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The worldwide integrated assessment on systemic pesticides: the emblematic case of neonicotinoïds

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► To cite this version:

Jean-Marc Bonmatin. The worldwide integrated assessment on systemic pesticides: the emblematic case of neonicotinoïds. BeeCaution / TFSP post-neonic symposium, Jun 2022, Bergen, Norway. <hal-03870695>

HAL Id: hal-03870695

<https://hal.science/hal-03870695v1>

Submitted on 9 Dec 2022

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**The worldwide integrated assessment on systemic pesticides:
The emblematic case of neonicotinoids**

Dr. Bonmatin Jean-Marc, Bergen, Norway, 7 June 2022

Task Force on Systemic Pesticides
WWW.TFSP.INFO

imidacloprid

Logos: European Union, French Government, CNRS (centre national de la recherche scientifique), CBM.

Neonicotinoids: Imidacloprid (Gaucho, Confidor, Premise, Advantage ...)

Dr. JM Bonmatin (CNRS) France

Spray & systemic (~ 500 g/ha)

Seed-dressing & systemic (~ 100 g/ha)

Dr. JM Bonmatin (CNRS) France

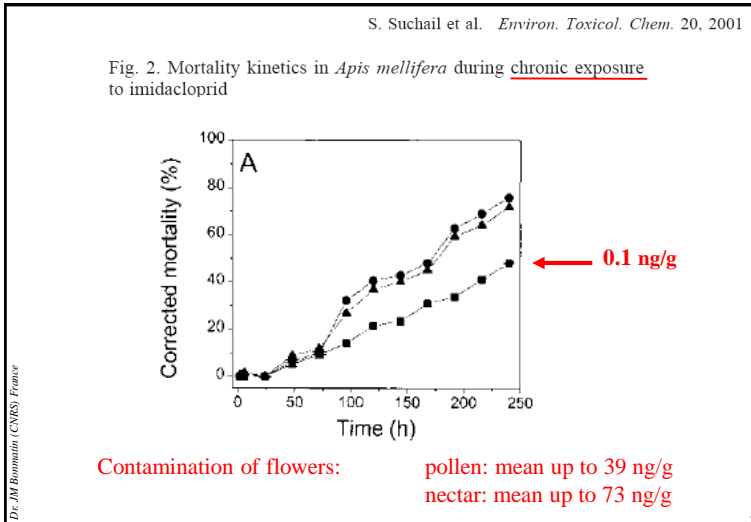
Worldwide Integrated Assessment of the Impact of Systemic Pesticides on Biodiversity and Ecosystems

Effects of neonicotinoids and fipronil on non-target invertebrates

Acute toxicity for honeybees

pesticide	®	Use	Dose g/ha	LD50 ng/ab	Tox/DDT
DDT	Dinocide	insecticide	200-600	27 000.0	1
thiaclopride	Proteus	insecticide	62,5	12 600.0	2.1
amitraze	Apivar	acaricide	-	12 000.0	2.3
acetamiprid	Supreme	insecticide	30-150	7 100.0	3.8
coumaphos	Perizin	acaricide	-	3 000.0	9
methiocarb	Mesulol	insecticide	150-2200	230.0	117
tau-fluvalinate	Apistan	acaricide	-	200.0	135
carbofuran	Curater	insecticide	600	160.0	169
λ-cyhalothrine	Karate	insecticide	150	38.0	711
thiaméthoxam	Cruiser	insecticide	69	5.0	5 400
fipronil	Regent	insecticide	50	4.2	6 475
imidaclopride	Gaucho	insecticide	75	3.7	7 297
clothianidine	Poncho	insecticide	50	2.5	10 800
deltamethrine	Décis	insecticide	7,5	2.5	10 800

Dr. JM Bonmatin (CNRS) France



Worldwide integrated assessment on systemic pesticides

Global collapse of the entomofauna: exploring the role of systemic insecticides

2014-2015: 8 scientific papers (154 pages)

- 5 years study
- First meta-analysis on neonicotinoids and fipronil
- 34 co-authors (no compelling interest)
- Comprehensive analysis (1100 publications & reports)
- Published in *Environmental Science and Pollution Research*

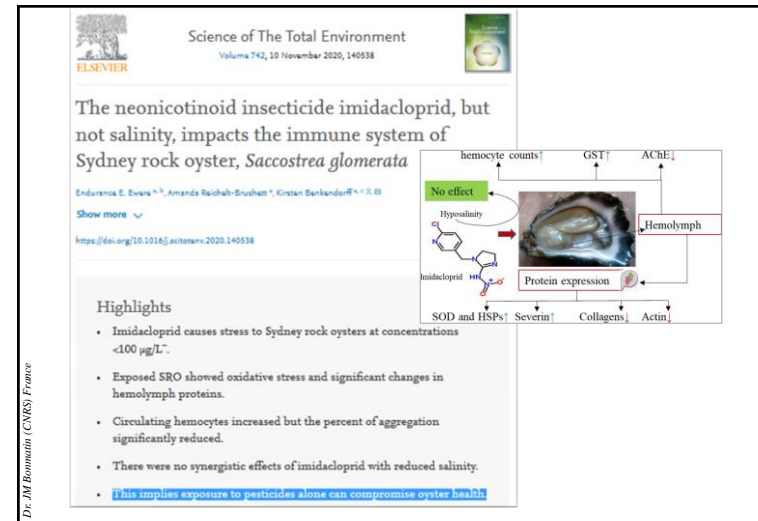
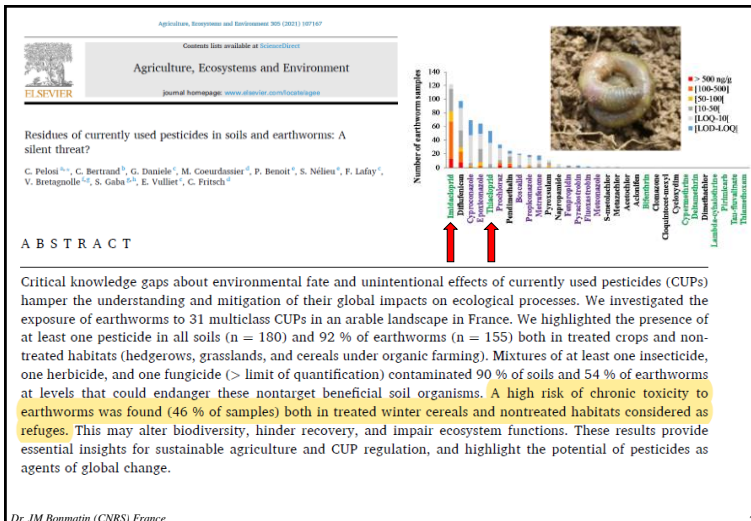
DOI: 10.1007/s11356-014-3220-1 DOI: 10.1007/s11356-014-3470-y
 DOI: 10.1007/s11356-014-3180-5 DOI: 10.1007/s11356-014-3277-x
 DOI: 10.1007/s11356-014-3332-7 DOI: 10.1007/s11356-014-3471-x
 DOI: 10.1007/s11356-014-3628-7 DOI: 10.1007/s11356-014-3229-5


2017-2021: 5 new scientific papers (147 pages)

- Update of the meta-analysis (neonicotinoids and fipronil)
 - About 30 authors (no compelling interest)
 - Inclusion of 800 new publications
- Update of WIA DOI: 10.1007/s11356-021-12853-6
 - Exposure & metabolism DOI: 10.1007/s11356-017-0394-3
 - Impacts on ecosystems DOI: 10.1007/s11356-017-0341-3
 - Resistances & Alternatives DOI: 10.1007/s11356-017-1052-5
 - Other alternatives DOI: 10.1007/s11356-020-09279-x



Dr. JM Bommatin (CNRS) France





Neonicotinoids disrupt aquatic food webs and decrease fishery yields

Masumi Yamamuro^{1,2,*}, Takashi Komuro², Hiroshi Kamiya³, Toshikuni Kato³, Hitomi Hasegawa⁴, Yutaka K...
 * See all authors and affiliations

Science 01 Nov 2019;
 Vol. 366, Issue 6465, pp. 620-623
 DOI: 10.1126/science.aax3442

Abstract

Invertebrate declines are widespread in terrestrial ecosystems, and pesticide use is often cited as a causal factor. Here, we report that aquatic systems are threatened by the high toxicity and persistence of neonicotinoid insecticides. These effects cascade to higher trophic levels by altering food web structure and dynamics, affecting higher-level consumers. Using data on zooplankton, water quality, and annual fishery yields of eel and smelt, we show that neonicotinoid application to watersheds since 1993 coincided with an 83% decrease in average zooplankton biomass in spring, causing the smelt harvest to collapse from 240 to 22 tons in Lake Shinji, Shimane Prefecture, Japan. This disruption likely also occurs elsewhere, as neonicotinoids are currently the most widely used class of insecticides globally.

Dr. JM Bonmatin (CNRS) France

Published: 09 July 2014

Declines in insectivorous birds are associated with high neonicotinoid concentrations

Caspar A. Hallmann¹, Ruud P. B. Foppen, Chris A. M. van Turnhout, Hans de Kroon & Eelke Jongejans

Nature 511, 341–343(2014) | Cite this article



Recent studies have shown that neonicotinoid insecticides have adverse effects on non-target invertebrate species^{1–6}. Invertebrates constitute a substantial part of the diet of many bird species during the breeding season and are indispensable for raising offspring⁷. We investigated the hypothesis that the most widely used neonicotinoid insecticide, imidacloprid, has a negative impact on insectivorous bird populations. Here we show that, in the Netherlands, local population trends were significantly more negative in areas with higher surface-water concentrations of imidacloprid. At imidacloprid concentrations of more than 20 nanograms per litre, bird populations tended to decline by 3.5 per cent on average annually. Additional analyses revealed that this spatial pattern of decline appeared only after the introduction of imidacloprid to the Netherlands, in the mid-1990s. We further show that the recent negative relationship remains after correcting for spatial differences in land-use changes that are known to affect bird populations in farmland. Our results suggest that the impact of neonicotinoids on the natural environment is even more substantial than has recently been reported and is reminiscent of the effects of persistent insecticides in the past. Future legislation should take into account the potential cascading effects of neonicotinoids on ecosystems.

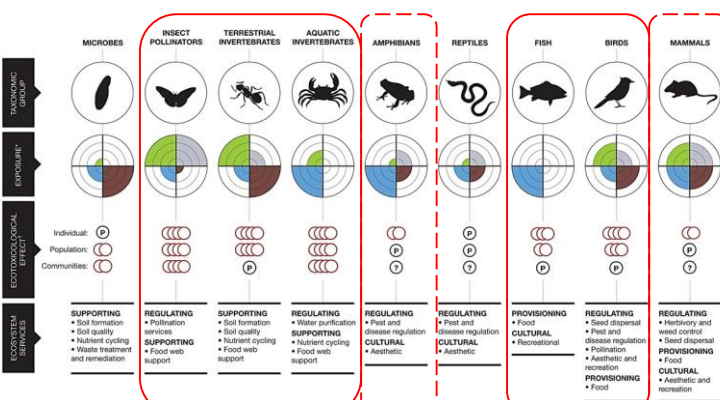
Dr. JM Bonmatin (CNRS) France

Environ Sci Pollut Res
 DOI 10.1007/s11356-017-0341-3

Worldwide Integrated Assessment of the Impact of Systemic Pesticides on Biodiversity and Ecosystems

An update of the Worldwide Integrated Assessment (WIA) on systemic insecticides. Part 2: Impacts on organisms and ecosystems

Lenhard Piao¹, Dave Goulson², Eu-Cheng Yang³, David Gibbons⁴, Francesc Sánchez-Bayo⁵, Edward Mitchell⁶, Alexandre Aebi⁶, Jeron van der Shijf^{6,7}, Chris J. K. MacQuarrie⁸, Chiara Girola⁹, Elizabeth Yin Long¹⁰, Melanie McField¹¹, Maarten Bijleveld van Lemond¹², Jean-Marc Bonmatin¹³



Dr. JM Bonmatin (CNRS) France

Contents lists available at ScienceDirect

Science of the Total Environment

journal homepage: www.elsevier.com/locate/scitotenv

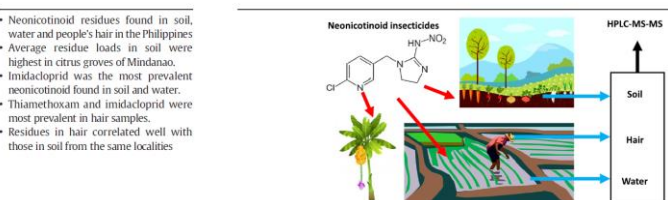
Residues of neonicotinoids in soil, water and people's hair: A case study from three agricultural regions of the Philippines

Jean-Marc Bonmatin^a, Edward A.D. Mitchell^{bc}, Gaëtan Glauser^d, Elizabeth Lumawig-Heitzman^e, Florencia Claveria^f, Maarten Bijleveld van Lemond^g, Kumiko Taira^h, Francisco Sánchez-Bayo^{ia}

HIGHLIGHTS

- Neonicotinoid residues found in soil, water and people's hair in the Philippines
- Average residue loads in soil were highest in citrus groves of Mindanao.
- Imidacloprid was the most prevalent neonicotinoid found in soil and water.
- Thiamethoxam and imidacloprid were most prevalent in hair samples.
- Residues in hair correlated well with those in soil from the same localities


GRAPHICAL ABSTRACT



Dr. JM Bonmatin (CNRS) France

<https://doi.org/10.1016/j.scitotenv.2020.143822>

Contents lists available at ScienceDirect
Environment International
 journal homepage: www.elsevier.com/locate/envint



Review article
Resolving the twin human and environmental health hazards of a plant-based diet

Kris A.G. Wyckhuys^{a,b,c,d}, Alexandre Aebi^b, Maarten F.L.J. Bijlveld van Loxmond^d, Carlos R. Bojaca^a, Jean-Marc Bonmatin^b, Lorenzo Furlan^c, Jairo A. Guerrero^e, Trinh V. Mai^f, Hoi V. Pham^g, Francisco Sanchez-Bayo^h, Yoshinori Ikenakaⁱ

ABSTRACT

Food can be health-giving. A global transition towards plant-based diets may equally help curb carbon emissions, slow land-system change and conserve finite resources. Yet, projected benefits of such 'planetary health' diets imperfectly capture the environmental or societal health outcomes tied to food production. Here, we examine pesticide-related hazards of fruit and vegetable consumption, and list proven management alternatives per commodity, geography and chemical compound. Across countries, pesticide use in these alleged healthful foods is extensive with up to 97% food items containing residues and up to 42% posing dietary risks to consumers. Multiple residues are present in 70–92% of US- and China-grown stone fruit while 58% US cauliflower is tainted with neonicotinoid insecticides. Science-based alternatives and decision-support frameworks can help food producers reduce risks and potential harm by deliberately abstaining from pesticide use. As such, opportunities abound to advance 'win-win' diets that simultaneously nurture human health and conserve global biodiversity.


Dr. JM Bonmatin (CNRS) France

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7-6-2016

Effects of Neonicotinoid Pesticide Exposure on Human Health: A Systematic Review.




Andru M Cimino
 Abec L. Boyles
 Kristina A Thayer
 Melissa J Perry
 George Washington University

Results: Eight studies investigating the human health effects of exposure to neonics were identified. Four examined acute exposure: three neonc poisoning studies reported two fatalities ($n=1280$ cases) and an occupational exposure study of 19 forestry workers reported no adverse effects. Four general population studies reported associations between chronic neonc exposure and adverse developmental or neurological outcomes, including tetralogy of Fallot (AOR 2.4, 95% CI: 1.1-5.4), anencephaly (AOR 2.9, 95% CI: 1.0-8.2), autism spectrum disorder (AOR 1.3, 95% CrI: 0.78-2.2), and a symptom cluster including memory loss and finger tremor (OR 14, 95% CI: 3.5-57). Reported odds ratios were based on exposed compared to unexposed groups.

Dr. JM Bonmatin (CNRS) France

SCIENTIFIC REPORTS

OPEN **Effects of Neonicotinoid Insecticides on Physiology and Reproductive Characteristics of Captive Female and Fawn White-tailed Deer**



Received: 19 September 2019
 Accepted: 22 February 2020
 Published online: 14 March 2020

Elise Hughes Berhain¹, Jonathan A. Jenko¹, Jonathan G. Lundgren¹, Eric S. Michal¹, Daniel Grover¹ & William F. Jensen¹

Over the past decade, abnormalities have been documented in white-tailed deer (*Odocoileus virginianus*) in west-central Montana. Hypotheses proposed to explain these anomalies included contact with endocrine disrupting pesticides, such as imidacloprid. We evaluated the effects of imidacloprid experimentally at the South Dakota State University Wildlife and Fisheries Captive Facility where adult white-tailed deer females and their fawns were administered aqueous imidacloprid (an untreated control, 1,500 ng/L, 3,000 ng/L, and 15,000 ng/L). Water consumption, thyroid hormone function, behavioral responses, and skull and jawbone measurements were compared among treatments. Additionally, liver, spleen, genital, and brain imidacloprid concentrations were determined by an enzyme-linked immunosorbent assay (ELISA). Results indicated that 1) control deer consumed more water than treatment groups, 2) imidacloprid was present in the organs of our control group, indicating environmental contamination, 3) as imidacloprid increased in the spleen, fawn survival, thyroxine levels, jawbone lengths, body weight, and organ weights decreased, 4) adult female imidacloprid levels in the genitals were negatively correlated with genital organ weight and, 5) behavioral observations indicated that imidacloprid levels in spleens were negatively correlated with activity levels in adult females and fawns. Results demonstrate that imidacloprid has direct effects on white-tailed deer when administered at field-relevant doses.

Dr. JM Bonmatin (CNRS) France

PLOS ONE 2019 | <https://doi.org/10.1371/journal.pone.0219208>

LC-ESI/MS/MS analysis of neonicotinoids in urine of very low birth weight infants at birth

Go Ichikawa^{1*}, Ryota Kuribayashi¹, Yoshinori Ikenaka^{2,3*}, Takahiro Ichise^{2*}, Shouta M. M. Nakayama^{2*}, Mayumi Ishizuka^{2*}, Kumiko Taira^{4*}, Kazutoshi Fujioka^{5*}, Toshihiro Sairenchi^{6*}, Gen Kobashi^{7*}, Jean-Marc Bonmatin^{7*}, Shigemi Yoshihara^{1*}

Results

DMAP, a metabolite of acetamiprid, was detected in 14 urine samples collected at birth (24.6%, median level 0.048 ppb) and in 7 samples collected on postnatal day 14 (11.9%, median level 0.09 ppb). The urinary DMAP detection rate and level were higher in SGA than in AGA infants (both $p < 0.05$). There were no correlations between the DMAP level and infant physique indexes (length, height, and head circumference SD scores).

Conclusion

These results provide the first evidence worldwide of neonicotinoid exposure in newborn babies in the early phase after birth. The findings suggest a need to examine potential neurodevelopmental toxicity of neonicotinoids and metabolites in human fetuses.

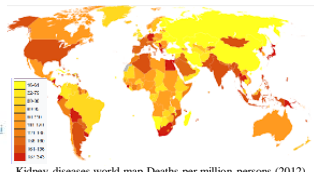
Dr. JM Bonmatin (CNRS) France

Article | Open Access | Published: 18 November 2021

Urinary concentrations of neonicotinoid insecticides were related to renal tubular dysfunction and neuropsychological complaints in Dry-zone of Sri Lanka

Kumiko Taira, Tomonori Kawakami, Sujithra Kaushalya Weragoda, H. M. Ayala S. Herath, Yoshinori Henaka, Kazutoshi Fujikawa, Madhubhani Hemachandra, Nirmalie Palliwatta, Yoshiko Aoyama, Mayumi Ishizuka, [Vinu-Marc Bonmann](#) & Makiko Komori

Scientific Reports 11, Article number: 22484 (2021) | [Cite this article](#)



Kidney diseases world map-Deaths per million persons (2012)

Table 3 Typical symptoms of neonicotinoid intoxication.

	Acute exposure	Subacute and chronic exposure
Cardiovascular	Tachycardia or bradycardia; hypertension or hypotension	Chest pain; palpitation; electrocardiographic abnormalities
CNS	Low GCS or unconsciousness; sleepiness; dizziness; convulsion; excitation	Headache; finger tremor; recent memory loss; dizziness upon standing; sleeplessness; agitation; fear; anger; abnormal behavior; altered consciousness; dreamy state; sudden change of senses of smell; auditory or visual hallucinations
Respiratory	Dyspnea or tachypnea; cough; cyanosis; respiratory arrest	Cough
Gastrointestinal	Nausea; vomiting; stomachache; oral-esophageal-gastric erosion	Stomachache; appetite loss; constipation or diarrhea
Secretion	Diaphoresis or anhidrosis; excessive discharge of saliva and bronchial secretion/mouth dryness	
Pupil	Mydriasis or miosis; abnormal light reflex	Abnormal light reflex
Body temperature	Fever or low body temperature	Fever (> 37°C)
Skeletal muscle	Muscle weakness or spasm; high creatine kinase	General fatigue; shoulder stiffness; muscle pain or spasm or weakness
Others	Metabolic acidosis; leukocytoclastic vasculitis; renal and hepatic dysfunction	Oliguria; edema; low or high urine volume; increase of urinary cystatin-c; skin eruptions or itching; reduced or increased body weight

<https://dx.doi.org/10.1038/s41598-021-01732-2>

Elsevier | Environment International | Journal homepage: www.elsevier.com/locate/envint

Alternatives to neonicotinoids

Hervé Jactel^a, François Verheggen^a, Denis Thiéry^a, Abraham J. Escobar-Gutiérrez^a, Emmanuel Gachet^a, Nicolas Desneux^a, the Neonicotinoids Working Group^a

A B S T R A C T

The European Food Safety Authority concluded in February 2018 that “most uses of neonicotinoid insecticides represent a risk to wild bees and honeybees”. In 2016, the French government passed a law banning the use of the five neonicotinoids previously authorized: clothianidin, imidacloprid, thiamethoxam, acetamiprid and thiacloprid. In the framework of an expert assessment conducted by the French Agency for Food, Environmental and Occupational Health and Safety to identify possible derogations, we performed a thorough assessment of the available alternatives to the five banned neonicotinoids. For each pest targeted by neonicotinoids use, we identified the main alternative pest management methods, which we then ranked for (i) efficacy for controlling the target pest, (ii) applicability (whether directly useable by farmers or in need of further research and development), (iii) durability (risk of resistance in targeted pests), and (iv) practicability (ease of implementation by farmers). We identified 152 authorized uses of neonicotinoids in France, encompassing 120 crops and 279 pest insect species (or genera). An effective alternative to neonicotinoids was available in 96% of the 2968 case studies analyzed from the literature (single combinations of one alternative pest control method or product × one target crop plant × one target pest insect). The most common alternative to neonicotinoids (89% of cases) was the use of another chemical insecticide (mostly pyrethroids). However, in 78% of cases, at least one non-chemical alternative method could replace neonicotinoids (e.g. microorganisms, semiochemicals or surface coating). The relevance of non-chemical alternatives to neonicotinoids depends on pest feeding habits. Leaf and flower feeders are easier to control with non-chemical methods, whereas wood and root feeders are more difficult to manage by such methods. We also found that further field studies were required for many promising non-chemical methods before their introduction into routine use by farmers. Our findings, transmitted to policymakers, indicate that non-chemical alternatives to neonicotinoids do exist. Furthermore, they highlight the need to promote these methods through regulation and funding, with a view to reducing pesticide use in agriculture.

ASSEMBLÉE NATIONALE

Le site de l'Assemblée Nationale

Accueil | Documents parlementaires | Amendements

ART. 51 QUATERDECIES N°452

ASSEMBLÉE NATIONALE
22 juin 2016

ADOPTÉ

AMENDEMENT N°452

ARTICLE 51 QUATERDECIES

Rédiger ainsi cet article :

« I. - L'article L. 253-8 du code rural et de la pêche maritime est ainsi modifié :

« 1° Au début du premier alinéa, est ajoutée la référence : « I » ;

« 2° Il est ajouté un II ainsi rédigé :

« II. - **Substitution de produits phytopharmaceutiques contenant une ou des substances actives de la famille des néonicotinoïdes et de semences traitées avec ces produits est interdite à compter du 1^{er} janvier 2020.**

« Des dérogations à l'interdiction mentionnée au premier alinéa du présent II peuvent être accordées jusqu'au 1^{er} juillet 2020 par arrêté conjoint des ministres chargés de l'agriculture, de l'environnement et de la santé.

« L'arrêté mentionné au deuxième alinéa du présent II est pris sur la base d'un bilan établi par l'Agence nationale de sécurité sanitaire de l'alimentation, de l'environnement et du travail qui compare les bénéfices et les risques liés aux usages des produits phytopharmaceutiques contenant des substances actives de la famille des néonicotinoïdes autorisés en France avec ceux liés aux usages de produits de substitution ou aux méthodes alternatives disponibles.

« Ce bilan porte sur les impacts sur l'environnement, notamment sur les pollinisateurs, sur la santé publique et sur l'activité agricole. Il est rendu public dans les conditions prévues par le dernier alinéa de l'article L. 1313-3 du code de la santé publique. »

« II. - Le dernier alinéa du II de l'article L. 254-7 du code rural et de la pêche maritime, dans sa rédaction résultant de la loi n° 2015-992 du 17 août 2015 relative à la transition énergétique pour la croissance verte est ainsi modifié :

« 1° Les mots : « et des » sont remplacés par le signe : « , » ;

« 2° Après la seconde occurrence du mot : « Conseil » sont insérés les mots : « et des produits dont l'usage est autorisé dans le cadre de l'agriculture biologique »

<http://www.assemblee-nationale.fr/14/amendements/3833/AN/452.asp>

Take home messages

- Biodiversity = life
- Pollinators = our food
- Neonicotinoids :
 - Exposure & toxicity for bees
 - Exposure & toxicity for biodiversity
 - Exposure & toxicity for mammals and humans
- Risk assessment => neonicotinoids to be banned
- What about other pesticide? (ex. glyphosate, SDHL...)
- Pesticides = private benefits & public risks 🤔

