Pesticide Use: A European Perspective

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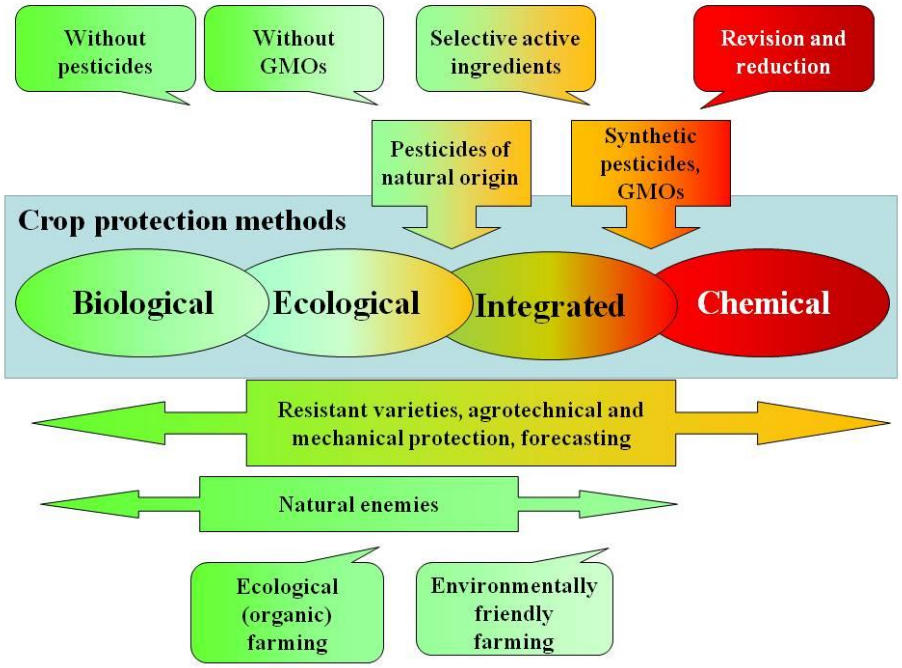
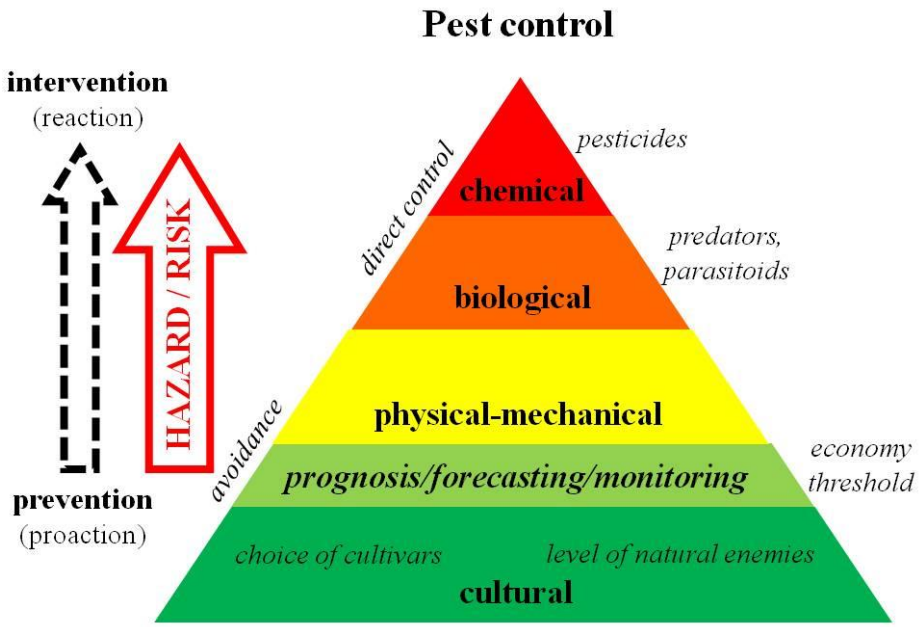
- **Integrated Pest Management** (IPM)
  - principles and practice
  - Why organic farming is known to consumers and IPM is not?

- **Risk assessment and hazard classification**
  - hazard characterization of pesticide a.i.s according to several classification studies
  - toxicity of formulated products differs from that of the active substance
  - current public debates (neonicotinoids, glyphosate)

Integrated Pest Management (IPM)

- principles and practice





- Why organic farming is known to consumers and IPM is not?

Székács and Darvas (2022) Attempts for undoing the ecological incompatibility of agricultural technologies: from ecological pest management to agroecology. Ecocycles, ***8*** *(2): 12-22.*

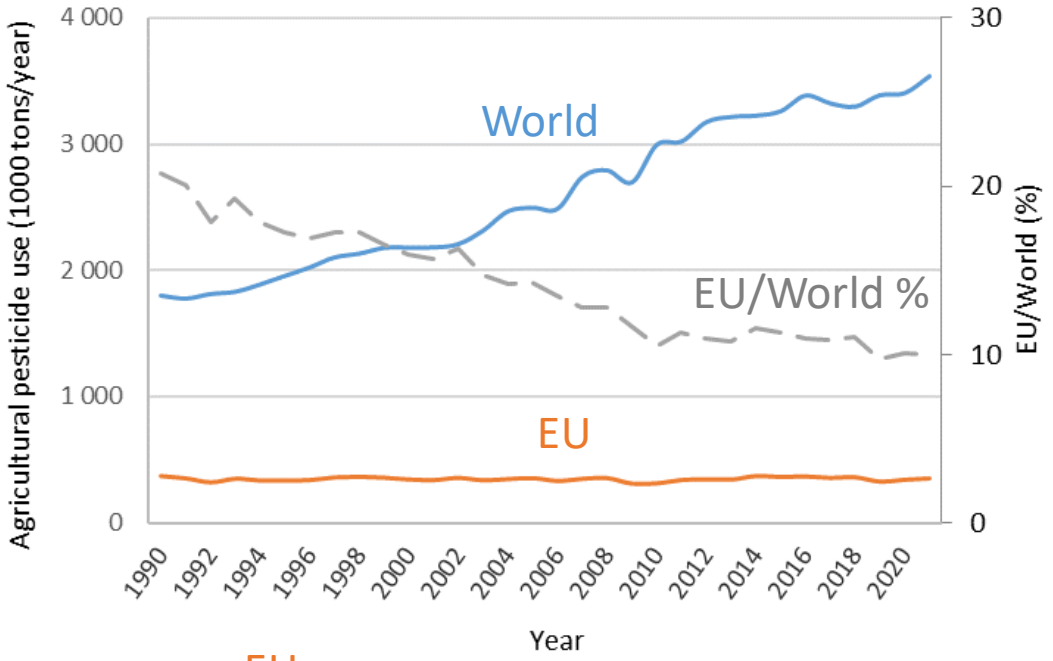
EU: a special case in

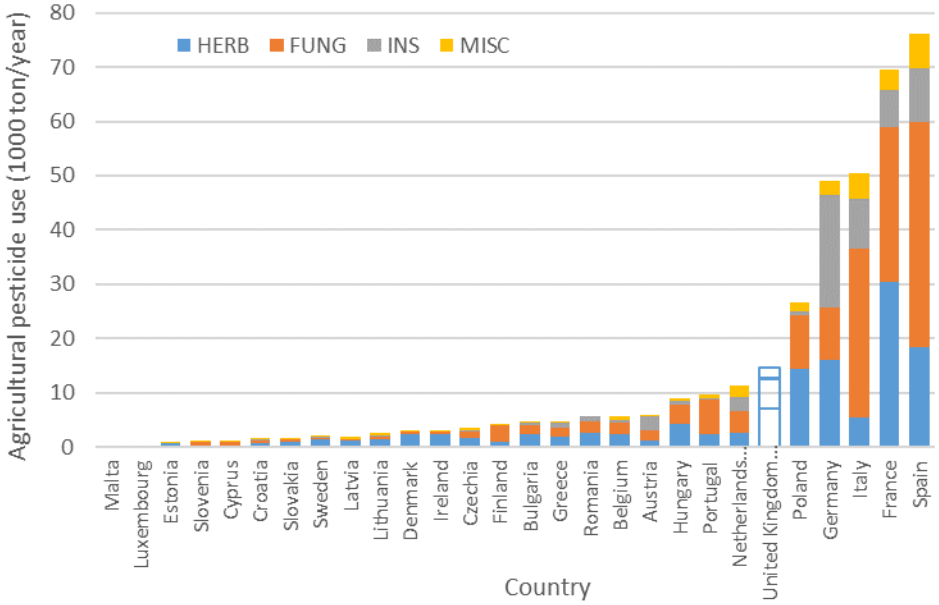
- pesticide use

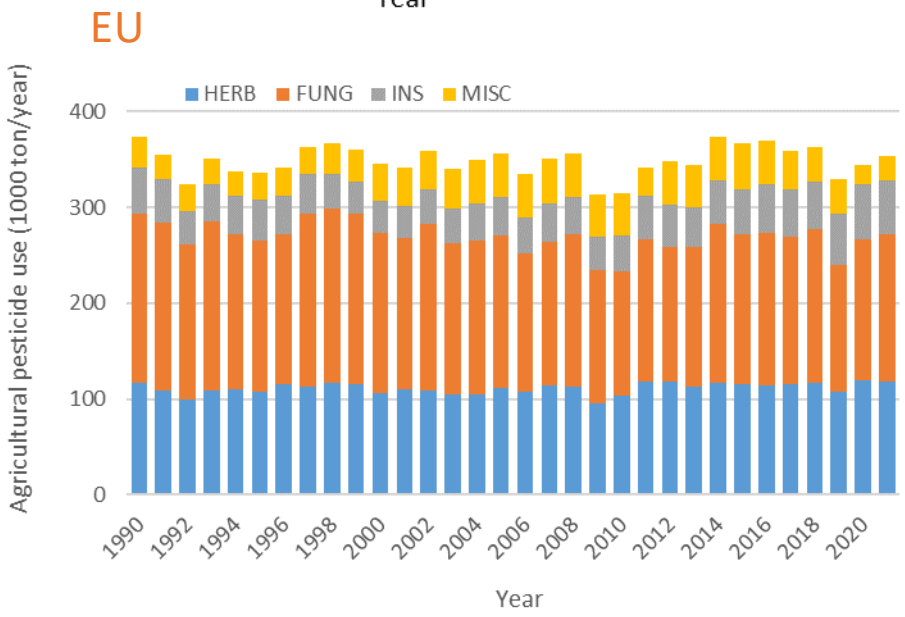
The European Green Deal

- pesticide registration

The Precautionary Principle







Food and Agricultural Organization (FAO). In: FAOSTAT. Pesticides Use 1991-2021

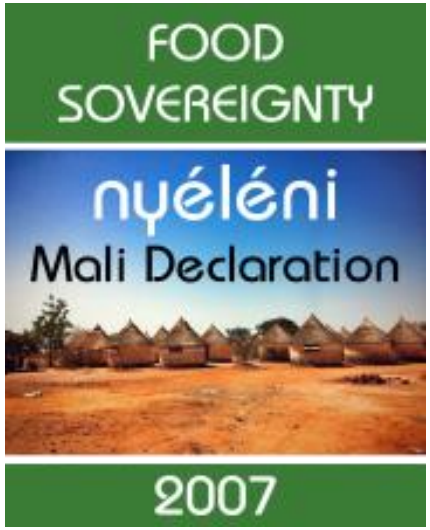
Pesticides and human health

- industrialization of agriculture → chemical burden on natural ecosystems
- pesticides – known ability to cause negative health/environmental effects
  – side-effects can be an important environmental health risk factor
- urgent need for a more sustainable and ecological approach
  innovative ideas e.g., agriculture reforms and food production
  implementing sustainable practice evolving to food sovereignty
- society needs the implementation of a new agricultural concept regarding
  food production, which is safer for man and the environment
  steps such as the Declaration of Nyéléni (2007)

- food sovereignty

- agroecology

- regenerative agriculture



Nicolopoulou-Stamati et al. *(2016) Chemical pesticides and human health: The urgent need for a new concept in agriculture.* Front. Public Helath, ***4**: 148.*

Risk assessment and hazard classification

- hazard characterization of pesticide active substances according to several classification studies
- toxicity of formulated products differs from that of the active substance
- current public debates (glyphosate, neonicotinoids)

Highly regulated:

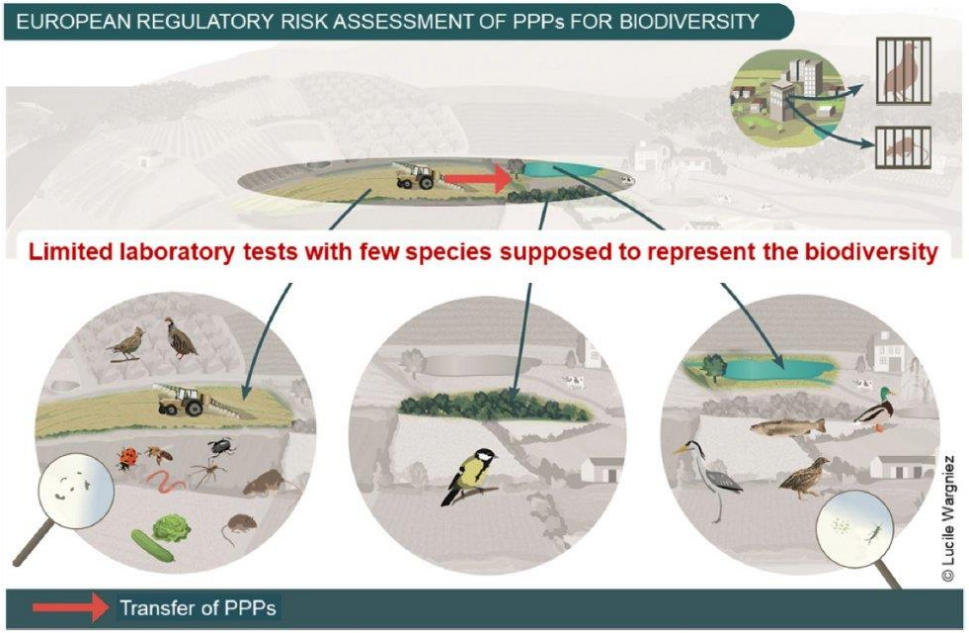
Regulation (EC) 1107/2009 Placing of PPPs on the market
Directive 2009/128/EC Sustainable use of pesticides
Regulation (EC) 1185/2009 Statistics on pesticides
Directive 2009/127/EC Machinery for pesticide application

Regulation (EC) 546/2011 Uniform principles
Regulation (EC) 547/2011 Labelling
Regulation (EC) 283/2013 Data requirements for active substances
Regulations (EU) 284/2013 Data requirements for PPPs
Regulations (EU) 2019/1381 Transparency and sustainability of the EU risk assessment

Limitations:

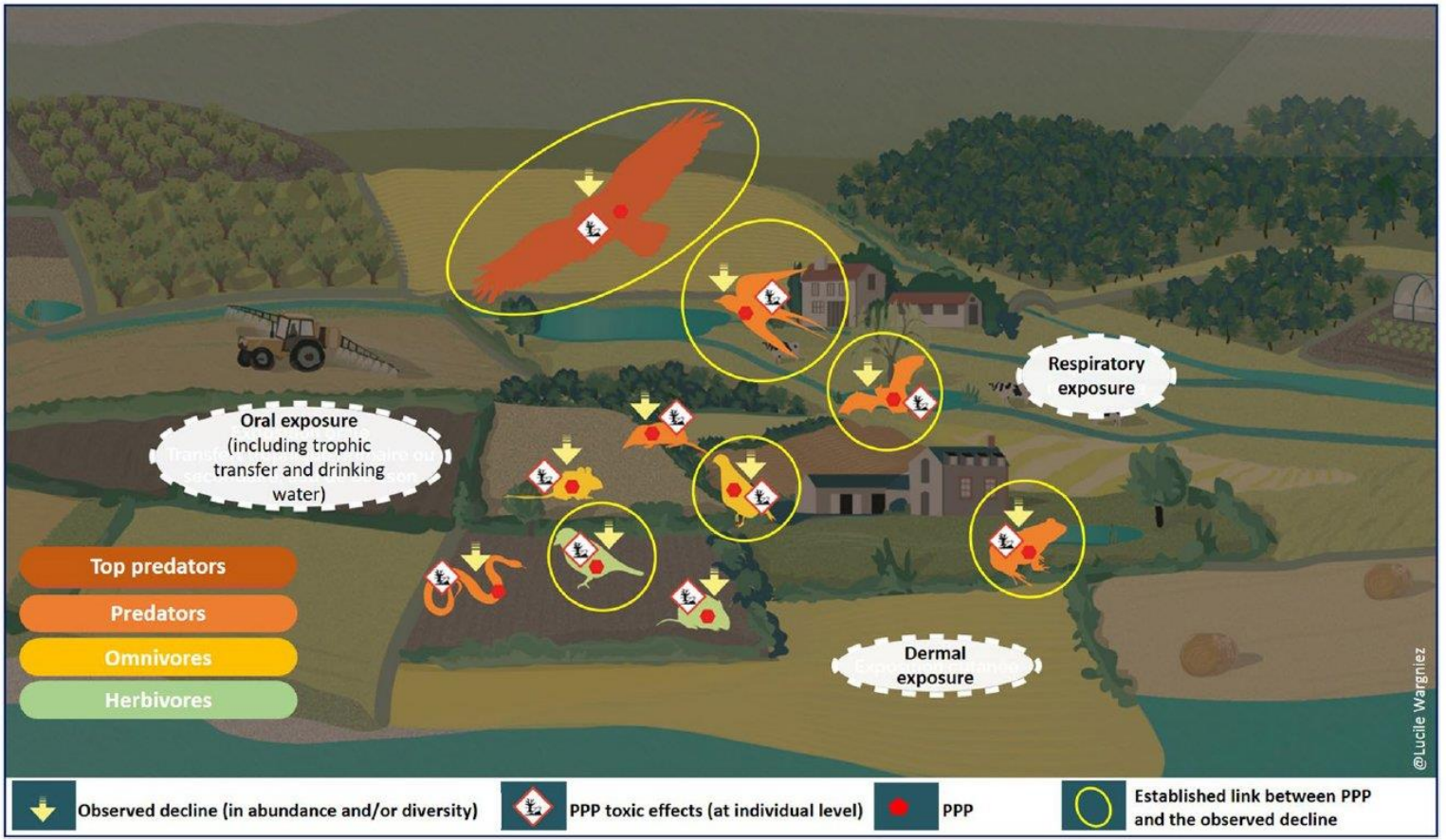
- multiplicity of applicable rules
- routinization of the evaluation procedures,
- lack of consideration of social data
- lack of independence of the evaluation

ERA focused on biodiversity



Doussan et al. *(2024) Regulatory framework for the assessment of the impacts of plant protection products on biodiversity…* Environ. Sci. Pollut. Res., ***31****, 36577–36590.*

Current regulatory assessment processes for PPPs fail to cover all effects



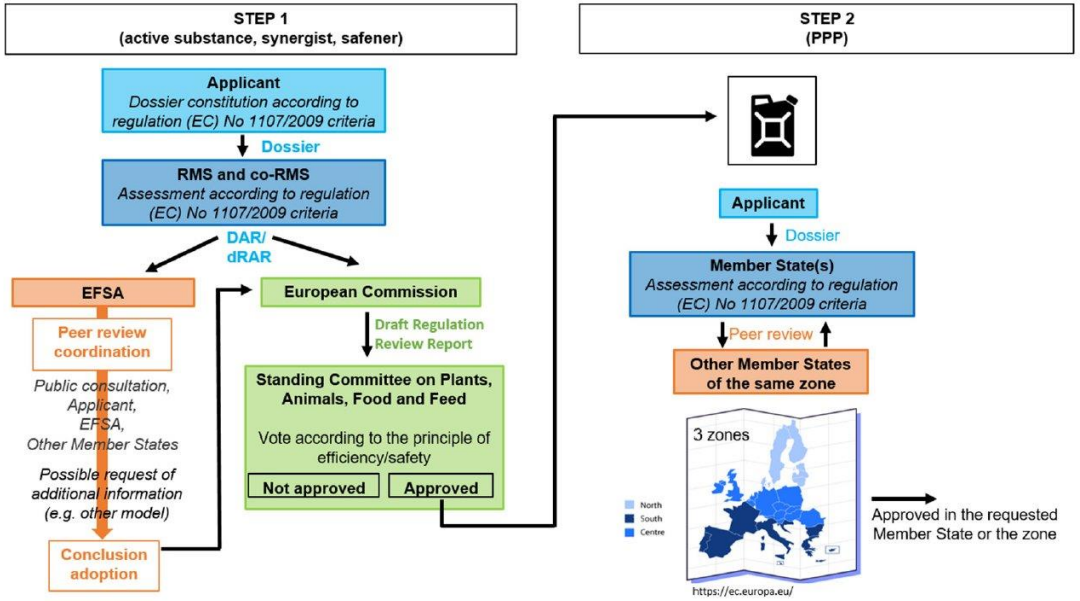
→ needs for both methodological/regulatory improvements

Pesce et al. *(2023) Main conclusions and perspectives from the collective scientific assessment of the effects of plant protection products on biodiversity and ecosystem services...* Environ. Sci. Pollut. Res*., online first*

Ecotoxicological models for PPP ERA 2011-2021

Models: SAR, toxicokinetics, toxicokinetics/toxicodynamics, species sensitivity distribution, population, community, mixed

- strong imbalance in model usage among the biological groups considered in the Regulation (EC) 1107/2009
- more often used for aquatic than for terrestrial organisms
- gap between models used / existing in the scientific literature



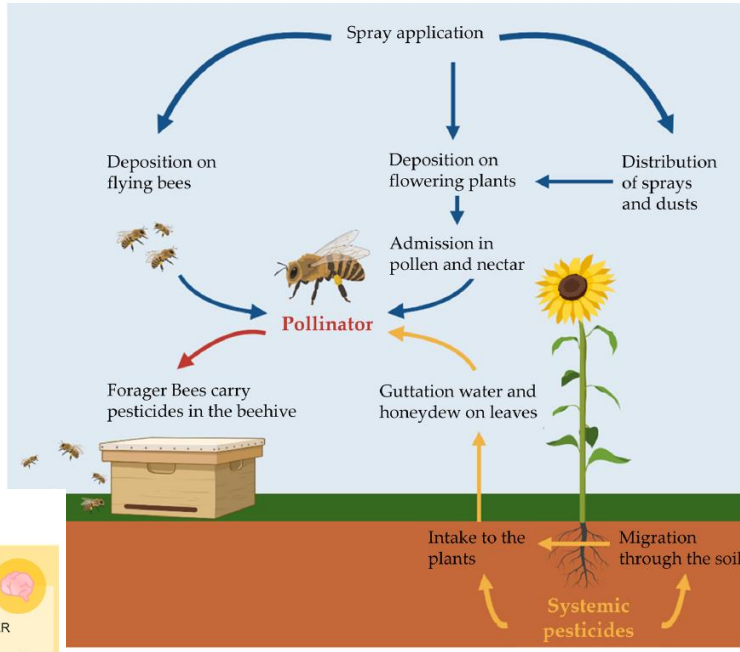
→ more sophisticated models into PPP regulation

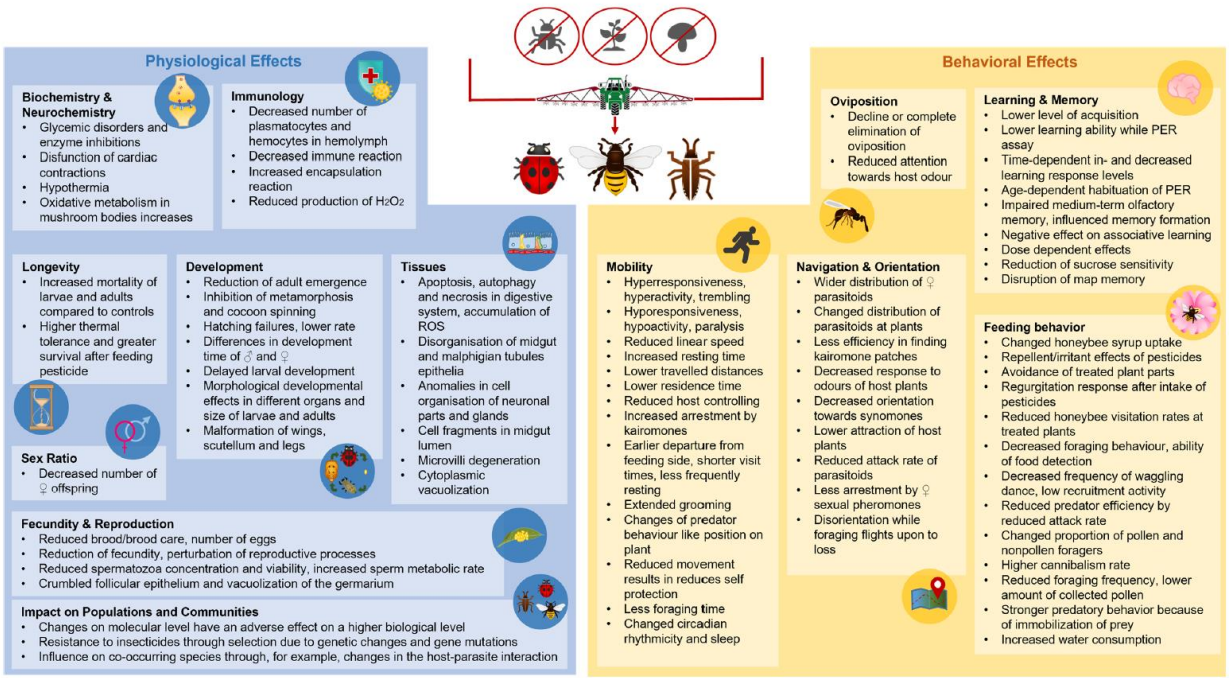
Larras et al. *(2022) A meta-analysis of ecotoxicological models used for plant protection product risk assessment before their placing on the market.* Sci. Total Environ., ***844****: 157003.*

Impact of sublethal doses on insect physiology/behavior

acute/chronic toxicity → sublethal doses

It is important to study the effects of different doses/exposure routes in a broad range of pollinators to assess the importance of sublethal amounts of PPPs in relation to insect decline.





Bartling et al. *(2024) Current insights into sublethal effects of pesticides on insects.* Int. J. Mol Sci., 25 *(11), 6007.*

Selection of minimal risk pesticides

selection criteria for end-users to factor by risk between compounds are rare

classification of 659 pesticides by acute/chronic risks to human health (e.g., respiratory and carcinogenic) and to the environment (e.g., biomagnification/atmospheric ozone depletion, aquatic/terrestrial life, pollinators)

→ a minimum (lower risk) pesticides list that meets IPM needs

	Aquatic algae	Aquatic invertebrate	Fish chronic	Small mammal	Avian acute	Avian reproductive	Worm	Pollinator	Inhalation
5th percentile (g/ha)*	404·39	8·45	134·62	174·01	363·31	33·10	3·02	0·78	0·0042
1	Chloropicrin (A, T, and P)	Gamma-cyhalothrin (A)	Gamma-cyhalothrin (A)	Aldicarb (HHP)	Terbufos (HHP)	Fentin hydroxide (A and T)	Sulfoxaflor	Spinosad (P)	1,3-dichloropropene (A, T, P, and B)
2	Flufenacet (A)	Dimethoate (A, T, P, and B)	Esfenvalerate (A and P)	Bromadiolone (HHP)	Carbofuran (HHP)	Fenpropathrin (A, T, and P)	Tefluthrin (HHP)	Emamectin benzoate (A and P)	Cube extracts (B)
3	Azoxystrobin (A)	Bifenthrin (A)	Tefluthrin (HHP)	Terbufos (HHP)	Phorate (HHP)	Diquat dibromide (T and B)	Methyl isothiocyanate (A and B)	Imidacloprid (HHP)	Methyl isothiocyanate (A and B)
4	Oxyfluorofen (A and T)	Tefluthrin (HHP)	Tolfenpyrad (A)	Parathion (HHP)	Parathion (HHP)	Diquat ion (T)	Terbufos (HHP)	Clothianidin (HHP)	Terbufos (HHP)
5	Fentin hydroxide (A and T)	Methamidophos (HHP)	Lambda-cyhalothrin (A and P)	Oxamyl (HHP)	Aldicarb (HHP)	Dicofol (T and B)	Thiophanate-methyl (T)	Thiamethoxam (HHP)	Methyl bromide (HHP)
6	Pyraflufen-ethyl	Phorate (HHP)	Cyfluthrin (HHP)	Phorate (HHP)	Diazinon (A, T, P, and B)	Tetraconazole (T)	Methidathion (HHP)	Avermectin (A and P)	Chloropicrin (A, T, and B)
7	Prosulfuron (A)	Esfenvalerate (A and P)	Methidathion (HHP)	Disulfoton (HHP)	Bendiocarb (A, T, P, and B)	Parathion (HHP)	Carbendazim (HHP)	Zeta-cypermethrin (A and P)	Parathion (HHP)
8	Copper sulphate (A)	Lambda-cyhalothrin (A and P)	Terbufos (HHP)	Avermectin (A and P)	Oxamyl (HHP)	Avermectin (A and P)	Dazomet (A, T, and P)	Dinotefuran (A and P)	Chlorpyrifos (A, T, P, and B)

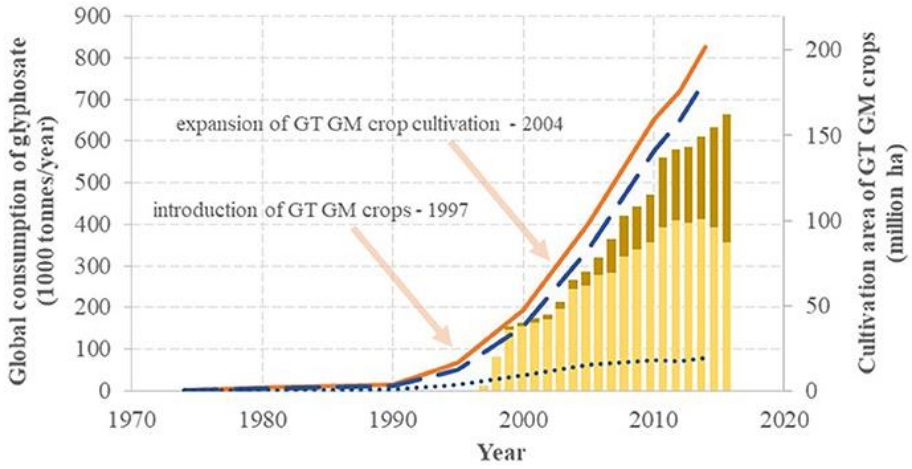
Jepson et al. *(2020) Selection of pesticides to reduce human and environmental health risks: a global guideline and minimum pesticides list.* Lancet Planet Health, ***4****: e56-63.*

Current public debates – glyphosate

Pesticide registration in the EU

a.i. – PPP

harmonization with the registration of veterinary drugs is urged



2017: re-registration – only for 5 years

2019: Assessment Group on Glyphosate

a four-country „rapporteur consortium”: SE, FR, HU, NL

15 Jun 2021: Draft Renewal Assessment Report submitted

ECHA 30 May 2022: Glyphosate: no change proposed to hazard classification

EFSA 25 Aug 2023: Peer Review Report Glyphosate

EC 28 Nov 2023: approval for 10 years

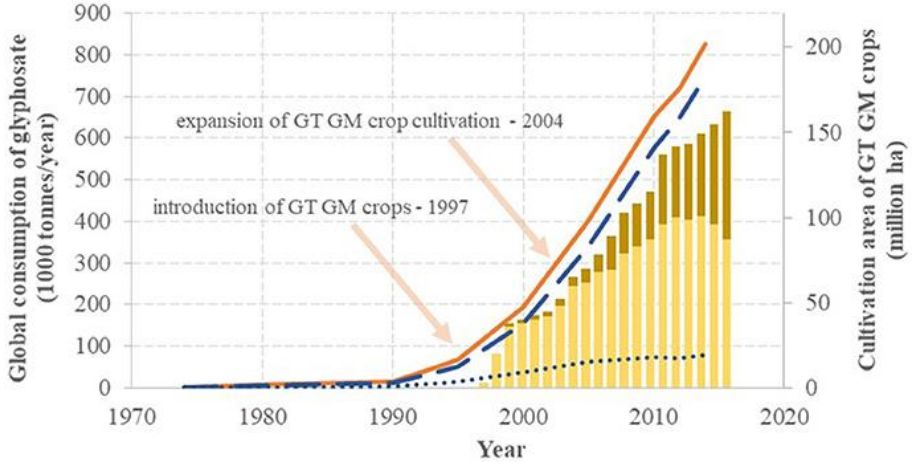
Klátyik et al. *(2017) Authorization and toxicity of veterinary drugs and plant protection products: residues of the active ingredients in food and feed and toxicity problems related to adjuvants.* Front Vet Sci ***4****, 146.*

Székács & Darvas (2018) Re-registration challenges of glyphosate in the EU. Front Environ Sci ***6****, 78.*

Current public debates – glyphosate

Excessive use – near 1 Mt/year

the phosphorous biogeochemical cycle



Market growth over 45% of the pesticide market

Ubiquitous water pollutant

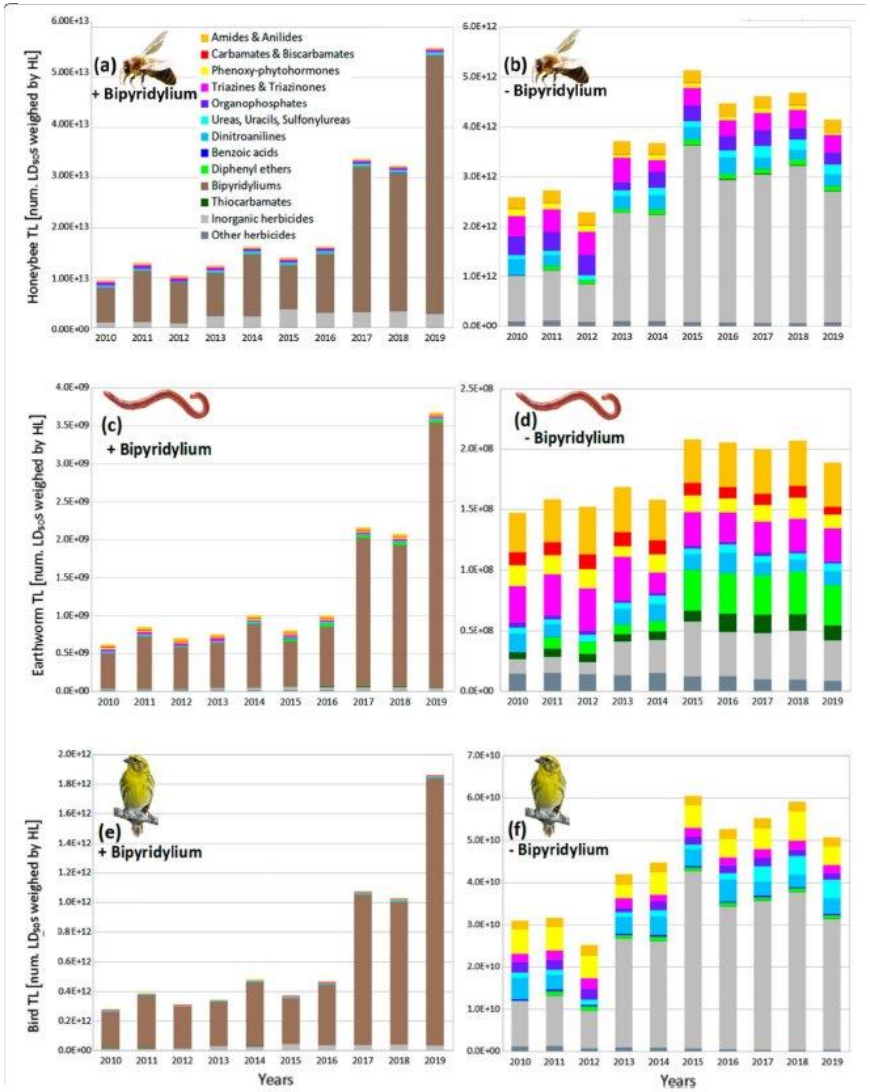
The POEA controversy

Formulating agents can exert ecotoxicity

and can modify the apparent toxicity of the a.i.s

Székács & Darvas (2018) Re-registration challenges of glyphosate in the EU. Front Environ Sci ***6****, 78.*

Toxic effects along with reduced herbicide use (Austria)



Use of 101 herbicide a.i.s in Austria (2010-2019) vs. potential toxic exposures of non-target organisms regarding their ecotoxicological properties (LD_{50}/LC_{50}) weighed by environmental persistence (DT_{50})

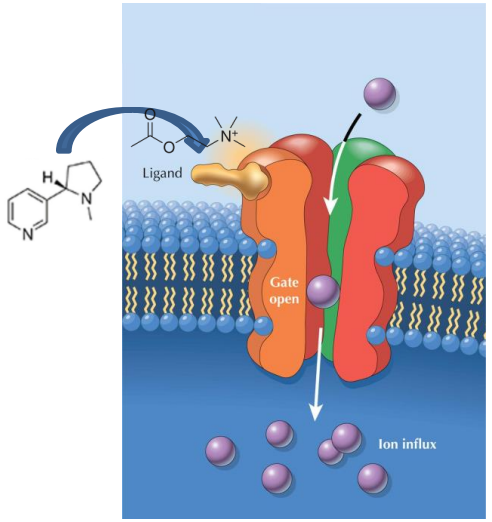
- honeybees (*Apis mellifera*)
- earthworms (*Eisenia fetida*)
- birds (*Serinus serinus*)

While human health risks decreased,
toxic loads to honeybees increased by 487% (oral exposure),
to earthworms by 498%,
to birds by 580%,

Possibly attributed to the use of more acutely toxic and especially more persistent a.i.s

Cech et al. *(2022) Reducing overall herbicide use may reduce risks to humans but increase toxic loads to honeybees, earthworms and birds.* Environ. Sci. Eur., ***34****: 44.*

Current public debates – neonicotinoids



Neonicotinoids: novel nicotine-like substances
acting on the nicotinic acetylcholine receptor (nAChR)

Market growth 25-33% of the insecticide market

Soil and water pollutant

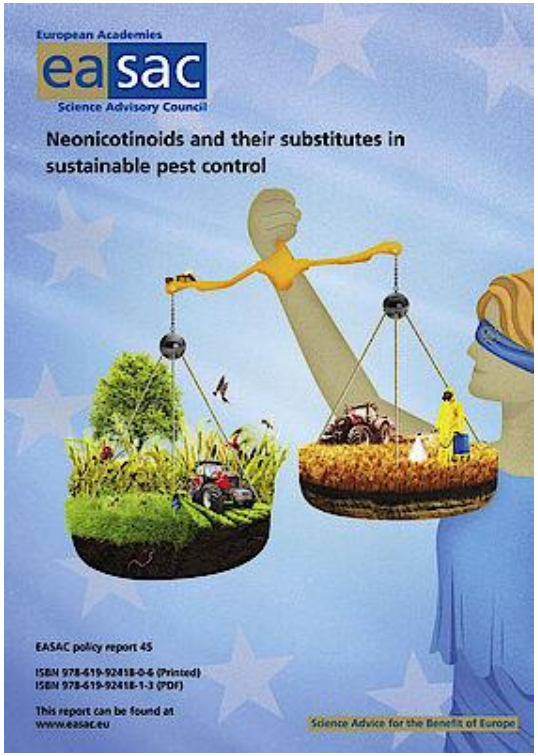
Toxicity to bees (LD_{50}): 3.7-38830 ng/bee

Prophylactic use
- seed coating
- dosages (granule > seed coating > spray)
- low absorbance rate (0.5-2%) into crop

Non-compliance with IPM
- timing of treatment / damage threshold

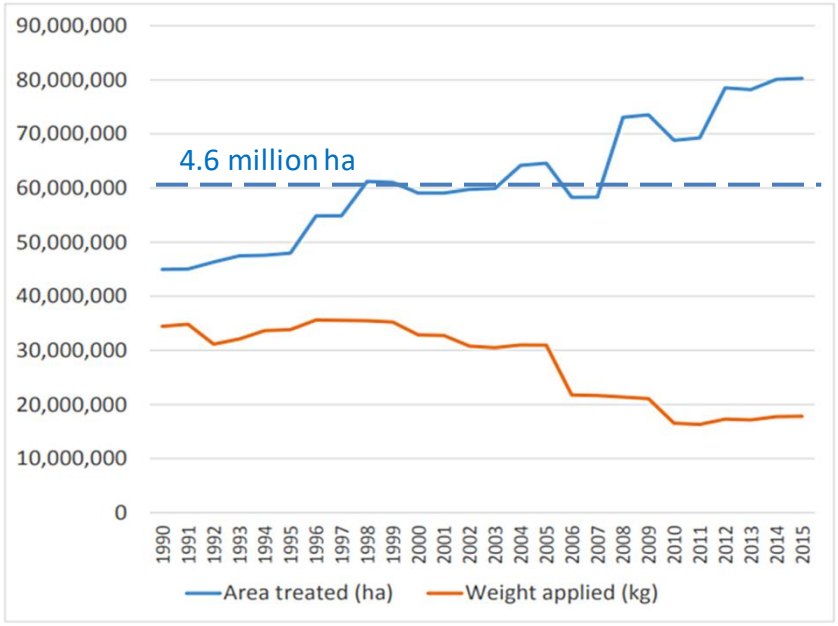
Other a.i.s with the same MoA

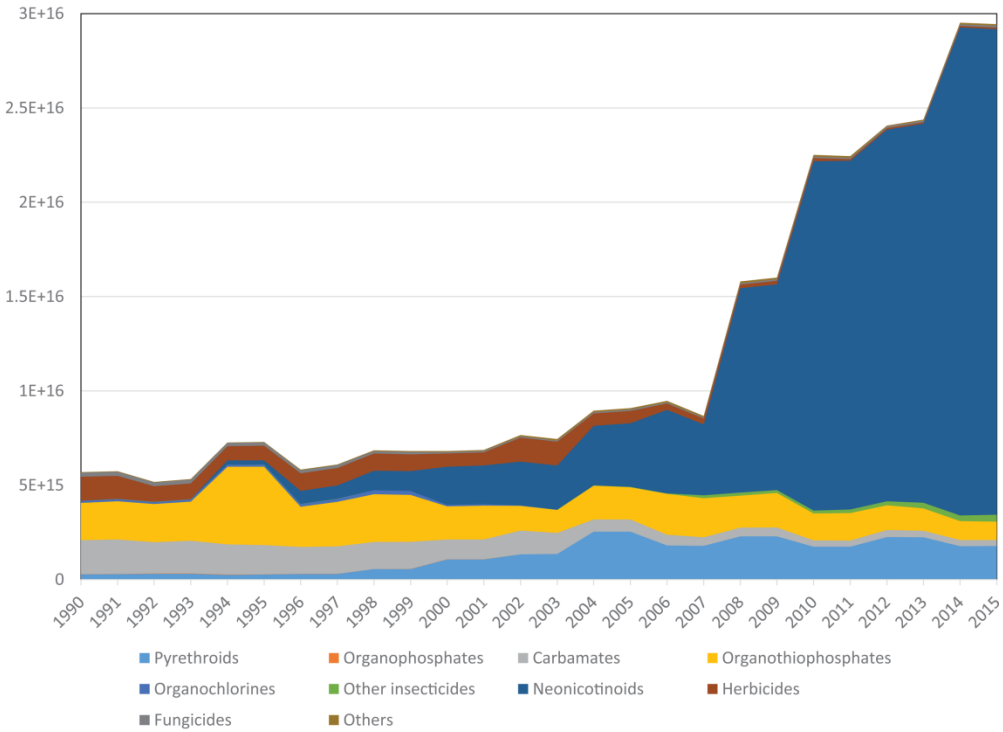
sulfoximines (sulfoxaflor), butenolids (flupyradifurone) offer no fundamental solution



Mörtl et al. (2020) Neonicotinoids: spreading, translocation and aquatic toxicity. International . J. Environ. Res. Publ. Health ***17*** *(6), 2006.*

Dosages and effects



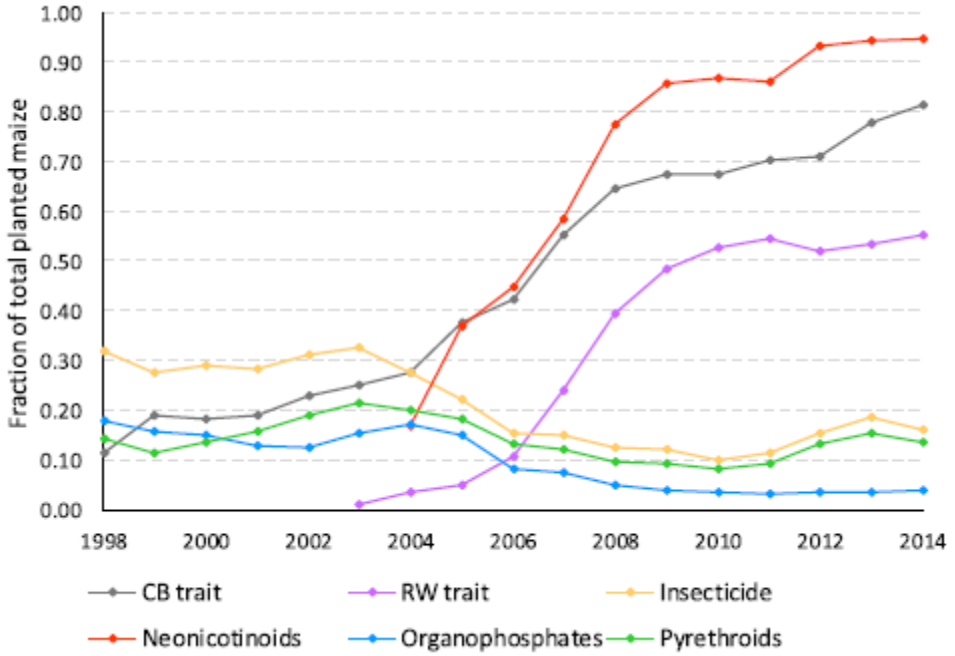


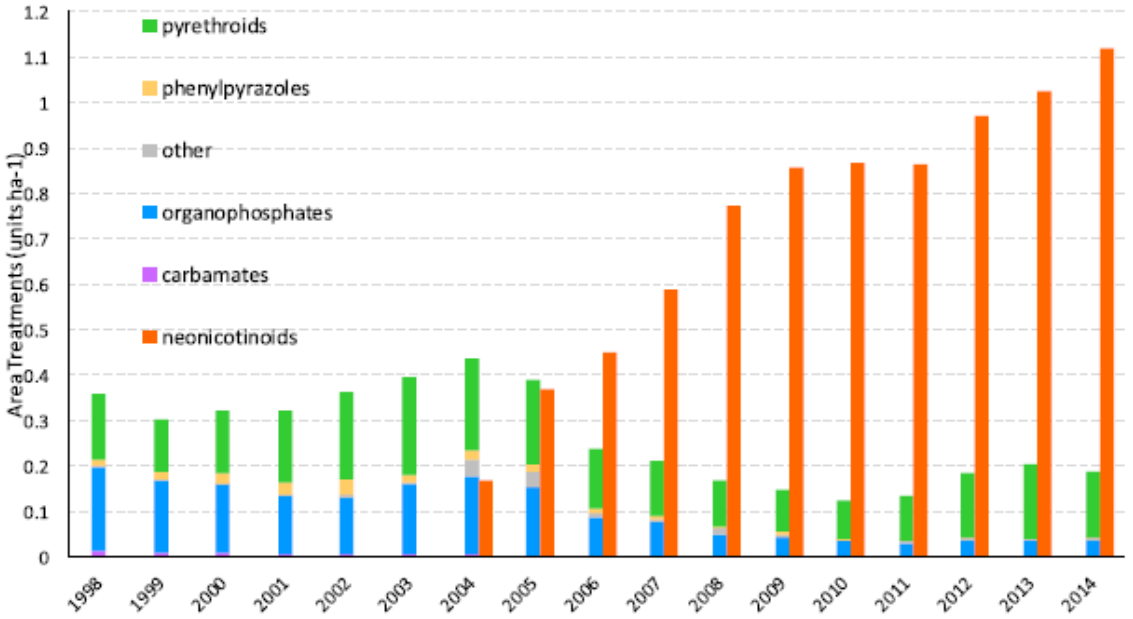
areas treated (ha) vs. **dsages applied** (kg)
1990 -2015 Great Britain
The overall cultivation area is roughly constant ~4.6 million ha
1990 avg. **7.5** kg/ha a.s., **9.8** treatments
2015 avg. **3.9** kg/ha a.s., **17.4** treatments

toxicity to bees
The number of potential LD_{50} dosages considering pesticides applied in Great Britain

Goulson et al. *(2018) Rapid rise in toxic load for bees revealed by analysis of pesticide use in Great Britain.* PeerJ., ***6****: e5355.*

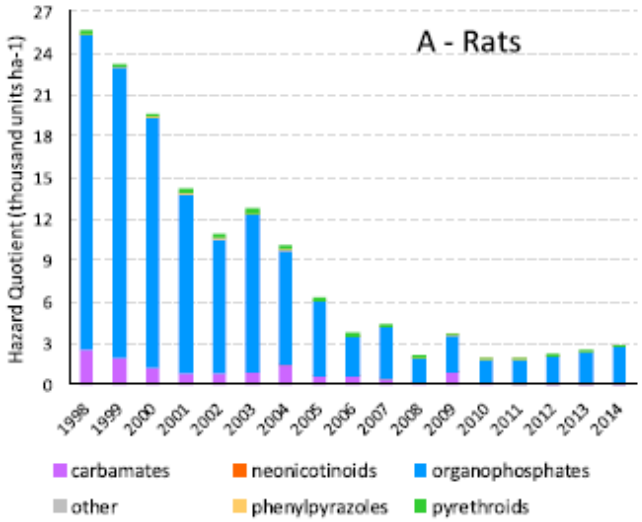
Replacement of neonicotinoids (USA)

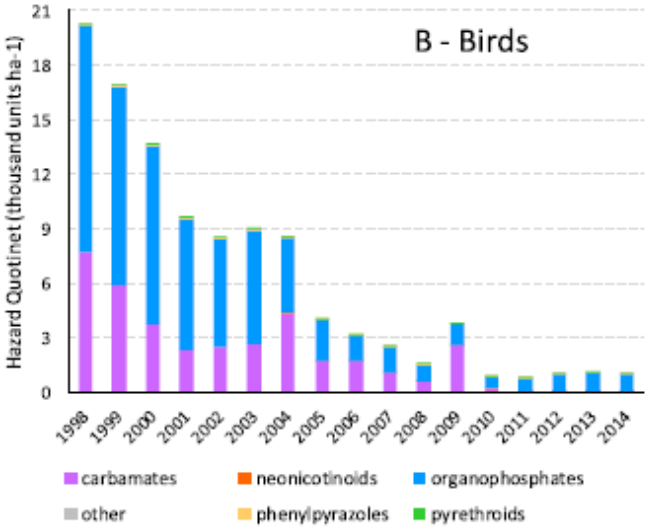


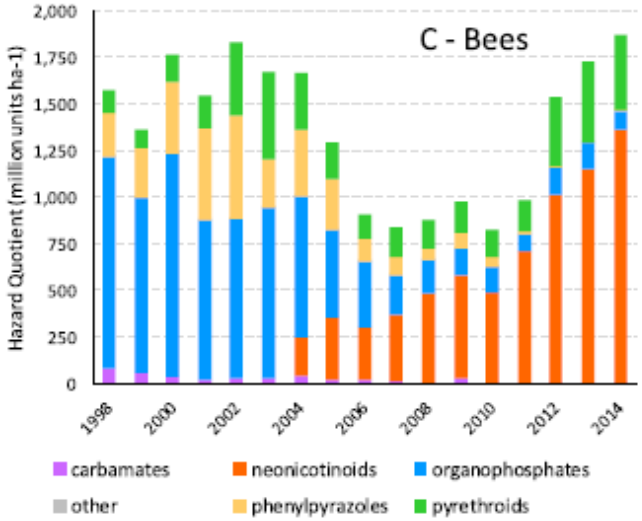


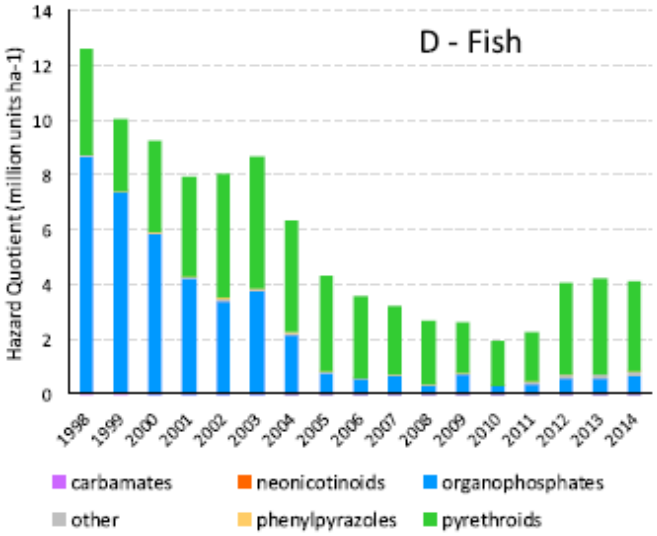
Perry and Moschini (2020) Neonicotinoids in U.S. maize: Insecticide substitution effects and environmental risk. J. Environ. Econ. Manag., ***102**: 102320.*

Toxic effects (USA)









Potential exposure to insecticides in maize cultivation
1998-2014 (USA)

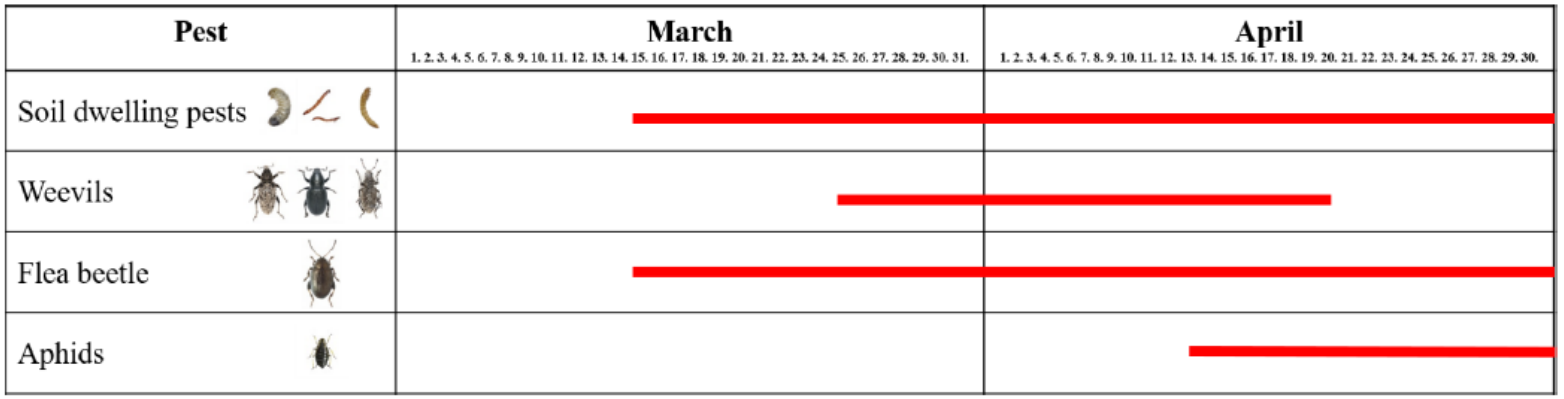
unit = LD_{50} mg/kg/ha (A,B), mg/L/ha (C), mg/bee/ha (D)

Perry and Moschini (2020) Neonicotinoids in U.S. maize: Insecticide substitution effects and environmental risk. J. Environ. Econ. Manag., ***102**: 102320.*

Toxic effects along with reduced neonicotinoid use (Hungary)

ban of neonicotinoids (in sugar beet) →
- less effective applications
- additional plant protection steps in the technology

chlorpyrifos – EU ban in 2023



- current crop treatment methods pose a higher overall environmental impact
- fupyradifurone have the same MoA as neonicotinoids
- use of cyantraniliprole may be a good alternative

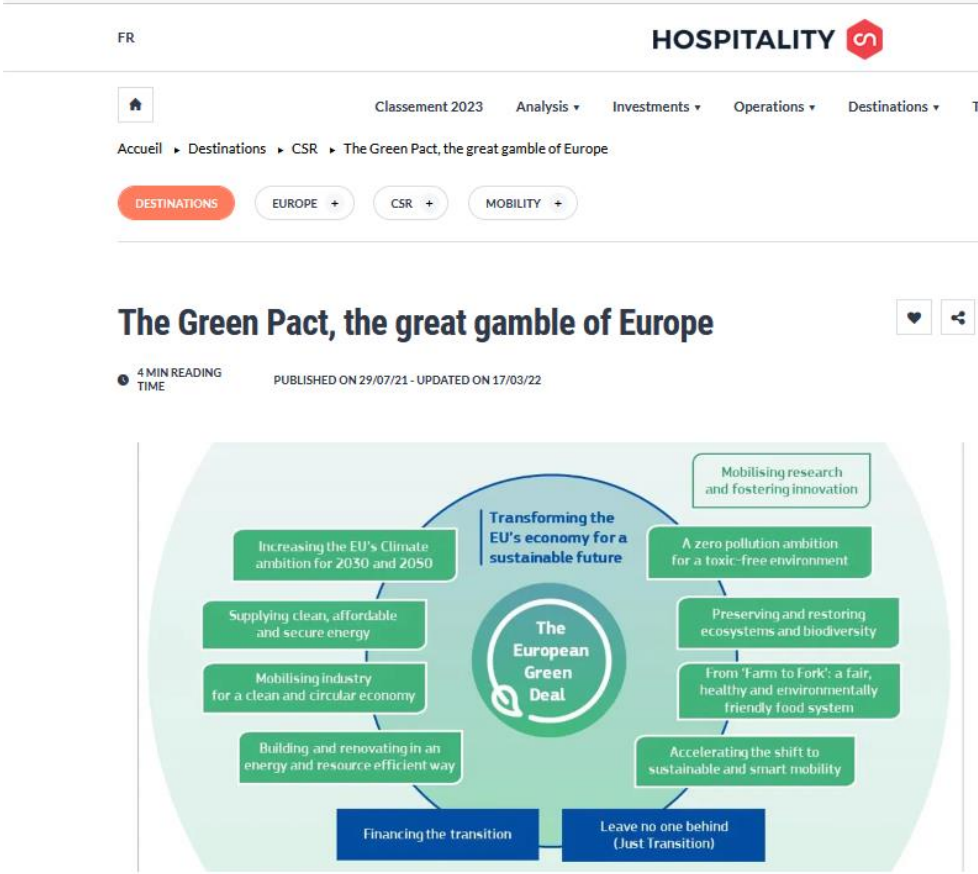
- application of systemic substances in sugar beet production has less direct environmental impact compared to other flowering crops and pose less risk of resistance and cross-resistance

Jócsák et al. *(2024) Plant protection consequences in Hungary of the withdrawal of systemic active substances from sugar beet seed treatment.* Front. Agronomy, ***6****: 1363950.*

Pesticide-related issues:

- pesticides jeopardizing the environment/ecosystem as the basis of production
- unique approach in the EU
- the Precautionary Principle

- the EU Green Deal needs to remain a key approach



- the principle and practice of IPM (why organic farming is common and IPM is not; IPM principles and practice)
- should the risk assessment vary depending on the intensity of use (glyphosate)
- controversies on neonicotinoids
- hazard classification of pesticide active substances according to several classifications
- toxicity of formulated products differs from that of the active substance

it is also important to, if possible (of course we leave this up to you) refer to the risks for both farmers and bystanders/people living in/near agricultural areas, related to the exposure of pesticides. As these risk are