)	Sets a target of 100% of pesticide application equipment used in field and orchard spraying having low-drift nozzles[48] within the period of the NAP (2018-2022).
Croatia NAP (2013)	Targets the strengthening of compliance with existing rules to protect pollinators, by introducing inspection controls of the application of pesticides in the field, with the aim of controlling the implementation of risk mitigation measures for bees and other important usage restrictions stipulated for individual pesticides, for the purpose of protecting non-target organisms and the environment.
Czechia NAP (2018)	The Ministry of Agriculture in cooperation with the Institute, the State Veterinary Administration, the BRI and the Beekeepers Association will by the end of 2019: • analyse the extent of use of preparations that are high risk for pollinators, such as foliar insecticides, insecticidal granules, insecticidal disinfectants and other preparations, and in relation to the risk of mass poisoning of bees, according to the results will assess the need for accepting further measures to eliminate risks; • consider the proposal to amend Decree No. 327/2012 Coll. on the protection of bees, game, aquatic animals and other non-target organisms in the case of use of plant protection products and, as appropriate, will

[47] However, the working group was able to meet only few times, the last one in 2019, and then was suspended because of the COVID pandemic, and there is not yet any progress to report.
[48] 50% minimum drift-reducing caps

	propose legislative adjustments to potentially improve risk management for pollinators in the case of professional treatment of seed and planting stock, including certification, and in the case of subsequent handling and sowing of treated seeds/planting stock in agricultural primary production; • consider the applicable law on seed and planting stock and the implementing decree and their coherence with the valid Phytosanitary Act and the implementing decree in the stated matter. Based on the outcome of the legal-phytosanitary assessment, it may propose legislative amendments to the EU and the CR standardisation of the marking of the package tags/labels for treated seed/planting stock taking into account risk management for pollinators and other non-target organisms; • in cooperation with crop associations analyse changes in the pest occurrence intensity, changes in the intensity of use of different insecticidal applications, especially in rape, maize, poppy, sunflower, etc. • consider the legislative possibilities in the mechanization decree, in the Act on Phytosanitary Care (chapter mechanization means), and in the draft decree on amending Decree No. 327/2012 Coll. on the protection of bees, game, aquatic animals and other non-target organisms when using plant protection products, where it is possible to respond to technological development and possibilities in the equipment of mechanization means.
Romania NAP (2019)	Draw up recommendations on the foliar application of plant protect products with a view to reducing the impact on bees. It is mandatory to use deflectors on vacuum-based pneumatic seed drills used in the sowing of agricultural crops whose seed is treated, with the aim of reducing dust emissions and the negative impact on (inter alia) pollinating insects.

4.2.3 Limits or prohibitions on pesticide use in specific areas – public spaces and Natura 2000

Scope for action for pollinators under the SUD

SUD Article 12 gives Member States, regional and local authorities the power to minimise or prohibit pesticide use in specific areas (i.e. public spaces and Natura 2000 sites), with due regard for the necessary hygiene and public health requirements and biodiversity, or the results of relevant risk assessments. There are regional or local bans or restrictions on pesticide use in order to minimise or eliminate risks to the health of vulnerable groups, or to reduce pressures on biodiversity in protected areas.

NAP actions on pesticide use in specific areas relevant to pollinators

As pointed out by the second Commission report on the NAPs, although 25 out of 28 MS report applying restrictions on pesticide use in at least some specific areas, these are almost all targeted to water protected areas (established under the Water Framework Directive), plus in some cases certain public spaces. The first Commission report already highlighted the lack of targets and measures to reduce pesticide risks and use in protected areas.

Member States are, however, increasingly taking initiatives to restrict or ban pesticide use in areas protected for nature conservation, including Natura 2000 areas, including efforts to find out more about which pesticides pose most risks due to their use in and around Natura 2000 sites (see Table 6). According to experts, the draft Italian NAP for 2019-2024 aims to pay more attention to the necessity to protect bees and other pollinators in and beyond protected areas, but it could not be included in this review[xv].

Table 6: Initiatives to restrict or ban pesticide use in areas protected for nature conservation

Belgium NAPAN (2018)	Flanders has a ban on the use of plant protection products in the Flemish Ecological Network (Vlaams Ecologisch Netwerk). The NAP proposes an awareness raising campaign to support these restrictions. It also proposes to create an inventory of areas and protected species affected by pesticide use, and then to develop a targeted awareness raising campaign to protect these species from pesticide pressures. In Brussels, pesticide use is forbidden in Natura 2000 sites and other semi-natural habitats[xvi].

	The NAP 2018-2022 plans an action to raise the awareness among residents and neighbours of protected (semi-) natural areas. Communication and awareness-raising activities will be carried out specifically in the Natura 2000 sites and nature reserves in which the use of pesticides is prohibited. The neighbouring residents of the areas concerned and those located in the safety perimeters (60 m around the Natura 2000 areas) area are also to be covered.
Bulgaria NAP (2012)	Declared an aim to introduce a ban on use of pesticides in the professional use category in specified districts, including certain protected territories, and pastures and meadows in some zones in the Natura 2000 network. The Minister for the Environment and Water (MOSV) was responsible for implementing the ban. The plan included an indicator of the number of infringements involving use of PPPs on protected areas and zones in the Natura 2000 ecological network where a prohibition on pesticide use has been introduced. The revised Bulgaria NAP has been submitted to the Strategic Environmental Assessment[xvii], but is not yet published by the European Commission, so it was not possible to check whether the action was completed or included in the new plan.
Spain NAP (2018)	Implemented a set of IPM rules for the whole territory, differentiated according to types of crop or non-crop system (vines, olives, arable, forest, etc.)[xviii]. The IPM rules include voluntary recommendations for the high-risk areas within the protection zones (i.e. protected areas including Natura 2000 and other areas with endangered species that are listed in the Spanish Catalogue of Endangered Species). The revised NAP has an objective to 'establish a method for assessing the effectiveness of the recommendations set for protection zones in relation to IPM'. The NAP states: '*Given that it is not possible to carry out strict checks of the application of the proposed measures a more workable idea is to assess their potential effect on fauna.*' (see Section 2).

Italy **NAP (2014)**	The NAP states the intention to support measures for protection of Natura 2000 sites, conservation areas and national parks, as defined in national or regional legislation and in the National or Regional Parks' plans. This resulted in a national decree passed in 2015, which defines measures for the sustainable use of pesticides in Natura 2000 sites and other protected areas[xix] (see section 2).

Luxembourg has withdrawn the authorization for glyphosate containing herbicides from December 2020 in the whole national territory, and the Austrian government is currently working on a similar measure. In some Member States, public organisations have gone further than the declarations in the NAP to implement restrictions or prohibitions on pesticide use in publicly managed green spaces. For example, in Luxembourg the use of pesticides in public spaces is prohibited by law since the beginning of 2016. Although these restrictions are not explicitly aimed at protecting pollinators, and the restrictions on glyphosate are primarily explained by concerns about effects on human health, some are partly motivated by the aim to protect biodiversity more widely (see Section 2).

4.2.4 Training and awareness raising on pesticides and pollinators

Scope for action for pollinators under the SUD

Member States should ensure that all professional users, advisors, and distributors have access to appropriate training by officially designated training bodies. The training should include identification and control of risks to non-target plants, beneficial insects, wildlife, biodiversity, and the environment in general, as appropriate for their different roles and responsibilities[49]. As part of the obligatory training for professional users, Member States could develop training sessions on the risks posed by pesticides to pollinators and what measures can be taken to reduce those risks, targeted to different types of professional pesticide users including farmers, public authorities, and others.

According to the SUD, Member States shall require distributors selling pesticides to non- professional users to provide general information regarding the risks for

[49] SUD Article 5.1. The training shall be designed to ensure that such users, distributors and advisors acquire sufficient knowledge regarding the subjects listed in Annex I, taking account of their different roles and responsibilities. SUD Annex I: 3. The hazards and risks associated with pesticides, and how to identify and control them, in particular: (c) risks to non-target plants, beneficial insects, wildlife, biodiversity and the environment in general.

the environment of pesticide use and to provide low-risk alternatives[50]. Member States can also take further measures to reduce risks to pollinators from non-professional pesticide users, including to:

- provide information on how pesticides can harm pollinators to citizens in gardening shops, gardening courses, public gardens and greenhouses, and promote non-chemical alternatives.
- clearly label pesticides with references to the potential negative effects on pollinators including images.
- withdraw certain pesticides from the market for non-professional users[51].

NAP actions on training and awareness raising relevant to pollinators

Most of the NAPs mention the inclusion of biodiversity and sometimes specifically risks to pollinating insects in the mandatory training for professional users of pesticides. Examples of planned training and awareness raising actions relevant to wild pollinators come from the NAPs of Sweden, Finland, Portugal, Netherlands, and Belgium (Table 7). In Croatia and Romania, it is not clear whether the training and awareness raising addresses risks to wild pollinators as well as honeybees or not. The Belgian NAP is the only one which explicitly plans awareness raising measures that address the public and amateur users, going beyond professional users of pesticides.

Table 7: NAP actions on training and awareness raising relevant to pollinators

Sweden NAP (2019)	Identifies actions on training, information and advice on the pollinators' vulnerability and the opportunities for adapting cultivation for their benefit, and better product and user information about plant protection products which can be toxic to pollinating insects. The NAP also defines an action to provide training, information and advice aimed at reducing the risks involved with using plant

[50] SUD Article 6.3. Member States shall require distributors selling pesticides to non- professional users to provide general information regarding the risks for human health and the environment of pesticide use, in particular on hazards, exposure, proper storage, handling, application and safe disposal in accordance with Community legislation on waste, as well as regarding low-risk alternatives. Member States may require pesticide producers to provide such information.

[51] The SUD requires Member States to take necessary measures to restrict sales of pesticides authorised for professional use to persons holding the certificate for professional users, but Member States can go further by restricting sales of pesticides authorized for non-professional use in order to protect pollinators.

	protection products which are toxic to bees on crops that are attractive to pollinators.
Portugal NAP (2019)	Includes an objective to promote the adoption of agricultural and forestry practices that protect biodiversity and auxiliary organisms, including pollinators. Implementing bodies are DGAV, DRAP, ANIPLA, GROQUIFAR, DGADR, ICNF, APG, beekeeping federations, farmers organisations, and forestry producers' organisations. The NAP plans awareness raising of the risks posed by pesticides to bees and other pollinators and of the measures to mitigate such risks on agricultural and forestry holdings and in recreational areas for the 2018-2023 period.
Finland NAP (2018-2022)	The Natural Resources Institute Finland (LUKE), the universities, MMM, and companies in the industry will produce information on actions promoting the use of pollinators and natural enemies of pests and take actions to ensure that farmers have sufficient knowledge on how to apply the relevant procedures and that the environment support conditions and other provisions enable the use of such procedures at the level of farms.
Netherlands national strategy on crop protection[xx] (2012)	The business community is to provide information to growers by about the risks of plant protection products for bees and other non-target organisms, so growers take this into account in their choice of means and method of application.
Belgium NAPAN (2018)	Plans activities in all three regions to raise the awareness of amateur users of pesticides to promote behaviour that minimises risks and reduces amateur pesticide use. Brussels will set up regional signposting for the ecological management of public spaces, Flanders will continue activities promoting pesticide-free management by public administrations and other land managers, and Wallonia will promote the development of alternative methods of control aimed at the non-agricultural public and particularly at private individuals. Pollinators are not explicitly mentioned in these objectives but in Brussels they follow the Regional Nature Plan, which also sets an objective for

	pollinators and green spaces. All three regions have introduced a ban on using broad-spectrum herbicides in public areas.
Latvia NAP (2020)	Sets objective to hold three information campaigns for protection of pollinating insects during 2020-2023 (led by State Plant Protection Service and Latvian Beekeepers Association). Indicator: The number of information campaigns held for protection of pollinating insects. Indicator: The number of informative materials on protection of pollinating insects produced and disseminated by type.
Croatia NAP (2013)	States that in the training provided to professional users there should be systematic awareness raising on the potential dangers of plant protection products to bees and non-target arthropods.
Luxembourg NAP (2017)	Measure 2-2 with objective to protect pollinating insects foresees measures to raise the awareness of pesticide users, with indicator 'number of awareness-raising sessions'.
Romania NAP (2019)	Organise workshops in collaboration with beekeepers' associations.

Other Member States identify such actions as a need in other strategies or documents, but the NAP does not register this, indicating that the NAP is not coherent with other national policies. For example, the **Ireland** NAP makes no mention of specific actions aimed at pollinators, but the All-Ireland Pollinator Plan 2015-2020[xxi] defines three actions to develop best-practice guidelines directed at wild pollinator conservation, to be led by the Department for Agriculture, Food and Marine, with AFBI and the National Biodiversity Centre, and by the Department of Environment, Community, Local Government and Heritage with Transport Infrastructure Ireland and local authorities.

The French national audit office recommended that the public should be informed annually about the use of pesticide active substances and the associated risks for human health and the environment, as a means of increasing accountability and strengthening the effectiveness of the NAP's measures (Cour des Comptes, 2020).

4.2.5 Promotion and implementation of integrated pest management and alternative approaches to protect pollinators in agriculture

Scope for action for pollinators under the SUD

IPM implementation is an obligation for all professional users, as of 1 January 2014, and chemical methods of pest control should only be used as a last resort. Member State authorities shall verify IPM implementation by professional users during official controls and enforce the existing legal requirements, and professional users are required to keep records of the application of pesticides. Member States can promote the uptake of IPM approaches through any combinations of funding incentives, advice and training, labels and marketing approaches, regulation, and increased compliance checks at farm level. Another strategy for Member States to reduce pesticide use is to promote organic agriculture, and to target alternative approaches to those farming systems where pesticide use is currently highest.

IPM systems and agroecological approaches such as organic farming include a number of farming practices that are likely to increase wild pollinator abundance, including: reduced or zero pesticide use, fallowing fields or parts of fields for a season or more (with no pesticide use), cover crops and green manure crops, tolerance of weeds, high densities of field margins and landscape features, diverse crop rotations, unsprayed crop headlands, strips or margins, and a diverse mix of crops, grassland and woody vegetation. IPM systems that effectively reduce insecticide use are particularly important for pollinators on crops that are highly attractive to pollinators, including fruit trees (apple, pear, plum, cherry) and soft fruit, sunflower, and legumes (beans, peas, clover, alfalfa, lupins etc).

Action in NAPs on IPM and alternatives relevant to pollinators

Most Member States are producing at least some IPM guidelines for specific cropping systems and users. For example, the Finland NAP included an action to update IPM guidelines specified for the main plant species where necessary and integrate them as part of the cropping guidelines. In Italy, the IPM National Committee has been publishing the "National guidelines for Integrated Pest Management" on an annual basis. With the exception of Spain, the NAPs do not specify how the IPM guidelines are expected to reduce impacts on biodiversity (including pollinators) but there is a general expectation that promotion of the guidelines will help to reduce pesticide use. In Spain, a set of national IPM guidelines are recommended to farmers in Natura 2000 sites and other biodiversity protection zones, with the aim of reducing impacts on endangered species (see Table 6).

Several Member States identified in their NAP how they aim to protect biodiversity using CAP measures, mainly agri-environment measures and/or support for organic farming, for example the Slovenia NAP refers to the fact that the RDP 2014-2020 is focused on improvement of biodiversity (target for 29% of agricultural land) and status of waters (25% of agricultural land) and soil (27% of agricultural land). It also mentions the support for conversion to organic farming provided by the RDP. However, mentions of pollinators in connection with IPM were only found in the NAPs of Austria, Hungary, and the Netherlands. It seems that none of the NAPs mention that Ecological Focus Areas (EFAs) must be pesticide free as from 2018.

In parallel to their CAP programmes, several Member States developed national projects to support changes in farming practices to reduce pesticide use or risks, for example the Dephy network in France (see Section 2). Italy also has a network of 23 IPM demonstration farms[xxii].

Germany has recently launched such a funding programme, but this is not linked to the NAP (see Section 2)

Table 8: Action in NAPs on IPM and alternatives that refers to pollinators.

Austria NAP (2018)	Refers to national legislation that mandates compulsory crop rotation and the creation of Ecological Focus Areas (EFAs). The Austrian NAP also mentions that the Austrian agri-environment programme (ÖPUL) is focused on maintaining and strengthening biodiversity and thus also protecting natural enemies of pests, and pollinators. The 'environmentally friendly and biodiversity-promoting management' agri-environment scheme requires at least 5% biodiversity areas, the retention of landscape features, and on grassland, no management, grazing or cut before 1st June, or on arable the sowing of seed mixtures of at least four insect-pollinated plant species (see Section 2). The other agri-environment schemes that aim to reduce or eliminate completely the use of synthetic chemical plant protection products are 'foregoing the use of insecticides in viticulture', 'limiting the use of inputs designed to increase yields', 'foregoing the use of fungicides and growth regulators', 'greening of arable land' and 'organic farming'.

Luxembourg NAP (2017)	Measure 2-2 of the revised NAP with the objective to protect pollinating insects foresees: - financial promotion of pheromone traps in viticulture - promotion of agri-environmental schemes and biodiversity contracts that promote pollinator protection
Netherlands national strategy on crop protection[xxiii] (2012)	Includes a specific action to encourage the voluntary creation of more field margins equipped for Functional Agro-Biodiversity (FAB) including pollinators, with financing from CAP 2014-2020 if possible. Farmers are obliged to maintain a cultivation free zone of 0.5 m around all crops, and the plan announced in 2014 that if set objectives were not be met after 2 years the distance would increase to 1-1.5 m. It also raised the goal of drift reduction to -75% (instead of the 50% reduction in the previous plan).
Hungary NAP (2012)	Ecological farming measure: Integration of environmental risk mitigating measures into ecological farming, support of programs for the maintenance of biodiversity and the protection of beneficial living organisms (e.g. not cultivated edges and bands, sowing edge plants providing food to pollinating insects). Introduction of two-tiered integrated crop production techniques: Establish ecological corridors, ecological levelling surfaces, forest bands, groups of bushes and trees providing hiding, feeding, and breeding sites for non-target organisms, particularly protection of beneficials. Flowering strips sown and maintained with flowering plants attracting pollinating insects on arable margins for safeguarding and increasing pollinating insect populations.

The first Commission report concluded that Member States have not developed clear criteria to assess the implementation of IPM principles in controls at farm-level and have not taken appropriate measures to deal with non-compliance in this regard. The second Commission report reached the same conclusion.

The European Court of Auditors (European Court of Auditors, 2020) concluded that Member States undertake only very limited control of farmers to verify that IPM principles are implemented, and that IPM implementation is not a condition for receiving CAP payments, resulting in little development of non-chemical alternatives and little incentive for farmers to take them up. The auditors recommended a stronger enforcement of IPM implementation through their integration into CAP conditionality and the development of practical and measurable criteria by Member-States, with the support of the Commission. They also recommended the collection of better pesticide statistics and the development of better risk indicators to assess impacts on the environment. The European Parliament also pointed to the lack of application of the IPM principles (Remáč et al, 2018).

Several Member States request farmers to fill out a form with information on how they have applied IPM. However, the forms are not currently checked by inspectors to determine compliance with the principles of IPM.

5. SECTION 2: EXAMPLES AND EFFECTIVENESS OF ACTIONS FOR POLLINATOR CONSERVATION

This section summarises the evidence on the effectiveness of the types of actions that Member States could take through their NAPs, if scientific assessments are available in the published literature (e.g. Dicks et al, 2013; Dicks, Showler and Sutherland, 2010). Where there is no evidence of effectiveness, the authors consulted with experts to assess the potential effectiveness at different scales as far as current information allows.

Secondly, the section identifies good practice examples of the types of actions for pollinator protection against negative impacts of pesticides that some Member States are promoting through their NAPs, in accordance with the SUD. Examples of these types of actions are identified from the literature and from consultations, focussed on the EU wherever possible. Good practice (successful approaches) was regarded as being a process or methodology that is replicable, has been shown to work well, succeeds in achieving its objective(s), and therefore can be recommended as a model. The decision on what are good practices was made based on the evidence gathered on impacts on reducing risk and/or increasing pollinator abundance.

5.1 National targets or objectives to reduce pesticide use aimed at pollinator conservation

5.1.1 Evidence of effectiveness of actions – targets, indicators, and monitoring

There is very little evidence of the effectiveness of pesticide reduction **targets** as few Member States have set quantified targets or implemented robust methods for measuring use reduction, as shown in Section 1. The national pesticide risk indicators used by Member States currently fail to identify the use patterns with the greatest risks for the environment from pesticide use (Möhring, Gaba and Finger, 2019). It is therefore not possible to map the greatest risks to pollinators from combined pesticide use in the EU, although this information would be important to designing effective policy measures to reduce risk.

To establish and monitor targets to reduce the risks of pesticides to wild pollinators that are effective, realistic, and measurable, you need **information** on the toxicity of pesticides to wild pollinators and the exposure of wild pollinators. You can then analyse the current pressure on pollinators from pesticide use and develop an indicator to measure progress. A widely used source of information on pesticide environmental toxicity is the Pesticide Properties DataBase (PPDB) managed by the University of Hertfordshire in the UK. This database lists the available information on acute and chronic toxicity to honeybees, bumble bees and solitary bees (Lewis et al, 2016). However, one problem is that the current information on toxicity is mainly based on acute toxicity to honeybees and does not fully capture the longer-term risks to wild pollinators. In most Member States, the pesticides identified as highly hazardous to honeybees are not allowed for use on crops during their flowering, or only at night when honeybees are not flying. It is likely that the current available information does not capture the pressures on wild pollinators, as the impacts will arise from the cumulative impact of pesticide applications that are not identified as acutely toxic on their own, and the longer-term and chronic exposure to pesticide residues in fields and field margins.

Information on the exposure of wild pollinators to pesticides and pesticide residues can come from surveys and monitoring. Several studies have measured the exposure of pollinators to pesticides, including:

- Measure of pesticide residues in the bodies of worker bumblebees collected with insect nets whilst foraging (Botías et al, 2017).
- Measure of pesticide residues in nectar and pollen of crop flowers and wildflowers growing near agricultural areas (David et al, 2016).
- Measure of pesticide residues in the pollen collected by returning honeybee foragers (beebread) by installing pollen brushes in apiaries during the active foraging season (Böhme et al, 2018).
- Measure of pesticide residues in honey samples (Woodcock et al, 2018).

So far there has only been one investigation of pesticide residues in wild bees. These two studies in the UK tested adult bumblebees, their pollen loads, and wildflower pollen from agricultural field margins, and found a large number of pesticide residues throughout the season (Botías et al, 2017; David et al, 2016) (see Box 2 for details). Numerous multi-year surveys of pesticide residues in honey and honeybees have demonstrated that honeybees are picking up many different pesticide residues, and some concentrations reach levels of concern for honeybee health (see Box 2). The results also demonstrate that honeybees are being exposed to illegal pesticide use in some places. However, a study has shown that residues in hives vary greatly, and there is no clear connection with agricultural land uses around the hive (Raimets et al, 2020). As honeybee colonies target their foraging on the most profitable flower resources in an area up to several km from the hive, their exposure to different crops and pesticides also varies from hive to hive. It is also questionable whether monitoring pesticide exposure of honeybees provides sufficient information to assess the exposure of wild pollinators. There are significant differences in their pathways of exposure and in the relative toxicity of pesticides to wild bees compared to honeybees.

Key points learned from pesticide residue surveys:

Exposure to many different pesticide residues at the same time and through multiple exposure routes

Concentrations can reach levels that exceed safety levels to avoid effects on bee health

Exposure to pesticide residues in nectar and pollen of crop flowers and wildflowers even years after pesticide was used in that field

Evidence of illegal pesticide use

To our knowledge, none of the surveys described above has been established on a permanent basis as a tool for monitoring pesticide risk to honeybees or wild bees. Multi-residue analysis methods are available that can quantify over 80 environmental contaminants, pesticides and veterinary drugs belonging to different chemical classes in pollens, honey, and bees. One method, combined with accurate and sensitive detection, allows quantification and confirmation at levels as low as 10 ng/g, with recoveries between 60 and 120%[52]. This information could be linked to the information from farmers pesticide usage records[53]. Residue studies on pollen and nectar are expensive and practically challenging. A recent review concluded that residue values in pollen and nectar exhibit large variations and standard measures are not available for many pesticide and crop species combinations, which results in inaccurate estimations and uncertainties in risk evaluation (Gierer et al, 2019). However, in contrast, the German research institute for cultural plants has tested multi-residue measurements of 240 different active substances in bees, bee pollen and other bee products, and plants, and found reliability between 70% and 110%, with standard deviations below 15% (Bischoff et al, 2020). A research project in Germany plans to set up a survey for pesticide residues in wild pollinators using *Osmia bicornis*, providing the first data set on field pesticide exposure of a solitary bee species (see example box below)

[52] The method combines the QuEChERS method for multiple pesticide residue screening with sensitive analytical techniques LC–MS/MS and GC-ToF

[53] According to Regulation (EC) No 1107/2009 Article 67, professional users of plant protection products shall, for at least 3 years, keep records of the plant protection products they use, containing the name of the plant protection product, the time and the dose of application, the area and the crop where the plant protection product was used.

Box 2: Examples of surveys of pesticide residues and pollinators

- A study in UK oilseed rape fields in 2013 (i.e. before the neonicotinoid ban came into force) showed that **bumblebee-collected pollen** contained a wide range of pesticides, notably including the fungicides carbendazim, boscalid, flusilazole, metconazole, tebuconazole and trifloxystrobin and the neonicotinoids thiamethoxam, thiacloprid and imidacloprid. In bumblebees, the fungicides carbendazim, boscalid, tebuconazole, flusilazole and metconazole were present at concentrations up to 73 nanogram/gram (ng/g). It is notable that pollen collected by bumble bees in rural areas contained high levels of the neonicotinoids thiamethoxam (mean 18 ng/g) and thiacloprid (mean 2.9 ng/g), along with a range of fungicides, some of which are known to act synergistically with neonicotinoids (David et al, 2016). The study also showed that the oilseed rape pollen and the pollen of wildflowers growing alongside the crop was heavily contaminated with a broad range of pesticides.

- A season long survey of **bumblebees** in 2014 in the UK collected specimens of five different species from farms and ornamental urban gardens in three sampling periods (Botías et al, 2017). Five neonicotinoid insecticides, thirteen fungicides and a pesticide synergist were analysed in each of the specimens collected. In total, 61% of the 150 individuals tested had detectable levels of at least one of the compounds, with boscalid being the most frequently detected (35%), followed by tebuconazole (27%), spiroxamine (19%), carbendazim (11%), epoxiconazole (8%), imidacloprid (7%), metconazole (7%) and thiamethoxam (6%). Quantifiable concentrations ranged from 0.17 to 54.4 ng/g (bee body weight) for individual pesticides. The majority of bees (71%) had more than one compound, with a maximum of seven pesticides detected in one specimen, and pesticides were present in bumblebees throughout the season, although concentrations decreased towards the end of summer. Concentrations and detection frequencies were higher in bees collected from farmland compared to urban sites.

- A five-year survey of pesticide residues in **honeybee-collected pollen** (2012-2016) (Böhme et al, 2018): 281 single day pollen samples were collected at three agricultural sites in southern Germany and subjected to a multi-pesticide residue analysis. The survey screened for 282 active ingredients (pesticides and some metabolites) currently used in agricultural practice. It found residues of 73 different pesticides, comprising herbicides, fungicides and insecticides (including varroacides and one insect repellent), and some of their metabolites. Twelve of the substances found are not supposed to appear in pollen because it is not permitted to apply them to flowering crops.

- A 3-year survey (2012-2014) of **honeybee-collected pollen** in Italy (Tosi et al, 2018): the pollen was tested for 66 commonly used pesticides, including acaricides, fungicides, insecticides, nematicides, and some metabolites. It found residues of 18 different pesticides (10 fungicides and 8 insecticides), with 62% of samples having at least one pesticide. The concentrations reached the level of concern for honeybee health at least once in 13% of the apiaries.
- A survey in Belgium measured 99 pesticide residues as well as viruses in 330 **honeybee colonies** for one season (Simon-Delso et al, 2017). The study found a positive correlation between exposure to fungicides and loss of colonies, and that hives in crop areas were more susceptible to losses than those in grassland.
- A 2-year (2016-2018) survey of pesticide residues in beebread (collected pollen), live and dead **honey bees** (Calatayud-Vernich et al, 2019) in Valencia, Spain, found that: Beebread was widely contaminated with two miticides (coumaphos and amitraz degradate 2, 4-dimethylphenylformamide (DMF), but most of the pesticide hazard was due to residues of insecticides sprayed during citrus bloom like chlorpyrifos and dimethoate. Dead bees collected during acute mortality episodes in two apiaries near agricultural settings had high levels of chlorpyrifos, dimethoate, omethoate and imidacloprid.
- A survey of **honey samples** (2014 and 2015) in the UK found neonicotinoids present in over a fifth of honey samples one year after the moratorium on their use in crops attractive to bees (Woodcock et al, 2018).

5.1.2 Examples of good practice: Objective setting, targets, and indicators of progress

Several Member States used their NAPs to programme initiatives to improve their information base on the toxicity of pesticides to wild pollinators and exposure of wild pollinators, so that they can analyse the current pressure on pollinators from pesticide use and develop an indicator to measure progress. Denmark's differentiated pesticide taxation system uses the available information on toxicity of pesticide active substances to pollinators to incentive the use of less harmful products and reduce pesticide use overall. In Sweden, work is underway to operationalise the NAP indicator to measure the impact of the plan on pollinator protection. Italy has defined a NAP indicator to measure the impact of pesticide use on wildlife as the population trends of birds sensitive to pesticides.[xxiv]

Denmark's pesticide tax rate is calculated for each authorized plant protection product based on the intrinsic properties of the individual pesticides products and active substances in the products and their expected effects on health and environment. For most insecticides, the ecotoxicology load is the most prominent sub indicator in the calculation, so the toxicity of pesticides towards bees has a high weight in the calculation of the pesticide tax. This is reflected in the tax level where most insecticides have a high pesticide tax compared to most herbicides and fungicides, in large part due to the toxicity to honeybees[54].

The **Swedish** NAP indicator to measure the impact of the plan on pollinator protection is described as the proportion of crop plants in flower which are treated with plant protection products which are toxic to pollinating insects. Discussions are ongoing to clarify what is meant by a flowering crop (for example, sugar beet has been excluded), and what pesticides are toxic to pollinators in what way (see example box)[55]. However, it is possible that the indicator will not be very effective at measuring the actual pressure on wild pollinators, as it will not capture exposure through weeds and plants in field margins, or through pesticide residues remaining in soil from previous applications and crops, and the indicator will only be as good as the information available on toxicity to pollinators. It will be possible to improve it in future as the understanding and information on exposure and toxicity to wild pollinators improves.

Several Member States used their NAPs to establish funding for research programmes on the impacts of pesticide use including impacts on pollinators, for example Finland and Denmark. **Finland** provides an example of research funded by the Ministry of the Environment to gain knowledge about pollinator exposure

---

54 Comments from Denmark regarding protection of pollinators submitted to DG ENV by Department of pesticides and biocides (Pesticider og Biocider) in the environment ministry (Miljøstyrelsen), 1 October 2020

55 Personal communication, Charlott Gissén, Jordbruksverket (Swedish Board of Agriculture), 25/9/2020

to pesticides in crop fields (see example box). In **Denmark**, the Environmental Protection Agency funded a research project on pesticide exposure of bumblebees on two different farms (Bruus et al, 2013). The project authors concluded that not enough information was available to assess whether the measured pesticide concentrations in the bees may be having a sublethal effect on behaviour, reproduction and survival, and that further research is needed, including effects of pesticide mixtures.

An example of an inventory of toxicity effects on wild pollinators, including sublethal effects, is the Belgian Biobest Group list of side effects of pesticides on bumblebees[xxv] (see example box). These types of information could be further developed and combined with other information sources to provide an analysis of the current level of risk to wild pollinators from pesticide use.

The Estonian monitoring plan has not yet been implemented. The current bumblebee monitoring programme monitors the differences in bumblebee abundance between farms which implement the agri-environment option for environmentally friendly farming, or organic farming, compared to reference farms. It is not, however, designed to separate out the effects of the leguminous crop planting supported by the agri-environment measure from the restrictions on pesticide use[xxvi].

Denmark: differentiated pesticide taxation based partly on toxicity to bees

Source: (Kudsk, Jørgensen and Ørum, 2018)

The pesticide load for ecotoxicology is calculated for each active substance on the basis of the acute toxicity to mammals, birds, fish, daphnia, algae, aquatic plants, earthworms and bees[1], and the chronic toxicity to fish, daphnia and earthworms[1]. The ecotoxicology load is combined with the sub indicators on environmental fate and human health, plus the core tax based on amounts, to give the overall level of tax for each product. For most insecticides, the ecotoxicology load is the most prominent sub indicator, so the toxicity of pesticides towards bees has a high weight in the calculation of the pesticide tax. The environmental toxicity to bees is, however, based only on values for acute toxicity to honeybees extracted from the Pesticide Property Database (PPDB) (Kudsk, Jørgensen and Ørum, 2018), and does not take into account the fact that most currently approved pesticides have not been tested for their toxicity to wild bees, and the evidence for significant chronic toxicity impacts on wild bees and other pollinators.

Sweden: Cataloguing and communicating toxicity of pesticides to wild pollinators

Source: personal communication, Charlott Gissén, Jordbruksverket (Swedish Board of Agriculture) and Preparat, farliga för pollinerande insekter. 2020-04-06. Jordbruksverket (Swedish Board of Agriculture). Available at https://webbutiken.jordbruksverket.se/sv/artiklar/ovr479.html

Plant protection products which are harmful to pollinating insects are those with labels displaying conditions of use for protecting pollinating insects or with a different message stating that the product is harmful to pollinating insects. As part of the government assignment being carried out by the Swedish Environmental Protection Agency, which involved mapping and proposing pollination initiatives, a need was identified for reviewing how information about plant protection products which are harmful to pollinating insects can be made more easily accessible. Therefore, the Swedish Board of Agriculture and Swedish Chemicals Agency have initiated efforts to review this issue, collating information about the rules and use of these products and making it easily accessible. The Board published an up-to-date list of all the plant protection products which are harmful to pollinating insects. It lists 13 products (12 pesticides and one biocide) containing 11 active substances that are classified as harmful[1]. Beta-cyfluthrin is not authorised at EU level so is only available under a derogation, and imidacloprid is only available for use on greenhouse crops until the end of the year. Two of the products are authorised for use by organic farmers in the EU (based on abamectin and on *Beauveria bassiana*). Better information can be expected to result in more effective advice and a reduction in the time spent by farmers, and better compliance with regulations. The aim is to restrict the use of

Finland: research to increase understanding of pollinator exposure to pesticides

Source: personal communication, Marja Jalli, LUKE (Natural Resources Institute Finland) 24 April 2020

The Finnish Ministry of the Environment is funding a two-year (2019-2020) study analysing exposure of pollinators to pesticides. The project is coordinated by LUKE (Natural Resources Institute Finland). The project studies in field conditions the extent to which pollinators (both managed honeybees and wild pollinators) are exposed to pesticides on oilseed rape fields. Results of the field investigations will be analysed by the end of 2020. A PhD research project at the University of Helsinki and University of Oulu is being executed in close co-operation with the Ministry funded project. The research will measure pollinators' exposure to pesticides and test how the pesticide residue levels affect bumblebees' cognition and foraging behaviour. The first results of the exposure surveys will be published in Finnish at the end of 2020 and the information will be made available to farmers and beekeepers.

Belgium: Biobest Group Side Effects Manual for use of pesticides with bumblebees

Source: Felix Wäckers, Biobest Group NV, Belgium and Side Effects Manual available at https://www.biobestgroup.com/en/side-effect-manual

The Biobest Group provide this service to their customers as one of their main products is the sale of bumblebee colonies for pollination of crops. The information is based on the Biobest Group's own side-effect tests performed according to IOBC guidelines and/or publicly available information. The list is searchable by pesticide active substance and by pesticide product and ranks each one according to its toxicity to natural enemies and toxicity to bumblebees. Risk is ranked in increasing order of toxicity as:

A close the bumblebee hive before application

B close and remove the hive before application

C not compatible

D require adaptation of bumblebee pollination management.

5.1.3 Examples of good practice: Monitoring impacts of pesticides on pollinators

Member States could set up regular **surveys to monitor** pesticide residues in the pollen or honey collected by honeybees or wild bees, or pesticide residues in bee bodies. A research project in Germany plans to set up a survey for pesticide residues in wild pollinators by placing solitary bee cocoons (of *Osmia bicornis*) and empty nesting tubes in different crop and non-crop locations and testing the resulting nest cells for pesticide residues, providing a data set on pesticide exposure of the tested solitary bee species (see example box). The research is funded through the German government's action programme for insect conservation.

Luxembourg has set up and funded a monitoring programme of pesticide residues in honeybees in support of the NAP objective to protect pollinating insects. It is measuring pesticide residues in honeybee-collected pollen and honey since 2018, and the NAP foresees a continuation of the monitoring beyond 2020 (see example box). The EU funded research project Insignia is developing a pilot network for monitoring pesticide residues in honeybees across the EU, but it does not include any wild pollinators (see example box). It may be possible to extend some of the methods used in these programmes to wild pollinators in future.

An example from France shows how surveillance of the impacts of farming practices including pesticide use on wildflower biodiversity on farmland could be used to infer impacts on wild pollinators. The French biovigilance network 500 ENI has been set up as a surveillance programme to monitor abundance and diversity in the functional groups earthworms, flora of field margins, beetles and birds, and to link that to information on farming practices including pesticide usage (see example box). The network does not monitor any wild pollinator groups, but the first results have demonstrated that such a monitoring network can detect the impacts of changes in herbicide use on the species richness of field margin flora after only three years of monitoring (Fried et al, 2019). The monitoring found that intensive agricultural areas have fewer plant species pollinated by insects (entomogamous species) (Fried, Villers and Porcher, 2018). Other research shows that field margin flowering plant diversity is related to wild pollinator abundance (Alberoni et al, 2020). In future the programme plans to assess the relative impacts of different types of pesticides and how pesticide use reduction interacts with changes in other farming practices, such as fertiliser use (Andrade et al, 2020).

Germany: Field survey of pesticide residues in a solitary bee species visiting pesticide treated crop fields

Source: Experimental investigations into the main risks of insect populations (InsectExpo) project description (InsektExpo project at University of Koblenz-Landau. https://www.uni-koblenz-landau.de/en/campus-landau/faculty7/environmental-sciences/ecotoxicology-environment/research-transfer/projects-terr-ecotox/InsectExpo) and personal communication, Dr. Carsten Brühl, Universität Koblenz-Landau, Germany.

The project „Experimental investigations into the main risks of insect populations (InsectExpo)" will evaluate pesticide exposure of insects in the agricultural landscape. The project will measure pesticide residues from samples of soil, puddle water, plant leaves, and pollen in the field, at the field edge and 20 m from the field edge in the neighbouring habitat in three different crops. Measurements will be done monthly, beginning before the start of the pesticide treatment in February, until the last pesticide treatment in October. The samples will be analysed using High Performance Liquid Chromatography (HPLC) and Gas Chromatography (GC) for more than 100 of the most common pesticides applied in Germany. Pollen for measuring pesticide loads will be obtained from the *Osmia bicornis* nesting tubes and endpoints of pesticide toxicity for larval developments will be evaluated. The dataset will provide the first information about realistic pesticide exposure of insects during the year in the agricultural landscape. The research project is funded by the German Federal Agency for Nature Conservation (Bundesamt

Luxembourg: BEEFIRST monitoring of pesticide residues in honeybee collected pollen and honey

Source: Landwirtschaftsportal BeeFirst at https://agriculture.public.lu/de/beihilfen/innovation-forschung/forschungsprojekte-tierproduktion/beefirst-2018-2020.html

The BeeFirst programme is being carried out by the Luxembourg Institute of Science and Technology (LIST) since 2018. The monitoring tests pollen samples taken from experimental hives in spring and summer. In 2018 168 samples were tested from 28 hives distributed in 7 different regions of Luxembourg. Initial results from 2018 showed significant concentrations of acetamiprid, azoxystrobin, boscalid, lambda-cyhalothrin, cyproconazole, diflufenican, dimethachlor, epoxiconazole, flufenacet, flutolanil, folpet, imidacloprid, metalaxyl, metazachlor, methiocarb, penconazole, permethrins, tebuconazole, thiacloprid, tolylfluanid, trifloxystrobin, the adjuvant piperonyl-butoxide and the breakdown products DCBA, DET, ethion, in pollen from different sites and hives.

EU: Using citizen science to scale up pesticide residue monitoring

Source: Environmental monitoring of pesticide use through honeybees (ret PP-1-1-2018) at https://www.insignia-bee.eu/introducing-insignia/

The Horizon 2020 funded Insignia project[1] (2018-2022) is developing a protocol for a citizen science monitoring programme using beekeepers to collect pollen samples from honeybee colonies every two weeks. These samples will be analysed for residues of licensed and unlicensed pesticides and veterinary drugs, and for the botanical origin of the pollen using state of the art DNA metabarcoding techniques. In 2019, the project made a comparison of sampling techniques in four countries: Austria; Denmark; Greece and the UK. In 2020, the most suitable and economical methods are being more extensively tested in a monitoring programme of sentinel apiaries in nine EU Member states: Austria; Belgium; Denmark; France; Greece; Ireland; Italy; Latvia and the UK.

France: programme for long term monitoring of impacts of pesticides on wildlife

Source: review of Ecophyto programme (République Française, 2020) and publication of preliminary results (Andrade et al, 2020; Fried et al, 2019; Fried, Villers and Porcher, 2018), personal communication, Nora Rouillier, Chargée de mission Observatoire Agricole de la Biodiversité & ENI Biovigilance, Muséum National d'Histoire Naturelle, and Guillaume Fried, Personne-ressource pour le réseau Biovigilance Flore / 500 ENI, ANSES.

The network 500 ENI is a monitoring network intended to measure the non-target effects of pesticides on nearly 500 permanent plots in 22 regions of mainland France, funded by the French NAP (Ecophyto). Around 350 plots are in arable crop rotations, around 100 in vineyards, and around 50 on market garden crops. In each region, 80% of the plots are conventionally farmed and 20% are organic. Four taxa have been monitored since 2012: earthworms, flora of field margins, beetles, and birds. The scientific support is led by INRAE and carried out by a group of organisations (INRAE, Anses, MNHN, the universities of Paris and Rennes, etc). The surveys are carried out by paid agricultural advisors or species experts, who use IT tools to submit photos of captured insects for expert identification. The farmers involved submit their pesticide spray records and these are anonymized by the researchers.

The first results were published in 2018 using three years of data (Fried, Villers and Porcher, 2018). These show that the monitoring is detecting the impacts of herbicide use on the species biodiversity of flowering plants in field margins, showing a decrease in species richness and functional diversity with higher levels of herbicide use. The characterization of other species traits related to herbicide sensitivity (e.g. leaf cuticle thickness) would support this result. However, the detected effects are weak compared to the impacts of other farming practices (notably fertiliser application but also frequency of field margin management) and other environmental factors (such as landscape diversity). With the current data set, it is not possible to detect the effects of individual pesticide products or groups. It will therefore be necessary to monitor for a longer period to derive more statistically significant results of the impacts of changes in pesticide use. In future analyses, it is planned to analyse according to chemical family, mode of exposure (contact versus systemic), and mode of action (target spectrum of each product).

5.2 Specific measures to limit impacts on pollinators and to ensure compliance

5.2.1 Evidence of effectiveness of actions

Specific measures can include restrictions on the use of certain pesticide products to reduce their hazard to pollinators, and/or certain pesticide mixtures, measures to mandate and/or promote the use of certain spray techniques, and information and decision-making tools for pesticide users to enable them to select less harmful pesticides[56].

Pesticide users can compare individual products using the information on the label. However, the information on the pesticide labels is not always standardised or clear. Most Member States have defined label restrictions on certain pesticides that are moderately or highly acutely toxic on contact to honeybees (see Box 3). These generally apply timing restrictions to the pesticide application during the crop flowering period of certain crops. These restrictions are generally specific to the pesticide product and related to the acute contact toxicity of the product to honeybees plus the residual time of the active substance on the crop. These restrictions are generally designed to reduce the acute contact toxicity risk to honeybees, which fly only during full daylight hours and return to the hive before sunset.

It is important to note that measures to protect wild pollinators may need to differ from measures to protect honeybees, because of differences in the behaviour and ecology of the wild pollinators. Restrictions limited to daylight hours may have negative impacts on night-flying moth pollinators. Compliance with such restrictions can only effectively be assessed through a system for beekeepers to register pesticide poisoning incidents, followed by on farm controls or sanctions.

Such regulations require enough data to be submitted during the pesticide approval process, the product-specific toxicity of residues on foliage, and the acute toxicity to the relevant wild pollinators likely to visit the crop. Most pesticide active substances are still not tested on wild pollinator species so their impacts are not known, and pesticide labelling only specifies measures to reduce their impact on honeybees. Wild pollinators differ greatly in their sensitivity to pesticide impacts, and this may be greater than in honeybee colonies, which can compensate for sublethal effects by producing more workers from the hive (Henry et al, 2015).

There appears to be little other easily accessible information available to pesticide users in the EU on the relative risks of different products to wild pollinators[57], to guide users' decision making.

[56] Some of these restrictions must be applied during the pesticide approval process governed by Regulation (EC) No 1107/2009, but they can be reinforced or complemented by measures under the SUD.

[57] An example from the US is the pesticide decision making guide to protect pollinators in fruit tree orchards in New York, which details the available evidence on acute and chronic toxicity of different pesticide active substances to pollinators, as well as the synergistic interactions and effects of adjuvants (van Dyke et al, 2018).

Box 3 Examples from Slovakia and Germany of current pesticide labelling system for risks to honeybees

In Slovakia, plant protection products (pesticides) are classified into three categories of risk to bees, under national edict no. 488/2011 (Vyhláška MPRV SR č. 488/2011 Z.z.). These individual risk classes are assigned according to the value of the acute Hazard quotient (HQ) to the honeybee, in line with the EU active substance risk assessment, as follows[xxvii.]:

Vč3	acceptable risk for bees	Honeybee acute hazard quotient HQ < 50
Vč2	harmful for bees	Honeybee acute hazard quotient HQ 50 – 2500
Vč1	toxic for bees	Honeybee acute hazard quotient HQ > 2500

National edict No. 488/2011 also defines a measure for tank mix combinations of certain products in the 'acceptable risk' class, which shifts the classification of the spray mixture to 'harmful to bees'. This year the edict No. 488/2011 and the Slovakia NAP are to be amended, giving scope for expanding the system to address pesticide risks to wild bees.

In Germany, a regulation specifies the pesticide use requirements to protect bees[xxviii]. All pesticide labels show one of four categories of risks to bees – however, this refers only to honeybees:

B1	Dangerous to bees. Should not be applied to plants that are flowering or otherwise attractive to bees, including weeds.
B2	Dangerous to bees. Should only be applied to plants that are flowering or otherwise attractive to bees, including weeds, after the end of bee flying at dusk and before 23:00 at night.
B3	Not dangerous to bees if product requirements for dosage and usage are followed.
B4	Not dangerous to bees up to the maximum permitted application rate or concentration.

Tank mixtures of a pyrethroid insecticide with an azole fungicide increases the risk classification of the mixture to B2 dangerous to bees. The label classification is based on acute toxicity to honeybees.

Pollinators are likely to be at risk from insecticide spraying in fruit orchards, because the chemicals have high toxicity to insects and spray drift means exposure is widespread, whilst bees and other pollinators are likely to be in the orchard or nearby due to the presence of flowers. Standard techniques using anti-drift nozzles and anti-drift adjuvants (such as rape oil) have been shown to reduce potential drift in orchards, decreasing the side effects on beneficial arthropods whilst maintaining the efficacy of the insecticides (Fornasiero et al, 2017). New pesticide spray technologies can provide additional significant reductions in spray exposure compared to most of the currently used equipment, but no evidence was found of whether the use of these technologies reduce the exposure of pollinator populations (Box 4).

Box 4 Pesticide application technologies that might reduce pollinator exposure to pesticides

Air Blast H30 spraying technology is an air sprayer that adjusts airflow and spray volume rate to the characteristics of the crop canopy and the target of the treatment, Using GPS, meteorological information from the internet, temperature, and relative humidity sensors, it provides user driven site and crop specific settings before spraying and automatically adjusts during spraying. Tests on citrus orchards showed that it reduces the potential sedimenting drift of pesticides by 48% with respect to the bottom-line reference sprayer tested (Garcerá, Berger and Chueca, 2018). No research was found that relates this with exposure of pollinator populations.

On-target tower sprayer with anti-drift air injector nozzles: tests comparing this sprayer with a standard axial sprayer equipped with ATR swirl nozzles showed that it was the most appropriate technology for the wind conditions in Trentino apple orchards (Bondesan et al, 2013).

DropLeg Technology. DropLeg nozzles spray pesticides below the crop canopy, which reduces the direct exposure of the crop flowers to pesticide, and therefore can reduce exposure of pollinators (Hausmann, Brandes and Helmbach, 2019), especially on oilseed rape (Heimbach et al, 2016). This type of nozzle also significantly reduces pesticide drift compared to conventional spraying (Wallner, 2014). However, no studies were found that reported any monitoring of the actual impacts on pollinator populations.

Tank mixtures of a pyrethroid insecticide with an azole fungicide increases the risk classification of the mixture to B2 dangerous to bees. The label classification is based on acute toxicity to honeybees.

Buffer zones around crops with high pesticide use intensity, such as fruit orchards, can prevent insecticide drift onto neighbouring habitats, which might have value as pollinator habitats. However, the current situation in EU apple orchards is that many conventionally managed orchards have no buffer or only a small margin to neighbouring fields and habitats (Box 5). A study in the Netherlands concluded that negative effects of pesticides, herbicides and fungicides on hedgerow plant communities can be reduced to zero with an unsprayed buffer zone of 2.25m around arable crops combined with the application of best practice in spraying (Alberoni et al, 2020; de Jong, de Snoo and van de Zande, 2008).

Box 5 Buffer zones around apple orchards in the EU

A detailed survey in three Member States in 2013 found marked differences between the width and composition of margins around apple orchards (Garthwaite et al, 2015). The apple orchards in the UK mostly had off-field margins comprised of wind breaks, woodland, or hedgerow, with in-field margins of spontaneous vegetation or sown grass averaging over 4m in width. Apple orchards in Italy (mainly in Trento and Bolzano Provinces) were mostly surrounded directly by other fields or artificial structures and roads, and half the orchards had no infield margins or a herbaceous margin of less than 1m width. In Poland, most orchards were also directly surrounded by other orchards or fields, and two thirds had no infield margin or a naturally regenerating margin less than 0.5m in width.

5.2.2 Examples of good practice in specific measures to reduce risk

Good practice examples include bee risk labelling, restrictions on tank mixes with high toxicity, promotion of exposure reducing spray technology, and policies that establish buffer zones around agricultural systems that use high risk pesticides.

Germany has a restriction on the use of pyrethroid and EDI fungicide mixtures on flowering plants and other plants visited by bees, limiting spraying to the time between evening (after end of honeybee foraging) to 23:00[58]. Germany also restricted the simultaneous use of neonicotinoid insecticides with fungicides in the EDI class (including the azoles) due to the increased toxicity of the mix to bees

[58] According to restriction (Bienenschutzauflage) NB6623, pyrethroids in the B4 class can only be used in mixtures with EBI fungicides on flowering plants and other plants visited by bees in the evening after honeybee foraging has ended until 23:00, unless the use of this mixture is expressly allowed by the label on the fungicide. Based on bee protection regulation (Bienenschutzverordnung vom 22. Juli 1992, BGBl. I S. 1410). BVL, 2019, available at https://www.bvl.bund.de/DE/Arbeitsbereiche/04_Pflanzenschutzmittel/01_Aufgaben/09_GesundheitNaturhaushalt/02_SchutzNaturhaushalt/02_Bienenschutz/Bienenschutz_node.html

(before the general ban on their use on outdoor crops)[59]. This is not mentioned in the NAP, which pre-dates the ban. However, there are no restrictions on spraying these mixtures on the same field within the same short period of time, which could have very similar toxicity effects (Wernecke and Castle, 2020).

In **Slovenia**, the Ministry of Agriculture, Forestry and Food has published a list of 46 pesticides dangerous for bees[xxix], containing 24 active substances. These pesticides are labelled with a graphic symbol to illustrate the risk to bees, as well as a text warning.

5.3 Limits or prohibitions on pesticide use in specific areas – public spaces and Natura 2000

5.3.1 Evidence of effectiveness of actions

There is little information available on how pesticides are used in Natura 2000 sites and other nature protected areas and what impact is that having on biodiversity conservation. Some Natura 2000 networks have relatively high proportions of agricultural land use associated with pesticide use, including arable farmland and permanent crops, as well as grassland, and some sites are quite small and surrounded by agricultural land, and therefore the species in the site are subject to pressures from the surrounding farming practices. Citizens groups in Germany have been trying for years to obtain information on pesticide use in the Natura 2000 network, which contains substantial areas of arable land and permanent crops. Several recent court cases have now ruled that public authorities must release to the public all the information they hold on pesticide use in Natura 2000 sites and other protected areas.[xxx]

The well-known Krefeld study was a long term data set of insect samples collected in protected areas in different regions of Germany, showing a long term decline of 75% of insect biomass within these nature reserves (Hallmann et al, 2017). The authors concluded that although pesticides were not used within the sites, they are so small that insect populations are strongly influenced by the intensive agriculture on the land around the sites, including pesticide use. The follow up project is continuing the monitoring and measuring farming practices around the sites, together with ecotoxicological analytics[xxxi].

---

[59] Restriction (Bieneneschutzauflage) NB6613 applies (NB the active substance prothioconazole is exempt from the restriction), based on bee protection regulation (Bienenschutzverordnung vom 22. Juli 1992, BGBl. I S. 1410). BVL 2018. Available at https://www.bvl.bund.de/SharedDocs/Fachmeldungen/04_pflanzenschutzmittel/2018/2018_11_12_Fa_Bienenschutz_Tankmischung_Insekt_Fung.html

The public attention focused on glyphosate has resulted in many regions, local authorities, towns, and public organisations announcing that they are no longer using glyphosate herbicides (see Box 6). If this change is associated with a greater tolerance for flowering weeds, then it is likely that it will be benefiting wild pollinators. However, if the change results in less use of cover crops and other cover vegetation, the use of other herbicides, and the maintenance of the same levels of weed control, the benefit to wild pollinators is unlikely to be significant.

Box 6 Restrictions or prohibitions on pesticide use that were not planned in NAPs

In **Germany**, the federal state of Bavaria has set itself the goal of halving chemical pesticide use by 2028. The state has banned area wide pesticide use on permanent grassland from 1 January 2022[xxxii]. Exceptions can be granted for spot treatment of poisonous or invasive weeds or weeds that can cause significant damage to grassland yield if they spread[60]. Broad-spectrum herbicides are banned on land owned by the federal state[61]. Over 550 local authorities in Germany have declared themselves pesticide free or that they are no longer using glyphosate herbicides[xxxiii] (including on agricultural areas that local authorities rent to farmers)[xxxiv]. The network of pesticide free local authorities (Pestizid-freie Kommune) is growing[xxxv].

In **France**, the Forest National Office decided to ban the use of pesticides in forest management from October 2019[xxxvi]. Glyphosate herbicides are banned for use in public spaces since 2017 and sale to the general public was stopped in January 2019. An increasing number of local authorities in France have declared that they are no longer using glyphosate herbicides[xxxvii]. Some French cities have had a pesticide free strategy for decades (Strasbourg, Rennes, Versailles, Grenoble).

In **Austria**, the federal state Kärnten declared a glyphosate ban in 2017 on all public spaces, which is now in force since January 2020[xxxviii]. Burgenland has declared its intention to become pesticide free[xxxix]. Burgenland set no timeline for this target, but 170 companies managing public land

[60] Exceptions according to Art. 3 Abs. 5 Satz 3 BayNatSchG. Exceptions can also be granted in the legally protected tall tree fruit orchards (Streuobstwiesen) to ensure the yield.
[61] Exceptions for research and training or under license from the relevant authority according to § 12 Abs. 2 Satz 3 PflSchG (Art. 5 (4) ZuVLFG).

have stopped using glyphosate since 2018[xl]. Burgenland has banned pesticide use on 5000ha of the Natura 2000 network in the region[xli]. An increasing number of local authorities in Austria have declared that they are no longer using glyphosate herbicides[xlii]. The public companies that manage motorways (ASFINAG) and railways (ÖBB) have either stopped glyphosate use completely or are close to it.

In **Ireland**, Dún Laoghaire-Rathdown County Council is implementing a management plan and staff training to completely cut out herbicide use on roadways and in public spaces[xliii], and other towns and local councils are following suit[xliv].

5.3.2 Examples of good practice in limiting pesticide use in specific areas important for pollinators

Member States and regions are taking numerous initiatives to restrict the risks of pesticide use to biodiversity in protected areas, to encourage the use of IPM approaches within Natura 2000 sites, and to find out more about pesticide use in the Natura 2000 network. Italy has defined an indicator of progress on implementing this provision of the SUD[xlv]. The indicator measures the number and type of regulatory, administrative, or contractual measures regarding the use of phytosanitary products in the site management plans and / or in the general conservation measures for Natura 2000 sites and National Parks (see example box).

The German federal state of **Bavaria** has banned pesticide use in its Natura 2000 network, and on all permanent grassland, but areas already intensively used for arable agriculture or aquaculture are excluded from the ban (see example box). The Belgian region of **Flanders** is implementing a ban on pesticide use on certain types of vegetation in the Flanders Ecological Network, which includes the Natura 2000 network (see example box). In **Italy**, a national decree defines measures for the sustainable use of pesticides in Natura 2000 sites and other protected areas[xlvi]. It makes recommendations for measures to reduce risks from pesticides, which can be included in management plans and in the conservation measures of Natura 2000 sites and other protected areas. The implementation, whether through mandatory or voluntary measures, is the responsibility of the regional authorities. Article 13 gives regional governments the option to replace, restrict or eliminate certain pesticides for the protection of species and habitats for the purpose of achieving conservation objectives under the Birds and Habitat Directives and for the protection of endemic species or species with high risk of extinction, of wild bees and other pollinators and related accompanying measures. According to the NAP indicator on measures related to pesticide use in Natura 2000 and other protected areas, in 2016 13 regions and 1 autonomous province reported conservation measures regarding the use of plant protection products on their Natura 2000 sites, whilst one National Park plan referred to the NAP (see example box).

The **Spanish** NAP, made national law in 2012, set the objective to reduce the risks from pesticide use in zones of significant interest for protected species. These protection zones defined as sensitive to pesticide use include protected areas (Natura 2000 and others) and other areas with endangered species that are listed in the Spanish Catalogue of Endangered Species[62]. The agriculturally used lands in the protection zones are mapped as either posing a high risk from pesticide use or a low risk[63]. Spain published IPM guidelines for a range of types of crop or non-crop system (vines, olives, arable, forest, etc.)[xlvii], and these include a set of voluntary recommendations to farmers in the high-risk areas[xlviii]. The new NAP set an objective to 'establish a method for assessing the effectiveness of the recommendations set for protection zones in relation to IPM', and the new Spanish strategy for the protection of wild pollinators also set the objective to evaluate the application of these measures in the protection zones and to increase farmers awareness of them[xlix]. This analysis will reveal whether the measures have actually reduced pesticide pressures on pollinators and other wildlife in the Natura 2000 network in Spain.

Luxembourg has targeted higher level biodiversity management contracts at farmers in sensitive areas (Natura 2000 sites and water protection zones), with a payment rate that requires the elimination of all pesticide use. In 2018, around 5,000 ha were under the contractual nature conservation schemes[l], which represents around a third of all the species rich grassland in Luxembourg, both within and outside the Natura 2000 network[li]. The 2017-2021 Nature Protection National Plan proposed to increase the subsidies for farmers under biodiversity contract within Natura 2000 sites and aimed to have 10 000 hectares of agricultural area under biodiversity contracts by 2021[lii].

Member States and regions are undertaking analysis and research to find out more about how much pesticide is currently being used in their Natura 2000 network. In Belgium, the **Flanders** region is compiling and analysing an inventory of

---

[62] According to the national objective to reduce the risks from pesticide use in the zones of significant interest for protected species, as defined by law in 2012 (Real Decreto 1311/2012, de 14 de septiembre artículo 34)
[63] Maps can be viewed on webplatform SIGPAC at http://sigpac.mapa.es/fega/visor/

which pesticides can have a significant impact on EU protected habitats, on vegetation of regional importance, and on the living environments of EU protected species, species with typical habitats and species that are of priority in Flanders, even where the pesticides have been used in accordance with good agricultural practices and the rules in force. This will form the basis for developing an awareness-raising campaign addressed to land managers.

In **Italy**, a national study mapped cropping systems within Natura 2000 sites using land cover data, as well as the cropping systems surrounding sites, and matched this with pesticide sales data to assess potential pesticide exposure in each site (ISPRA, 2015). Sensitivity values were assigned to the EU protected habitats and species for which the Natura 2000 sites are designated, using EU ecotoxicology risk assessment information and expert judgement to assess the risk posed by each pesticide used in Italy. The study produced maps indicating sites and regions with higher and lower potential risk to biodiversity from agricultural pesticide use. It identified some Natura 2000 sites at particularly high risk from pesticide use, mainly sites with freshwater ecosystems because they have the most highly sensitive EU protected habitats and species. The risk map is not validated by the results of field sampling; therefore, a revision of the method is underway[64]. A research project is now investigating options for farming with reduced use of pesticides in Natura 2000 areas (see example box).

[64] Personal communication, Susanna d'Antoni, Istituto Superiore per la Protezione e la Ricerca Ambientale (ISPRA), 17/10/2020

Italy: Indicator and research on measures to reduce pesticide use in Natura 2000 and other protected areas

Sources: NAP indicator 'measures related to pesticide use in Natura 2000 and other protected areas'[1]; Susanna D'Antoni, ISPRA Dipartimento per il Monitoraggio e la Tutela dell'Ambiente e per la Conservazione della Biodiversità, Alberto Masci, Ministero delle politiche agricole alimentari e forestali Dipartimento delle politiche europee ed internazionali e dello sviluppo rurale

The NAP indicator for Article 12 of the SUD measures the number and type of regulatory, administrative or contractual measures regarding the use of phytosanitary products in the site management plans and / or in the general conservation measures for Natura 2000 sites and National Parks. In 2016, 13 regions and 1 autonomous province reported conservation measures regarding the use of plant protection products on their Natura 2000 sites. An analysis was carried out in 2015 to set the baseline for the NAP indicator on measures related to pesticide use in Natura 2000 and other protected areas. It analysed only the sites with 20% or more of the area as utilized agricultural area (UAA), calculated on the basis of the surfaces belonging to CORINE Land Cover (2012) classes for arable land in non-irrigated areas and irrigated areas, rice fields, vineyards, and orchards and minor fruits. For all Natura 2000 sites with 20% or more of UAA in arable or permanent crops, there was a detailed analysis of the specific, transversal, and general conservation measures defined in the decrees establishing the SACs, in regional / provincial council resolutions, and in Natura 2000 site management plans approved by the end of 2015. It was not possible to obtain meaningful results for the national parks, as only 9 of the 25 parks have an approved management plan, and 8 of these have not been updated since the publication of the NAP. Two national parks have banned glyphosate within their area of competence.

The analysis identified conservation measures that refer to pesticide use in Piedmont and Fiuli Venezia Giulia. Reasons for the lack of specific measures for the reduction of pesticides in Natura 2000 management plans include the managing bodies' lack of knowledge of the effects of the use of pesticides on biodiversity and ecosystems, and the lack of information on current pesticide use practices in Natura 2000. An additional reason is the lack of progress in updating or even establishing management plans for national parks. There are also challenges to establishing effective measures as most farmers in Natura 2000 areas are part-time small-scale farmers who find it difficult to invest time and resources in organic certification.

A research project was funded by Italian Ministry of the Environment from 2015 to 2020 to identify indicators of impacts of pesticides on biodiversity (including pollinators), and to compare pollinator populations between organic and conventional crops in Natura 2000 areas. The research was led by ISPRA in collaboration with the Piedmont Environmental Protection Agency, and the Universities of Turin and Rome Tor Vergata. The project was carried out in rice fields and vineyards in Piedmont (north Italy) and in hazelnut and arable land in Latium (central Italy) located in Natura 2000 areas. In general, in 2018 and 2019, a significantly larger number of bees and butterflies in organic farms was recorded compared to "conventional" ones, on more than 20 different pairs of biological and conventional fields (rice fields, vineyards and hazelnut groves). The population monitoring of the species considered as bioindicators (pedofauna, soil arthropods, Apoidea, butterflies, dragonflies, amphibians, reptiles, bats) showed that in general there are more individuals and species in organic fields than in fields treated with pesticides.

Germany (Bavaria): regional ban on pesticide use in protected areas

Source: personal communication, Wolfram Güthler, Naturschutzförderung und Landschaftspflege, Bayerisches Staatsministerium für Umwelt und Verbraucherschutz

The German federal state of Bavaria revised its nature conservation law in 2019. One of the objectives of the new law is to ban area wide pesticide use on permanent grassland from 1 January 2022. This includes nearly all the Annex I grassland in the Natura 2000 network. Exceptions can be granted for spot treatment of poisonous or invasive weeds or weeds that can cause significant damage to grassland yield if they spread1. Broad-spectrum herbicides are banned on land owned by the federal state1. The law also includes a clause that prohibits pesticide use in protected areas, including Natura 2000 sites and nationally and regionally designated protected areas and habitats (biotopes)1. However, this excludes areas already intensively used for agriculture or aquaculture1. There is not currently enough information available to show how much of the Natura 2000 network is still subject to pesticide use1.

Änderung des Bayerischen Naturschutzgesetzes (BayNatSchG vom 23. Februar 2011 (GVBl.S. 82, BayRS 791-1-U): Art. 23a Verbot von Pestiziden. 1 Die Anwendung von Pestiziden (Pflanzenschutzmittel und Biozide) gemäß Art. 3 Nr. 10 der Richtlinie 2009/128/EG des Europäischen Parlaments und des Rates vom 21. Oktober 2009 über einen Aktionsrahmen der Gemeinschaft für die nachhaltige Verwendung von Pestiziden (ABl. L 309 vom 24. November 2009, S.71) in der jeweils geltenden Fassung ist in Naturschutzgebieten, in gesetzlich geschützten Landschaftsbestandteilen und in gesetzlich geschützten Biotopen außerhalb von intensiv genutzten land- und fischereiwirtschaftlichen Flächen verboten. 2 Die Naturschutzbehörde kann die Verwendung dieser Mittel zulassen, soweit eine Gefährdung des Schutzzwecks der in Satz 1 genannten Schutzgebiete oder geschützten Gegenstände nicht zu befürchten ist. 3 Weitergehende Vorschriften bleiben unberührt. " Bayerischer Landtag 18. Wahlperiode Drucksache 18/1736.

Belgium: regional restrictions on pesticide use in sensitive areas to protect pollinators and their habitats

Source: personal communication, Chris Lambert, Flanders Government Departement Omgeving, Afdeling Strategie internationaal beleid en dierenwelzijn (department of international policy and animal welfare), taken from the NAPAN 2018-2022 intermediate report on actions undertaken by ANB

The use of plant protection products is prohibited as a matter of principle for certain types of vegetation within the Flemish Ecological Network (Vlaams Ecologisch Netwerk), and certain spatially sensitive areas. Since January 1st, 2018, the Flemish Agency for Nature and Forests is no longer using pesticides to combat invasive species. The single exception still allowed is the spot treatment of Japanese Knotweed (*Fallopia japonica*) in the rare cases where other methods are not feasible. The pesticide can only be applied by licensed professionals by means of injection of the stem.

Italy: Indicator and research on measures to reduce pesticide use in Natura 2000 and other protected areas

Sources: NAP indicator 'measures related to pesticide use in Natura 2000 and other protected areas' (ISPRA Indicatori 2019. Misure relative alla gestione dei prodotti fitosanitari nei Siti Rete Natura 2000 e nelle aree naturali protette. https://indicatori-pan-fitosanitari.isprambiente.it/sys_ind/26 (accessed 19/10/2020)); Susanna D'Antoni, ISPRA Dipartimento per il Monitoraggio e la Tutela dell'Ambiente e per la Conservazione della Biodiversità, Alberto Masci, Ministero delle politiche agricole alimentari e forestali Dipartimento delle politiche europee ed internazionali e dello sviluppo rurale

The NAP indicator for Article 12 of the SUD measures the number and type of regulatory, administrative or contractual measures regarding the use of phytosanitary products in the site management plans and / or in the general conservation measures for Natura 2000 sites and National Parks. In 2016, 13 regions and 1 autonomous province reported conservation measures regarding the use of plant protection products on their Natura 2000 sites. An analysis was carried out in 2015 to set the baseline for the NAP indicator on measures related to pesticide use in Natura 2000 and other protected areas. It analysed only the sites with 20% or more of the area as utilized agricultural area (UAA), calculated on the basis of the surfaces belonging to CORINE Land Cover (2012) classes for arable land in non-irrigated areas and irrigated areas, rice fields, vineyards, and orchards and minor fruits. For all Natura 2000 sites with 20% or more of UAA in arable or permanent crops, there was a detailed analysis of the specific, transversal, and general conservation measures defined in the decrees establishing the SACs, in regional / provincial council resolutions, and in Natura 2000 site management plans approved by the end of 2015. It was not possible to obtain meaningful results for the national parks, as only 9 of the 25 parks have an approved management plan, and 8 of these have not been updated since the publication of the NAP. Two national parks have banned glyphosate within their area of competence.

The analysis identified conservation measures that refer to pesticide use in Piedmont and Fiuli Venezia Giulia. Reasons for the lack of specific measures for the reduction of pesticides in Natura 2000 management plans include the managing bodies' lack of knowledge of the effects of the use of pesticides on biodiversity and ecosystems, and the lack of information on current pesticide use practices in Natura 2000. An additional reason is the lack of progress in updating or even establishing management plans for national parks. There are also challenges to establishing effective measures as most farmers in Natura 2000 areas are part-time small-scale farmers who find it difficult to invest time and resources in organic certification.

A research project was funded by Italian Ministry of the Environment from 2015 to 2020 to identify indicators of impacts of pesticides on biodiversity (including pollinators), and to compare pollinator populations between organic and conventional crops in Natura 2000 areas. The research was led by ISPRA in collaboration with the Piedmont Environmental Protection Agency, and the Universities of Turin and Rome Tor Vergata. The project was carried out in rice fields and vineyards in Piedmont (north Italy) and in hazelnut and arable land in Latium (central Italy) located in Natura 2000 areas. In general, in 2018 and 2019, a significantly larger number of bees and butterflies in organic farms was recorded compared to "conventional" ones, on more than 20 different pairs of biological and conventional fields (rice fields, vineyards and hazelnut groves). The population monitoring of the species considered as bioindicators (pedofauna, soil arthropods, Apoidea, butterflies, dragonflies, amphibians, reptiles, bats) showed that in general there are more individuals and species in organic fields than in fields treated with pesticides.

5.4 Training and awareness raising on pesticides and pollinators

5.4.1 Evidence of effectiveness of actions – training and awareness raising

Training is generally considered to be an effective way to reduce pesticide risks to the environment, if the trained users then have enough scope for action embedded in an enabling policy context. Demonstrating the effectiveness of training for pollinators is more difficult, as it would require follow up surveys and monitoring to demonstrate reductions in pesticide use and associated increases in pollinator populations.

There are large differences in how different farmers receive and use information on IPM, including what sources of advice they most access and trust, whether and how they use professional advice and training, and how networked they are with other farms using IPM. A recent study in Denmark found that pesticide supplier-affiliated advisors are less likely to recommend the use of lower doses than independent government funded advisors (Pedersen et al, 2019). The advisors did not differ significantly in their environmental risk perceptions about pesticide use, nor in their perceptions of the demands for advice coming from farmers, so the differences were due to other reasons.

5.4.2 Examples of good practice – training and awareness raising

There are an increasing number of tools and information sources available for farmers to assist them with IPM. As an example, the CROPROTECT team and database is interacting with users to determine priorities in terms of the pests, weeds, and diseases covered and is providing key information to assist with their management (Bruce, 2016). Several EU funded projects are working with farmers to develop tools for IPM and demonstrate that these can reduce pesticide use, for example the projects DESSA, EUCLID and ENTOMATIC.

Some Member States have set up national networks of demonstration farms to develop and promote low pesticide use farming systems. The Dephy network in France was established in 2010 and is starting to show results (see example box). The German federal government is this year providing over €3 million in funding for a six-year project to establish a network of 30 farm partnerships in the federal state of Lower Saxony to pilot pesticide free farming practices (see example box).

The CAP EIP-AGRI innovation fund has funded several pilot projects working with farmers to trial pesticide free methods and improve habitat quality for wild pollinators on their farms. A project in Slovenia is working with fruit growers to increase food resources for wild pollinators, which has raised the awareness of the farmers to the need to reduce insecticide use (see example box). Another EIP-

AGRI project in Portugal is researching and disseminating good practices among fruit orchard growers to enhance pollination by both honeybees and wild bees[65].

Wallonia aims to develop alternatives to pesticides to meet the demand from non-farming professionals and private citizens, with simple, affordable, and sustainable non-chemical methods and materials. Wallonia will issue a call aimed at the technical schools, independent inventors, and specialized firms for projects to develop these materials and methods[66].

France: The DEPHY farms network

The **French DEPHY farms** network was set up to promote and develop low-input cultural systems that would put less pressure on biodiversity, including pollinators. Starting with 178 farms in 2010, the ambition has been growing and the latest revision of the NAP aimed to expand the network to 30,000 farms. Currently, there are around 3,000 farms in the Dephy network. The pesticide use of recruited farms ranged from high to low. They are classed as "economical" regarding pesticide use if their treatment frequency index (TFI) is less than 50% of the regional reference and "very economical" when it is less than 70%. In 2016 the network reported an 18% reduction in pesticide use across all types of cropping system (Écophyto, 2016), although others judged that the network had not yet been able to demonstrate a significant decrease in pesticide use across all participating farms (Guichard et al, 2017). A survey of vineyards enrolled in the network found that after four years, these professional growers used 8 to 22 percent fewer pesticide treatments than vineyards not in the programme (as measured in a regular survey by the national government) (Lapierre, Sauquet and Subervie, 2019). The decrease is driven by a significant decrease in fungicide use and an increase in the use of biocontrol products against fungal diseases ranging from 24 to 33 percent. This change of practices resulted The Flanders region is currently compiling and analysing an inventory of which pesticides can have a significant impact on EU protected habitats, on vegetation of regional importance, and on the living environments of EU protected species, species with typical habitats and species that are of priority in Flanders, even where the pesticides have been used in accordance with good agricultural practices and the rules in force. This will form the basis for developing an awareness-raising campaign addressed to land managers. The Flemish Research Institute for Nature and Forest (EVINBO) is responding to a demand for advice to better protect species of conservation concern in agricultural areas, such as farmland birds. All species protection programmes must include measures to decrease the use of pesticides. Measures can include the promotion of a more sensible use or restrictions on the use of certain pesticides. This will be accompanied by an awareness raising campaign.

[65] PoliMax - Promoção e aumento da eficiência da polinização entomófila em macieiras, pereiras e cerejeiras. https://poli-max.webnode.pt/

[66] Personal communication, Denis Godeaux, Point focal SPW "Pesticides & Environnement" Service public de Wallonie, 30/9/2020

Germany: research funding for large on-farm project to pilot pesticide free farming practices

Source: BMU press release 3 June 2020 (https://www.bmu.de/pressemitteilung/bmu-und-bfn-foerdern-insektenschutz-im-ackerbau-mit-ueber-3-millionen-euro/ (accessed 18/9/2020)) and project profile on BfN website (Bundesamt für Naturschutz (2020) FINKA – Förderung von Insekten im Ackerbau. At https://biologischevielfalt.bfn.de/bundesprogramm/projekte/projektbeschreibungen/finka.html (accessed 8/12/2020)

The German Environment Ministry and German Federal Agency for Nature Conservation have announced over €3 million in funding for 6 years for a network of 30 farm partnerships in the federal state of Lower Saxony to pilot pesticide free farming practices. The conventional farms will be paired with organic farms to stimulate sharing of experiences and co-learning and will undertake to farm without herbicides and insecticides on one parcel of the farm for five years (fungicide and fertiliser use is unrestricted). The abundances and species richness of weeds and insect will be measured on the managed parcel and compared with fields with the same or similar crop managed according to usual practice on both the conventional and organic farms. The farmers will take part in demonstration days and presentations to disseminate experiences to other farmers and regions in Germany.

Slovenia: training and awareness raising to help solitary bee pollinators in pear orchards

Source: Danilo Bevk, National Institute of Biology, Slovenia, EIP-AGRI funded project 'Fruit growers for pollinators and pollinators for fruit growers.' Poster presented at European Commission conference February 2020 on 'Halting the loss of pollinators: Role of EU agricultural and regional development policies'.

The project's objectives are to: develop improved application of knowledge regarding wild pollinators in fruit growing within Slovenia, establish good practices for the protection of pollinators in orchards, enhance biodiversity in orchards and improve conditions for wild pollinators, and increase the quality and reliability of pollination services. Using funding from the Slovenian EIP-AGRI from 2018 to 2021, the project team is working with orchard farmers to set up nesting stations and increase food plants and meadows for pollinators in orchards. It is providing training for farmers concerning pollinators and biodiversity, producing a brochure and educational videos about pollinators, and organising expert meetings. The orchard farmers have already recognised the pollination benefits that the wild pollinators are bringing to their pear harvests and are strongly motivated to continue the actions. The project includes one organic farm and five farms that use integrated production. It does not monitor the pesticide use of the farms, but the project organisers feel that it has resulted in them reducing their insecticide use.

5.5 Promotion and implementation of integrated pest management and alternatives to protect pollinators

5.5.1 Evidence of effectiveness of actions

Integrated pest management (IPM) is defined by the SUD Directive in eight principles that fit within sustainable farm management. These IPM principles need to be operationalised as decision making tools, techniques, and tools relevant to the diverse farming system and regions of Europe. The development of sustainable crop protection strategies can be complex, as one change in the farming system has consequences for other parts, and IPM approaches generally need to be site-specific, dynamic, systemic, and knowledge-intensive (Barzman et al, 2015). At the same time, there are methods that farmers can easily implement to control some key pests or diseases, whilst at the same time reducing the use of insecticides and fungicides. However, the basic IPM strategies established as standards across farming sectors and associations in the EU still rely heavily on the use of pesticides (though they rule out the use of certain highly toxic pesticides), and therefore do not always result in a reduction of overall pesticide use (Damos, Escudero Colomar and Ioriatti, 2015). These standards are implementing only part of the IPM principles and hence lack effectiveness in the aim of reducing pesticide use.

Some IPM methods that directly benefit pollinators (see Box 7) are to:

- Stop using herbicides in permanent crops (in vineyards, orchards, olive groves etc) and maintain ground cover between rows that provide flowers and nesting sites for wild bees. Weeds can be controlled by cutting without tillage during winter to avoid damaging bee nests and hibernating bees. For example, orchard ground cover could be optimised for andrenid bees, the single most important pollinator taxa, by increasing the availability of early-flowering plants.

- Stop using herbicides and manage weeds in annual crops using cover crops, minimum tillage, crop rotations, and mechanical weeding. Increase tolerance of flowering weeds as most current arable systems could maintain yield with a higher abundance of weeds than is currently tolerated.

- Avoid the use of insecticides and fungicides using an IPM approach on the field crop (using non-chemical pest management, resistant varieties, reducing seedling density, etc.), and plant flowering strips or field margins that benefit both pollinators and natural enemies of crop pests.

- Increase the unsprayed area by increasing ecological fallow and unsprayed headlands or crop edges or strips and introducing unsprayed crops into the crop rotation.
- Maintain field margin structures and landscape features on the farm, such as trees, hedges, bare soil banks, stone walls and piles, so that they provide feeding, nesting, and hibernating sites for both pollinators and natural enemies of crop pests, combined with an IPM approach that avoids insecticides and fungicides.

Planting strips or field margins with flowering plants is a well-known way to attract pollinators and natural predators to agricultural fields. They could, however, become an ecological trap, if the pollinators that are attracted to these strips are exposed to pesticides through drift from the crop and/or pesticide residues in the flowers (e.g. Mogren and Lundgren, 2016). This can be avoided by combining the support for the flowering strips with support for implementing IPM on the field itself, avoiding pesticides with significant non-target effects, whilst ensuring that the seed mix for the strip includes plants that support a healthy population of natural enemies of crop pests. The flowering strip then provides both pollination and pest control services to the crop and other nearby crops (Tschumi et al, 2016; Tschumi et al, 2015). One approach is to orient agri-environment contracts to a point-based system that scores unsprayed areas, so that a higher payment rate incentivises a higher proportion of unsprayed area (Hötker et al, 2018).

A review of evidence in Germany concluded that compensating damages to bird and mammal populations through pesticide use needs a minimum unsprayed area of at least 10 % of the size of the total treated area, and experts judge that birds require at least 15 % of arable land area and flowering plant populations at least 20% of arable land as unsprayed area (Hötker et al, 2018). An expert group reviewed what we currently know about the impacts of pesticide and fertiliser use in farmland on the effectiveness of adjacent pollinator conservation measures such as flowering strips and hedgerows (Alberoni et al, 2020). The group concluded that there are studies that show the potential for non-target exposure of pollinators to pesticides when foraging in field edge habitats, but the limited evidence meant that they could not draw any conclusions. The experts identified evidence gaps on: how farmers are using best practice recommendations on spray technologies, unsprayed buffer zones and other pesticide application methods, what impact spray drift reducing technologies are having, how pollinators are exposed and impacted in woody field margin structures (such as hedges), and how pollinators are exposed and impacted by combined pesticide applications and pesticides for which research is missing.

Box 7 Evidence of the impacts of IPM measures on pollinators and natural biological control of pests and diseases

Flowering strips, flowering ground cover, flowering field margin habitats (hedges, etc)

Increasing flowering plants in and around crops can provide resources for both pollinators and natural enemies of crop pests, with the potential to deliver both benefits to the crop. A study in Switzerland showed that flowering strips sown next to winter wheat fields increased yield by controlling pest damage by cereal leaf beetles (Tschumi et al, 2016). The winter wheat fields were not treated with any insecticides. The flowering strips controlled pest density and crop damage even when the surrounding landscape was arable with low density of landscape features. The authors conclude that the flowering strips are an effective alternative to insecticide use to control cereal leaf beetle in winter wheat (Tschumi et al, 2015). A pilot project in the Netherlands reported that farmers achieved more than 90% reduction in insecticide use in arable fields bordered by targeted flower mixtures (van Rijn, 2018). A study of flowering margins around oilseed rape fields showed that oilseed rape yield gains were correlated with pollinator (bees and flies) visitation rates, and that the rate of decline in per capita growth rates of aphid colonies was increased by natural predators from the species-rich field margins up to 50 m into the crop (Woodcock et al, 2016). In apple and pear orchards, the planting of surrounding hedgerows and flowering plants strips have been shown to increase populations of natural enemies and pollinators (Damos, Escudero Colomar and Ioriatti, 2015). In contrast, a study of flowering strips in apple orchards in the UK demonstrated that flower strips enhanced overall wild insect abundance but not pollination services (Campbell et al, 2017). All orchards were sprayed with insecticides against aphids prior to and immediately after blossom. The study did not examine what effect this had on the pollinators.

IPM techniques in apple and pear orchards

The PURE project developed an evaluation framework to assist apple and pear orchard managers to make decisions about innovative IPM systems (Caffi et al, 2017). The demonstration farms in Italy, France, Hungary, and the Netherlands showed that, in general, innovative performed better than standard for environmental quality and provided similar yield and pest management without any significant extra costs. In apple and pear orchards, granulovirus preparations and nematodes are available as highly selective control options for the codling moth *Cydia pomonella* L.; pheromone dispensing systems are available against *C. pomonella* and tortricid leafrollers, and a series of other secondary pests; and the efficacy of mass trapping technique against *Ceratitis capitata* (medfly) has been confirmed (Damos, Escudero Colomar and Ioriatti, 2015). No information was identified to show what potential benefits this has brought to wild pollinator populations, but it is likely that the use of these methods has reduced applications of the insecticides spinetoram, chlorantraniliprole, lambda-cyhalothrin, and chlorpyrifos, which are considered to be a risk to pollinators (Baron, Raine and Brown, 2014; Biondi et al, 2012; Ceuppens et al, 2015; Smagghe et al, 2013; Urlacher et al, 2016)

Agroecological approaches such as organic farming are generally considered to be beneficial for pollinator populations, due to the absence of chemical pesticide use combined with greater crop diversity including legumes, greater abundance of flowering weeds, and better quality and wider field margin habitats (such as hedges) (see Box 8). However, the factors which increase pollinator abundance and richness are not present on all organic farms, as some organic farms may have almost equally intensive management as conventional, for example weed control (Brittain et al, 2010). Pollinator populations are also strongly affected by factors operating at the landscape scale (such as the presence of semi-natural habitats including extensive grassland and woodland), so pollinators on isolated organic farms surrounded by conventional farmland do not necessarily benefit. A meta-review of studies across the EU concluded that the landscape surrounding the focal field or farm either enhances or reduces the positive effects of organic farming or acts via interactions where the surrounding landscape affects biodiversity or ecosystem services differently on organic and conventional farms (Winqvist, Ahnström and Bengtsson, 2012).

Box 8 Evidence that organic farming benefits wild pollinators

Studies have shown that organic mixed farms have higher wild bee abundance in certain months (Austin, Lawson-Handley and Gilbert, 2019), higher butterfly abundance and species richness (Jonason et al, 2011) and richer hoverfly communities (Andersson et al, 2013) than nearby conventional mixed farms. Another study showed that organic farms had higher pollination rates of Field Bean (*Vicia faba*) than conventional farms, because of their higher bumblebee abundance (Andersson et al, 2014). Strawberries had higher pollination success and the proportion of fully pollinated berries were higher on organic compared to conventional farms and this difference was already evident 2–4 years after conversion to organic farming (Andersson, Rundlöf and Smith, 2012). Triticale crop fields under organic management had five times higher plant species richness and about twenty times higher pollinator species richness compared to conventional fields (Krauss, Gallenberger and Steffan-Dewenter, 2011). Uncultivated fallow strips adjacent to organic wheat fields had significantly higher wild bee density and diversity than the same fallow strips adjacent to conventionally managed wheat fields (Holzschuh, Steffan-Dewenter and Tscharntke, 2008). Nocturnal flying insect abundance, species richness, and moth species diversity were significantly higher on organic farms than on conventional farms in the UK (Wickramasinghe et al, 2004). In England, organic crop habitats supported a higher density of flowers, insect-wildflower visits, and fruit set of the tested flowering plants than farms under the entry level agri-environmental scheme (Hardman et al, 2016). In contrast, a study in Estonia found no differences in bumblebee abundance between farms managed under agri-environment contracts and those managed as organic, but both had more bumblebees in the field margins than conventional farms, because both schemes required farms to plant a greater abundance of legume crops highly attractive to bumblebees (Marja et al, 2018). Organically managed pastures in Ireland had higher abundance of insect-pollinated forbs (mainly Trifolium spp.) which attracted a higher abundance and species richness of hoverflies than conventionally managed grasslands, and the higher total cover of hedgerows was also important (Power, Jackson and Stout, 2016). In organically managed olive orchards, colonisation rates of wild bees were higher than in conventional olive groves, because of the less intensive management of the ground cover which resulted in a higher abundance of flowering ground herbs (Martínez-Núñez et al, 2019).

Organic apple orchards had a higher abundance of natural enemies and fewer aphid colonies, but no difference in pollinator visits, fruit set or number of seeds per apple, compared to orchards managed in an IPM system applying insecticides to control aphids (Porcel et al, 2018). The authors conclude that the lack of an effect on pollinators was because the pollinator abundance was influenced by the broader landscape scale rather than the scale of the individual orchards. Similarly, a study of isolated organically farmed vineyards surrounded by conventional vineyards in Veneto in Italy, where the organic vineyards did not offer more floral resources or semi-natural habitat, found no differences in pollinator abundance and species richness (Brittain et al, 2010). The vineyards had similarly intensive between row vegetation management - organic (mown) and conventional (herbicide treated). However, there was a high variation in pollinator abundance perhaps reflecting the high disturbance levels, and this will have influenced the ability of the study method to detect differences.

5.5.2 Examples of good practices – promoting IPM and alternative pest management methods for pollinators

The promotion of IPM and non-chemical pest management methods are a core part of all NAPs as required by the SUD, but most NAPs do not specify what environmental gains they expect from IPM implementation, nor how they propose to check compliance. A good practice example that integrates farmer training and awareness raising comes from the Austrian RDP.

In Austria, the success of the agri-environmental option for 'environmentally friendly and biodiversity-promoting management' has created pesticide free biodiversity areas on farms, that go beyond the ecological focus area requirement of the greening measure in the CAP 2014-2020 (see example box). An important component of the success has been that all participating farmers must take part in training, which provides farmers with information on wild pollinators and the risks of pesticide use, which increases understanding and motivation.

In Germany, the promotion of a set of IPM techniques in vineyards has significantly reduced to use of insecticides (see example box). There is no information on how this has benefited wild pollinators, though vineyards can be good pollinator habitat (Brittain et al, 2010).

A key component of support for IPM is the provision of timely and spatially precise information on pest and disease prevalence and forecasts of risks. An example is the Austrian the Plant Protection Alert System[liii], which provides a warning system for all the main crops, pests, and diseases. The DG SANTE audit of SUD implementation in Austria reported that a feedback survey of rapeseed growers using the application showed a decrease in the number of pesticide applications from six to two sprays[liv]. Another DG SANTE audit of SUD implementation found that Italy has reliable sources of information to guide professional users in IPM in the publicly available phytosanitary bulletins and crop specific IPM guidelines produced by the regions[lv], though there is no information on impacts.

Austria: Agri-environment measure 'environmentally friendly and biodiversity-promoting management' creates pesticide free biodiversity areas on farms

Source: Austria case study by Suske et al (2019) for report by (Mottershead and Underwood, 2020)

The 'environmentally friendly and biodiversity-promoting management' agri-environment scheme requires at least 5% biodiversity areas, and the retention of landscape features on all participating farms, as well as their environmentally friendly management (as specified in the scheme rules). No pesticide use is allowed on the biodiversity area. On grassland, requirements are the first cut at the same time as the second cut of comparable areas (at the earliest as of the 1st of June), no grazing or fertiliser use before first cut, removal of the cut grass from the area, and no pesticide use on the whole area. On arable, the requirements are to sow seed mixtures of at least four insect-pollinated plant species before the 15th of May (this is important for pollinators as the plants should not flower too late in the year) and keep this for at least 1.5 years on the same area with no fertiliser or pesticide use, mown/chopped once annually, maximum two times per year. On 50% of the biodiversity area mowing at the earliest on 1 August, on the other 50% no restrictions concerning mowing date. No grazing or harvesting of seeds. Only mechanical removal of the biodiversity area through chopping or ploughing is allowed. As an additional option, the scheme funds the cultivation of flowering crops such as St. John's Wort, camomile, milk thistle, marigolds and echinacea, to encourage more diverse crop rotations and more areas of crops attractive to insect pollinators. However, some of these crops require insecticide treatments to produce a commercially viable yield.

The scheme has a high take up amongst Austrian farmers (nearly half of all CAP registered farmers in Austria), partly because the biodiversity areas were counted as ecological focus area for the greening payment. All participating farmers are required to attend training on environmental priorities including biodiversity with reference to insects. The training is organised differently in each federal state, but an educational concept was prepared, which helped to ensure that biodiversity topics were covered in almost all trainings. The two more strongly nature conservation focused agri-environment measures include the visit of an ecologist to the farm, to provide site specific advice on biodiversity conservation measures.

Germany: IPM techniques for vineyards have reduced insecticide use (though impact on pollinators is unknown)

Source: Dr Erich Jörg, Dr Andreas Kortekamp, DLR Rheinlandpfalz (BMEL, 2020), national report on pesticide use (Julius Kühn-Institut (JKI) PAPA Ergebnisse: Wirkstoffmengen. https://papa.julius-kuehn.de/index.php?menuid=33 (accessed 21/9/2020)

Most German vineyards have adopted a set of integrated protection techniques that have significantly reduced the use of insecticides on German grapes. German pesticide spray monitoring has shown a declining trend for use of insecticides in vineyards[1], which can be expected to have had a positive impact on wild pollinators visiting flowers in vineyards. The IPM techniques use cultural techniques, pheromone treatments, and biological control to avoid the use of chemical insecticides. Predatory mites have been able to build up permanent populations in vineyards, as almost all the pesticides authorized for use on vines are categorised as nontoxic or low risk to predatory mites, and they effectively control pest mites. As a result, vine growers now use acaricide treatments only occasionally. They are introduced into new vineyards in pieces of foliage or wood from established vines. Around two-thirds of vineyards use pheromone treatments to prevent pest damage from two Lepidoptera whose caterpillars damage the flowers and growing berries, also helping to reduce damage from secondary fungal infections. The pheromones are released from dispensers placed in the vineyards throughout the season. The risk of infection by the newly expanding pest *Drosophila suzukii* is being kept low using cultural techniques (removal of foliage around ripening grapes to maximise sun and wind exposure, maintenance of low height of ground vegetation) and an adapted harvesting time. As a result, insecticide treatments against *Drosophila* are only necessary in years when the weather conditions are unfavourable.

In contrast, the use of fungicides against downy and grey mildews (*Botrytis*) is increasing, as the increasingly warm winters caused by climate change are favouring their carry over from season to season (Roßberg and Ipach, 2015). This might be increasing risk to pollinators, for example from myclobutanil, which has a sublethal effect on honeybees exposed via pollen (Mao, Schuler and Berenbaum, 2017), and could also be affecting wild bees.

6. RECOMMENDATIONS FOR HOW MEMBER STATES COULD IMPROVE THEIR SUD NAPS TO BENEFIT POLLINATORS

The review of NAPs and of good practices showed that although the issue of wild pollinator conservation is only just starting to be reflected in the NAPs, some Member States have planned initiatives that are developing approaches and improving knowledge and tools to protect wild pollinators. Current NAPs tend not to go beyond a compilation of already existing initiatives for pesticide reduction, such as agri-environment measures (with exceptions as highlighted in this report). Nevertheless, NAPs could become roadmaps towards a progressive and systematic reduction of the risk posed by pesticides to wild pollinators.

NAPs can be used to set national targets or objectives to reduce pesticide use aimed at pollinator conservation and develop monitoring and indicators of risk or impacts on pollinators. To establish and monitor targets to reduce the risks of pesticides to wild pollinators that are effective, realistic, and measurable, you need information on the toxicity of pesticides to wild pollinators and the exposure of wild pollinators. You can then analyse the current pressure on pollinators from pesticide use and develop an indicator to measure progress.

Several initiatives are underway to establish indicators of pesticide risk to pollinators and to improve the knowledge base to better assess the risk and target measures. The Danish pesticide load indicator takes account of toxicity of pesticide active substances to bees, as far as the current EU wide risk assessments have identified effects. It is used to calculate the tax and so incentivises the use of less harmful products. The Swedish government is assembling an inventory of knowledge about the risks of pesticides to pollinating insects and using this to harmonise pesticide labelling messages and create better information tools for farmers. There is a common need amongst Member States for compiled information on pesticide impacts on wild pollinators, and for an improved compilation of statistics on pesticide use to assess exposure.

- Recommendation: to pool expert knowledge across EU research projects and other initiatives to produce an inventory of the current ecotoxicity information on pesticides and wild pollinators. Wild pollinator protection needs research to identify the most sensitive species and to get realistic exposure data, since wild pollinators are exposed during their lifetime to multiple pesticide formulations and potential synergistic effects need to be accounted for. Furthermore, an assessment of the potential to extrapolate the available toxicological information from one pollinator species to another should be carried out.

Whilst the declarations in the revised NAPs about developing monitoring and indicators relevant to wild pollinators promise improvements in future, the current situation is that very little monitoring of impacts of pesticides on pollinators is being carried out. The few pesticide residue surveys in wild bees reveal exposure to multiple chemicals through a combination of exposure routes. Methods are available to set up residue studies, and several projects are setting up long-term residue monitoring in honeybee-collected pollen, but long-term programmes to monitor residues in wild pollinators are expensive and practically challenging. The French biovigilance programme has demonstrated how long-term observations of on-farm biodiversity can be linked to records of farming practices, including pesticide use, to reveal the impacts of changes in practices. However, pollinators react at the landscape scale so disentangling the effects of changes in pesticide use from other influencing factors requires careful design and large data sets.

- Recommendation: to encourage the insertion of targets for pollinator population recovery in both NAPs and CAP strategic plans, and to integrate pesticide impact monitoring with the European Pollinator Monitoring Scheme, which is being rolled out on a network of sites across the EU. This will require the implementation of methods to gather more information on pollinator populations, as there is currently no desired reference value that could serve as a basis for recovery and there are no validated recording methods.

NAPs can include specific measures to control impacts of pesticides on pollinators and to ensure compliance with risk mitigation measures. Specific measures can include restrictions on the use of certain pesticide products to reduce their hazard to pollinators, and/or certain pesticide mixtures, measures to mandate and/or promote the use of certain spray techniques and technologies, measures to mandate and/or promote buffer strips to decrease pesticide exposure in off field habitats, restrictions on certain practices such as systematic prophylactic use, and information and decision making tools for pesticide users to enable them to select less harmful pesticides. There appears to be little easily accessible information available to pesticide users in the EU on the relative risks of different products to wild pollinators, and descriptions of bee risk on pesticide labels use different words and pictures in each country and even within countries. Most pesticide labels refer only to risks to honeybees, and it is important to note that measures to protect wild pollinators may need to differ from measures to protect honeybees, because of differences in the behaviour and ecology of the wild pollinators. Pesticide label warnings could contain general messages about potential hazards to wild pollinators. Harmonisation of approaches should be in line with efforts to harmonize risk assessment procedures under Regulation (EC) No 1107/2009 and in accordance with Commission Regulation (EU) 547/2011.

- Recommendations include the development of a more unified approach to pesticide labelling of risks to bees, through harmonization between Member States, and broaden the warning to cover all pollinators; to promote drift reduction techniques; and to raise awareness and regulatory controls on mixtures of pesticides that have higher toxicity to pollinators.

The risk assessment and approval of pesticide active substances at the EU level, and of pesticide products at Member State level, is not regulated by the SUD Directive. However, Member States could use their SUD NAPs to improve protection according to a precautionary approach regarding the risk assessment for wild pollinators, and to support research and development of alternative products and approaches. Specific measures to reduce risk require enough data to be submitted during the pesticide approval process, the product-specific toxicity of residues on foliage, and the acute toxicity to the relevant wild pollinators likely to visit the crop.

The SUD gives scope for Member States to take regulatory or other measures to reduce pesticide use or risk in specific areas including Natura 2000 sites and other protected areas, thus minimising the risk arising from pesticide use. Little information is available on much pesticide is used in Natura 2000 sites and other nature protected areas and what impact is that having on biodiversity conservation, but Italy and Spain illustrate how pesticide risks to the Natura 2000 network have been mapped, to facilitate targeted measures. In Spain, a set of voluntary guidelines for IPM are being targeted at farming systems within Natura 2000 and other areas with sensitive protected species and habitats, and in Italy, research is ongoing to identify alternative farming systems that can be promoted within the Natura 2000 network as being compatible with protection of species and habitats.

- A recommendation is that national and regional authorities responsible for the sustainable use of pesticides and for the Natura 2000 network (as well as other protected areas such as national and regional parks) to collaborate to improve the information base and develop targeted incentives and regulatory measures to reduce or eliminate pesticide use in protected areas. It is also important to target measures at farms in the buffer zones around protected sites.

Integrated Pest Management is mandatory under the SUD since 2014, including giving priority to non-chemical alternatives, use of crop rotation, resistant cultivars, and avoiding prophylactic uses such as spraying based on crop development stage and seed treatments.

- Member States should ensure the development of farm advisory services, as planned by the SUD, to help farmers achieve such a change in practice, to reduce the overall use of pesticides and therefore a better protection of wild pollinators.

NAPs can be used to strengthen training and awareness raising on the risks and impacts of pesticides on pollinators and ways to reduce pesticide use, through the obligatory training of professional users, and information and awareness raising targeted to non-professional pesticide users. National Action Plans could promote non-chemical alternatives for non—professional users. France and Belgium have taken the approach of phasing out the sale of synthetic pesticides to non-professional users altogether.

Member States can use their NAP to take measures to prioritise non-chemical methods of pest control in agriculture with a view to protecting pollinators, by enforcing the uptake of IPM approaches, by promoting organic agriculture, and by controlling and verifying the IPM approach at the farm level. Although farmers are obliged to keep records of their pesticide use, and to follow the IPM principles, it is not possible to check from the spray records whether farmers have implemented IPM or not.

The European Commission has stated that it expects Member States to make the best possible use of their NAPs to support the objectives of the EU Farm to Fork Strategy and the EU Biodiversity Strategy 2030, including the goal to reverse the decline of pollinator populations. The European Parliament is also expecting an improved implementation of the SUD, including a better application of the IPM principles by Member States. The European Court of Auditors recommended a stronger enforcement of IPM principles through their integration into CAP conditionality and the development of practical and measurable criteria by Member-States, under the control of the Commission, the collection of better pesticide statistics and the development of better risk indicators to assess impacts on the environment. On the EU Pollinators Initiative, the auditors recommend that the next phase assesses the need for actions to address threats that were not fully considered in the first phase, such as pesticides, with appropriate governance and monitoring mechanisms.

Overall, the NAPs should deliver substantially more positive action to reduce the pressures of pesticides on wild pollinators. An overarching recommendation is to set up mechanisms to share and exchange good practices between countries.

7. REFERENCES AND ENDNOTES

Alberoni, D, Alix, A, Dicks, L, Dietzsch, A C, Krahner, A, Kroder, S, Leonhardt, S D, Mommaerts, V, Mukherjee, N, Pettis, J, Simon Delso, N, Sançana, A, Vanbergen, A J, Vasileiadis, V P, van der Kooi, C J, Villa, S, Whitehorn, P R, Wood, T J and Woodcock, B A (2020) *What do we currently know about the impacts of pesticide and fertiliser use in farmland on the effectiveness of adjacent pollinator conservation measures such as flower strips and hedgerows, and what additional research is needed?* Report prepared by an EKLIPSE Expert Working Group, UK Centre for Ecology & Hydrology, Wallingford, UK.

Andersson, G K S, Birkhofer, K, Rundlöf, M and Smith, H G (2013) Landscape heterogeneity and farming practice alter the species composition and taxonomic breadth of pollinator communities. *Basic and Applied Ecology* No 14 (7), 540-546.

Andersson, G K S, Ekroos, J, Stjernman, M, Rundlöf, M and Smith, H G (2014) Effects of farming intensity, crop rotation and landscape heterogeneity on field bean pollination. *Agriculture, Ecosystems & Environment* No 184, 145-148.

Andersson, G K S, Rundlöf, M and Smith, H G (2012) Organic farming improves pollination success in strawberries. *PLoS ONE* No 7 (2), e31599.

Andrade, C, Villers, A, Balent, G, Bar-Hen, A, Chadoeuf, R, Cylly, D, Cluzeau, D, Fried, G, Guillocheau, S, Pillon, O, Porcher, E, Tressou, J, Yamada, O, Lenne, N, Jullien, J and Monestiez, P (2020) A real-world implementation of a nationwide, long-term monitoring program. *Ecology and Evolution* No in press, mnhn-02915505f.

Austin, A J, Lawson-Handley, L and Gilbert, J D J (2019) Plugging the hunger gap: Organic farming supports more abundant nutritional resources for bees at critical periods. *bioRxiv* No 10.1101/837625, 837625.

Baron, G L, Raine, N E and Brown, M J F (2014) Impact of chronic exposure to a pyrethroid pesticide on bumblebees and interactions with a trypanosome parasite. *Journal of Applied Ecology* No 51 (2), 460-469.

Barzman, M, Bàrberi, P, Birch, A N E, Boonekamp, P, Dachbrodt-Saaydeh, S, Graf, B, Hommel, B, Jensen, J E, Kiss, J, Kudsk, P, Lamichhane, J R, Messéan, A, Moonen, A-C, Ratnadass, A, Ricci, P, Sarah, J-L and Sattin, M (2015) Eight principles of integrated pest management. *Agronomy for Sustainable Development* No 35 (4), 1199-1215.

Biondi, A, Mommaerts, V, Smagghe, G, Vinuela, E, Zappala, L and Desneux, N (2012) The non-target impact of spinosyns on beneficial arthropods. *Pest Management Science* No 68 (12), 1523-1536.

Bischoff, G, Grasz, B, Nowak, H, Paulutt, K and Pistorius, J (2020) Auf der Suche nach Rückständen von Pflanzenschutzmitteln in Bienen, Pflanzen und Bienenprodukten. *Journal für Kulturpflanzen (Journal of Cultivated Plants)* No 72, (5). Julius Kühn-Institut - Bundesforschungsinstitut für Kulturpflanzen, Quedlinburg.

BMEL (2020) *Jahresbericht 2019: Nationaler Aktionsplan zur nachhaltigen Anwendung von Pflanzenschutzmitteln*. Bundesministerium für Ernährung und Landwirtschaft, Berlin.

Böhme, F, Bischoff, G, Zebitz, C P W, Rosenkranz, P and Wallner, K (2018) Pesticide residue survey of pollen loads collected by honeybees (*Apis mellifera*) in daily intervals at three agricultural sites in South Germany. *PLoS ONE* No 13 (7), e0199995.

Bondesan, D, Rizzi, C, Angeli, G and Ioriatti, C (2013) Evaluation of spray drift in apple orchards of Trentino: comparison of different solutions to reduce environmental contamination. *IOBC-WPRS Bulletin* No 91, (2013) pp493-499. IOBC-WPRS International Organization for Biological Control Western Palaearctic R S.

Botías, C, David, A, Hill, E M and Goulson, D (2017) Quantifying exposure of wild bumblebees to mixtures of agrochemicals in agricultural and urban landscapes. *Environmental Pollution* No 222, 73-82.

Brittain, C, Bommarco, R, Vighi, M, Settele, J and Potts, S G (2010) Organic farming in isolated landscapes does not benefit flower-visiting insects and pollination. *Biological Conservation* No 143 (8), 1860-1867.

Bruce, T J A (2016) The CROPROTECT project and wider opportunities to improve farm productivity through web-based knowledge exchange. *Food and Energy Security* No 5 (2), 89-96.

Bruus, M, Dupont, Y L, Grant, R, Mathiassen, S K, Kryger, P, Spliid, N H, Stjernholm, M, Strandberg, B and Sørensen, P B (2013) *Betydningen af pesticider for forekomsten af vilde bier – og metoder til undersøgelse af denne*. [*The importance of pesticides for the occurrence of wild bees - and methods for studying this*]

Miljøstyrelsen [Research funded by Danish Environmental Protection Agency], Denmark.

Caffi, T, Helsen, H H M, Rossi, V, Holb, I J, Strassemeyer, J, Buurma, J S, Capowiez, Y, Simon, S and Alaphilippe, A (2017) Multicriteria evaluation of innovative IPM systems in pome fruit in Europe. *Crop Protection* No 97 (Supplement C), 101-108.

Calatayud-Vernich, P, Calatayud, F, Simo, E, Pascual Aguilar, J A and Pico, Y (2019) A two-year monitoring of pesticide hazard in-hive: High honey bee mortality rates during insecticide poisoning episodes in apiaries located near agricultural settings. *Chemosphere* No 232, 471-480.

Campbell, A J, Wilby, A, Sutton, P and Wäckers, F L (2017) Do sown flower strips boost wild pollinator abundance and pollination services in a spring-flowering crop? A case study from UK cider apple orchards. *Agriculture, Ecosystems & Environment* No 239, 20-29.

Ceuppens, B, Eeraerts, M, Vleugels, T, Cnops, G, Roldan-Ruiz, I and Smagghe, G (2015) Effects of dietary lambda-cyhalothrin exposure on bumblebee survival, reproduction, and foraging behavior in laboratory and greenhouse. *Journal of Pest Science* No 88 (4), 777-783.

Cour des Comptes (2020) *Le bilan des plans Écophyto*. Lettre à Monsieur Édouard Philippe Premier Ministre le 27 novembre 2019, Cour des Comptes, France.

Damos, P, Escudero Colomar, L-A and Ioriatti, C (2015) Integrated Fruit Production and pest management in Europe: the apple case study and how far we are from the original concept? *Insects* No 6 (3), 626-657.

David, A, Botías, C, Abdul-Sada, A and Goulson, D (2016) Widespread contamination of wildflower and bee-collected pollen with complex mixtures of neonicotinoids and fungicides commonly applied to crops. *Environment International* No 88, 169-178.

de Jong, F M W, de Snoo, G R and van de Zande, J C (2008) Estimated nationwide effects of pesticide spray drift on terrestrial habitats in the Netherlands. *Journal of Environmental Management* No 86 (4), 721-730.

Dicks, L V, Abrahams, A, Atkinson, J, Biesmeijer, J, Bourn, N, Brown, C, Brown, M J F, Carvell, C, Connolly, C, Cresswell, J E, Croft, P, Darvill, B, De Zylva, P, Effingham, P, Fountain, M, Goggin, A, Harding, D, Harding, T, Hartfield, C, Heard, M S, Heathcote, R, Heaver, D, Holland, J, Howe, M, Hughes, B, Huxley, T, Kunin, W E, Little, J, Mason, C, Memmott, J, Osborne, J, Pankhurst, T, Paxton, R J, Pocock, M J O, Potts, S G, Power, E F, Raine, N E, Ranelagh, E, Roberts, S, Saunders, R, Smith, K, Smith, R M, Sutton, P, Tilley, L A N, Tinsley, A, Tonhasca, A, Vanbergen, A J, Webster, S, Wilson, A and Sutherland, W J (2013) Identifying key knowledge needs for evidence-based conservation of wild insect pollinators: a collaborative cross-sectoral exercise. *Insect Conservation and Diversity* No 6 (3), 435-446.

Dicks, L V, Showler, D A and Sutherland, W J (2010) *Bee Conservation: Evidence for the effects of interventions*. Synopses of Conservation Evidence, Volume 1, Conservation Evidence.

Écophyto (2016) *Le réseau DEPHY FERME: D'une idée à 3000 agriculteurs*. Ministre de l'Agriculture, de l'Agroalimentaire et de la Forêt, France.

European Commission (2017) *Guidance on monitoring and surveying of impacts of pesticide use on human health and the environment under Article 7(3) of Directive 2009/128/EC establishing a framework for Community action to achieve the sustainable use of pesticides (referred to as the Sustainable Use Directive)*. COMMISSION NOTICE C(2017) 6766 final, European Commission, Brussels.

European Court of Auditors (2020) *Sustainable use of plant protection products: limited progress in measuring and reducing risks*. Special Report 05/2020, European Court of Auditors, Brussels.

Fornasiero, D, Mori, N, Tirello, P, Pozzebon, A, Duso, C, Tescari, E, Bradascio, R and Otto, S (2017) Effect of spray drift reduction techniques on pests and predatory mites in orchards and vineyards. *Crop Protection* No 98 (Supplement C), 283-292.

Fried, G, Andrade, C, Villers, A, Porcher, E, Cylly, D, Cluzeau, D, Guillocheau, S, Pillon, O, Yamada, O, Jullien, J, Lenne, N and Monestiez, P (2019) Premiers résultats du réseau Biovigilance 500 ENI sur le suivi des effets non-intentionnels des pratiques agricoles sur la biodiversité. *Innovations Agronomiques* No 75, (2019) pp87-98. INRAE, France.

Fried, G, Villers, A and Porcher, E (2018) Assessing non-intended effects of farming practices on field margin vegetation with a functional approach. *Agriculture, Ecosystems & Environment* No 261, 33-44.

Garcerá, C, Berger, L T and Chueca, P (2018) Efficiency assessment of H30 Smartomizer in citrus. *Aspects of Applied Biology* No 137, 93-100.

Garthwaite, D, Sinclair, C, Glass, R, Pote, A, Trevisan, M, Sacchettini, G, Spanoghe, P, Ngoc, K D, Fevery, D, Machera, K, Charistou, A, Nikolopoulou, D, Arapaki, N, Tsakirakis, A, Gerritsen-Ebben, R, Spaan, S, González, F E, Stobiecki, S, Sliwinski, W, Stobiecki, T and Hakaite, P (2015) *Collection of pesticide application data in view of performing Environmental Risk Assessments for pesticides*. EFSA supporting publication 2015:EN-846.

Gierer, F, Vaughan, S, Slater, M, Thompson, H M, Elmore, J S and Girling, R D (2019) A review of the factors that influence pesticide residues in pollen and nectar:

Future research requirements for optimising the estimation of pollinator exposure. *Environmental Pollution* No 249, 236-247.

Guichard, L, Dedieu, F, Jeuffroy, M-H, Meynard, J-M, Reau, R and Savini, I (2017) Le plan Ecophyto de réduction d'usage des pesticides en France : décryptage d'un échec et raisons d'espérer. *Cahiers Agricultures* No 26, (14002). EDP Sciences, Paris.

Hallmann, C A, Sorg, M, Jongejans, E, Siepel, H, Hofland, N, Schwan, H, Stenmans, W, Müller, A, Sumser, H, Hörren, T, Goulson, D and de Kroon, H (2017) More than 75 percent decline over 27 years in total flying insect biomass in protected areas. *PLoS ONE* No 12 (10), e0185809.

Hardman, C J, Norris, K, Nevard, T D, Hughes, B and Potts, S G (2016) Delivery of floral resources and pollination services on farmland under three different wildlife-friendly schemes. *Agriculture, Ecosystems & Environment* No 220, 142-151.

Hausmann, J, Brandes, M and Helmbach, U (2019) Effects of dropleg application technique during flowering of oilseed rape on insect pests. *Crop Protection* No 126, 104917.

Heimbach, U, Brandes, M, Hausmann, J and Ulber, B (2016) Effects of conventional and dropleg insecticide application techniques on pests during flowering of oilseed rape. *IOBC-WPRS Bulletin* No 116, 35-37.

Henry, M, Cerrutti, N, Aupinel, P, Decourtye, A, Gayrard, M, Odoux, J-F, Pissard, A, Rüger, C and Bretagnolle, V (2015) Reconciling laboratory and field assessments of neonicotinoid toxicity to honeybees. *Proceedings of the Royal Society B Biological Sciences* No 282 (1819), 20152110-DOI: 20152110.20151098/rspb.20152015.20152110.

Holzschuh, A, Steffan-Dewenter, I and Tscharntke, T (2008) Agricultural landscapes with organic crops support higher pollinator diversity. *Oikos* No 117 (3), 354-361.

Hötker, H, Brühl, C, Buhk, C and Oppermann, R (2018) *Biodiversitätsflächen zur Minderung der Umweltauswirkungen von Pflanzenschutzmitteln: Anforderungen an Kompensationsmaßnahmen im Risikomanagement*. Studie durchführt von Michael-Otto-Institut im NABU, ecocoGbR & Institut für Agrarökologie und Biodiversität (IFAB), Umweltbundesamt, Dessau-Roßlau.

ISPRA (2015) *Valutazione del rischio potenziale dei prodotti fitosanitari nelle Aree Natura 2000 [Assessment of potential risk of pesticides in Natura 2000 network]*.

Rapporti 216/2015, ISPRA - Istituto Superiore per la Protezione e la Ricerca Ambientale, Italy.

Jonason, D, Andersson, G K S, Öckinger, E, Rundlöf, M, Smith, H G and Bengtsson, J (2011) Assessing the effect of the time since transition to organic farming on plants and butterflies. *Journal of Applied Ecology* No 48 (3), 543-550.

Krauss, J, Gallenberger, I and Steffan-Dewenter, I (2011) Decreased functional diversity and biological pest control in conventional compared to organic crop fields. *PLoS ONE* No 6 (5), e19502.

Kudsk, P, Jørgensen, L N and Ørum, J E (2018) Pesticide Load—A new Danish pesticide risk indicator with multiple applications. *Land Use Policy* No 70, 384-393.

Lapierre, M, Sauquet, A and Subervie, J (2019) *Providing technical assistance to peer networks to reduce pesticide use in Europe: Evidence from the French Ecophyto plan*. CEE-M Working Paper 2019-15 (updated version February 2020), INRAE, France.

Lewis, K A, Tzilivakis, J, Warner, D J and Green, A (2016) An international database for pesticide risk assessments and management. *Human and Ecological Risk Assessment: An International Journal* No 22 (4), 1050-1064.

Mao, W, Schuler, M A and Berenbaum, M R (2017) Disruption of quercetin metabolism by fungicide affects energy production in honey bees (*Apis mellifera*). *Proceedings of the National Academy of Sciences* No 114 (10), 2538.

Marja, R, Viik, E, Mänd, M, Phillips, J, Klein, A-M and Batáry, P (2018) Crop rotation and agri-environment schemes determine bumblebee communities via flower resources. *Journal of Applied Ecology* No 55 (4), 1714-1724.

Martínez-Núñez, C, Manzaneda, A J, Isla, J, Tarifa, R, Calvo, G, Molina, J L, Salido, T, Ruiz, C, Gutiérrez, J E and Rey, P J (2019) Low-intensity management benefits solitary bees in olive groves. *Journal of Applied Ecology* No 57 (1), 111-120.

Mogren, C L and Lundgren, J G (2016) Neonicotinoid-contaminated pollinator strips adjacent to cropland reduce honey bee nutritional status. *Scientific Reports* No 6, 29608.

Möhring, N, Gaba, S and Finger, R (2019) Quantity based indicators fail to identify extreme pesticide risks. *Science of the Total Environment* No 646, 503-523.

Pedersen, A B, Nielsen, H Ø, Christensen, T, Ørum, J E and Martinsen, L (2019) Are independent agricultural advisors more oriented towards recommending reduced pesticide use than supplier-affiliated advisors? *Journal of Environmental Management* No 242, 507-514.

Porcel, M, Andersson, G K S, Pålsson, J and Tasin, M (2018) Organic management in apple orchards: Higher impacts on biological control than on pollination. *Journal of Applied Ecology* No 55 (6), 2779-2789.

Power, E F, Jackson, Z and Stout, J C (2016) Organic farming and landscape factors affect abundance and richness of hoverflies (Diptera, Syrphidae) in grasslands. *Insect Conservation and Diversity* No 9 (3), 244-253.

Raimets, R, Bontšutšnaja, A, Bartkevics, V, Pugajeva, I, Kaart, T, Puusepp, L, Pihlik, P, Keres, I, Viinalass, H, Mänd, M and Karise, R (2020) Pesticide residues in beehive matrices are dependent on collection time and matrix type but independent of proportion of foraged oilseed rape and agricultural land in foraging territory. *Chemosphere* No 238, 124555.

Remáč, M, Traon, D, Dachbrodt-Saaydeh, S, Kudsk, P, Brkanovic, S, Schuh, B and Gorny, H (2018) *Directive 2009/128/EC on the sustainable use of pesticides: European Implementation Assessment*. EPRS | European Parliamentary Research Service, Brussels.

République Française (2020) *Écophyto: Note de Suivi 2018-2019*. République Française Le Gouvernement, France.

Roßberg, D and Ipach, R (2015) Erhebungen zur Anwendung von Pflanzenschutzmitteln im Weinbau [Survey on application of chemical pesticides in grapes (for wine production)]. *Journal für Kulturpflanzen* No 67, (12) pp410-416. Verlag Eugen Ulmer KG, Stuttgart.

Simon-Delso, N, San Martin, G, Bruneau, E, Delcourt, C and Hautier, L (2017) The challenges of predicting pesticide exposure of honey bees at landscape level. *Scientific Reports* No 7 (1), 3801.

Smagghe, G, Deknopper, J, Meeus, I and Mommaerts, V (2013) Dietary chlorantraniliprole suppresses reproduction in worker bumblebees. *Pest Management Science* No 69 (7), 787-791.

Tosi, S, Costa, C, Vesco, U, Quaglia, G and Guidod, G (2018) A 3-year survey of Italian honey bee-collected pollen reveals widespread contamination by agricultural pesticides. *Science of the Total Environment* No 615, 208-218.

Tschumi, M, Albrecht, M, Bärtschi, C, Collatz, J, Entling, M H and Jacot, K (2016) Perennial, species-rich wildflower strips enhance pest control and crop yield. *Agriculture, Ecosystems & Environment* No 220, 97-103.

Tschumi, M, Albrecht, M, Entling, M H and Jacot, K (2015) High effectiveness of tailored flower strips in reducing pests and crop plant damage. *Proceedings of the Royal Society B: Biological Sciences* No 282 (1814).

Urlacher, E, Monchanin, C, Rivière, C, Richard, F-J, Lombardi, C, Michelsen-Heath, S, Hageman, K J and Mercer, A R (2016) Measurements of chlorpyrifos levels in forager bees and comparison with levels that disrupt honey bee odor-mediated learning under laboratory conditions. *Journal of Chemical Ecology* No 42 (2), 127-138.

van Dyke, M, Mullen, E, Wixted, D and McArt, S (2018) *A Pesticide Decision-Making Guide to Protect Pollinators in Tree Fruit Orchards*. Cornell University Department Of Entomology, USA.

van Rijn, P C J (2018) *Waarden van Akkerranden in de Hoeksche Waard*. [*Value of field margin strips in the Hoeksche Waard*] Institute for Biodiversity and Ecosystem Dynamics (IBED), Amsterdam.

Verschoor, A M and et al (2019) *Tussenevaluatie van de nota 'Gezonde Groei, Duurzame Oogst' : Deelproject Milieu*. [*Midterm evaluation of the Dutch plant protection policy (memorandum 'Healthy Crops, Sustainable Harvest')*] RIVM Rapportnummer 2019-0044, Rijksinstituut voor Volksgezondheid en Milieu RIVM.

Wallner, K (2014) DroplegUL – die bienenfreundliche Düse. *Innovation* No 2, pp4-6. Verlag Th. Mann GmbH, Bonn.

Wernecke, A and Castle, D (2020) Auswirkungen von PflanzenschutzmittelTankmischungen auf Honigbienen und mögliche physiologische Interaktionen. *Journal für Kulturpflanzen* No 72, (5) pp154-161. Verlag Eugen Ulmer KG, Stuttgart.

Wickramasinghe, L P, Harris, S, Jones, G and Vaughan Jennings, N (2004) Abundance and species richness of nocturnal insects on organic and conventional farms: Effects of agricultural intensification on bat foraging. *Conservation Biology* No 18 (5), 1283-1292.

Winqvist, C, Ahnström, J and Bengtsson, J (2012) Effects of organic farming on biodiversity and ecosystem services: taking landscape complexity into account. *Annals of the New York Academy of Sciences* No 1249, 191-203.

Woodcock, B A, Bullock, J M, McCracken, M, Chapman, R E, Ball, S L, Edwards, M E, Nowakowski, M and Pywell, R F (2016) Spill-over of pest control and pollination services into arable crops. *Agriculture, Ecosystems & Environment* No 231, 15-23.

Woodcock, B A, Ridding, L, Freeman, S N, Pereira, M G, Sleep, D, Redhead, J, Aston, D, Carreck, N L, Shore, R F, Bullock, J M, Heard, M S and Pywell, R F (2018) Neonicotinoid residues in UK honey despite European Union moratorium. *PLoS ONE* No 13 (1), e0189681.

---

[i] https://ec.europa.eu/food/plant/pesticides/sustainable_use_pesticides/nap_en

[ii] 'Bed & Breakfast for Bees' launched in 2019. Available at: https://www.government.nl/documents/reports/2018/02/02/nl-pollinator-strategy-bed--breakfast-for-bees

[iii] DG SANTE (2019) Final report of an audit carried out in Ireland from 29 January 2019 to 7 February 2019 in order to evaluate the implementation of measures to achieve the sustainable use of pesticides. DG(SANTE) 2019-6720 report, European Commission.

[iv] Biene Österreich (24/8/2017) Stellungnahme im Rahmen des Öffentlichkeitsbeteiligungsverfahrens zum Nationaler Aktionsplan zur nachhaltigen Anwendung von Pflanzenschutzmitteln 2017-2021. https://cdn.netletter.at/imkerbund/media/download/2017.08.29/1504004417153992.pdf?d=Stellungnahme

[v] Rijksoverheid (2013) Gezonde Groei, Duurzame Oogst. Tweede nota duurzame gewasbescherming periode 2013 to 2023. Available at: https://edepot.wur.nl/258217

[vi] All-Ireland Pollinator Plan 2015-2020 available at: https://pollinators.ie/

[vii] République Française Le Gouvernement (2020) Note de Suivi 2018-2019. Available at: https://www.generations-futures.fr/wp-content/uploads/2020/01/ecophyto_note_de_suivi_2018-2019_vdef.pdf

[viii] European Commission DG SANTE (2019) Newsroom 14/11/2019: Pesticides: Harmonised risk indicators show encouraging trend in the risks associated with plant protection products used in the EU. https://ec.europa.eu/newsroom/sante/item-detail.cfm?item_id=662644

[ix] INTERMINISTERIALE 15 luglio 2015. Modalità di raccolta ed elaborazione dei dati per l'applicazione degli indicatori previsti dal Piano d'Azione nazionale per l'uso sostenibile dei prodotti fitosanitari. (INTERMINISTERIAL DECREE July 15, 2015. Methods of collecting and processing data for the application of the indicators provided for by the National Action Plan for the sustainable use of plant protection products).

[x] ISPRA (2019) Popolazione di uccelli sensibili ai prodotti fitosanitari - Edizione 2019. https://indicatori-pan-fitosanitari.isprambiente.it/sys_ind/14 (accessed 19/10/2020)

[xi] Biene Österreich (24/8/2017) Stellungnahme im Rahmen des Öffentlichkeitsbeteiligungsverfahrens zum Nationaler Aktionsplan zur nachhaltigen Anwendung von Pflanzenschutzmitteln 2017-2021. https://cdn.netletter.at/imkerbund/media/download/2017.08.29/1504004417153992.pdf?d=Stellungnahme

[xii] All-Ireland Pollinator Plan 2015-2020 available at: https://pollinators.ie/

[xiii] Biene Österreich (24/8/2017) Stellungnahme im Rahmen des Öffentlichkeitsbeteiligungsverfahrens zum Nationaler Aktionsplan zur nachhaltigen Anwendung von Pflanzenschutzmitteln 2017-2021. https://cdn.netletter.at/imkerbund/media/download/2017.08.29/1504004417153992.pdf?d=Stellungnahme

[xiv] https://agriculture.gouv.fr/protection-des-abeilles-et-autres-insectes-pollinisateurs-le-gouvernement-met-en-place-un-groupe-de

[xv] IEEP (2019) Member States initiatives to support wild pollinators populations: Italy. Prepared by IEEP for the European Commission. Available at:

https://wikis.ec.europa.eu/display/EUPKH/Member+States+initiatives. Citing: Tosi (2018) Il secondo Pan e in arrive – Gli obiettivi e le strategie. Published on Terra e Vita.

[xvi] https://environnement.brussels/thematiques/espaces-verts-et-biodiversite/les-pesticides/legislation-sur-lutilisation/reserves

[xvii] http://www.p-united.org/en/news-and-projects/article/articleid/97 (accessed 18/9/2020)

[xviii] https://www.mapa.gob.es/es/agricultura/temas/sanidad-vegetal/productos-fitosanitarios/guias-gestion-plagas/ (accessed 05/8/2020)

[xix] Guidelines for the protection of the aquatic environment and drinking water and for the reduction of the use of plant protection products and related risks in Natura 2000 sites and in protected natural areas. Interministerial Decree of 10 March 2015 measures no 13 and 16. (GU General Series March 26, 2015, n. 71, SO n. 16).

[xx] Rijksoverheid (2013) Gezonde Groei, Duurzame Oogst. Tweede nota duurzame gewasbescherming periode 2013 tot 2023. Available at: https://edepot.wur.nl/258217

[xxi] All-Ireland Pollinator Plan 2015-2020 available at: https://pollinators.ie/

[xxii] DG SANTE (2017) Final report of a fact-finding mission carried out in Italy from 03 to 11 May 2017 in order to evaluate the implementation of measures to achieve the sustainable use of pesticides. DG(SANTE) 2017-6006 report. European Commission.

[xxiii] Rijksoverheid (2013) Gezonde Groei, Duurzame Oogst. Tweede nota duurzame gewasbescherming periode 2013 tot 2023. Available at: https://edepot.wur.nl/258217

[xxiv] ISPRA (2019) Popolazione di uccelli sensibili ai prodotti fitosanitari - Edizione 2019. https://indicatori-pan-fitosanitari.isprambiente.it/sys_ind/14 (accessed 19/10/2020)

[xxv] Biobest (2020) Side Effects Manual. Available at https://www.biobestgroup.com/en/side-effect-manual (accessed 25/9/2020)

[xxvi] Personal communication, Dr. Marika Mänd and Dr. Reet Kerise, Estonian University of Life Sciences, 18/9/2020

[xxvii] See the list of authorised plant protection products in the section on classification of products in terms of classification and labelling. On the website of the central control and testing institute in agriculture website. Ústredný kontrolný a skúšobný ústav poľnohospodársky v Bratislave (ÚKSÚP). Available at: https://www.uksup.sk/orp-zoznamy-pripravkov-na-ochranu-rastlin (accessed 23/9/2020)

[xxviii] Verordnung über die Anwendung bienengefährlicher Pflanzenschutzmittel 22. July 1992

[xxix] Ministry of Agriculture, Forestry and Food (2020) Slovenia. List of PPPs dangerous for bees. At http://spletni2.furs.gov.si/FFS/REGSR/EN/FFS_sezn.asp?L=1&S=1&top=1 (accessed 6/12/2020)

[xxx] Pestizidstreit: „Gerichtsurteile sind Klatsche für das Land" - Klagen von NABU und Landeswasserversorgung stärken Bürgerrecht auf Information. NABU newsletter September 2020. Available at: https://baden-wuerttemberg.nabu.de/news/2020/september/28631.html (accessed 18/9/2020)

[xxxi] Diversity of Insects in Nature protected Areas (DINA) Insektenforschung. Funded by Federal Ministry of Education and Research. https://www.dina-insektenforschung.de/?lang=en

[xxxii] Bayerisches Naturschutzgesetz (Art. 3 Abs. 4 Satz 1 Nr. 8 BayNatSchG) - der flächenhafte Einsatz von Pflanzenschutzmitteln auf Dauergrünland ab dem 01.01.2022 verboten

[xxxiii] BUND project 'Pestizidfreie Kommunen' at https://www.bund.net/umweltgifte/pestizide/pestizidfreie-kommune/ (accessed 26/9/2020)

[xxxiv] BUND (2020) Stadtnatur ohne Gift – pestizidfreie Kommunen. Bund für Umwelt und Naturschutz Deutschland. https://www.bund.net/fileadmin/user_upload_bund/publikationen/umweltgifte/umweltgifte_broschuere_pestizidfreie_kommunen.pdf

[xxxv] BUND (Friends of the Earth Germany) Pestizid-freie Kommunen: Es tut sich was. https://www.bund.net/umweltgifte/pestizide/pestizidfreie-kommune/

[xxxvi] L'ONF annonce l'abandon des pesticides en forêt publique. 18/10/2019. La Liberation, France. https://www.liberation.fr/direct/element/lonf-annonce-labandon-des-pesticides-en-foret-publique_104180/ (accessed 18/9/2020)

[xxxvii] https://www.franceinter.fr/environnement/info-france-inter-la-carte-des-communes-qui-ont-pris-des-arretes-anti-pesticides (accessed 18/9/2020)

[xxxviii] https://www.ots.at/presseaussendung/OTS_20190328_OTS0159/glyphosat-kaerntner-landtag-beschliesst-verbot-einstimmig-bild (accessed 18/9/2020)

[xxxix] https://www.burgenland.at/news-detail/news/fuer-ein-nachhaltiges-gesundes-burgenland/ (accessed 18/9/2020)

[xl] https://www.burgenland.at/news-detail/news/gemeinsam-fuer-ein-glyphosatfreies-burgenland/ (accessed 18/9/2020)

[xli] DG SANTE (2019) Final report of an audit carried out in Austria from 26 February to 7 March 2019 in order to evaluate the implementation of measures to achieve the sustainable use of pesticides. DG(SANTE) 2019-6712. European Commission.

[xlii] https://de.statista.com/statistik/daten/studie/1000027/umfrage/anteil-der-gemeinden-mit-verzicht-auf-glyphosat-in-oesterreich-nach-bundeslaendern/ (accessed 18/9/2020)

[xliii] Dún Laoghaire-Rathdown County Council Municipal Services Cleansing & Beaches Section (2018) Weed Control on Hard Surfaces - Development of an Integrated Weed Control Plan. At https://pollinators.ie/wp-content/uploads/2020/03/dlr_pesticide_free_weed_control_on_hard_surfaces_plan_2018.pdf (accessed 6/12/2020)

[xliv] All-Ireland Pollinators Plan: Councils. https://pollinators.ie/councils-become-partners-with-the-all-ireland-pollinator-plan/

xlv ISPRA Indicatori 2019. Misure relative alla gestione dei prodotti fitosanitari nei Siti Rete Natura 2000 e nelle aree naturali protette. https://indicatori-pan-fitosanitari.isprambiente.it/sys_ind/26 (accessed 19/10/2020)

xlvi Guidelines for the protection of the aquatic environment and drinking water and for the reduction of the use of plant protection products and related risks in Natura 2000 sites and in protected natural areas. Interministerial Decree of 10 March 2015 measures no 13 and 16. (GU General Series March 26, 2015, n. 71, SO n. 16).

[xlvii] https://www.mapa.gob.es/es/agricultura/temas/sanidad-vegetal/productos-fitosanitarios/guias-gestion-plagas/ (accessed 05/8/2020)

[xlviii] Gobierno de Espana (MAGRAMA). Recommendaciones para el uso sostenible de phytosanitarios. https://www.miteco.gob.es/es/biodiversidad/temas/conservacion-de-especies/ce_silvestres_fitosanitarios_recomendaciones_tcm30-201432.pdf (accessed 11/120

[xlix] encaminada a evaluar la aplicación de las recomendaciones en zonas de protección e incrementar su conocimiento por parte de los agricultores para minimizar el riesgo del uso de productos fitosanitarios para los polinizadores (medida D.1.12)

[l] SICONA (2019) Artenreiches Grünland – Lebensraum und wertvolles Futter zugleich. In: 13. Internationale Grünlandtage, Luxembourg. Available at: http://www.grengland.lu/sites/default/files/files/brochure_iglt_2019_d_f_v2_low.pdf (accessed 13/10/2020)

[li] ANF (ADMINISTRATION DE LA NATURE ET DES FORETS) (2019) Application Biodiversité – Version 4–13 (Février 2019). Unveröffentl. Datenbank der Vertragsnaturschutzflächen nach der „Biodiversitätsverordnung". Administration de la Nature et des Forêts (ANF), Luxembourg.

[lii] Biodiversity measures, Luxembourg Ministry for Environment: https://environnement.public.lu/dam-assets/documents/natur/biodiversite/Broschuer-Biodiv-210x148-version-finale-vect-DOWNLOAD.pdf

[liii] Pflanzenschutz-Warndienst, Ländliches Fortbildungs Institut und Landwirtschaftskammern. https://warndienst.lko.at/

[liv] DG SANTE (2019) Final report of an audit carried out in Austria from 26 February 2019 to 7 March 2019 in order to evaluate the implementation of measures to achieve the sustainable use of pesticides. DG(SANTE) 2019-6721 report, European Commission.

[lv] DG SANTE (2017) Final report of a fact-finding mission carried out in Italy from 03 to 11 May 2017 in order to evaluate the implementation of measures to achieve the sustainable use of pesticides. DG(SANTE) 2017-6006 report. European Commission.