Study

Pesticide tax in the EU
–
Various levy concepts and their impact on pesticide reduction

by

Stefan Möckel, Erik Gawel, Matthias Liess
(Helmholtz Centre for Environmental Research – UFZ)

and

Lars Neumeister
(Pesticide Expert)

On behalf of the GLS Bank and GLS Bank Stiftung

With financial support from:

Greenpeace e.V.

WWF Deutschland

Bündnis für eine enkeltaugliche Landwirtschaft e.V.

Foodwatch e.V.

Soil & More Impacts GmbH

GLS Treuhand – Zukunftsstiftung Landwirtschaft

Aurelia Stiftung

Deutsche Umwelthilfe e.V.

Bioland e.V.

BioBoden Genossenschaft eG and BioHöfe Stiftung für eine zukunftsfähige Agrarkultur

Pestizid Aktions-Netzwerk e.V. (PAN Germany).

2021

“Member States shall take all necessary measures to promote low pesticide-input pest management, giving wherever possible priority to non-chemical methods, so that professional users of pesticides switch to practices and products with the lowest risk to human health and the environment among those available for the same pest problem”.

Article 14 of Directive 2009/128/EC
establishing a framework for Community action to achieve the sustainable use of pesticides,
adopted on 1 October 2009 by the Member States and the European Parliament

Foreword

Crop protection can be achieved in many ways: with preventive and adaptive cultivation as well as mechanical, biological, or chemical measures that minimise harmful organisms. In this regard, manufacturers of chemical plant protection products promote their goods as the simplest and cheapest method. However, the active substances (pesticides) involved also have the most far-reaching effects on the environment, as they regularly affect non-target organisms in the treated area as well as soil; the respective substances are also carried to other areas and stretches of water by wind as well as water. Moreover, they pose risks to the health of users and residents but even more the consumers of treated agricultural products due to residues. Sustainable plant protection, i.e., plant protection that considers the environment and human health in the long term, can therefore only be achieved by widely minimising the use of pesticides.

Respective goals have existed at the European level for a long time. The Member States of the European Union have committed to allow only integrated crop protection from 2014 on at the latest, giving priority to non-chemical measures (Art. 55 Regulation 1107/2009/EC and Art. 14 Directive 2009/128/EC). According to its Green Deal strategies for agriculture, biodiversity and pollution, the European Commission wants to halve both the use and risk of chemical pesticides as well as the use of higher-risk pesticides by 2030.

These goals are difficult to achieve with stricter European regulations on authorisation and use only, unless the European legislator tightens authorisation requirements for pesticides significantly and, in particular, severely restricts the spatial as well as substantial scope of use as well as invests in an area-wide control of application requirements. However, a (tax or non-tax) levy could change the cost-benefit analysis underlying pesticide use so that, due to the economic incentives established by the regulatory framework, pesticides would be used more sparingly, and more non-chemical plant protection methods would come to bear. Experiences in some Member States have already demonstrated such positive effects.

In our study, we compare different concepts for a levy on pesticides and analyse in particular developments in Denmark, where a risk-based pesticide tax was introduced in 2013. Taking Germany as an example, we use a dynamic database approach to simulate the different steering effects of the various levy concepts in order to estimate how different levies would change pesticide use in terms of quantity, treatable area, and risks. What the simulation made clear is that it is important to consider the differences in the authorised maximum application doses per hectare and year per respective pesticide when designing a levy; after all, these doses can vary up to a thousand-fold due to the different efficacy of the active substances used. The results of the simulation and the derived recommendations can be applied to other Member States and the EU as a whole.

Based on the study Möckel et al. 2021 written in German language, the text presented here additionally examines and unpacks the legal backdrop for introducing an EU-wide levy. For this purpose, the sections of the original study were omitted that looked into the current use of plant protection products in Germany and outlined the legal conditions for an introduction in Germany.

The authors thank the GLS Bank and other financial backers listed on page two for they support. They made this study and its English language version possible in the first place. Most parts of text was translated by Harry Bauer, London.

Table of Contents

Figures

Tables

List of Acronyms and Abbreviations

a	year
AS	active substance
ADI	Acceptable Daily Intake
AOEL	Acceptable Operator Exposure Level
Art.	Article
BfN	Federal Agency for Nature Conservation in Germany
B.t.i.	Bacillus thuringiensis israelensis
B.t.t.	Bacillus thuringiensis sspec. tenebrionis
BVL	Federal Office of Consumer Protection and Food Safety in Germany
CAP	Common Agricultural Policy of the European Union
CC	Cross Compliance
CfS	Candidate for Substitution
cf.	compare following
DKK	Danish Krone
EEA	European Environment Agency
EC	European Community
ECJ	European Court of Justice
et al.	and others
et seq.	subsequent page
et sqq.	subsequent pages
EU	European Union
g	gram
ha	hectare
kg	kilogram
L	Load (indicator in Denmark)
lit.	letter
Mio.	Million
OJ	Official Journal
PLI	Pesticide-Load-Index
PPDB	Pesticide Properties Database
PPP	plant protection products
SEK	Swedish Krona
t	ton
TEU	Treaty on European Union
TFEU	Treaty on the Functioning of the European Union
TFI	Treatment frequency index
UBA	German Environment Agency
µg	Microgram

Summary and Recommendations

The authors of this study argue in favour of a risk-based levy on all chemical plant protection products supplementing existing regulations on the authorisation and use of plant protection products at the European level. This would allow the European Union to achieve its objectives and promote integrated pest management. The levy could be introduced as a tax paid into the EU or national budgets, or as a non-tax levy, the revenue from which would be allocated to a special fund at the European or national level.

Within the regulatory framework (which currently does not limit the total amount of pesticides used per hectare and year), a taxation of plant protection products changes the cost-benefit ratio of pesticide use. The experiences made in Denmark and the simulations carried out for Germany indicate that a levy can halve both the total sales of plant protection products as well as active substances (pesticides) and the sales of particularly hazardous pesticides (see Figures A and B) given that it is sufficiently high and differentiated taking into account effects on and risks for humans and the environment.[1] In particular, the study finds that a levy could help achieve the European Green Deal[2] target of reducing by 2030 both the use and risk of chemical pesticides and the use of higher risk pesticides by 50 percent, elaborated in the Farm to Fork Strategy, the EU Biodiversity Strategy for 2030 and the Zero Pollution Strategy.[3] The findings of the simulation can be applied to other Member States and the EU as a whole. A levy would indeed foster the practical implementation of integrated pest management, which has been required by EU law since 2014 under Art. 55 of EU Regulation 1107/2009/EC.

The steering effects of a levy on plant protection products can be further strengthened, if the incurred revenues are used to expand state advisory and training services on sustainable crop protection as well as to promote the conversion to non-chemical crop protection. A levy on plant protection products could therefore provide a decisive impetus for a more comprehensive paradigm shift towards a holistic pesticide policy fostering ecologically sustainable agriculture in the European Union, since preventive or non-chemical crop protection is regularly accompanied by a general reduction in farming intensity (e.g., less fertilisation and more diverse crop rotation).[4] It would therefore also be an effective complement to the first pillar of the Common Agricultural Policy with its flat-rate area-based direct payments for income support and its associated control-intensive cross-compliance and greening requirements.[5]

With the help of the developed database model,[6] the study modelled the steering effects of various levy concepts on the total demand for plant protection products in Germany. The simulation and the experience with the Danish tax show that a levy on plant protection products should be linked to the maximum permissible application dose per hectare and year (vegetation period) specified in the authorisation for each product. The application dose can vary up to a thousandfold due to the different efficacy of the respective active substances (see Table 9 in Section 5.4). For example, the difference between the herbicides metsulfuron (5-8 g per hectare

---

1 Cf. also Lee/den Uyl/Runhaar 2019; Böcker/Finger 2017; Finger et al. 2017b.

2 European Commission 2019.

3 Cf. European Commission 2020b, p. 6; European Commission 2020a, p. 7; European Commission 2021, p. 3, 9.

4 Cf. Hulot/Hiller 2021; Möhring et al. 2020; Niggli et al. 2020, 14 et seq., 18 et sqq.; Dorninger et al. 2020; Chaplin-Kramer et al. 2019; Lechenet et al. 2017; Femenia/Letort 2016; Petit et al. 2015; Lechenet et al. 2014; Lefebvre et al. 2014; Jacquet/Butault/Guichard 2011; Verschuur/van Well 2001.

5 For the low effectiveness of the Common Agricultural Policy, see only European Court of Auditors 2021, European Court of Auditors 2020a; European Court of Auditors 2020b; Pe'er et al. 2019.

6 However, the database model does not allow to draw conclusions about economic or operational effects on users, nor about possible adaptations, e.g., in the field of agricultural management.

per year) and glyphosate (1.8-3.6 kg) is 1:225 to 1:720, depending on the area of application. In terms of percentage, this corresponds to a difference of 22,400 percent to 71,900 percent.

A levy concept that takes these immense differences into account was proposed by the UFZ in 2015[7] and is developed further in this study. It suggests a basic levy rate of 20 EUR for the maximum permissible application dose per hectare and year, which is then multiplied by a risk-based factor for the human toxicity of the active substances contained and, if necessary, by further additional factors (e.g., for substitution candidates and home and small garden products; see Figure E).

Reference to the maximum permissible application dose ensures that highly effective products are just as heavily burdened by the levy as products for which much higher application doses are required and permitted to the same effect. This avoids that, as in Denmark, users of high-dose pesticides (e.g., the herbicide glyphosate or the insecticide pirimicarb) switch to low-dose, high-efficacy pesticides (e.g., the herbicide metsulfuron or the insecticide and pyrethroid lambda-cyhalothrin) if, in relation to hectare and year, the levy burden is lower for low-dose, high-potency products despite comparable effects on target and non-target organisms (see Table A).

Due to the emphasis on maximum permissible application doses, in the simulation carried out for Germany the UFZ levy concept reduced the potentially treatable total area[8] much more than the Danish concept, although in the model the latter reduces more the total quantity of active substances applied (see Figure C and D). The improvement for humans and the environment is therefore higher with the maximum permissible application dose as reference point than with a tax that rests merely on a risk-based kilogram or litre assessment of active substances, as in Denmark.

The positive effects of a levy linked to application quantities can further its impact on biodiversity, if a higher levy rate applies to herbicides and insecticides (including acaricides) than to fungicides, growth and germination regulators and other pesticides. Both groups of active substances have a high direct or immediate impact on wild plant and animal species and especially on insects and birds, many of which are natural antagonists of pests. At the same time, a variety of preventive and non-chemical methods exist to regulate unwanted plant growth and pest infestations.

Due to its emphasis on the maximum permissible application dose, the modified UFZ concept achieves a much greater reduction in the potentially treatable total area in the model (–54 percent) than the Danish concept (–42 percent). In the Danish concept but also in non-risk-based levy concepts, on the other hand, a shift is incentivised from high-dose pesticides to high-potency low-dose pesticides, so that the negative effects and risks for the environment and human health do not decrease yet could even increase.

Overall, the simulation carried out for Germany indicates that a levy on plant protection products can significantly reduce both the amount of pesticides used and the risk they pose. With an EU-wide levy based on the modified UFZ concept (see Figure E), the goals of the Green New Deal could be achieved without further tightening regulations on authorisation or application. Based on the Treaty on the Functioning of the European Union (TFEU), the European Union can introduce a risk-based levy on plant protection products either as its own tax or as a member state obligation to introduce corresponding national levies. In Chapter 7, this study examines in detail the competence provisions that could be considered for such an endeavour.

---

7 Möckel et al. 2015.

8 This is the area that could be treated with the current or estimated sales volume of all active substances for each levy concept, if the maximum permissible application dose per hectare and year were exhausted (see Chapter 2.1).

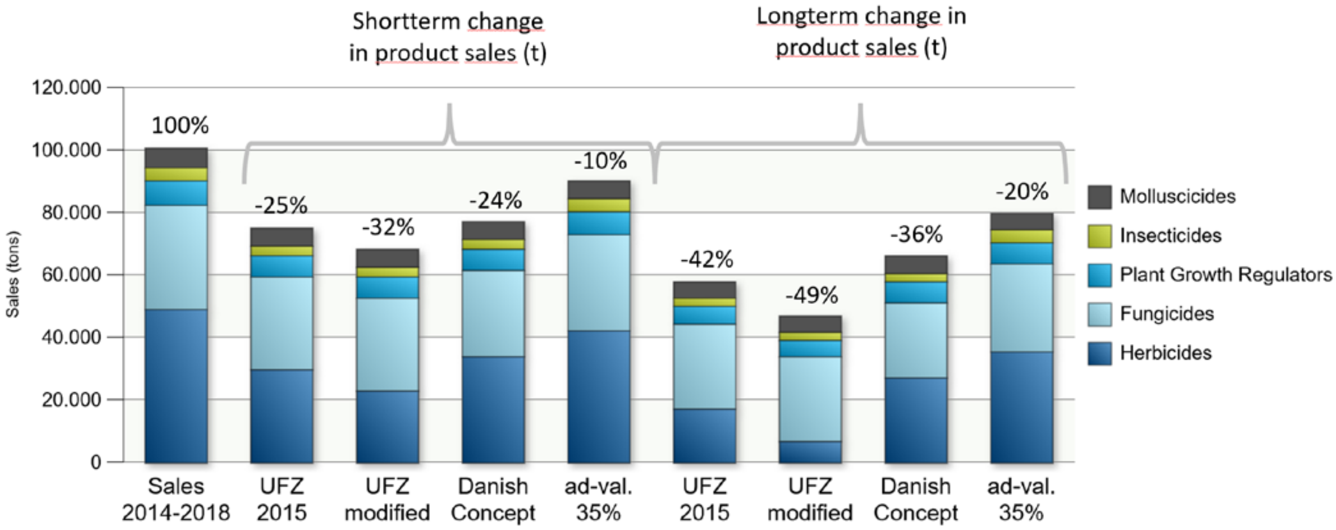


Figure A Simulated changes in sales volumes of plant protection products (excluding inert gases) in Germany depending on levy concept and pesticide scope

Explanation: The left column (sales 2014-18) represents the averaged actual sales in Germany in the years 2014 to 2018. The following columns display the results of the modelling for the four levy concepts examined with an assumed price elasticity of –0.2 for short-term and –0.4 for long-term steering effects of a price increase (further information can be found in Chapter 6).

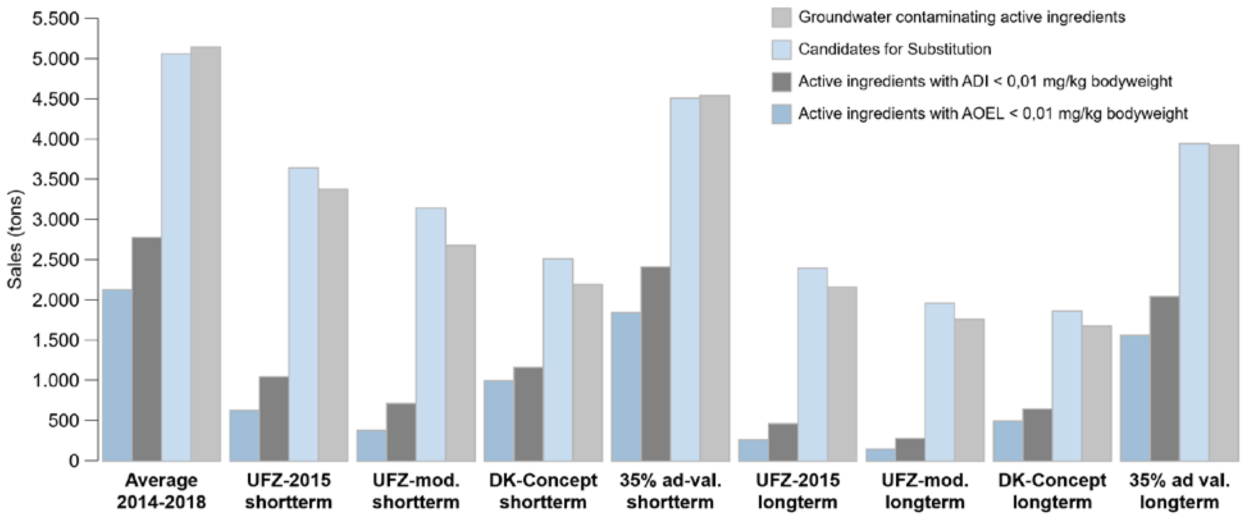


Figure B Simulated changes in potentially treatable areas for active substances with certain hazard potentials depending on levy concept

Explanation: The left column (mean 2014-18) displays the average actual sales of active substances in Germany between 2014 and 2018. For further explanation, see Figure A.

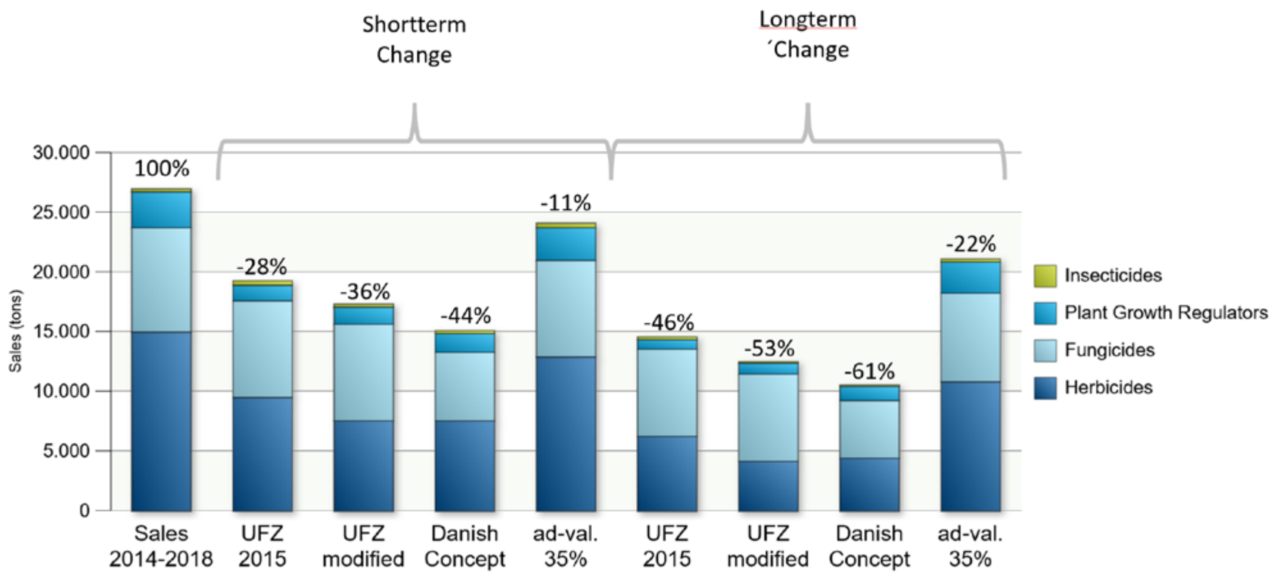


Figure C Simulated quantity changes of active substance sales in Germany depending on levy concept and pesticide scope

For further explanation, see Figure A.

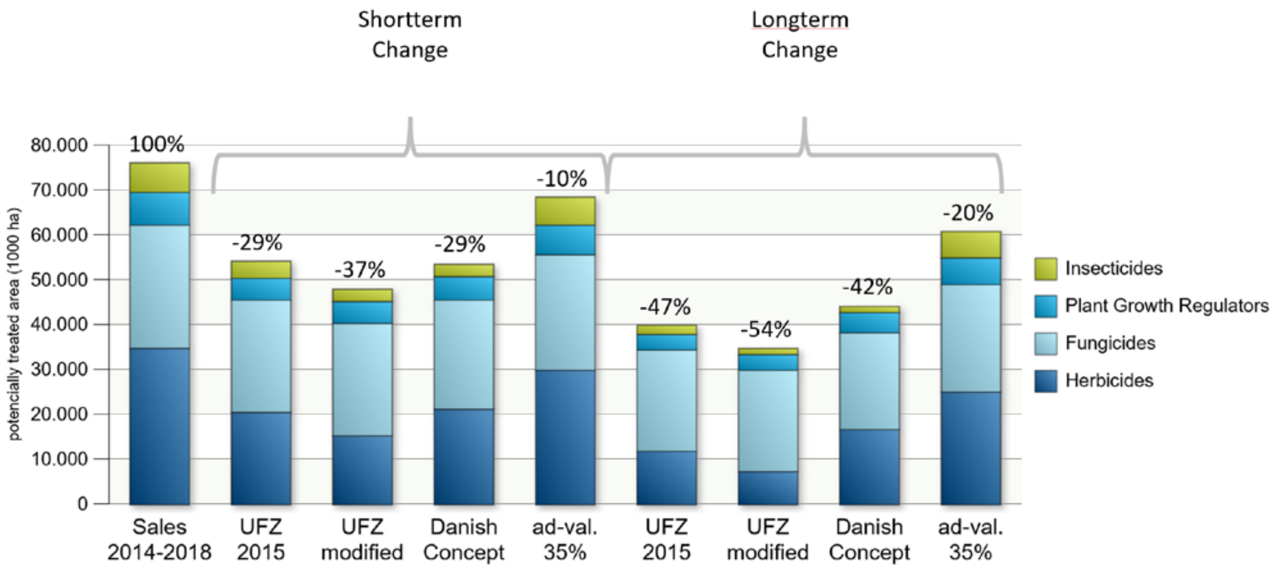


Figure D Simulated changes in the potentially treatable area in Germany depending on levy concept and pesticide scope

For further explanation, see Figure A.

Table A Comparison of two herbicides with different maximum permissible application doses

Plant protection products	ACCURATE	Roundup PowerFlex
Scope of application	Herbicide	Herbicide
Active substance	Metsulfuron	Glyphosat
Active substance level	192.6 g/kg	480 g/kg
Maximum permissible active substance application dose per hectare and year for winter barley		
	6 g	1,800 g
Factor difference:	1 to	300
Percentage difference:	29,900 %	
Current costs		
Market price 2020 for plant protection products	233.09 EUR/kg	11.12 EUR/kg
Costs for maximum permissible application dose	6.99 EUR per ha/a	84.42 EUR per ha/a
Additional levy burden depending on the levy concept		
per maximum permissible application dose in EUR per ha/a (per kilogram in EUR/kg)	UFZ 2015 30.01 (1,000.25) UFZ mod. 45.01 (1,500.37) DK-Concept 0.44 (14.71) 35 % ad val. 2.45 (81.58)	UFZ 2015 22.40 (2.99) UFZ mod. 33.60 (4.48) DK-Concept 32.98 (4.40) 35 % ad val. 29.20 (3.89)

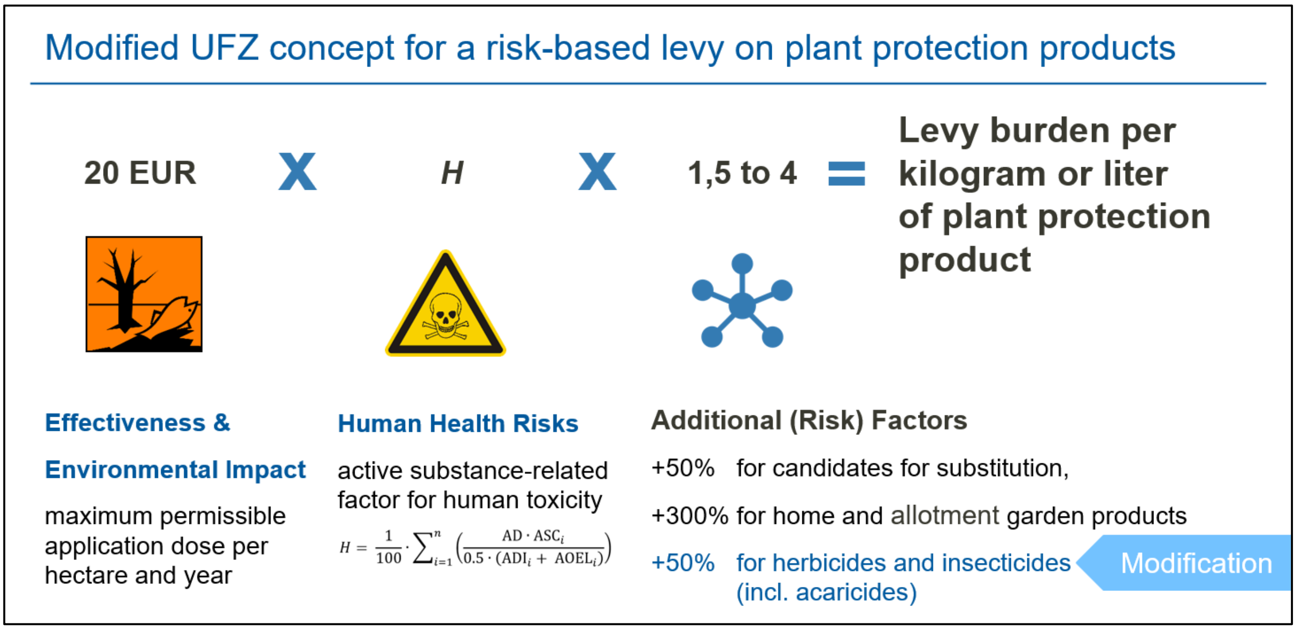


Figure E Modified UFZ concept for a risk-based levy on plant protection products

The exact formula for the UFZ concept is presented in Chapter 5.4., including the calculation of the human toxicological factor and the conversion of the levy burden per kilogram or litre of plant protection product into a percentage price surcharge.
The modification made is explained in detail in Chapter 5.5. A further additional factor of 1.5 (corresponds to additional 50 percent) for herbicides and insecticides (including acaricides) is added to the initial 2015 formula.

1 The Aims and Methodology of the Study

The European Commission's Ecosystem Assessment evaluated the state of the ecosystem and biodiversity in the European Union (EU) and came to the following conclusion about agroecosystems and pesticides:

> "Agroecosystems cover almost half of the EU land area (36.4% cropland and 11.4% grassland). The EU ecosystem assessment shows that main pressures (use of pesticides, gross nitrogen balance) have remained stable, so as the structural condition of agroecosystems, measured by indicators including landscape mosaic, crop diversity, share of dominant crop, share of high nature value farmland, and share of protected agroecosystems. Moreover, almost 600 km^2 of agroecosystems are lost each year due to soil sealing. Organic farming has increased reaching 7% of the utilised agricultural area. Improving trends are also marked by nitrogen concentration in groundwater and exceedance of critical loads. However, this has not been sufficient to prevent further erosion of agrobiodiversity. Since the start of the observations in 1990, the farmland bird index has declined by 33%, and the grassland butterfly index by 39%.
>
> [...]
>
> Reversing negative trends in agroecosystems will depend on reducing key pressures that are still high, particularly in terms of nutrient and pesticide use. Improving the condition of agroecosystems and delivering the EU target to restore high-diversity landscape features to cover 10% of agricultural land will also be essential in order to safeguard agriculture-related biodiversity and important ecosystem services such as soil fertility, pollination and natural pest control."[9]

Plant protection products and their active substances (pesticides) are intended to protect forestry and agricultural crops from disease and pests, to safeguard harvests, or, for instance, to keep railway tracks and other traffic areas free of vegetation. Many pesticides are also approved for use at home and in allotment gardens, although neither professional users nor business interests are involved. European authorisation legislation as well as European and national regulations on the use of plant protection products attempt to limit the associated negative effects and risks for the environment as well as human health. Still, they cannot exclude all negative effects and risks due to the intended effect on target organisms, the large number of active substances, applications, and users as well as complex ecosystem interrelations (see Chapter 2).

The use of pesticides, especially in conventional agriculture and in certain applications (e.g., railway tracks), is currently still considered necessary by the European legislator. It is therefore not limited to a few non-synthetic products and areas of application as in organic farming. At the same time, with the Sustainable Use Pesticide Framework Directive 2009/127/EC[10], the European legislator wants to reduce the use of pesticides in Europe as much as possible due to the manifold negative effects and risks for humans and the environment. Under the Green Deal[11], The European Commission has now substantiated this aim to the effect that the use and risk of chemical pesticides as well as the use of higher-risk pesticides should each be halved in the EU by 2030.[12]

However, the regulatory requirements for the authorisation and use of plant protection products involve a trade-off between the benefits sought and the costs to society.[13] Even if opinions differ on the level of benefits or

9 European Commission 2021, p. 16.

10 Directive 2009/128/EC of the European Parliament and of the Council of 21.10.2009 establishing a framework for Community action to achieve the sustainable use of pesticides, OJ L 309, 24.11.2009, p. 71

11 European Commission 2019.

12 Cf. European Commission 2020b, p. 6; European Commission 2020a, p. 7; European Commission 2021, p. 3, 9.

13 Cf. UBA 2016; Storck/Karpouzas/Martin-Laurent 2017.

costs, there is nevertheless a broad consensus that, according to the principles of integrated pest management, which have been binding since 2014 under Art. 55 of Regulation 1107/2009/EC[14] following Annex III to Directive 2009/127/EC, the use of chemical plant protection products should be avoided as far as possible. Whether, which and how many plant protection products are used across an area in a year, however, is ultimately decided upon by the professional users and the private individuals applying them, who in each case also make a business or private cost-benefit calculation.[15] Although the maximum dose per application and the number of applications per hectare and year are specified in the authorisation (usually with differentiations depending on the crop to be protected), the latter only refers to one product and not to the total number of plant protection products used in an area per hectare and year (see 2.1). In the cost-benefit calculation, the impact on the environment and health of other people have so far been left out, as harm did not materialise as a cost to the users.[16]

At the same time, the level of pesticide use is closely related to the type and intensity of agricultural and forestry management. Reduced crop rotations and a lower genetic diversity of the cultivated crops, large fields, microbiologically impoverished soils, and a high supply of nutrients increase the susceptibility of the cultivated crops to fungal diseases, pests, and eyespot.[17] High fertiliser use not only promotes the growth of the crop but also the emergence of weeds. In conventional agriculture, the above-mentioned consequential problems have so far been minimised mainly through the use of pesticides, since non-chemical and preventive measures such as harrowing, more diverse crop rotations or reduced fertilisation require a greater change of farming methods or cause higher farming costs.[18] As pesticides often reduce the diversity and number of non-target organisms on and off the field as well as in the soil (e.g., mycorrhizal fungi), they weaken natural crop protection as well as the vitality of crops and their resilience to diseases and pests, which is why the need for pesticides continues to increase.[19]

Whether in the form of a tax or a non-tax levy, levies on plant protection products contribute to the involved cost-benefit calculation by charging at least part of the social costs of plant protection products to producers, distributors, and users in a generalised form, thereby changing the cost-benefit ratio of chemical crop protection overall (see Chapter 3). While regulatory law sets the boundaries of legality and obliges integrated pest management, levies within this framework provide economic incentives to use pesticides more sparingly and to give priority to non-chemical pest management measures, which is why levies are an important complement to regulatory law.[20] Studies further show that a reduction in pesticide use of up to 40 percent is possible without a significant decrease in agricultural productivity and profitability.[21] Depending on the level of the levy, the incentive to reduce pesticide use becomes stronger or weaker. If the levy also takes into account the different degree of effect and risks for humans and the environment, an incentive is created at the same time to replace more dangerous products or active substances with less dangerous ones.

---

14 Regulation (EC) No 1107/2009 of the European Parliament and of the Council of 21.10.2009 concerning the placing of plant protection products on the market and repealing Council Directives 79/117/EEC and 91/414/EEC, OJ L 309, 24.11.2009, p. 1.

15 Cf. Pedersen et al. 2012 and Pedersen/Nielsen/Daugbjerg 2020, who however also indicate that not all users follow a purely economic cost-benefit calculation.

16 UBA 2016, p. 27 et sqq.

17 Cf. Finckh et al. 2021; Finckh/Van Bruggen/Tamm 2015; Huber/Haneklaus 2007; Hofmeester 1992; Culliney/Pimentel 1986 et sqq.

18 Cf. Petit et al. 2015; Jacquet/Butault/Guichard 2011, Tab 2.

19 Cf. Bergmann 2019; Van Bruggen et al. 2019; Brzozowski/Mazourek 2018; Altieri/Ponti/Nicholls 2012; de Vries et al. 2018; Mbanaso et al. 2014; Krüger et al. 2013; Lekberg/Koide 2005.

20 Cf. Möhring et al. 2020; Lee/den Uyl/Runhaar 2019; Chaplin-Kramer et al. 2019; Finger et al. 2017b; Böcker/Finger 2016; Femenia/Letort 2016; Petit et al. 2015; Lechenet et al. 2014; Lefebvre et al. 2014; Brewer/Goodell 2012; Jacquet/Butault/Guichard 2011; Verschuur/van Well 2001.

21 Lechenet et al. 2017 for France. Cf. Femenia/Letort 2016; Grovermann et al. 2017; Freier et al. 2014.

According to Member State data collected by EuroStat, the total sales of active substances used in plant protection products have remained largely constant in the EU over the last decade, at around 380,000 tonnes per year between 2011 and 2018.[22] However, trends in quantities sold tells little about the intensity of pesticide use, as the permitted application doses can vary up to a thousandfold due to the different efficacy of the active substances. For example, the difference between the herbicides metsulfuron (5-8 g per hectare per year) and glyphosate (1.8-3.6 kg) is 1:225 to 1:720, depending on the area of application. In terms of percentage, this corresponds to a difference of 22,400 percent to 71,900 percent. In recent decades, more and more highly effective and correspondingly low-dosed agents have been approved, which is why the number of treatments and the ecological hazard potential have increased (see also chapter 4 and. 5.4).[23]

The European Union has developed two additional indicators to better measure the use and risks of pesticide use.[24] The harmonised risk indicator 1, which measures trends in the use and risk of chemical pesticides, recorded a decrease of around 30 percent between 2011 and 2019.[25] Trends in the individual Member States are very different, and not all Member States have agreed that the Commission publishes their data.[26] While in Austria, for instance, the use and risk of chemical pesticides increased significantly, in Denmark it has fallen considerably since 2013 as a result of the amended pesticide tax (see also Chapter 4). The harmonised risk indicator 2, which measures the use of more hazardous pesticides, showed no discernible progress between 2011 and 2019, and the indicator even increased significantly between 2012 and 2016.[27] Here, there are major differences between the individual Member States (e.g., between Austria and Denmark).[28]

In the 1990s, the European Commission commissioned a comprehensive report of the future environmental Community policy in the field of crop protection products, which included levies.[29] Oskam et al. 1997 dealt with alternatives to regulatory law and discussed, among other things, the management of the use of plant protection products. The authors consider the impact of a sales tax, which, however, would remain ineffective due to the input tax deduction prescribed for all professional users under Art. 167-72 of the Directive on the EU Common System of Value-Added Tax, as well as an independent consumption levy.[30] With regard to the consumption levy of interest here, the study examines three different variants. Two models propose a percentage increase in the sales price of plant protection products (so-called ad valorem levies). One variant is linked to the quantity of the active substance in a product (quantity levy). What they all have in common is that they are levied at the sales stage and are thus payable by manufacturers, importers, or resellers. For ad valorem levies, the study uses levy rates of 10 or 25 percent of product prices as basis. It also assumes a price

22 European Court of Auditors 2020b, p. 8; JRC et al. 2020, p. 89.

23 Cf. Schulz et al. 2021; Goulson/Thompson/Croombs 2018.

24 European Commission, Farm to Fork targets - Progress, https://ec.europa.eu/food/plants/pesticides/sustainable-use-pesticides/farm-fork-targets-progress_en; European Commission, Harmonised risk indicators, https://ec.europa.eu/food/plants/pesticides/sustainable-use-pesticides/harmonised-risk-indicators_en (retrieved on 20.6.2021)

25 European Commission, EU: Trends – Trend in use and risk of chemical and more hazardous pesticides, https://ec.europa.eu/food/plants/pesticides/sustainable-use-pesticides/farm-fork-targets-progress/eu-trends_en (retrieved on 20.6.2021).

26 European Commission, Member States: Trends – Trend in use and risk of chemical and more hazardous pesticides, https://ec.europa.eu/food/plants/pesticides/sustainable-use-pesticides/farm-fork-targets-progress/member-states-trends_en (retrieved on 20.6.2021).

27 European Commission, EU: Trends – Trend in use and risk of chemical and more hazardous pesticides, https://ec.europa.eu/food/plants/pesticides/sustainable-use-pesticides/farm-fork-targets-progress/eu-trends_en (retrieved on 20.6.2021).

28 European Commission, Member States: Trends – Trend in use and risk of chemical and more hazardous pesticides, https://ec.europa.eu/food/plants/pesticides/sustainable-use-pesticides/farm-fork-targets-progress/member-states-trends_en (retrieved on 20.6.2021).

29 Oppenheimer et al. 1997.

30 Oskam/Vijftigschild/Graveland 1997, p. 122 et sqq. and p. 133 et sqq.

elasticity of –0.4, which is the average value various studies apply.[31] Accordingly, Europe-wide sales of plant protection products would decline by four percent or 10 percent respectively.[32] For the quantity levy, a levy rate of 1.80 EUR per kilogram of active substances was assessed, which, in relation to the reference year 1994, corresponded to a 10 percent increase in the average price of 18 €/kg of active substance. In the case of the quantity levy and the 10 percent ad valorem-levy, the authors estimate the revenue at around 512 million EUR per year,[33] although they assumed a higher steering effect (price elasticity) of –0.495 for the quantity levy. Due to the different price levels for plant protection products in the individual Member States, the differences between the quantity and ad valorem levies would be even greater in some cases.[34]

Building on the results of Oskam et al. 1997, the Commission commissioned Hoevennagel et al. 1999 to conduct an in-depth study of a Europe-wide levy on plant protection products outlining its possible economic and ecological effects. According to the study, an ideal levy would be differentiated according to the environmental damage of the pesticides, select the correct levy rate, be collected and reimbursed efficiently, be fraud-proof and constantly incentivise farmers to reduce their use of pesticides.[35] From the multitude of design options, they developed two variants. Scenario 1 applies a uniform levy of 20 percent for all plant protection products. Scenario 2 differentiates between a rate of 40 percent on hazardous products, 20 percent on less hazardous products and 10 percent on harmless products.[36] For the price elasticity used in the modelling, the authors used values of 15 other studies and differentiated between low and high price elasticity and between fungicides (–0.4/–0.8), herbicides (–0.7/–0.9) and insecticides (–0.3/–0.8).[37] On the basis of nine pesticide chains evaluated, it was concluded that an EU-wide levy on pesticides of 20 percent will have a substantial impact on the use of pesticides by agricultural enterprises.[38] The results of the modelling are shown in Table 1.

Table 1 Results of the modelling by Hoevenagel et al. 1999 for a Europe-wide pesticide levy (average changes as well as lowest/ highest value)

	Scenario 1	Scenario 2
Pesticide use	–14 % (–8 % / –18 %)	– 18 % (–7 % / –32 %)
Total production costs	+0.1 % (–0.1 % / +0.2 %)	+ 0.02 % (–0.2 % / +0.2 %)
Gross revenue per farmer	–143 € (–7 € / –365 €)	– 155 € (–9 € / –396 €)

Source: Hoevenagel et al., p. 39 et seq., 65

The modelling results show that a uniform, but even more so a differentiated levy brings ecological improvements. Economically, Hoevennagel et al. assume that agricultural profits will decline somewhat due to lower yields following lower pesticide use.[39] The more intensive the previous land use, the higher the

31 Oskam/Vijftigschild/Graveland 1997, p. 135.
32 Oskam/Vijftigschild/Graveland 1997, Table p. 138.
33 Oskam/Vijftigschild/Graveland 1997, p. 137, 141.
34 Cf. Oskam/Vijftigschild/Graveland 1997, Table 8.2.1 and 8.2.2, p. 138 et seq.
35 Hoevenagel/van Noort/de Kok 1999, p. 27.
36 Hoevenagel/van Noort/de Kok 1999, p. 45 et seq. The categorisation refers to the classification of the then Directives 93/21/EWG and 91/414/EWG (see Hoevenagel/van Noort/de Kok 1999, p. 32 et sqq.).
37 Hoevenagel/van Noort/de Kok 1999, p. 39 et seq., 46.
38 Hoevenagel/van Noort/de Kok 1999, p. 46 et seq., 84.
39 Hoevenagel/van Noort/de Kok 1999, p. 47.

decline.[40] In order to reduce the economic profit losses, they recommend returning the revenue from the levy to the affected agricultural enterprises, whereby they consider environmental protection payments to be more effective than pure area payments.[41] Overall, the authors concluded “that introducing an EU wide levy on pesticides will be both effective and useful.”[42] They therefore recommended that the European Community should oblige its Member States to introduce a levy with differentiated minimum rates for different risk classes or effective ranges.[43] At that time, the authors assumed that it was not feasible to further differentiate active substances on the basis of their respective ecological impacts and risks.[44]

The both studies provided the basis for the Thematic Strategy on the Sustainable Use of Pesticides presented by the European Commission in 2006,[45] which laid the groundwork for the subsequent Pesticide Framework Directive 2009/12/EC and the amendment to the authorisation legislation via Regulation 1107/2009/EC and the new Regulation 1185/2009/EC concerning statistics on pesticides[46]. However, the Commission was not in favour of a levy on pesticides at the European level, arguing:[47]

> “Setting-up of a system of taxes/levies to influence qualitatively pesticide use. At this point in time, it will be virtually impossible to devise an efficient and manageable system of taxes/levies that would reflect adverse effects of individual pesticides. Member States could explore introducing ‘banded’ systems (flat rate systems are currently applied in some Member States), adapted to their specific situations and the protection objectives they wish to pursue.”

The only recommendation was:

> “Invitation to Member States to apply normal VAT rates to pesticides in order to reduce the incentive for illegal cross border exchange of non-authorised products due to price differentials.”[48]

Since then, in the EU, policies involving pesticide levies have been limited to a few Member States. Positive experiences with levies on pesticides have so far been made mainly in Sweden and Denmark, while the very low French levy introduced in 2006[49] had no discernible steering effects (see Figure 1).[50] Developments in Denmark are particularly interesting, as an active substance-specific risk-based tax was introduced in 2013. The extent to which pesticides are taxed differently as a result, and what effects the tax has had on the intensity of pesticide use and the various active substance groups in Denmark to date is therefore examined in detail in Chapter 4 on the basis of comprehensive data.[51]

---

40 Hoevenagel/van Noort/de Kok 1999 Table 5.13 p. 65.

41 Hoevenagel/van Noort/de Kok 1999, p. 67, 76 et sqq., 85.

42 Hoevenagel/van Noort/de Kok 1999, p. 85.

43 Hoevenagel/van Noort/de Kok 1999, p. 73 et sqq.

44 Hoevenagel/van Noort/de Kok 1999, p. 71 et sqq., 85 et seq.

45 European Commission 2006.

46 Regulation (EC) No 1185/2009 of the European Parliament and of the Council of 25.11.2009 concerning statistics on pesticides, OJ L 324, 10.12.2009, p. 1.

47 European Commission 2006, p. 11. In the preparatory communication, it opposed a special consumption levy and argued in favour of a higher VAT rate on plant protection products (European Commission 2002, p. 33-35).

48 European Commission 2006, p. 10.

49 For more details cf. Möckel et al. 2015, p. 89-92.

50 Cf. also Finger et al. 2017b; Böcker/Finger 2016.

51 Lars Neumeister has calculated the tax payable for all active substances approved in Denmark and juxtaposed it with the long-term changes in the sales of active substances.

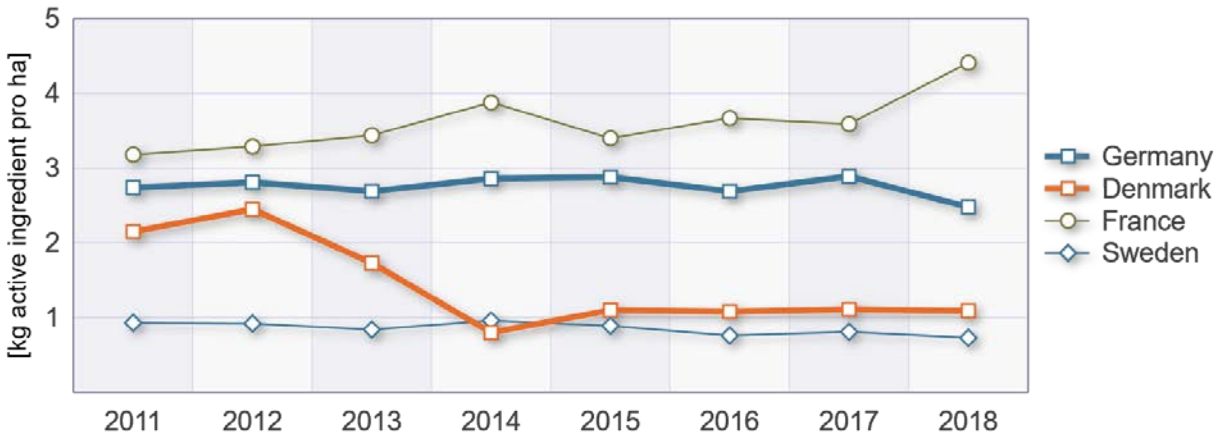


Figure 1 Sales of active substances (excluding inert gases) in Denmark, Germany, France, and Sweden 2011 to 2018 converted into kilograms per hectare of agricultural land (arable land and permanent crops, excluding permanent grassland)

Source: Own presentation and calculation based on Eurostat data.

Today, in its Green Deal strategies, the European Commission is aiming for greater use of environmentally oriented levies to implement the polluter-pays principle more effectively in the future and to provide tax incentives for more sustainable behaviour by producers, users and consumers.[52] Due to their various effects, levies in particular would be suitable for significantly promoting the Green Deal objectives for pesticides, if they are structured appropriately and incur costs at the right level. With reference to Sweden and Denmark, a levy on plant protection products has also been repeatedly demanded in Germany[53] and various proposals for a risk-based levy have been developed.[54] The situation is similar in France, for example.[55] Chapter 5 gives an overview of different risk-based and non-risk-based levy concepts that have already been introduced or are proposed.

The steering effects of the different concepts were assessed with regard to the total demand for plant protection products in Germany by means of a dynamic database model (Chapter 6), which includes the data listed in Table 2 and allows analyses.[56] However, the database model does not currently allow for analyses of and conclusions on economic or operational effects on users or on possible adaptations, e.g., in the area of agricultural management. The following concepts were simulated:

- an undifferentiated flat-rate ad valorem-levy of 35 percent on net sales prices,
- the Danish tax concept (DK concept) with the tax payable differentiated according to risks per kilogram or litre of plant protection product,
- the 2015 UFZ concept, which is linked, among other things, to the maximum permissible application dose per hectare and year (vegetation period of 12 months), and
- a modified UFZ concept, which takes even greater account of effects on biodiversity.

52 Cf. European Commission 2019, p. 17; European Commission 2020b, p. 14; European Commission 2020a, p. 17; European Commission 2021, p. 11.

53 Niggli et al. 2020, 17 et sqq.; SRU/WBBGR 2018, p. 31; Schäffer et al. 2018, p. 38 et seq.; FÖS 2018; UBA 2016, p. 29; SRU 2016, p. 404 et sqq.; Möckel et al. 2015. Critical on behalf of the chemical industry Mußhoff 2017.

54 Finger et al. 2017b; Finger et al. 2017a; Möckel et al. 2015; Möckel 2006.

55 Femenia/Letort 2016.

56 Further information on the data, methodology and calculations can be found in Chapters 6 and 9.

The English version of the study is rounded off by an assessment of the legal competences of the EU to introduce an EU-wide levy either as a separate European tax or as a mandate to the Member States to levy corresponding national levies under European law (Chapter 7).

Table 2 Overview of the dynamic database model

Data Sources
• Current prices of many authorised plant protection products in Germany based on market analysis • Price elasticities (short- and long-term) for plant protection products based on literature analysis • Active substance levels of all plant protection products authorised in January 2021 (formulation) according to the specifications made in the authorisation • Sales volumes of all active substances in Germany as multi-year time series based on the data of the Federal Office of Consumer Protection and Food Safety • Maximum permissible application dose per hectare and year for all plant protection products for which the authorisation for the respective areas of application/ crops specifies the dose per application and the number of applications per hectare and year[57]
Derivable Analyses
• Calculation of levy payments per kilogram or litre of plant protection product (product sold) and per hectare and year at maximum application dose for different levy concepts • Modelling of relative volume changes (percentage changes) in sales of plant protection products depending on the levy concept using the estimated short- and long-term price elasticities • Estimation of potential total revenue for each levy concept taking into account short- and long-term price elasticities • Estimation of relative changes in sales of active substances or groups of active substances based on relative changes in sales of plant protection products per levy concept • Calculation of the potential treatment area that could be treated with the quantity of active substances sold or estimated according to the levy concept, if the maximum permissible application quantities were exhausted.

[57] Plant protection products whose authorisation does not specify an application dose per usage and no usage frequency per hectare and year were not included into the database model, as the UFZ levy concepts are based on the maximum permissible application dose. This concerns plant protection products that are only approved as stock protection products or as home and small garden products or for seed dressing.

2 The Limits of Regulatory Law

The authorisation and use of chemical plant protection products and their active substances (pesticides) are currently managed by regulatory provisions of the European Union and the federal government. Thus, the state only relies on one instrument to protect the environment and human health from the risks of pesticides, which is supplemented by information services provided by state agricultural and environmental authorities. In principle, regulatory law is a very effective and also efficient instrument.[58] However, it reaches its limits when, as in the case of pesticides, not all effects and risks for humans and the environment are examined or can be determined in the authorisation procedure, and therefore cannot be excluded by means of prohibitions and bans (see Section 2.1).[59] In addition, there are extensive difficulties in monitoring the application specifications, since plant protection products are used by more than 10 million farms on about 40 % of the EU land area and an unknown number of non-professional users at different times.

Pesticides intended to suppress or decimate target organisms (undesirable plants, pathogens and pests) regularly have a direct toxic effect on many non-target organisms (including beneficial organisms)[60] and, together with other intensification measures (e.g., high nutrient supply, narrow seed rows) also cause indirect negative effects for ecosystems (e.g., the decline of bird populations due to a lack of food because of the decline of insects and wild herbs).[61] Recent studies show that pesticides are also dispersed to a much greater degree by wind and water away from application sites than currently assumed in the approval process, so that they can be detected in many running waters and even at greater distances and in nature reserves (see Section 2.2).

2.1 Authorisation Procedures and Regulatory Application Rules do not prevent Environmental Effects and Health Risks

There is a widespread assumption among the public that the use of plant protection products is harmless to the environment and human health, because the products are subject to an extensive authorisation procedure. However, this assumption is not correct, as neither the European authorisation procedure nor the European regulations on the use of plant protection products prevent all effects on and risks for the environment and human health.[62]

According to Regulation 1107/2009/EC concerning the Placing of Plant Protection Products on the Market, plant protection products (i.e., products sometimes containing several active substances) and active substances require authorisation, which is granted for active substances by the European Commission and for products by the individual Member States.[63] Within the framework of the authorisation, both active substances and plant protection products must be examined with regard to their effects on the environment and human health (Art. 4 and Art. 29 in conjunction with Annex II of Regulation 1107/2009/EC). Active substances and plant protection products must be sufficiently effective and must not have any immediate or delayed harmful effects on human or animal health, unacceptable effects on plants, the environment, biodiversity, and ecosystems, or

---

58 Cf. Möckel 2016.

59 Cf. Storck/Karpouzas/Martin-Laurent 2017.

60 Cf. Schulz et al. 2021; Liess et al. 2021; Calvo-Agudo et al. 2020; Wintermantel et al. 2020; Uhl/Brühl 2019; Goulson/Thompson/Croombs 2018; Schäffer et al. 2018, p. 17 et sqq.; SRU/WBBGR 2018, p. 19 et sqq.; SRU 2016, p. 381 et sqq.; Mbanaso et al. 2014; Milanovic/Milutinovic/Stojanovic 2014; Krüger et al. 2013; Boily et al. 2013.

61 Cf. Niggli et al. 2020, 4 et sqq., 9 et sqq.; Silva et al. 2019; Uhl/Brühl 2019; SRU/WBBGR 2018, p. 19 et sqq.; BfN 2018, p. 3 et sqq.; Schäffer et al. 2018, p. 18 et sqq., 28 et sqq.; UBA 2016, p. 8 et sqq.; SRU 2016, p. 376 et sqq., 384 et sqq.; Hallmann et al. 2014; Hötker et al. 2014; Meyer et al. 2013; Steffen et al. 2013.

62 SRU 2016, p. 371 et sqq., 389 et sqq.; Möckel et al. 2015, p. 53 et seq., 61 et sqq.

63 Cf. Overview in European Court of Auditors 2020 and SRU 2016, p. 371 et sqq.

cause unnecessary suffering or pain to vertebrates. If they pose hazards that have been classified as particularly relevant (e.g., carcinogenic, mutagenic, toxic for reproduction or endocrine-disrupting properties for humans and animals), or if they are persistent, bio-accumulative, or toxic in the environment to an extent defined in the Regulation, their placing on the market is either prohibited, or their use is restricted by specified conditions.

Even if there are no reasons for exclusion, every authorisation involves a consideration of efficacy in crop protection and negative effects as well as risks for humans and the environment, since efficacy against target organisms is regularly accompanied by undesirable effects on non-target organisms.[64] The same applies for medicinal products: No effect without side effects. Decisive for the efficacy as well as the type and extent of undesirable side effects is the quantity of active substances applied and the frequency of application as well as, if applicable, the method of application of the respective plant protection product. The authorisation therefore specifies the maximum application dose per hectare and the maximum number of applications per year (vegetation period of 12 months) for each plant protection product for respective crops as well as the waiting periods between applications according to the different efficacies, properties of the active substances contained, and special requirements of the respective crops.[65] The specifications are supplemented, where appropriate, by special hazard warnings for users with regard to the protection of health or the environment (e.g., pointing to personal protective equipment or special caution with regard to water) and, where necessary, by application requirements in order to manage risk.

In addition to the effects on and risks to the environment and human health permitted by an authorisation, there are also unrecognised effects and risks, since not all short- and long-term effects and risks are determined in the authorisation procedure.[66] The reason for this is, on the one hand, that the analyses are mainly laboratory tests and, at best, studies on the real long-term effects also exist, if the active substances or products have been used for many years. Artificial test systems, however, are based on few laboratory-tested species[67] in mostly completely artificial environments, which do not mirror ecosystems with their wide variety of animal and plant species, their interactions as well as other stress factors (e.g., other active substances and pollutants, lack of food and water, heat/ frost). The authorisation procedure, therefore, does in particular not determine and take into account cumulative, long-term, and indirect effects of pesticides on wild species. In addition, the approval procedure has so far also only taken into account the dispersal of pesticides by wind and water for a close range of up to 50 meters from the application site, although active substances and their breakdown products disperse over much greater distances (see Section 2.2).[68]

On the other hand, only individual active substances or plant protection products are examined in the authorisation procedure. Interactions between different active substances or plant protection products as well as the effects of pesticides cumulating in the environment including the interplay with further stress factors (e.g., heat, drought, other pollutants) are in fact not examined, although in reality a large number of pesticides and degradation products often accumulate on agricultural land and in the soil and waters.[69] Only with regard to human or animal health, cumulative and synergistic effects are to be taken into account in the authorisation process according to Art. 4 of Regulation 1107/2009/EC; this, however, only “where the scientific methods accepted by the Authority to assess such effects are available”. Although many improvements in risk

---

64 SRU 2016, p. 376 et sqq.; UBA 2016, p. 8 et sqq.

65 Cf. BVL 2020b.

66 Cf. Critique in Knillmann et al. 2021; Weisner et al. 2021; Niggli et al. 2020, 14 et sqq.; Silva et al. 2019; Uhl/Brühl 2019; Schäfer et al. 2019; Storck/Karpouzas/Martin-Laurent 2017; SRU 2016, p. 389 et sqq.; UBA 2016, Liess/Schäfer/Schriever 2008.

67 As a proxy for the wild species groups.

68 BVL 2020c, p. 8-19. Cf. Liess et al. 2021; Weisner et al. 2021; Hofmann et al. 2020, p. 125-129; Niggli et al. 2020, p. 6 et sqq.; Schäffer et al. 2018, p. 21 et sqq.

69 Cf. Knillmann et al. 2021; Weisner et al. 2021; Liess et al. 2021; Silva et al. 2019.

assessment are necessary and feasible,[70] it will hardly be possible in future to predict all direct and indirect effects of pesticide use in an authorisation procedure.

If the authorisation does not prevent all negative effects and risks for humans and the environment, then the application and corresponding application instructions are all the more important. According to Art. 55 of Regulation 1107/2009/EC, plant protection products must be used “properly”. This includes following the principles of good plant protection practice and complying with the conditions laid down in accordance with Art. 31 of Regulation 1107/2009/EC and indicated on the label (application instructions and (hazard) information on the ‘package insert’). Furthermore, the provisions of Directive 2009/128/EC establishing a framework for Community action to achieve the sustainable use of pesticides, and in particular, since 2014, the principles of integrated pest management set therein in Art. 14 and Annex III, must be complied with.

Integrated pest management requires that professional users give preference to non-chemical methods whenever possible and use those methods and products that pose the least risk to human health and the environment. Due to the lacking specification of the principles of integrated pest management (e.g., with regard to damage thresholds and precautionary measures) in European and national plant protection legislation and the resulting issue of official monitoring, extensive implementation deficits exist in practice.[71] Compliance with the principles has not yet been a cross-compliance requirement within the framework of the European direct payments for agricultural enterprises according to Art. 93 in conjunction with Annex II of Regulation 1306/2013, as statutory management requirement SMR 10 does not refer to sentence 3 of Art. 55 of Regulation 1107/2009/EC. The European Court of Auditors takes this as a reason for the low level of compliance with the principles by agricultural enterprises and the insufficient monitoring by Member States.[72] Integration could indeed promote compliance with the principles of integrated pest management due to the European control and sanction requirements for cross-compliance. However, even with such a linkage under state aid law, the regulatory deficits in integrated pest management and the monitoring difficulties on the ground remain.

Overall, neither the authorisation nor the application requirements under European law completely rule out negative effects and risks for the environment and human health. Particularly serious is the lack of corresponding upper limits for the number of plant protection products used per hectare and year as well as the lack of legally binding damage thresholds and reporting obligations within the framework of integrated plant protection. In view of these limitations, it is difficult to achieve the EU's target of halving the use of plant protection products by dint of authorisation procedures and application requirements alone. If fewer products are authorised, the remaining ones will be used more widely so that the area and intensity of treatment will change little as a result. Restrictions on the maximum permissible application doses or on crop- or site-specific application areas could reduce the use, but, like stricter requirements for integrated pest management, this would require a significant increase in monitoring activities by the Member States to ensure compliance with the application requirements. At present, according to the European Court of Auditors, Member State monitoring is far from sufficient.[73]

70 Cf. Knillmann et al. 2021; Niggli et al. 2020, p. 6 et sqq.; Schäfer et al. 2019; Schäffer et al. 2018, p. 21 et sqq.; UBA 2016.

71 Cf. European Court of Auditors 2020.

72 European Court of Auditors 2020, p. 20 et seq.

73 European Court of Auditors 2020b.

2.2 Input of Pesticides into the Environment Outside the Treated Areas

The use of plant protection products not only has a direct impact on the flora and fauna of the treated areas but also regularly leads to contamination of non-target areas including protected areas, settlements, and water bodies. Long-known entry pathways are: spray drift of plant protection products during application through air movement, volatilisation (transition into the gaseous phase) after accumulation on the target area, re-deposition in the immediate vicinity, and the airborne transport of seed coating dusts during the sowing process.[74] In the European approval procedure, however, the dispersal is only taken into account up to a close range of 50 meters from the application site.[75] Yet, according to the German Federal Office of Consumer Protection and Food Safety (BVL), it has been known since the 1990s at the latest and has been the subject of many studies that pesticides are also dispersed over much greater distances via the air.[76]

In a recent study, the long-distance air travel of pesticides in Germany was documented on the basis of samples of bark, passive collectors, air filters and bee bread, with most of the pesticides detected having travelled a distance of 100 to over 1,000 meters.[77] There were no significant differences between the samples from protected areas (including national parks, biosphere reserves, nature reserves and Natura 2000-sites) and those taken outside protected areas, either in terms of the number of pesticides or their concentration; but similar or in some cases even higher pesticide loads were found in protected areas than outside.[78]

Pesticides and their breakdown products are also carried into water bodies[79] via precipitation and transported to the seas via flowing waters. If applied improperly,[80] direct input can also occur. Extensive studies have found a wide variety of pesticides in large rivers and streams in Germany,[81] with corresponding negative effects on river ecosystems.[82] In 2018 and 2019, the Helmholtz Centre for Environmental Research (UFZ) was commissioned by the Federal Environment Ministry to sample small and medium-sized flowing waters at 140 monitoring sites in agricultural landscapes across Germany.[83] The sampling recorded both short-term load peaks due to the runoff after heavy rainfall (using event-controlled samplers) and the average load over a longer period of time (using passive samplers and stream fleas as living passive samplers).

Based on the analysis of 101 sections of flowing waters throughout Germany, the results of the project[84] show that 83 percent of the sampled streams did not meet the pesticide-related ecological objectives under the European Water Act and exceeded the current legal thresholds in 81 percent of the sampled flowing waters. Furthermore, it was found that exposure to agricultural pesticides was the main factor in reducing sensitive insects in aquatic invertebrate communities, surpassing the relevance of other anthropogenic stressors such as poor hydro-morphological structure. These results are in line with other studies in which pesticides have been detected in flowing waters and according to which these pesticides have a decisive share in the damage to the

---

74 BVL 2020c.

75 BVL 2020c, p. 8.

76 BVL 2020c, p. 8 with further references.

77 Hofmann et al. 2020, p. 125-129.

78 Hofmann et al. 2020, p. 102 et sqq. In another study, significant amounts of pesticides were also detected in nature reserves North Rhine-Westphalia and Rhineland-Palatinate (Buijs/Mantingh 2020).

79 Directly or via soil and groundwater.

80 Cf. according to § 12 para. 2 German Plant Protection Act (Pflanzenschutzgesetz), plant protection products may not be applied in or in close proximity to surface waters and coastal waters.

81 Weisner et al. 2021; Schäfer et al. 2011.

82 Knillmann/Liess 2019; Beketov et al. 2013.

83 Project „Umsetzung des Nationalen Aktionsplans zur nachhaltigen Anwendung von Pflanzenschutzmitteln (NAP) – Pilotstudie zur Ermittlung der Belastung von Kleingewässern in der Agrarlandschaft mit Pflanzenschutzmittel-Rückständen“ (Kleingewässermonitoring – KgM), https://www.ufz.de/kgm/index.php?de=44480.

84 Liess et al. 2021.

aquarian biocoenosis within agricultural catchment areas.[85] This also shows that the current authorisation of pesticides, which aims to prevent unacceptable adverse effects, underestimates the actual ecological risk as (i) measured pesticide concentrations exceeded current regulatory acceptable concentrations in 81% of the agricultural streams investigated, (ii) for several pesticides the inertia of the authorisation process impedes the incorporation of new scientific knowledge and (iii) existing thresholds of invertebrate toxicity drivers are not protective by a factor of 5.3 to 40.

Thus, according to the current state of the art, it is proven that a large amount of the pesticides applied are dispersed by wind and water over medium to long distances and that neither the European authorisation legislation nor the application regulations in Europe and Germany have been able to prevent this sufficiently so far.

3 Levies as Steering and Financing Instruments

3.1 Objectives of a Steering Levy on Plant Protection Products

3.1.1 Conceptual Considerations on the Objectives of a Plant Protection Product Levy

Environmental levies provide economic decisions on environmentally relevant scarce resources with an (additional) state-administered price, which is supposed to reflect the economic value of the environmental and health impacts of these decisions not yet taken into account in the market price. The additional price component expressed in the levy thus places incentives to reconsider resource use economically, namely now under the impression of completed cost signals. The incentives conveyed by prices basically work to reduce the use of resources that are harmful to the environment and/or health. Environmental levies are therefore also referred to as the ‘economic lever’ of environmental policy. Steering levies on plant protection products follow this logic and set state-administered price signals on the purchase and use of plant protection products.

A levy on plant protection products fulfils a dual steering function:

(1) *Effective Purpose:* By making the use of plant protection products relatively more expensive (compared to alternatives that are not subject to the levy or are less subject to the levy, or to partial or complete abandonment), the levy restructures the economic profitability of the use of plant protection products and in this way creates economic incentives for users to reconsider their previous use (*substitution effects*). In addition to a reduction in the overall use of plant protection products, this also includes a shift in demand from relatively toxic and risky to comparatively less risky plant protection products (so-called *internal substitution*). At the same time and as a result of the levy, any continued use of plant protection products becomes more expensive for users, which in turn affects the profitability of plant protection product-intensive production itself and causes multiple secondary effects, such as an increase in prices for respective products on sales markets (*income effects*; also: *market and price effects*). A steering levy acts as an ‘economic lever’ both directly through the desire to avoid the levy (reduced use, substitution of the products or active substances subject to the levy) and indirectly through the continuing obligation to pay for the quantities used that were not avoided or substituted (loss of purchasing power). Both effects comprise the purpose of a steering levy and constitute its actual economic steering function. In the sense of a structural change, economic decisions (the use of plant protection products as production factors, product prices, purchase decisions, investment decisions) are re-

85 Cf. for Europe (Beketov et al. 2013; Schäfer et al. 2011; Liess/Ohe 2005), North America (Chiu/Hunt/Resh 2016), South America (Hunt et al. 2017) and Australia (Beketov et al. 2013).

evaluated and adjusted along the entire value chain for agricultural, forestry or horticultural products under the influence of a price for the production factor ‘plant protection products’ corrected by the state by dint of a levy.

Such adjustment decisions are made both by the users of pesticides themselves and by the consumers of agricultural end products, by the manufacturers of plant protection products (product innovations, new compositions, or active substances) or by investors in sectors that use plant protection products. Whether a reduction of plant protection products occurs, to what extent, in which region and sector as well as at which stage of the value chain and for which products (e.g., markets for plant protection products themselves or markets for agricultural end products), and when exactly (now or later) remains open in the context of a steering levy. In contrast to regulatory law, levies maintain degrees of freedom in decision-making and thus the possibility for users to consider the individual costs incurred by abandonment or substitution, for instance. In any case, the secondary market and price effects on upstream factor markets (e.g., the capital market) and downstream sales markets contribute in the long-term to a structural change, which will also be accompanied by reductions in the use of plant protection products. For example, products that are made without or reduced use of plant protection products will gain a further cost and price advantage due to the levy, which will become noticeable in the competition on the sales markets. Furthermore, innovations on the side of producers are incentivised in the long term. This means that dynamic long-term effects are also an important component of steering activity. Incidentally, a levy also leads to a more economically efficient use of plant protection products in the sense that only those applications are made for which the user's estimated benefit exceeds the costs of use (which are now corrected upwards due to the levy). The reduction of ‘inefficient’ pesticide use (economic aspect) also helps to improve the quality of environmental media at the same time (ecological aspect).

(2) *Purpose of funds application:* Irrespective of the various incentives to change behaviour by reducing purchasing power in the private sector, a regulatory charge that does not completely stop the levied behaviour always also provides the public sector with financial resources (*revenue effect*). This revenue effect is not ‘alien to steering’, as is sometimes wrongly argued; nor does it stand in any fundamental tension with steering. On the contrary, every sensibly designed steering levy (without the intention of eradication) necessarily incurs a fiscal revenue: This revenue precisely reflects the state-administered environmental costs that arise in the remaining, economically efficient use of plant protection products and in this way is compensated for by users. The revenue for a public budget (*financing effect*) and the withdrawal of funds from the private sector (*income effect*) are in fact mirror images of each other. Thus, the resulting revenue (as a withdrawal of funds from the private sector for environmental effects) is in this respect also an elementary component of steering. If the conceptual focus is now also on the targeted use of these funds that flow into public budgets, then the levy has an intended purpose in addition to its effective purpose. Typically, environmental steering levies are in practice combined *effective purpose/ intended purpose levies*, which see their objectives both in the sphere of raising and in the subsequent use of funds.

Such an understanding would also be useful for levies on plant protection products in Germany. Concrete uses could, for example, refer to compensatory but steering-neutral income transfers to the payer sectors (agriculture, forestry, horticulture) but also to additional crop protection product-related mitigation and relief measures, such as the introduction of side strips or recolonisation sections (‘stepping stones’) as well as to the financing of accompanying informational measures (user advice). Moreover, the funds could also be used to establish buffer zones, to finance compensation payments in water protection areas or to provide advice and financial support for the further development of non-chemical plant protection measures. If the funds are used in a targeted manner in the sense of a steering function, this can also have a ‘topping-up’ effect in contrast to the pure steering effect of collecting the levy.

Table 3 summarises the various functions of a combined effective purpose/ intended purpose levy. In addition to the steering and financing functions already mentioned, functions are also significant that result specifically from a combination of levy and regulatory steering of plant protection products (policy mix). Here, on the one hand, a plant protection product levy has a *function supporting enforcement*, in which compliance with regulatory requirements, in particular those with enforcement deficits, is effectively *supported* by the 'economic lever'; on the other hand, the regulatory management of plant protection products is *supplemented* in that the remaining use of plant protection products, even if requirements are complied with, is subject to a levy (remaining use burden). This remaining use would be left unaddressed by regulatory law and free of external costs.

Table 3 Functions of a combined effective purpose/ intended purpose levy

<table>
<tr><th colspan="6">Levy Functions (Combined Effective Purpose/ Intended Purpose Levy)</th></tr>
<tr><th colspan="4">General Functions</th><th colspan="2">Special Functions in the Regulatory Policy Mix</th></tr>
<tr><td colspan="3">Steering ('Effective purpose')</td><td rowspan="3">Financing ('Funds application purpose')</td><td rowspan="4">Enforcement support</td><td rowspan="4">Remaining use burden</td></tr>
<tr><td rowspan="2">Substitution effects (Steering burden)</td><td colspan="2">Income effects (Payment burden)</td></tr>
<tr><td>static (Market and price effects)</td><td>dynamic (Innovation, long-term effects)</td></tr>
<tr><td colspan="3">Top-up effect</td><td>↵</td></tr>
</table>

The possible steering effects of a levy on plant protection products are compiled in Table 4, according to the static effects that will occur in the short and medium term with regard to the direct substitution of plant protection products and the indirect effects via the value chain (*market and price effects*). These effects reflect the various economic responses to the relative increase in the price of plant protection products under given conditions. However, these conditions are themselves also changed in the long-term by the incentive effects, e.g., through innovation effects that relate to novel, less hazardous products or allow a reduction in the volume or frequency of use. Such incentives aim primarily at manufacturers, because they will be interested in developing products and active substances that can be marketed without or with a lower levy burden, yet which offer similar benefits for users. At the same time, there will be incentives in the longer term for users to make greater efforts to obtain information about the targeted use of plant protection products, i.e., to demand information. This makes it possible to reduce the use of plant protection products in an appropriate manner, bypassing the levy burden, without significantly reducing the yield-stabilising effect of the products (reduction of excessive use of plant protection products beyond what is necessary).

A levy imposes two economic burdens on those paying it, i.e., the users of plant protection products: the actual payment burden for the not avoided quantities of plant protection products, but also the adjustment or steering burden, which consists of the fact that under the impression of the obligation to pay the levy, changes are now made that were not economically sensible before, i.e. without the levy, and serve the purpose of avoiding the payment burden. The payment burden and the steering burden each trigger typical behavioural changes along the value chain.

Table 4 The economic functions of a special-purpose levy through the effects (burden) of levy payment and steering behaviour

Functions of payment burden		**Functions of steering burden**
Dynamic Effects	**Static Effects**	
	Secondary Effects (Market- and price effects)	**Primary Effects** (Substitution effects)
Innovations in active substances and PPP products Long-term reductions in use due to technological progress Incentives to demand information	Restriction of production due to reduced profitability Correction of market distortions in favour of PPP-free/ low products Decrease in market demand for goods produced under intensive use of PPP Market exit of marginal suppliers	Restrain of PPP use Transition to alternative PP methods (integrated PS, etc.) Substitution of active substances Reduction in use frequency Reduction in use quantity

3.1.2 The Objectives of a Plant Protection Product Levy in Germany

It seems sensible to design a steering levy on plant protection products in Germany as a combined effective purpose/ intended purpose levy of the '*demeritorisation type*' (structural change levy), which in this respect builds on the experience with environmental steering levies in Germany.[86] The sub-objectives of avoiding and substituting active substances, supporting regulatory enforcement and financing (e.g., further plant protection product measures, compensation in the form of lump-sum refunds to users of plant protection products) play a key role here. However, linking the levy to concrete compliance targets or timelines is not recommended. The steering objectives of avoidance, substance substitution and enforcement support are aimed equally at a general reduction in the use of plant protection products but at the same time also at a reduction of pollution caused by them.

Moreover, the environmental impact can be mitigated by substituting active substances, even if plant protection products are used. Targeted substitution geared towards 'more environmentally compatible' plant protection products has important advantages because of the special direction of the steering (environmental relief) and because of the lower costs 'per unit of environmental relief' for the users (cost relief). However, the informational and practical requirements for implementing such a levy are considerable, because there must be available corresponding reliable information on the relative environmental compatibility of active substances and combinations of active substances, which usually also depend on the specific application (duration of use, frequency of use, dose used per application) and the exposed organisms. These differentiations would also have to be implemented in concrete terms when it comes to collecting the levy. In addition, there is often a risk of undesirable displacement effects, for example with regard to non-target organisms.

Therefore, the general reduction in the use of plant protection products should be the primary function of a steering plant protection product levy. In addition, however, substances that pose a lower environmental risk but at the same time have a very specific effect, can, for instance, receive reduced levy rates in order to encourage the increased use of these substances as substitutes. This means that a certain but pragmatic differentiation of the levy can also be made according to environmental or health risks. Both objectives

86 See Ewringmann/Schafhausen 1985; Gawel et al. 2011.

correspond to the goals of European and national plant protection and environmental policy.[87] On the other hand, active substances that are particularly hazardous to the environment could be identified by regulatory means via the authorisation regime in the course of tests and requirements on persistence, bioaccumulation, mobility, and toxicity and kept off the market by means of restrictions. Here, a (eradicating) levy would not be the appropriate vehicle.

3.2 The Prerequisites for a Successful Steering Levy

A steering levy is ‘successful’, if it fulfils its basic functions of steering (effective purpose) and raising revenue as well as using funds respectively (intended purpose).

In the short and medium term, the extent of the expected reduction in use depends not only on the level of the levy rate and its inflation hedging (e.g., as a price premium [so-called *ad valorem-levy*] compared to a pure quantity levy) but also crucially on the willingness to pay for plant protection products. If the latter is very high, because users expect large yield improvements from the use of plant protection products, and if the possibilities are favourable for passing on the additional costs onto the sales market, only minor restrictions will result. This effect is theoretically measured in the so-called price elasticity of demand. The price elasticity of demand indicates the ratio of the relative change in volume to the relative (levy-related) change in price. Price elasticities in the value range between 0 and –1 indicate that the quantity demanded reacts disproportionately to a price impulse; a (e.g., levy-related) percentage price increase is thus responded to by a disproportionately small reduction in quantity. In this case, however, the product of price and volume (revenue from the seller's point of view, procurement expenditure [= costs] from the buyer's and user's point of view) still increases. This is referred to as an inelastic responsiveness of demand. Values that are mathematically below –1, e.g., –1.5, on the other hand, indicate an elastic demand responsiveness, in which the volume demanded responds disproportionately, relatively speaking, to a certain percentage price impulse.[88]

Regardless of the conceptual economic-theoretical seperation into an elastic (disproportionately high quantity reaction) and an inelastic range (disproportionately low quantity reaction), this must not be confused with ‘strong’ and ‘weak’ reaction. This error of interpretation is, of course, widespread outside of economics. A disproportionately low quantity reaction can also represent a noticeable, strong reaction. For example, a price elasticity of demand of –0.5 implies that a doubling of the price, e.g., from 2 EUR to 4 EUR, is met with a halving of the previous quantity demanded. This will probably have to be described as quite substantial, although it is ‘inelastic’, because +100 percent in price results in ‘only’ –50 percent in quantity. For this reason, practically all price elasticities that are mathematically smaller than –0.1 (e.g., –0.15, –0.3 etc.) embody significant quantity reactions (and by no means rigid demand conditions). Empirically determined price elasticities are in many cases even ‘below’ this level, i.e., they are to be regarded as even stronger (see Chapter 6 for more details).

The extent to which a pesticide levy affects the equilibrium price on the sales market at all, i.e. is initially reflected in the market price, depends not only on demand elasticity but also on supply elasticity as well as on the type and design of the levy (quantity or ad valorem-levy; choice of levy payers etc.), the role of trade and finally the extent of the intensity of competition at all market levels (producers, wholesalers, retailers). Except

---

87 Cf. Recital 19 of the Directive 1107/2009/EG and the recitals 5, 12, 18 and 20 of the Directive 2009/128/EG.

88 See Gawel 2009, p. 49 et sqq.

in the case of completely inelastic demand, it can be assumed that the resulting market price increase will lag behind the levy rate.[89]

The higher the price elasticity on the buying market for the production factor ‘plant protection product’, the more a certain levy-related increase in the price of plant protection products in the equilibrium price will result in lower demand. Here again, a number of factors are significant:

- What is the extent of substitution alternatives (known to the users), such as alternative methods of plant protection or plant protection products with a lower environmental impact?
- What changes in yield are likely to result from these alternatives or from not using them? What (possibly incorrect) expectations do users have in this regard?
- To what extent is there overdosage that can be reduced without risk to yield, and what is the respective level of information among users? Can spontaneous market institutions or accompanying instruments improve this level of information?
- How high is the price elasticity of demand on the markets for end products (e.g., fruits, vegetables, cereals) and thus the possibility of passing on cost increases in the sales price, if necessary?
- What is the extent of the competitive advantage that products with lower pesticide levels or without the use of pesticides can realise over conventional products as a result of the levy on the sales markets (levy-induced price spread)?

In reality, moreover, decisions on factor inputs in agriculture are not only made according to strictly economic rational criteria; rather, there is a plethora of other influencing factors that can override a purely rational price reaction.[90]

In the medium to long term, the dynamic potentials of structural change also emerge as success factors: What effect does the price spread have on consumer behaviour in the long term? To what extent do incentives succeed at the producer level for the development of alternative or less environmentally harmful plant protection products? To what extent can the level of information of users be improved? Will demand elasticities on the buying markets change as a result? What is the role of accompanying or complementary measures that can be financed via the revenues of the levy?

It is important to note that the steering success of a levy is not called into question by the fact that no or only minor substitution effects occur in the short term; the income effects (the ‘need to pay’) then become all the more noticeable in the long term, as high payment burdens are incurred on hardly or only slightly reduced pesticide quantities, which place a heavy burden on profitability and trigger quests for alternatives – the market is used as a ‘inquiry procedure’. This is particularly true for *demeritorisation levies*, which do not have a concrete environmental policy target and, as mere structural change levies, do not even promise to reduce any specified quantities.[91]

---

89 This is a fundamental insight of taxation theory; see Schmölders/Hansmeyer 1980, pp. 175 et sqq. A volume levy of 1 EUR per unit should therefore generally lead to an increase in the equilibrium price on the market concerned of less than 1 EUR per unit.

90 See, for example, the empirical findings for Denmark in Pedersen/Nielsen/Daugbjerg 2020.

91 In addition, a variety of conditions are crucial for the success of levies on plant protection products. These include, for example, a coherent integration with the regulatory requirements for the use of plant protection products or the actual complex environmental impacts emanating from plant protection products and their (potential) substitutes. Furthermore, it must not be forgotten that an isolated consideration of the regulation of plant protection products falls short in practice. If, for example, less nitrogen is used as fertilizer, the use of plant protection products is likely to be decline concomitantly: on the one hand, the growth is less dense then, which, among other things, leads to reduced humidity and fungal population. On the other hand, less nitrogen in plants means reduced attractiveness to harmful organisms (e.g., aphids). This is a strong argument to carefully embed a levy on plant protection products into the overall management of the environmental compatibility of agricultural and forestry production as well as horticulture.

3.3 The Added Value of a Plant Protection Product Levy in the Policy Mix of Pesticide Policy

Typically, levies are not used as an isolated instrument to solve an environmental problem. Rather, there are regularly multi-instrument constellations in which a levy has an additional effect. The interaction with regulatory approaches is widespread, which is also characteristic of pesticide policy. Here, it is important to avoid friction through a policy mix and to organise a contoured division of labour that ensures the added value of a levy.

In principle, levies as economic levers fulfil certain purposes of a pesticide policy that cannot be fulfilled at all or only to a very limited extent by other instruments. Levies therefore possess special added values, also within the framework of a policy mix. For this reason, they are an important, indeed indispensable part of the instruments supporting any political risk and pollution reduction strategy in the area of plant protection products. But what are these added values?

1. The efficient structuring of direct efforts to reduce use: The steering levy is not only intended to achieve an arbitrary, general reduction in use, but also an economically efficient composition of individual efforts to achieve the goal. The imposition of external costs contributes specifically to achieving a certain target condition at minimum economic cost.

2. The efficient structural change of the economy by dint of market and price effects: The imposition of external costs through levies not only aims at direct measures on the part of the levy payers directly burdened, but also at passing on the price correction down the value chain: noticeable environmental and resource costs (ERC) reduce the profitability of capital used in pesticide-intensive production, possibly also – depending on the degree of passing on – increased product prices and thus demand effects for agricultural products produced in a pesticide-intensive manner. These market and price effects are an important component of the economic functions of levies.

3. The automatic adjustment to changing framework conditions (dynamic efficiency): Permanently imposed external costs confront users with the remaining opportunity costs of their use of nature and encourage them to permanently review whether the individual benefit of their use of plant protection products is still ‘profitable’ in view of the additional social costs of the use indicated by the levy. Changes in costs, technologies and market conditions that suggest a change in economically rational use are implemented in a decentralised manner with low transaction costs, without relying on regulatory implementation that is susceptible to resistance and delays.

4. Innovation: The permanent reflection on the appropriate use of resources also includes the incentive for innovation that can contribute to a reduction in future costs (and not under current conditions) and at the same time to a reduction in the use of nature.

5. Fiscality: Unlike, for example, regulatory law, ‘voluntary’ solutions or informational instruments, levies generate financial resources for the benefit of the public sector. These funds are open for use and offer space for additional activities.

6. Charges are polluter-based (unlike in the case of general tax financing); they convey monetary responsibility for the external costs of impacts on landscape, water, and health. They also do this for the remaining pollution still permissible under regulatory law (unlike, for example, ‘voluntary’ solutions).

7. Levies are a softer means of the precautionary principle (unlike, for example, plant protection product authorisation law). They do not impose yes/ no decisions but leave degrees of freedom for decentralised consideration. They merely require a monetary assumption of responsibility.

Against this backdrop, levies are needed in the policy mix of an effective plant protection product policy, because

– the current plant protection product policy is not achieving its goals and urgently needs new impetus;
– regulatory law has reached its limits in terms of enforcement and due to the emphasis of authorisation law on hazard prevention;
– the negative impacts on soils, water, habitats and human health have so far been insufficiently reflected in product prices (especially for conventionally produced agricultural products);
– because low-pesticide or pesticide-free agriculture has so far not been able to reflect its social added value in agricultural prices;
– pesticide levies have long since proven their feasibility and functionality in other European countries;
– it is unclear how the many special benefits of a levy as an environmental policy instrument (incentives, financing, cost efficiency, etc.) could be ensured elsewhere in the policy mix.

3.4 Construction Elements of a Plant Protection Product Levy

The design elements of a steering pesticide levy include the following basic components, based on which a concrete proposal must then develop respective specifications:

- *Targets* of the levy (effective purpose, intended use, steering concept and, if applicable, specification of objectives),
- *Legal nature* of the levy obligation (e.g., tax, special levy),
- *Debtor of the levy:* Who is liable to pay?
- *Subject* of the levy: What is the levy imposed on? (reference point),
- *Basis of assessment of* the levy: Is a quantity or the sales value (price × quantity) used as the basis of assessment (ad valorem vs. quantity levy)? Is there an environmental risk differentiation?
- *Tariff or levy rates* of the levy: How is the actual payment burden generated from the assessment basis? Does a differentiation of levy rates come into play?
- Finally, *rules on the use of revenue*: What is to be done with the financial resources generated, and for what purpose are they to be used?

The targets of the levy for plant protection products in Germany have already been outlined in Chapter 3. The legal nature of the pesticide levy must be assessed in the light of the overall design and is considered in more detail in Chapter 7. The possibilities for the use of revenue were discussed in detail in the UFZ levy concept of 2015.[92]

With regard to the tax debtor, the technical question must be answered as to who actually owes the payment burden to the enforcement authorities. This answers the question of the ‘levy payer’, which needs to be kept separate from the ‘levy bearer’, who ultimately has to shoulder the economic burden resulting from the levy, and the ‘levy destinatar’, to whom the legislator assigns to carry the burden of the levy.[93] While the levy payer and the levy destinatar can be determined by law, levy bearing is the result of market processes. In principle,

[92] Möckel et al. 2015, p. 262-283.
[93] See Schmölders/Hansmeyer 1980, p. 137 et sqq.

manufacturers, traders, and users can be considered as levy payers. For reasons of collection, it makes sense to link the levy to the placing on the market via (retail) trade, which is already covered by turnover tax and makes a collection from a large number of users (not yet covered) unnecessary. Retail is an important interface in the value chain, which ensures that tax impulses can have an effect on the user level as well as on the manufacturer level.[94]

The actual design of the levy, i.e., the question of what its *subject* is, what the concrete *basis of assessment* is and what the *levy rate or tariff* is, is the matter the respective levy concept; several of which are compared in the context of this study (see Chapters 5 and 6).

94 Including the recommendation of Hoevenagel/van Noort/de Kok 1999, p. 75 et seq.

4 Pesticide Use in Denmark and the Impact of the Pesticide Tax Amended in 2013

Agriculture in Denmark differs from that in Germany in terms of the crops grown. Crops with high treatment indices (vegetables, strawberries, and permanent crops) have smaller or no shares of surface area compared to Germany (viticulture, hops) (see Figure 2[95]). The distribution of crops in Denmark is thus more similar to that of northern Germany.

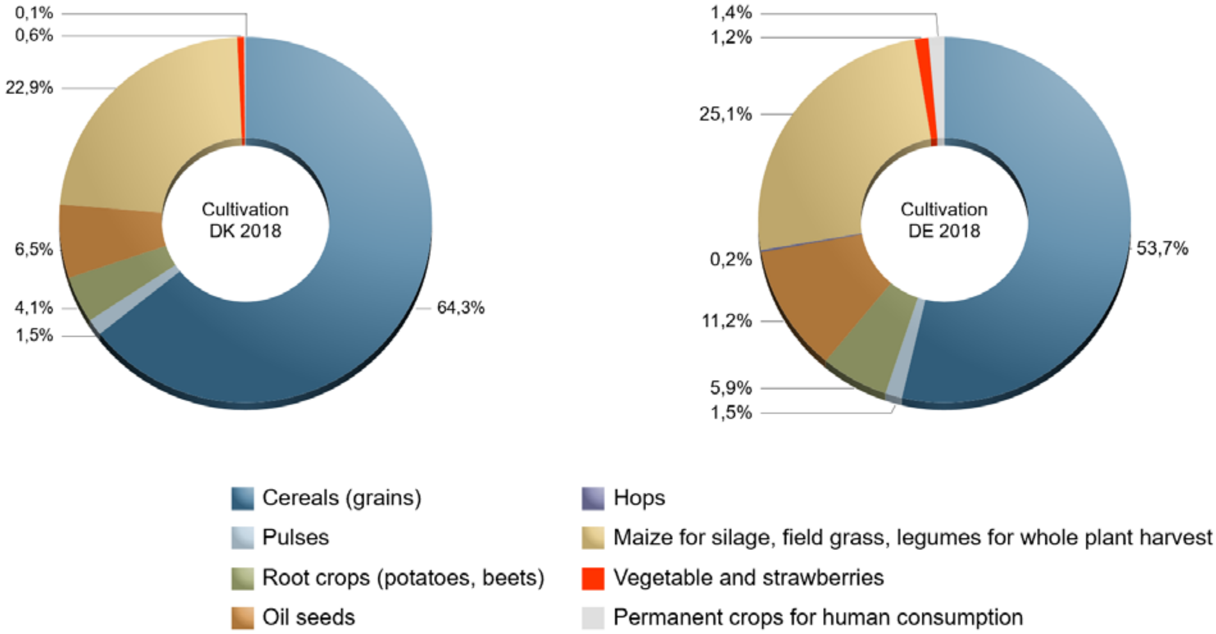


Figure 2 Agricultural use in Denmark (left) and Germany (right) (both excluding permanent grassland and nurseries)

Denmark possesses a higher share of organic production compared to other EU Member States,[96] and especially for table potatoes and in the fruit and vegetable sector the share of area is high, i.e., over 20 percent to over 30 percent. The organically farmed area has increased since 2013,[97] but this increase cannot be attributed to the reform of the pesticide tax. The increase is due (as in almost all EU countries) to an increase in the dairy sector, since the milk price for organically produced milk is much higher than for conventionally produced milk.

In Denmark, significantly fewer active substances are authorised than in Germany. Whereas in Germany between 245 and 290 active substances have been approved in recent years, in Denmark it was between 160 and 180 (see Figure 3). Among other things, important maize and cereal herbicides as well as copper-based fungicides[98] are not permitted in Denmark, unlike in Germany.

95 See Eurostat Data: https://ec.europa.eu/eurostat/web/agriculture/data/database.

96 See Eurostat Data: https://ec.europa.eu/eurostat/statistics-explained/index.php/Organic_farming_statistics.

97 Landbrugsstyrelsen 2020.

98 There is only an authorisation as a biocide for wood preservation.

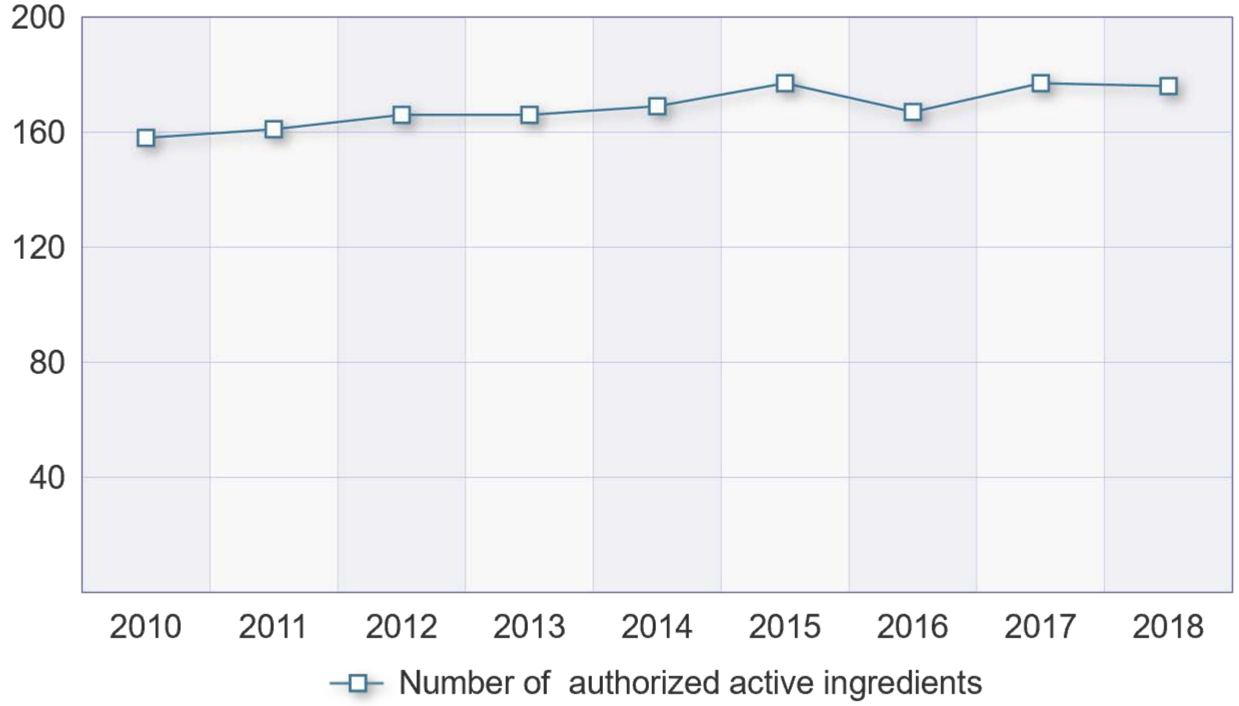


Figure 3 Number of active substances approved in Denmark from 2010 to 2018

4.1 An Overview of Pesticide Use and Sales in Denmark

As early as 1972, Denmark introduced an undifferentiated ad valorem-levy of 3 percent on the price of plant protection products to finance the National Pesticide Plan.[99] In 1996, the levy was converted into a tax, which was still designed as a percentage ad valorem-levy on net sales prices.[100] Not only was the level of the levy increased, but the tax rates became also differentiated. From 1998 onwards, the tax rate for insecticides and chemical agents for soil disinfection was 35 percent, for herbicides, fungicides, plant regulators and repellents 25 percent and for microbiological plant protection products 3 percent.[101] Overall, total sales in Denmark decreased by about 50 percent in the period of 1986 to 2005 (see Figure 4).[102]

99 Pedersen 2016.

100 Pedersen/Nielsen/Andersen 2015.

101 LOV nr. 787 af 09/11/1998. Converted into percentage mark-ups on net sales prices (excluding VAT), the tax rates were 54 percent and percent (Miljøministeriet/Miljøstyreslen, Background and content of the new pesticide tax, 2013, p. 1).

102 Cf. Impact Analysis at Pedersen/Nielsen/Andersen 2015.

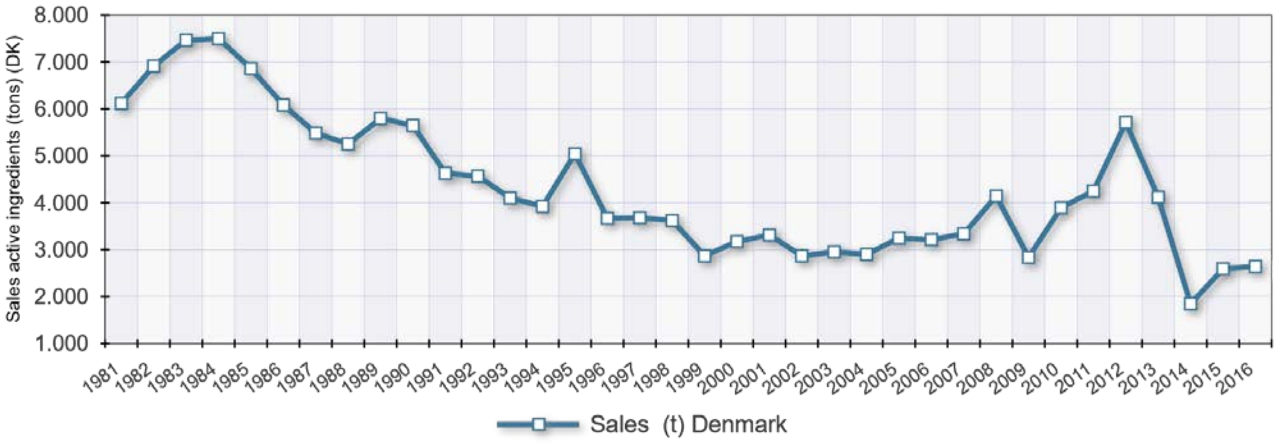


Figure 4 Sales of plant protection products in tonnes in Denmark from 1981 to 2016

Source: Own presentation according to Eurostat[103] and FAOSTAT[104] data

The decline in total sales during this period was mainly due to the abandonment of unprofitable areas and the European promotion of set-aside areas, while the treatment intensity according to the Treatment Frequency Index (TFI) decreased only slightly for the cultivated areas, and the target of 1.7 TFI set in the Action Plan was not achieved.[105] Since the total sales of pesticides increased significantly again from 2007 onwards, a fundamental reform was developed and put into effect on 1 July 2013.[106] The aim of the amendment was, in addition to a general reduction of pesticide use by 40 percent compared to 2010, also to provide tax incentives for substituting the most harmful plant protection products with less harmful ones. Plant protection products with microbiological active substances were exempted from the tax.

With the new tax, the tax level was more than doubled and the ad valorem-levy was changed to a risk-based quantity levy, in which the tax amount payable per kilogram or litre of plant protection product depends on the number of active substances contained and the active substance-specific risks for the environment and human health, summarised in a pesticide load index.[107] The detailed design of the tax is presented in Section 5.3.

While between 3,000 and 6,000 tonnes of pesticide active substances were sold to the agricultural sector in the period from 2007 to 2012 (with a significant slump as a result of the financial crisis in 2008), sales have been significantly lower since 2013 following the tax reform (see Figure 5). Unsurprisingly, the highest sales took place in the year before the reform, as agricultural enterprises increased their stocks in 2012 and the first half of 2013 in view of the discussion about an amendment to the pesticide tax. It must therefore be assumed that pesticide use after 2013 was higher for a certain period than sales data reflect. On average, around 3,840 tonnes were sold annually between 2007 and 2011, and around 2,370 tonnes between 2014 and 2018 – a reduction[108] of around 38 percent.

---

103 Eurostat for 1981-2000: http://epp.eurostat.ec.europa.eu/ portal/page/portal/statistics/search_database#.

104 FAOSTAT for 2000-2016: http://www.fao.org/faostat/en/#data/RP.

105 Pedersen/Nielsen/Andersen 2011; Pedersen/Nielsen/Andersen 2015.

106 LOV nr 594 af 18/06/2012 om ændring af lov om afgift af bekæmpelsesmidler (Omlægning af afgiften på plantebeskyttelsesmidler til mængdeafgift differentieret efter sundheds- og miljøkriterier og forenkling af afgiften på biocider m.v.), https://www.retsinformation.dk/eli/lta/2012/594. Current version LBK nr 595 af 29/04/2020 (Gældende), last amended by LOV nr 168 af 29/02/2020.

107 Miljøministeriet / Miljøstyreslen 2013; Pedersen/Nielsen/Daugbjerg 2020, p. 5 et seq.; Möckel et al. 2015, p. 70 et sqq.

108 Only data from active substances that were approved over the entire period are included in the calculation.

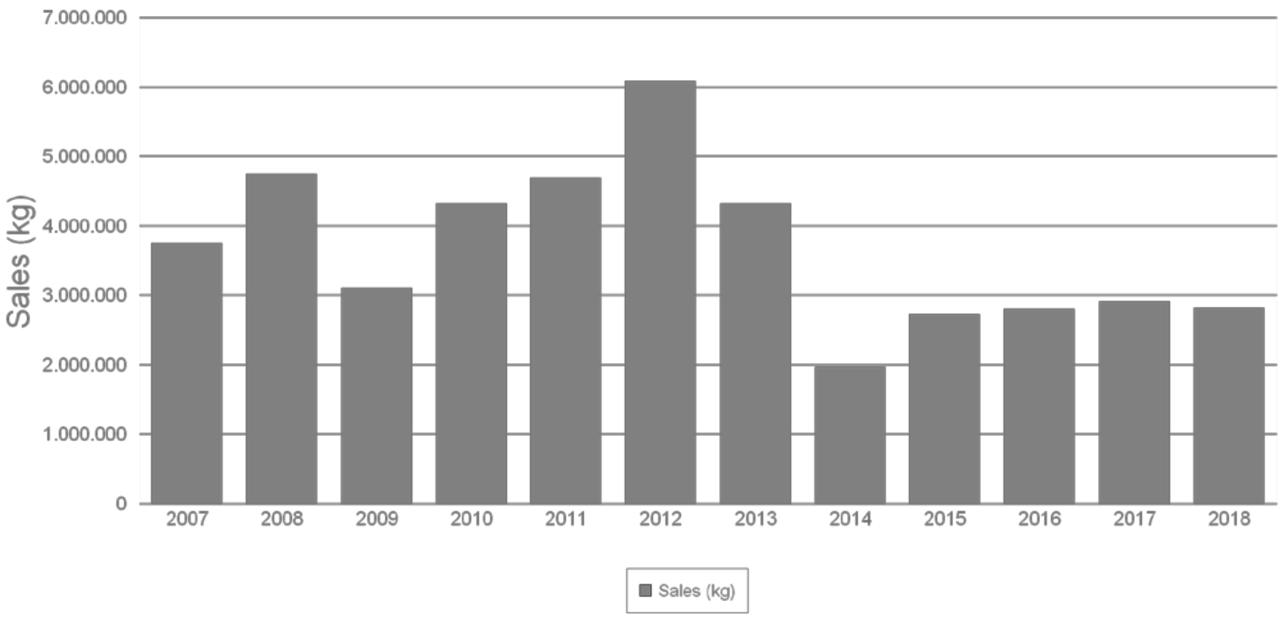


Figure 5 Sales of active substances for agricultural use in Denmark from 2007 to 2018

The impact of the pesticide tax amendment on production volumes and yields has already been studied.[109] No negative effects were established, nor can an accelerated 'extinction of farms' be observed. The continuing decline of agricultural holdings in Denmark is in line with the long-term change (see Figure 6), which can also be observed internationally since the industrialisation of agriculture began. The reformed pesticide tax has not accelerated this process; in fact, the decline in farms between 2005 and 2012 was much greater (–23 percent) than between 2012 and 2019 (–16 percent).

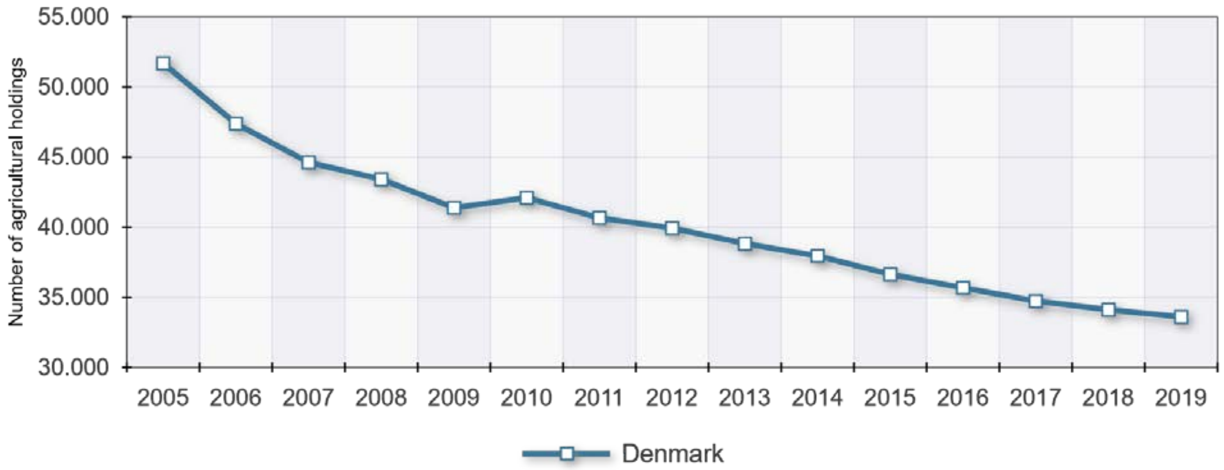


Figure 6 Number of agricultural holdings in Denmark from 2005 to 2019[110]

Due to the high share of cereals in cultivation, herbicides make up the largest share of agricultural pesticide sales in Denmark. They account for 70 to over 80 percent of sales, depending on the respective year. Fungicides account for 15 to 22 percent and growth regulators for about 5 to 10 percent of sales. Insecticides, acaricides

[109] Neumeister 2019; Ørum et al 2018.

[110] Data available at https://www.statbank.dk/ and er BDF11 (Farms by region, unit, type of farms and area) and years.

and other pesticides[111] account for less than 3 percent of the sales volume. Insecticides, acaricides and other pesticides account for less than 3 percent of the sales volume. The following figure shows the distribution of sales by application for the period of 2007 to 2018.

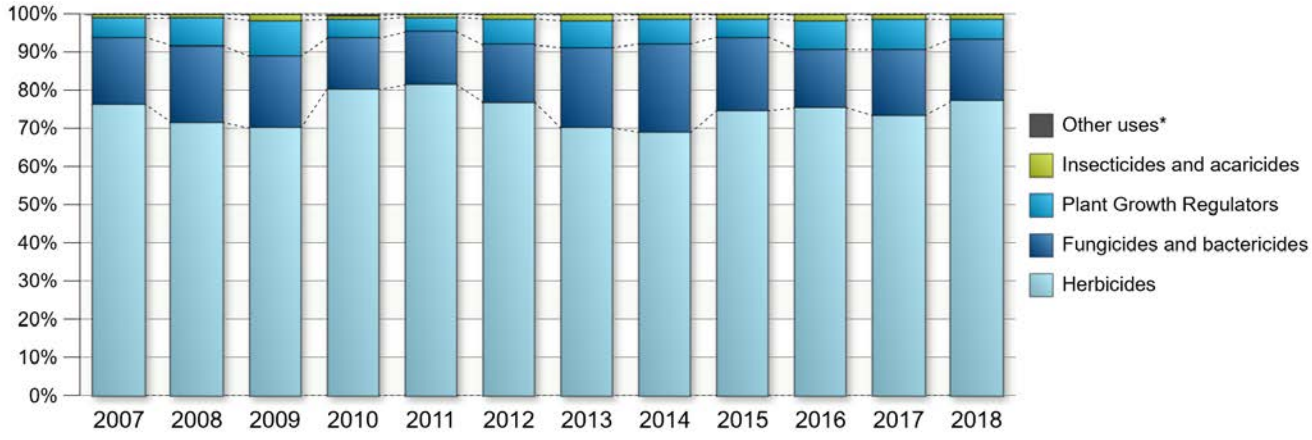


Figure 7 Distribution of sales by application in Denmark from 2007 to 2018

However, the sales volume of active substances says little about the intensity of use, the hazardousness of the individual active substances, the impact on the environment or on human health.[112] An important indicator for assessing the intensity of pesticide use is the treatment index. This describes how often a crop was treated with the full permitted application dose over the entire area. The higher the treatment index, the higher the intensity of product-based crop protection. As the intensity increases, the risk usually increases as well, since the frequency of exposure increases.

Although sales volumes have decreased after the reform of the pesticide tax, the cumulative treated area (see Figure 8) and treatment frequency (see Figure 9)[113] have not decreased overall. For insecticides and acaricides, the cumulative treated area seems to have decreased, but it should be noted that stocks hoarded in 2012 and 2013 were used up in the period from 2014 onwards. The national treatment index (cumulative treated area divided by conventional cultivated area) has accordingly not decreased either.

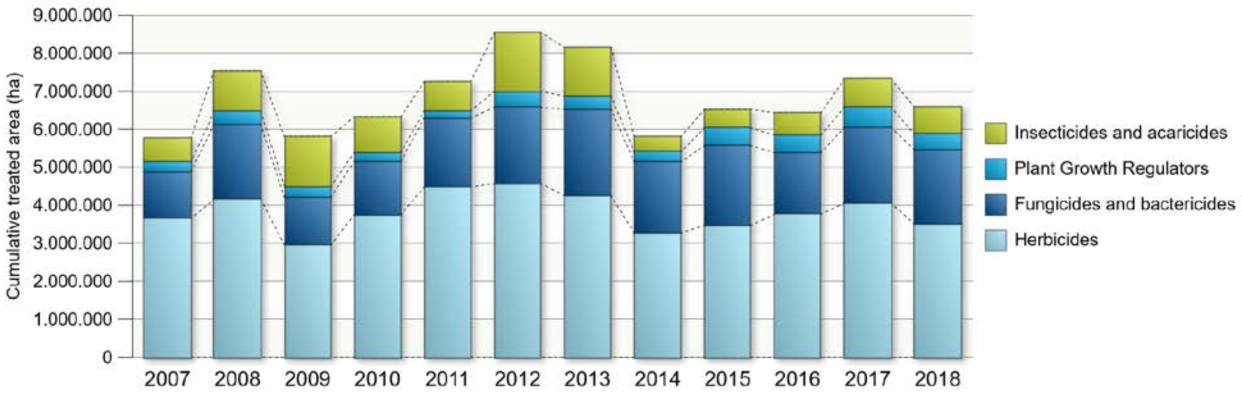


Figure 8 Cumulative treated area (ha) by application in Denmark from 2007 to 2018

[111] Without molluscicides. Only iron phosphate is sold as molluscicide, which mainly goes to private households.

[112] Cf. Schulz et al. 2021; Goulson/Thompson/Croombs 2018

[113] See also Figure 1.2 in Miljøstyrelsen 2020.

The following figure gives an overview of the treatment indices, the sales of glyphosate and of active substances with a high toxic load indicator (>100 points). The Danish Toxic Load Indicator (TLI) summarises the overall toxicity of active substances (see Chapter 5.3). The higher the score, the more problematic the properties of an active substance. The data clearly show the effect of the Danish tax: The total amount of active substances sold in kilograms fell, and sales of active substances with high overall toxicity fell sharply. However, the treatment index did not decrease permanently.

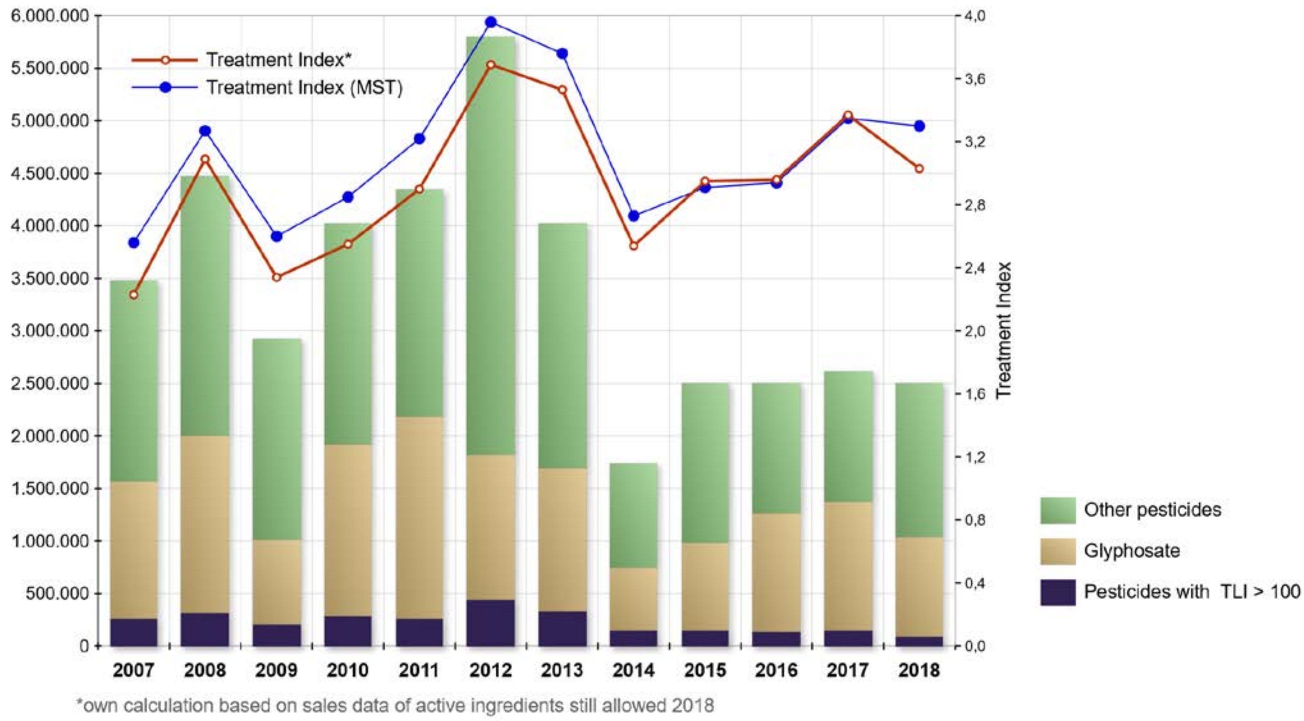


Figure 9 Sales of active substances (kilograms) and treatment index for Denmark from 2007 to 2018

Source: Own calculation and data from Miljøstyrelsen 2018

4.2 Price Development and Sales Volume by Area of Application

The following Chapters trace the development of sales for the most important areas of application. Only active substances that were approved over the entire period from 2007 to 2018 are considered in order to exclude approval effects. Non-agricultural sales are also excluded from the analysis.

4.2.1 Herbicides

The Danish average prices in relation to the maximum permissible application dose per hectare and year (vegetation period of 12 months) show a strong increase for five important herbicides due to the tax reform (see Figure 10). The price of diflufenican[114] remained almost stable and the group of sulfonylurea herbicides saw a reduction. The subsequent price reductions for products with pendimethalin and prosulfocarb are due to changes in the active susbtances formula of the products offered. As of 2017, only one product with prosulfocarb and a low price was sold – this lowered the average price. The number of products sold with

[114] Before the tax was amended, there was a price rise – with the reform the per hectare prices decreased.

pendimethalin has also decreased, and from 2017 the maximum permitted dose for this important active substance was lowered.

The sales data in Figure 11 indicates a corresponding large reduction for active substances. Pendimethalin, whose price per hectare has more than doubled, was sold significantly less. However, low-dose herbicides become hardly visible in this quantity-focussed analysis.

Figure 10 Herbicides – Danish average prices per hectare and year in relation to the maximum permitted application dose for products with relevant active substances 2009 to 2019

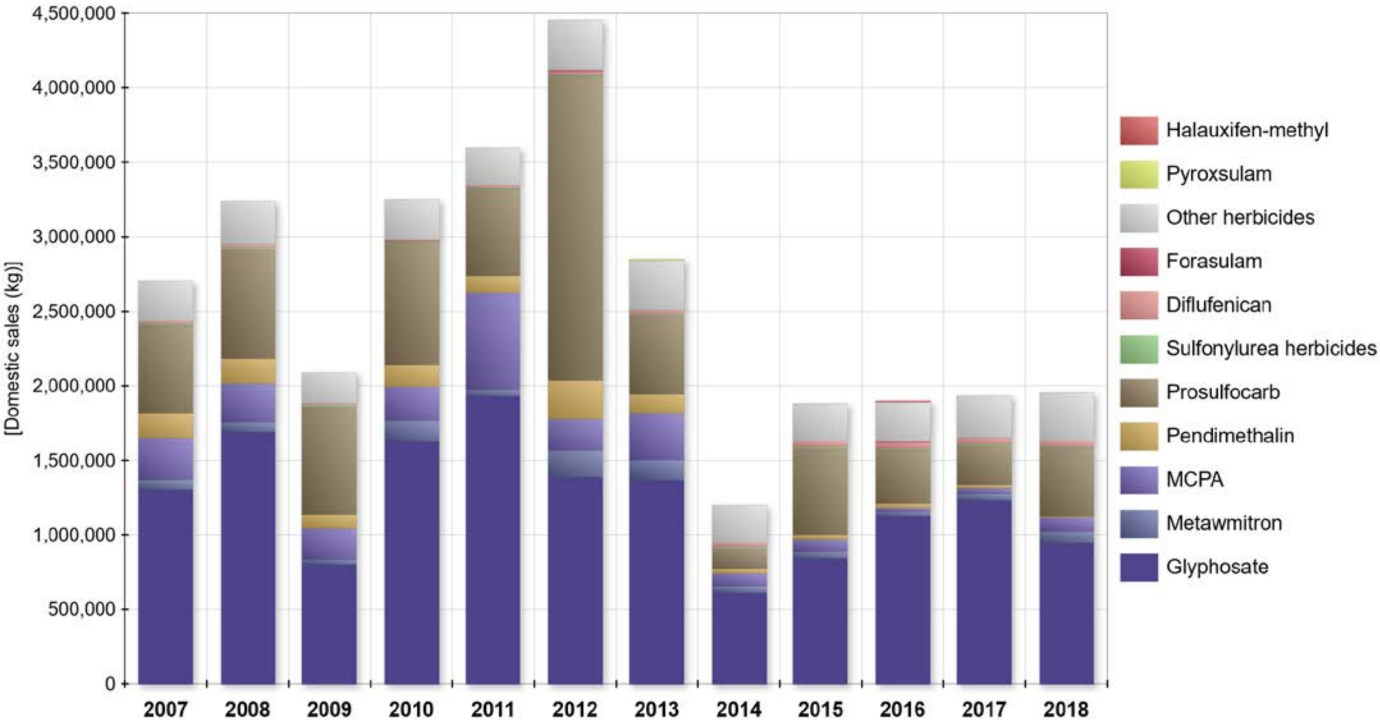


Figure 11 Sales of herbicides in Denmark from 2007 to 2018

A calculation that looks at the active substance quantities used to treat areas, however, shows a different picture than the one that looks at sales volume only (Figure 12). Since the tax amendment, low-dose herbicides have replaced high-dose herbicides (glyphosate, MCPA, pendimethalin, prosulfocarb, metamitron) in many cases. The total area that can be treated with all sold active substances has not declined as a result.

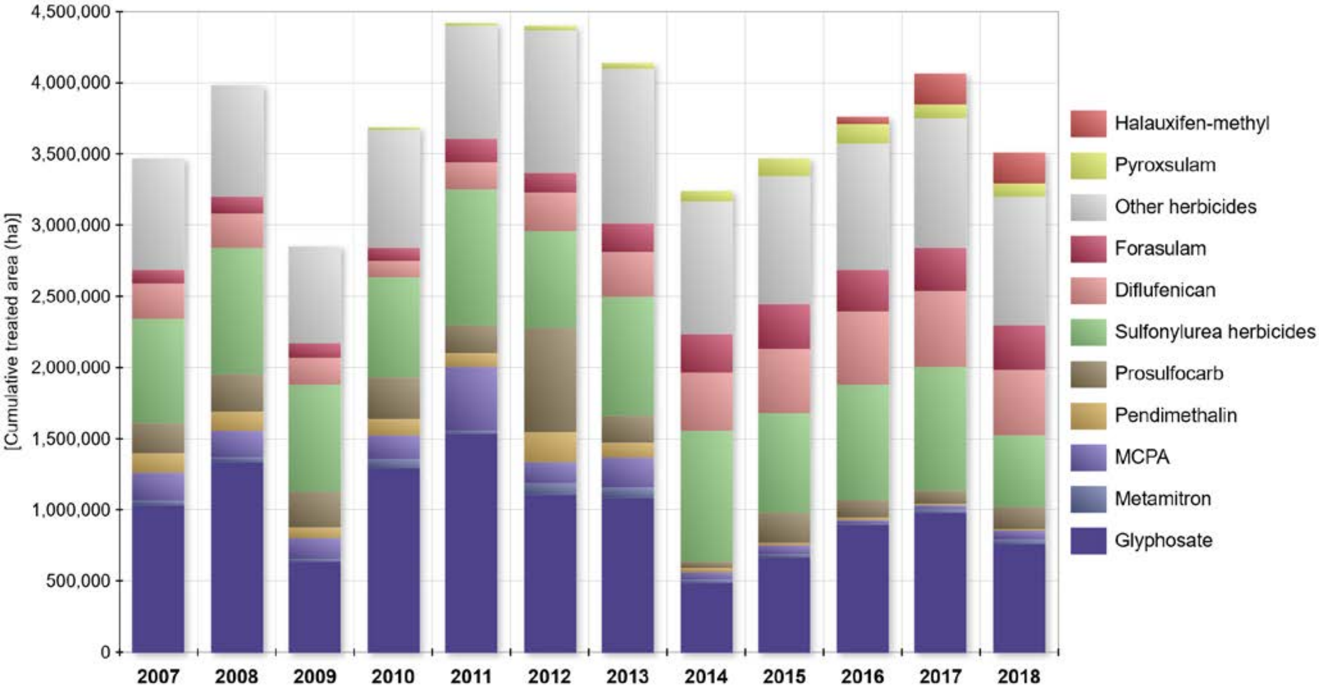


Figure 12 Herbicides – treated area in Denmark from 2007 to 2018

Table 5 provides an overview of price and quantity changes. Interestingly, similar price increases do not have the same effect. The price increase per kilogram of glyphosate, pendimethalin and metamitron is approximately the same. In relation to the maximum permissible application dose, however, the price increase for pendimethalin is significantly higher. Users in Denmark may therefore have replaced this active substance with other herbicides (substitution), which would explain the very high decrease in pendimethalin. A similar substitution effect could also be present for MCPA, while sales of metamitron fell much less sharply despite similar cost increases.

Table 5 Changes in price and sales of important herbicides in Denmark

	Average Price Change since 2011 in EUR			Change in quantity mean of 2007-2011 to mean of 2014-2018 (percent)
Active Substance	**For active substance per kg or l**	**For maximum permissible application dose per ha/a**		
		For cultivation with lowest application dose	For cultivation with highest application dose	
Glyphosat	2.1	2.1	1.8	–55
Pendimethalin	2.3	2.2	**2.6**	**–478**
Prosulfocarb	1.7	1.7	1.5	–93
Metamitron	2.5	2.1	**2.5**	**–46**
MCPA	3.1	3.9	**2.4**	**–385**
Diflufenican	0.9	0.9	0.9	+58
sulfonylurea Herbicide	0.7	0.7	0.8	–27 ×

× The reduction took place mainly in 2018 characterised by drought (see also Figure 12)

4.2.2 Fungicides

In the case of fungicides, the sales prices of products containing mancozeb have risen sharply due to the tax. Before 2014, this high-dose active substance usually accounted for 50 percent or more of total fungicide sales by quantity. There was a very small price increase for the group of triazole fungicides[115] and smaller price changes for boscalid-containing products (Figure 13). The price increase for mancozeb almost eliminated sales after 2013 (Figure 14). Compared to 2007 to 2011, significantly more triazole fungicides were sold in the period of 2014 to 2018. Since mancozeb is a high-dose fungicide and has been replaced by triazole fungicides, among others, the cumulative area treated with fungicides has not decreased (see Figure 15).

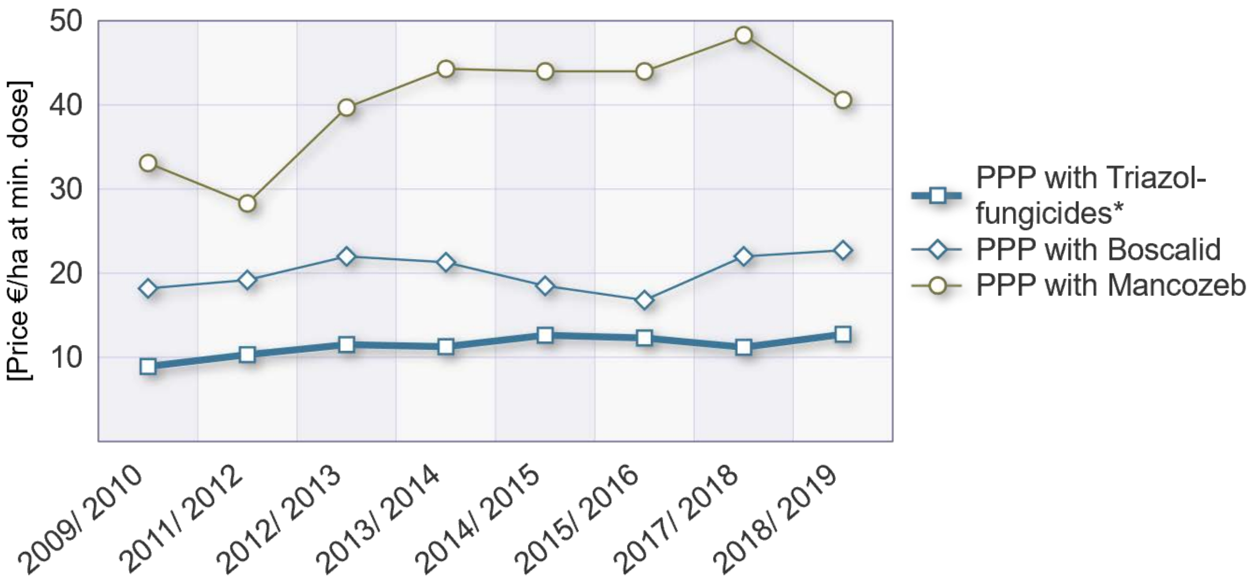


Figure 13 Fungicides – Danish average prices per hectare and year in relation to the maximum permitted application dose for products with relevant active substances from 2009 to 2019

115 Prices for products with one or more triazole fungicides but without other mixing partners.

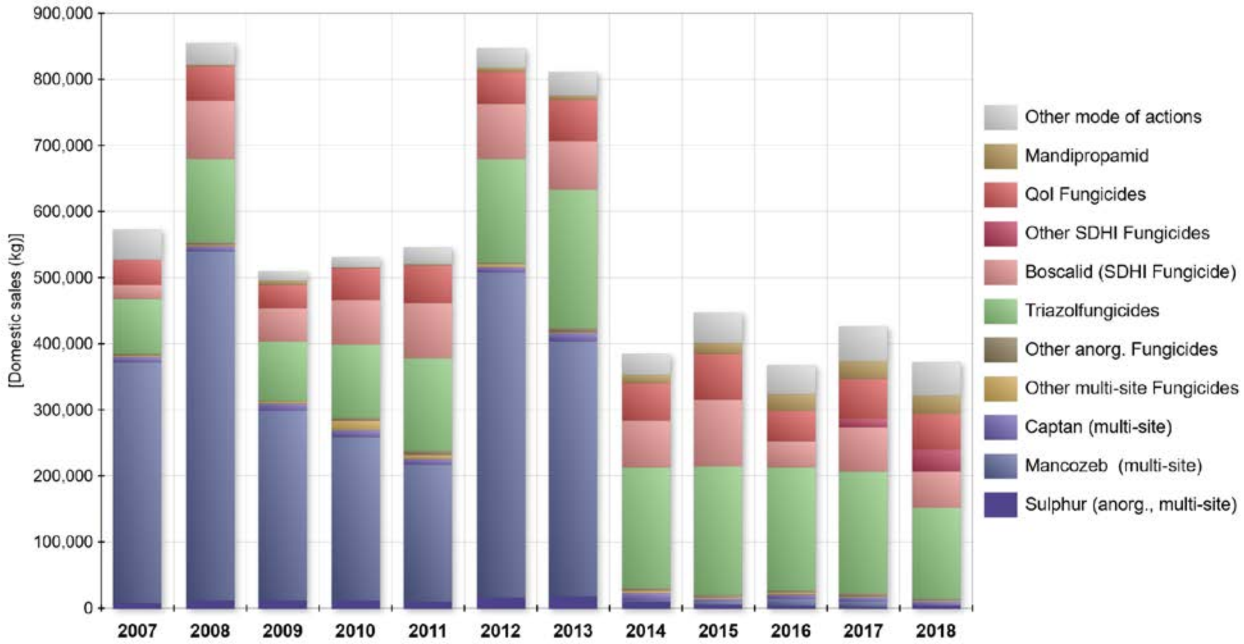


Figure 14 Sales of fungicides in Denmark from 2007 to 2018

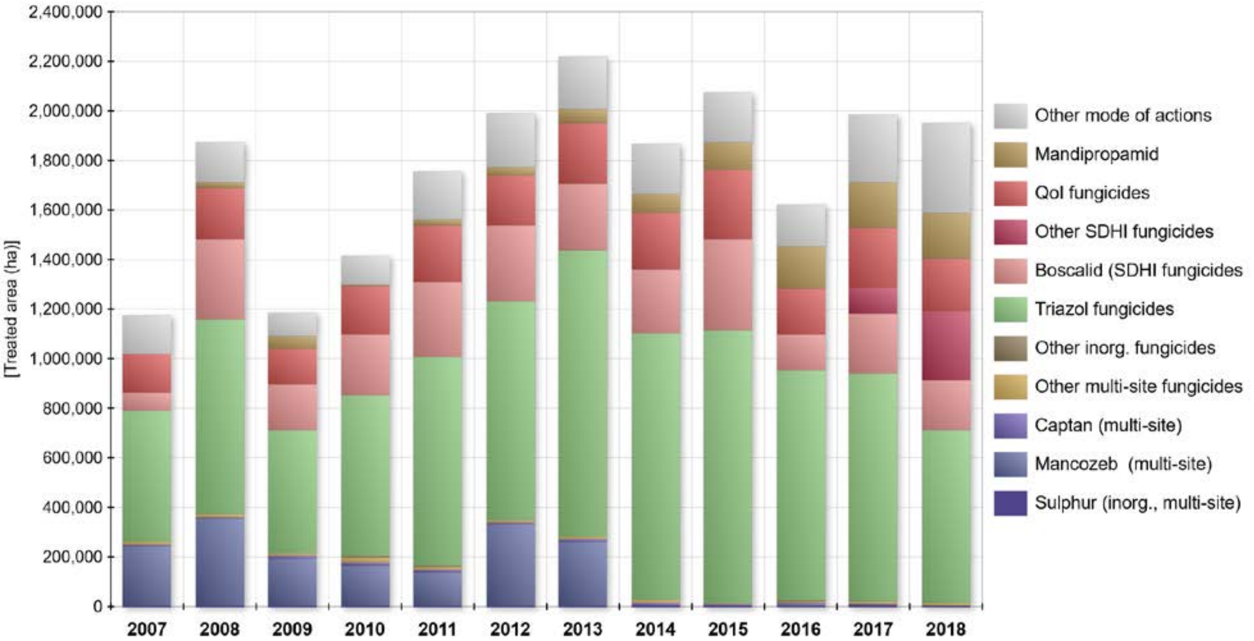


Figure 15 Fungicides – treated area in Denmark from 2007 to 2018

4.2.3 Growth Regulators

There were also clear substitution effects in the area of growth regulators due to the tax reform. Chlormequat, the dominant growth regulator in terms of volume until 2013, became significantly more expensive and was therefore mostly replaced by trinexapac, the prices of which had already fallen before the tax amendment. This development is particularly interesting, since despite the price increase, products with chlormequat were for a longer period still cheaper than products with trinexapac (see Figures 16 to 18).

Figure 16 Growth regulators – Danish average prices per hectare and year in relation to the maximum permissible application doses for products with relevant active substances from 2009 to 2019

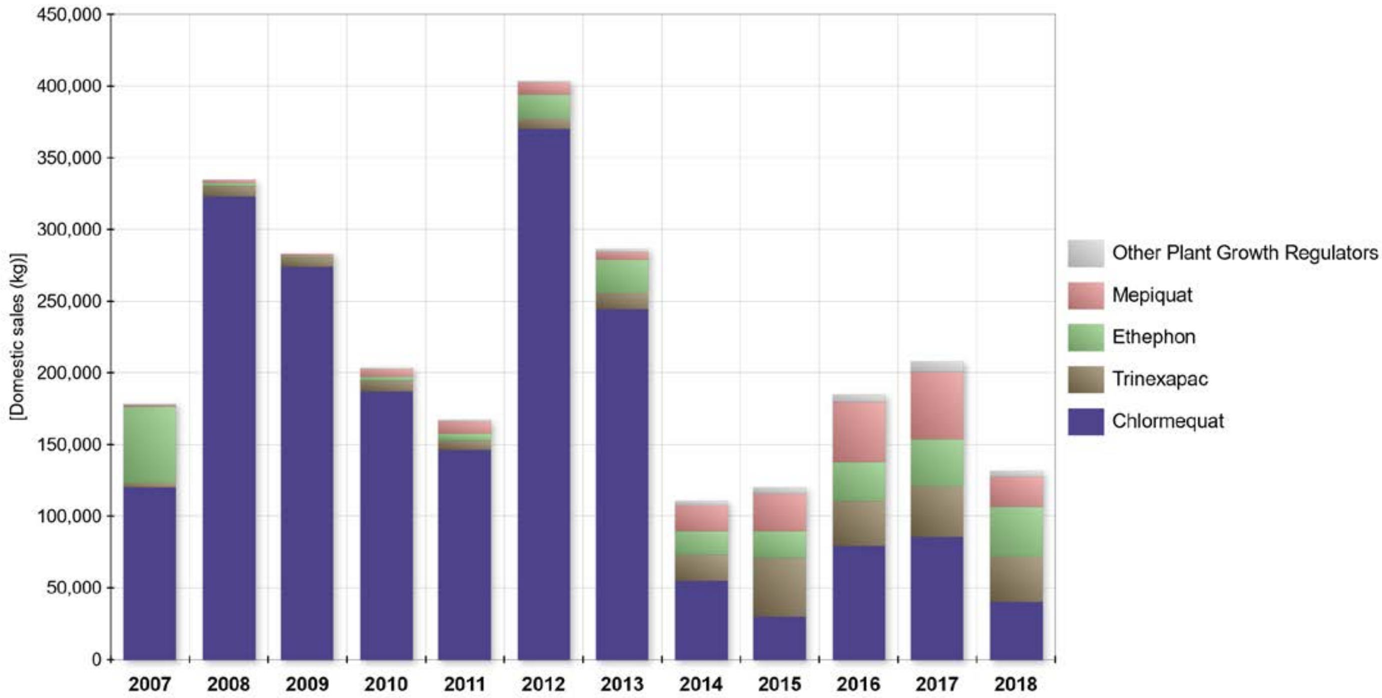


Figure 17 Sales of growth regulators in Denmark from 2007 to 2018

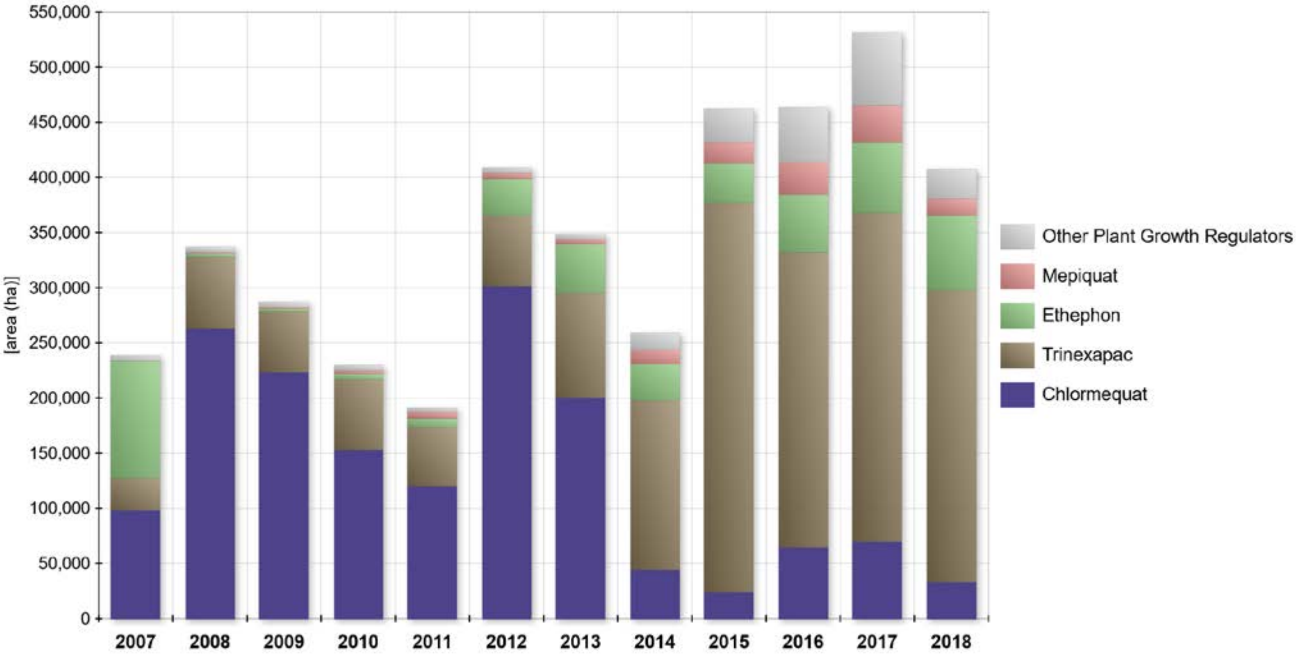


Figure 18 Growth regulators – treated area in Denmark from 2007 to 2018

4.2.4 Insecticides and Acaricides

In the case of insecticides and acaricides, there are no consistent price developments for the years after 2013, because agricultural businesses hardly buy pyrethroids anymore, which were the dominant insecticides before the tax reform. An exception is lambda-cyhalothrin, which became more expensive, but its price increased less than for other pyrethroids (Figure 19).[116] However, the tax set for lambda-cyhalothrin deviated massively from the legal requirements[117] and instead of the PPDB other data were used as basis. The tax rate would be significantly higher, if the PPDB data were used as is the case for other active substances. In the case of insecticides and acaricides, the reduction in quantity triggered by the tax reform (Figure 20) also had an effect on the treated area (Figure 21).

[116] Products with the related gamma-cyhalothrin recently cost over 800 EUR per litre and thus 22 EUR to 35 EUR per maximum permissible application dose per hectare and year.

[117] For the modelling of the levy/ tax concepts and their validation, the Danish payable tax burden was calculated and compared separately with the Danish data and the PPDB data.

Figure 19 Insecticide lambda-cyhalothrin – Danish average prices per hectare and year based on the maximum permitted application dose for products containing this active substance from 2009 to 2019

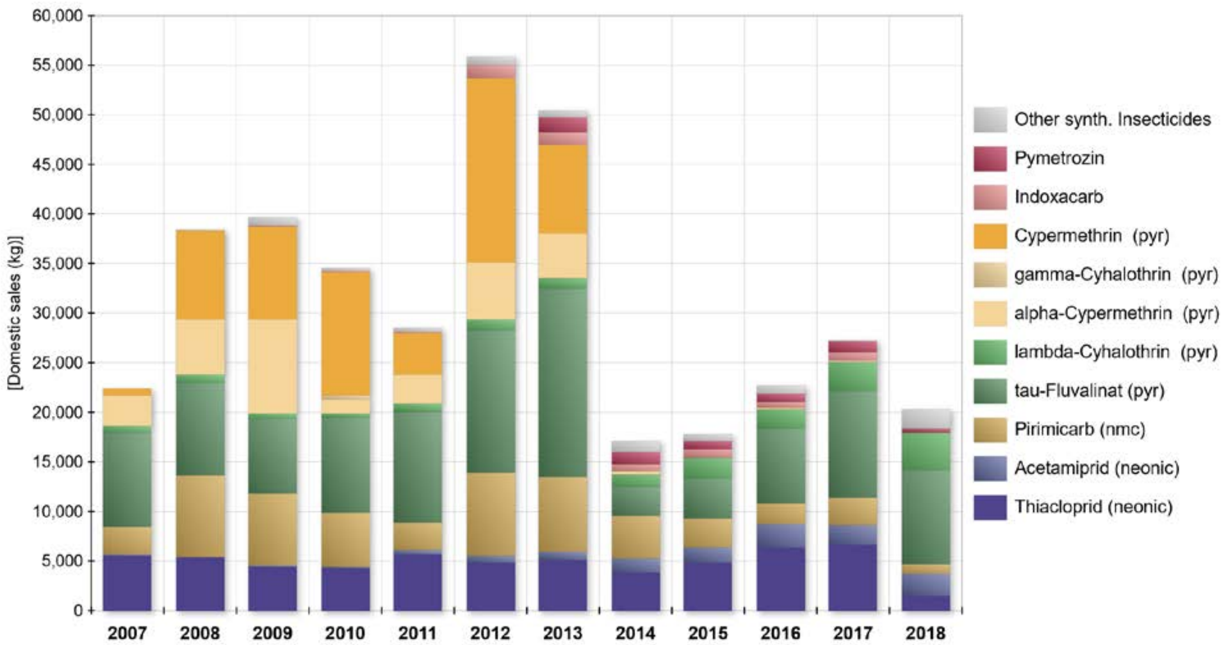


Figure 20 Sales of insecticides and acaricides in Denmark from 2007 to 2018

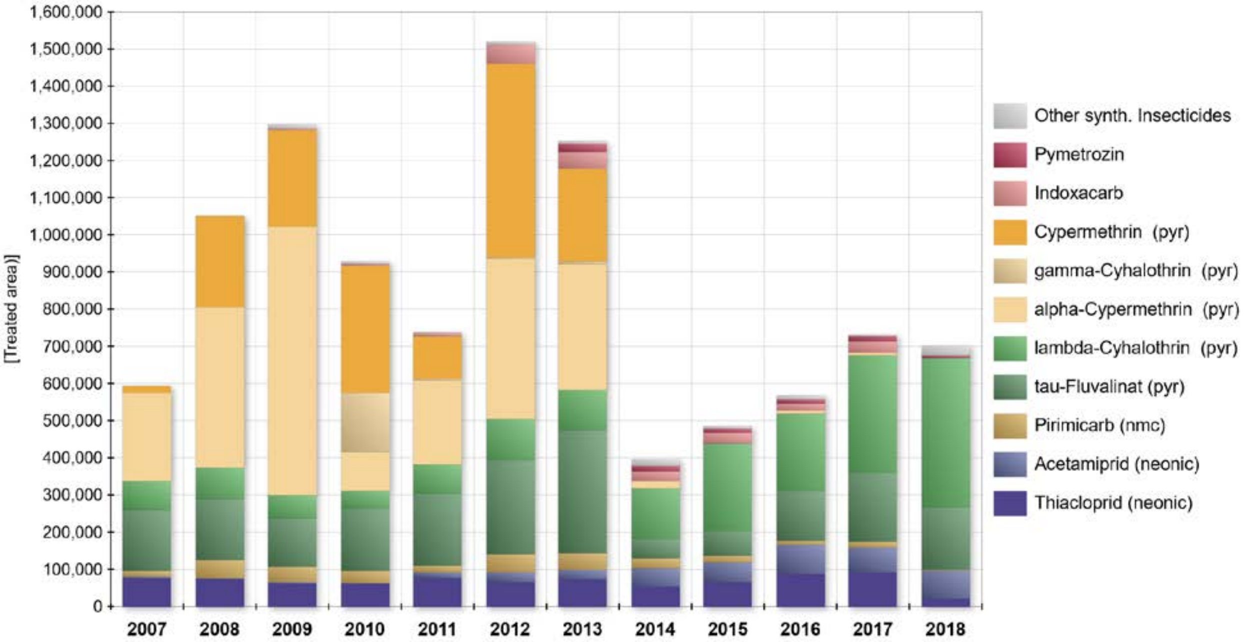


Figure 21 Insecticides and acaricides – treated area in Denmark from 2007 to 2018

4.3 Evaluation According to Selected Hazard Potentials

The use of plant protection products can have negative effects on human health and the environment. There are various parameters and classifications for the level of the respective potential risk. For example, authorities use the properties of substances and empirical data to determine whether an active substance may be hazardous to groundwater or is a candidate for substitution (CfS, see below).

4.3.1 Active Substances with high Exposure Risk for Users and Residents

The risk potential for users and residents from pesticides is made manifest, among other things, by the 'Acceptable Operator Exposure Level' (AOEL). Active substances with a very low AOEL value of less than 0.01 mg per kilogram of body weight, such as diquat, glufosinate, chlorothalonil, but also epoxiconazole, pose a high risk for users and respective residents. Even the proper use of products containing these active substances with protective clothing can lead to the acceptable exposure being exceeded.[118] The UFZ levy concept integrates the AOEL value into the calculation of human toxicity with the same weight as the values for 'acceptable daily intake' (ADI) (see Chapter 5.4).

Active substances with low AOEL values were sold in lower quantities after 2014, but there was significant stockpiling in 2012 (Figure 22), especially for the herbicide prosulfocarb. The treatment index for these active substances did not fall after 2013 (Figure 23).

[118] EFSA 2005; EFSA 2008, p. 2; EFSA 2015, p. 10; EFSA 2018.

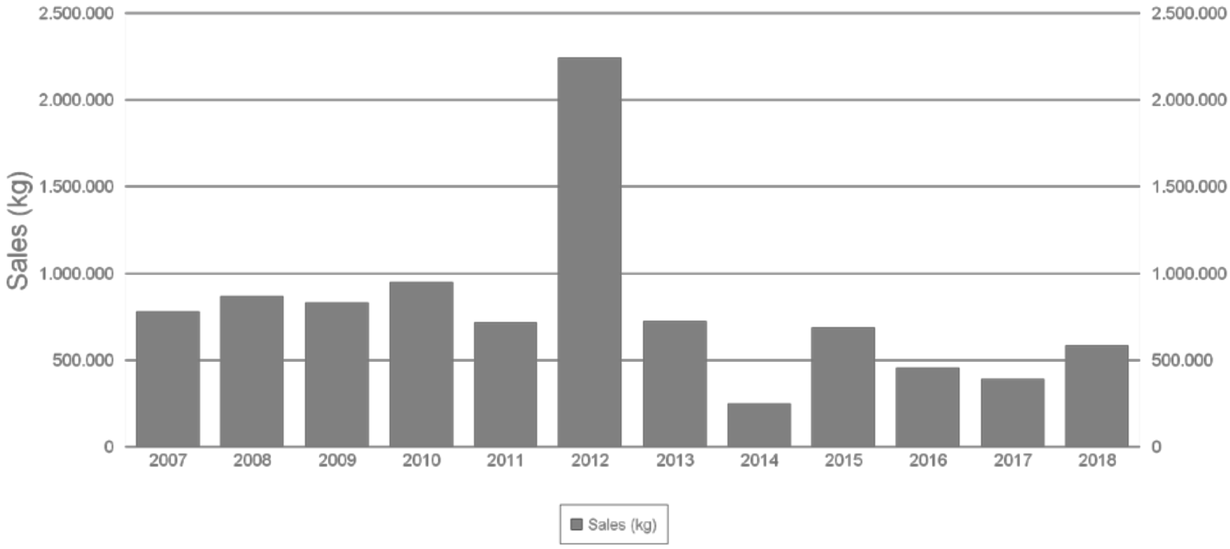


Figure 22 Sales volumes of active substances with high toxicity for operators in Denmark from 2007 to 2018 (excluding seed dressing products)

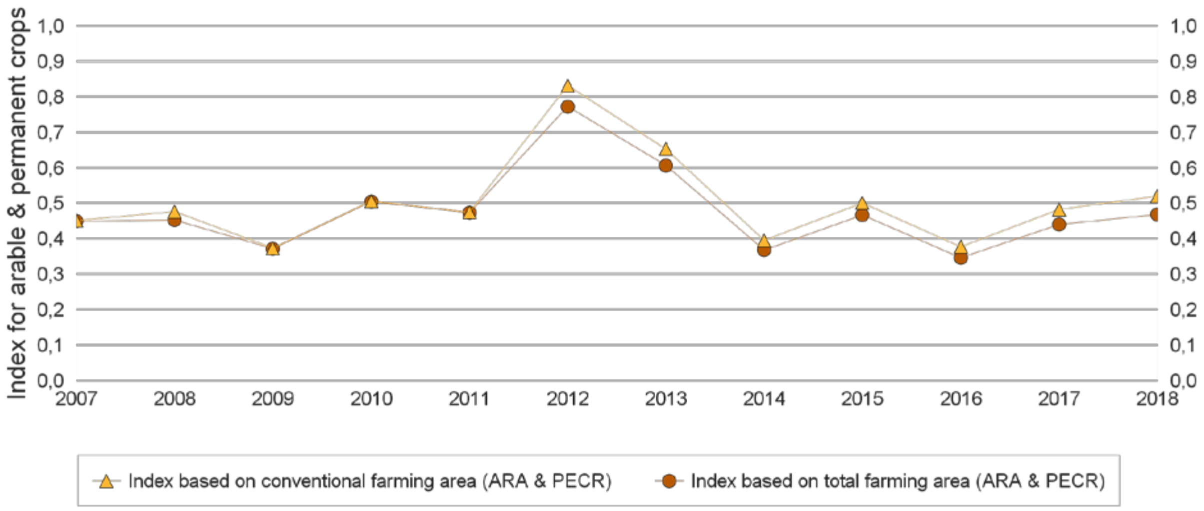


Figure 23 Area index for active substances with high toxicity for users in Denmark from 2007 to 2018 (excluding seed dressing products)

4.3.2 Active Substances with High Bee Toxicity

Active substances with a lethal dose of less than 2µg/bee (oral ingestion or contact) are considered very toxic to bees. Almost all chemically synthesised insecticidal active substances display such high levels of toxicity.

Sales of active substances with high acute bee toxicity declined slightly after 2013. There was also significant stockpiling in 2012 and 2013 (see Figure 24), and it is not clear for how long these stocks were used up. The treatment index for these active substances dropped to 0.1 after 2013 and has been rising again slightly since 2016 (see Figure 25).

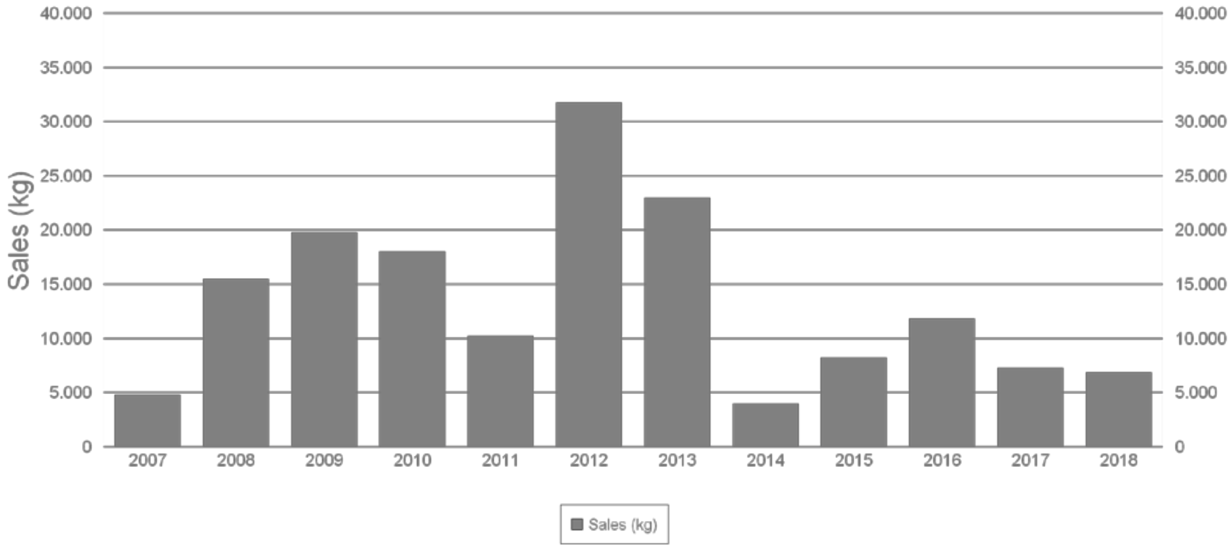


Figure 24 Sales volumes of active substances with high bee toxicity in Denmark from 2007 to 2018 (excluding seed dressing products)

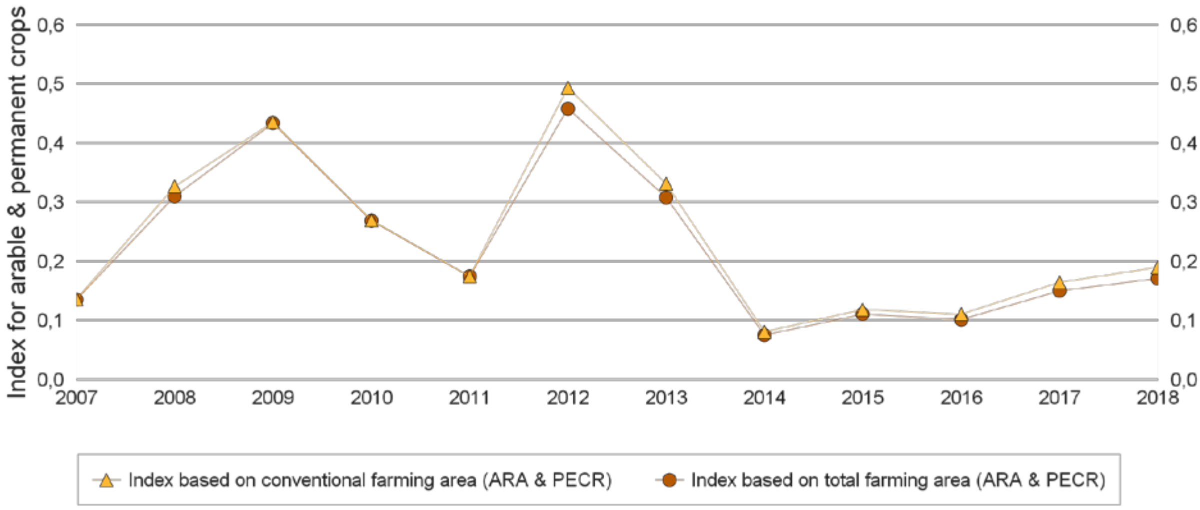


Figure 25 Area index for active substances with high bee toxicity in Denmark from 2007 to 2018 (excluding seed dressing products)

4.3.3 PBT Active Substances

Art. 24 of Regulation 1107/2009/EC stipulates that active substances with certain properties receive a shorter approval period. The regulatory objective is to replace these active substances with more compatible methods (chemical and non-chemical). These substances are called candidates for substitution (CfS). They include, among others, active substances that degrade slowly in the environment and/ or accumulate in fish and/ or have certain toxicological classifications (see Annex 2, point 3.7 et seq. of Regulation 1107/2009/EC)[119]; two of the three criteria (i.e., two out of three PBT properties) must be met in order to be classified as a candidate for substitution. These types of substances are internationally referred to as PBT substances: **p**ersistent,

[119] 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, OJ. EU L 309 v. 24.11.2009, p. 1 et sqq.

bioaccumulative, **t**oxic. These include, for example, (old) pesticide active substances such as DDT and Lindane, but also many industrial chemicals, such as PCBs and brominated flame retardants.

The Danish tax calculation system considers the persistence and bioaccumulation of active substances, when it comes to establish the actual tax burden. Persistence is even taken into account several times via a variety of indicators. Nevertheless, there was only a moderate decrease in the amount of PBT active substances since 2013 (see Figure 26), which was mainly due to the reduction of pendimethalin (P & B) and epoxiconazole (P & T). However, sales of other PBT active substances increased (e.g., diflufenican [P & T]) and some other triazole fungicides (tebuconazole, difenoconazole) as well as lambda-cyhalothrin (B & T). The total area treated with PBT active substances remained the same after 2013 (see Figure 27).

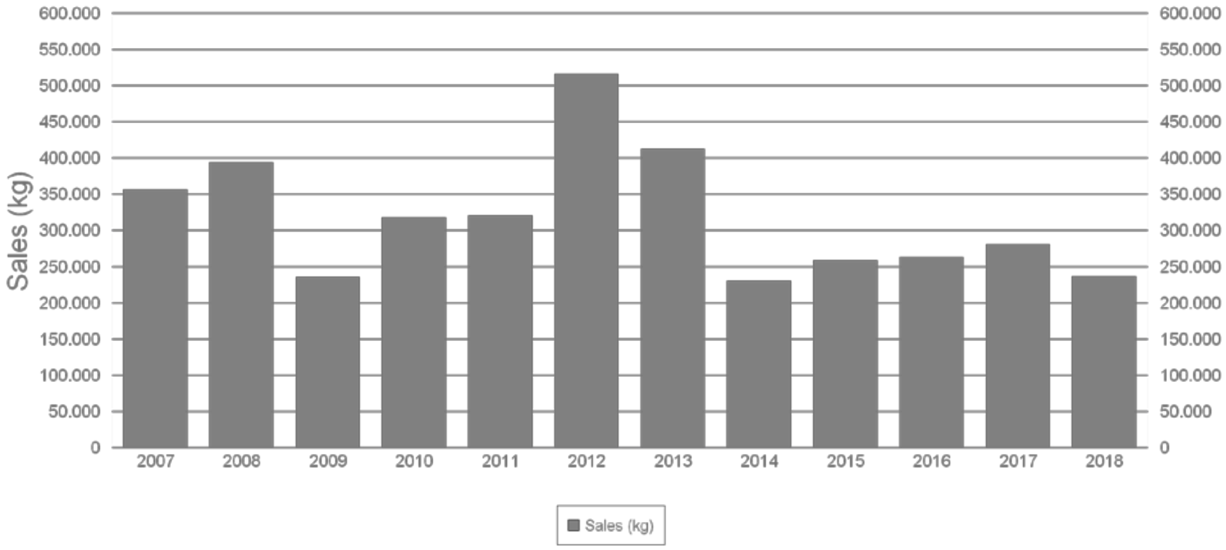


Figure 26 Sales volumes of active substances with two out of three PBT properties (substitution candidates) in Denmark from 2007 to 2018 (excluding seed dressing products)

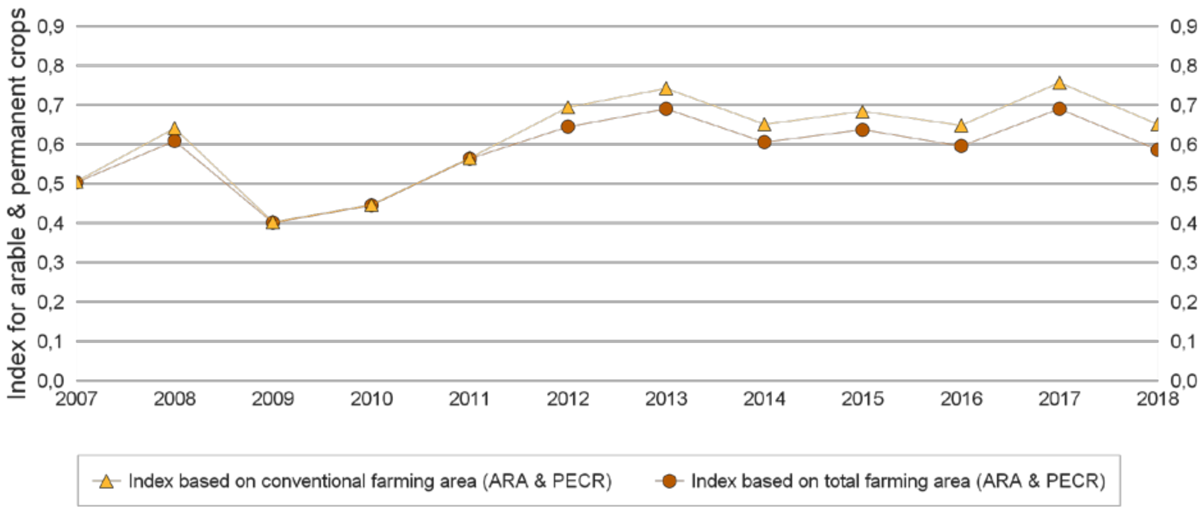


Figure 27 Area index for active substances with two out of three PBT properties (substitution candidates) in Denmark from 2007 to 2018

4.3.4 Active Substances Hazardous to Groundwater

Pesticides can enter the groundwater and remain there for decades. The residues then cause permanently high costs for water analysis[120] and drinking water treatment. Only recently, the highly toxic fungicide chlorothalonil or its metabolites were detected very frequently in Swiss groundwater/ drinking water.[121] New metabolites of the herbicide terbuthylazine were also detected very frequently.[122]

In the Danish calculation system for the pesticide tax, the potential risk to groundwater is also considered. Here, the properties of the active substances and their metabolites are taken into account. However, the groups of active substances that can endanger groundwater in Denmark almost only encompass low-dose herbicides (e.g., sulfonylurea) and fungicides (e.g., triazoles). However, the Danish quantity-based tax on low-dose active substances has almost no impact; sales volumes have therefore hardly decreased after 2014 (Figure 28). The lower sales volume in 2018 had a lot to do with the dry weather. The area index shows a slight downward trend from 2013 to 2018 (see Figure 29).

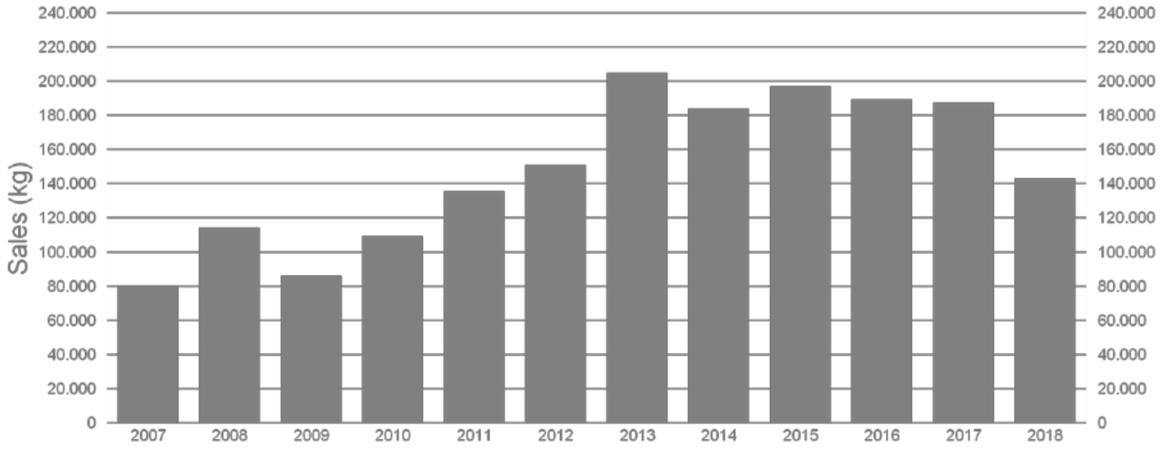


Figure 28 Sales volumes of active substances potentially hazardous to groundwater in Denmark from 2007 to 2018 (excluding seed dressing products)

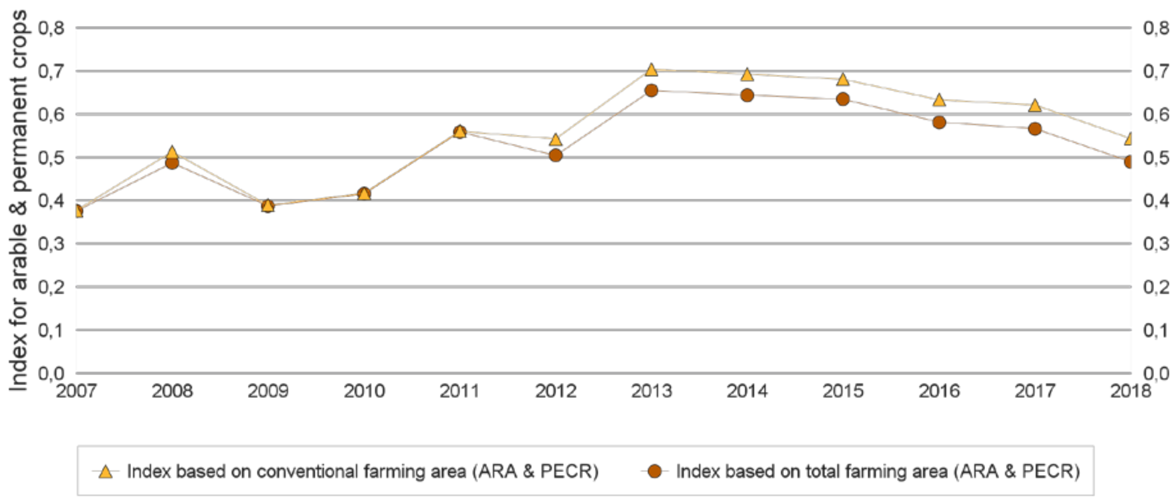


Figure 29 Area index for active substances potentially hazardous to groundwater in Denmark from 2007 to 2018 (excluding seed dressing products)

---

120 Neumeister 2010.

121 Cf. https://www.srf.ch/news/schweiz/fungizid-im-trinkwasser-gefahr-aus-dem-wasserhahn.

122 Kiefer et al. 2019.

4.4 Lessons Learned from the Danish Pesticide Tax

- Since the amendment of the tax in summer 2013 (see Chapter 5.3), the quantity (by weight) of all active substances sold in Denmark has fallen by 38 percent overall, with sales of toxic substances dropping even more sharply. Active substances for which a high price increase was to be expected were hoarded before the tax was reformed.
- However, neither the area treatable with these active substances nor the treatment index have fallen since 2013. Since the Danish tax does not take into account the maximum permissible application dose per hectare and year (growing season with 12 months), users have increasingly switched to tax-favoured, low-dose products. The mere evaluation of sales volumes provides therefore an inaccurate picture of the relief effects for humans and the environment. In addition, the tax does not consider indirect ecological effects, e.g., through the use of herbicides (see Chapter 5.5).
- The increase in organically farmed area after 2013 is not down to the amendment of the pesticide tax. Although this area has indeed grown more since 2013 than before, such a trend can also be observed in other countries and is mainly down to conversions in the dairy sector triggered by higher milk prices for organically produced milk. The tax reform had not accelerated the fall in the number of agricultural enterprises, which has been ongoing for decades.
- Furthermore, the change in the basis of taxation (from an ad valorem-levy to differentiated taxation according to human toxicological properties, environmental toxicity, and environmental behaviour) did not lead to an increase in prices for all products. For some plant protection products, the amendment reduced the tax burden.
- Although in the Danish tax concept the groundwater permeability of the active substances is taken into account as a separate factor, sales of active substances that are hazardous to groundwater have not fallen. This is due to the fact that, as in Germany, mainly highly effective and therefore low-dose active substances are used such as sulfonylurea herbicides and triazole fungicides, for which the tax burden is very low in relation to the maximum permissible application dose.
- *Overall*, due to the lack of consideration of the maximum permissible application dose, the Danish tax has the effect of favouring plant protection products containing highly effective pesticides and a correspondingly low application dose per hectare and year, which is why the Danish tax had only a low impact on the treatment area and the treatment index (number of active substances per hectare).

5 An Overview of Design Options for a Plant Protection Product Levy

As explained in Chapter 2, the recommendation made applies also to Germany to use both the steering and the financing effects of levies and taxes to reduce pesticide use as well as its effects and risks for the environment and human health. In addition to short-term savings and substitution effects in pesticide use, a combined effective purpose and intended purpose levy promotes long-term structural change in plant protection. Even if the direct effects of a levy on the sales of plant protection products cannot be proven causally due to the multitude of reasons for purchasing decisions, the different levels of sales in Germany and Sweden as well as the convergence of the Danish sales level with Swedish conditions since 2013 (see Figure 1 in Chapter 1) indicate that plant protection product levies have effects. The effects of the Danish pesticide tax, which was significantly increased and redesigned in summer 2013, are discussed in detail in Chapter 4. The revenue of a pesticide levy can also be used to finance additional measures of sustainable plant protection (e.g., for implementation the national action plans under the Directive 2009/128/EC) or compensation measures for the unavoidable consequences of plant protection.[123]

When designing a levy on chemical plant protection products, both legal aspects (see Chapter 7) and economic as well as toxicological aspects are decisive. Economically, all levies include a price surcharge set by the state. This surcharge can come in the form of an absolute amount on a certain quantity of a plant protection product (quantity levy) or in the form of a relative, percentage amount on the sales price or value of a plant protection product (ad valorem-levy) (see Section 2.4). The advantage of ad valorem levies, such as VAT, is that the incentive effect is not increasingly devalued by inflation over the years, as is the case with a quantity levy, since the absolute payment burden grows along with it. Conversely, falling prices for plant protection products (e.g., due to falling production costs or the discontinuation of patent protection) reduce the absolute payment burden and the revenue in the case of an ad valorem-levy, even if the relative payment burden remains the same.

From a toxicological point of view, the question arises as to what extent a levy should take into account not only the quantity or value but also certain properties of plant protection products, leading to different payment burdens per quantity or value. Differentiated payment burdens would set greater or lower steering incentives for certain plant protection products and generate higher or lower revenues. On the one hand, this would stimulate the substitution of more dangerous pesticides with less dangerous ones, and on the other hand, correspondingly higher external environmental and health costs would be internalised on a flat-rate basis for more dangerous products. From a toxicological perspective, risk-based levies therefore offer advantages over quantity or ad valorem levies with undifferentiated payment rates. However, this advantage goes hand in hand with a higher complexity of the levy, which can cause difficulties both in the political process and in formal levy collection. Toxicological differentiation can, however, also promote acceptance among users and citizens, provided that the differentiation criteria are comprehensible and purposeful. Differentiation based on the polluter-pays principle is also preferable for legal reasons.

The concept submitted by the UFZ in 2015 suggests a risk-based ad valorem-levy on plant protection products in Germany[124]. In other EU countries and in the literature, undifferentiated volume levies (Sweden) or ad valorem levies (Femenia/Letort 2016) and risk-based quantity levies (Denmark) are already being applied or discussed. In the following, these four different approaches will be briefly presented and supplemented by a modified variant of the 2015 UFZ levy concept.

---

123 Detailed cf. Möckel et al. 2015, p. 262-283.

124 Möckel et al. 2015, p. 100-122.

5.1 The Swedish Undifferentiated Quantity Levy

Sweden has entertained a levy on plant protection products since 1984.[125] The levy and its objectives were presented in detail in Möckel et al. 2015.[126] The tax is charged for all plant protection products in the form of a uniform monetary amount per kilogram of active substance. There is no differentiation between the types of active substances. The tax rate has been increased repeatedly from originally 4 SEK /kg (0.40 EUR /kg)[127] to currently 34 SEK /kg (3.37 EUR /kg)[128]. The tax applies when the product is delivered to the buyer or used for a purpose other than sale (§ 5 Lag 1984/210). Lower revenue of 70 to 75 million SEK (7.5 to 8 million EUR) was reported for 2015 and 2016.[129] With around 40 to 50 companies, the number of taxpayers is low, which is why the administrative burden for the collection of the levy is also low (approximately 0.01 to 0.05 percent of pesticide tax revenue).[130]

As a pure quantity levy, the Swedish levy is easy to collect. The repeated increases in the levy rate take account of inflation, albeit with delays. The much lower sales levels of plant protection products per hectare of agricultural land in Sweden compared to Denmark or France (see Figure 1 in Chapter 1) is, apart from climatic and geographical reasons, also a result of the levy, as sales fell sharply after its introduction and each increase in the levy rate caused changes in sales volumes.[131] A problem with the Swedish concept is that no differentiation is made between active substances or types of active substance, although the maximum permissible application dose per hectare and year can differ by a factor of 10 or more depending on the active substance (see Table 9 in Section 5.4). Highly effective substances such as neonicotinoids or pyrethroids, for which only a few grams per hectare are sufficient and permitted, receive thus a strong tax incentive compared to pesticides that require a much higher quantity per hectare to achieve the same effect. The undifferentiated Swedish quantity levy thus sets strong steering incentives, which can have undesirable effects from an ecological and human toxicological point of view.

5.2 The Undifferentiated ad Valorem-Levy as Proposed by Femenia/Letort 2016

Ad valorem levies with a percentage tax rate on the sales price are common in tax law. An ad valorem-levy on pesticides existed in Denmark until 2013; the levy had last been established with three different rates in 1996 (see Section 4.1). In a recent study, researchers from the INRA Institute for France modelled the incentive effects of an undifferentiated ad valorem tax on pesticides.[132] The authors emphasise that a levy differentiated according to risk would achieve a greater reduction in more hazardous products; yet they also add that they could only simulate an undifferentiated levy given the available data.[133]

Their study was based on the hypothesis that an ad valorem-levy could not only lead to a reduction in pesticide use but could also bring about structural changes in agricultural businesses.[134] In their impact analysis, they estimated the extent to which an ad valorem-levy would encourage conventional farms to adopt more extensive

---

125 Lag (1984:410) om skatt på bekämpningsmedel, http://www.riksdagen.se/sv/Dokument-Lagar/Lagar/Svenskforfattningssamling/Lag-1984410-om-skatt-pa-bek_sfs-1984-410/?bet=1984:410 (retrieved on 14.1.2021). The law was last amended in 2015.

126 Möckel et al. 2015, p. 86-89.

127 ECOTEC et al. 2001, p. 98 et seq.

128 SFS 2015:469 about the amendment of § 2 of Lag 1984:410.

129 Böcker/Finger 2016, 4.

130 ECOTEC et al. 2001, p. 98 et seq.; Oskam/Vijftigschild/Graveland 1997, p. 136.

131 Möckel et al. 2015, p. 87 et seq.

132 Femenia/Letort 2016.

133 Femenia/Letort 2016, 32 et seq.

134 Femenia/Letort 2016, 32 et sqq. The authors share this assumption (see also Chapter 2.3 and Möckel et al. 2015, p. 177-181).

farming practices (low-input cropping practices), which would use less fertilisers and pesticides and produce lower yields per hectare. Secondly, they investigated the extent to which an ad valorem-levy reduces pesticide use when

- Scenario 1: Low-input-practices are not increasingly used, or
- Scenario 2: Such practices are taken up as soon as they are more profitable for an agricultural enterprise.

In their modelling, they conclude that an ad valorem-levy of 35 percent of net sale prices[135] would encourage 90 percent of agricultural enterprises to adopt low-input practices, which would reduce overall pesticide use in France by 25 percent compared to the average use over the last ten years.[136] If low-input practices are not available or not adopted (scenario 1), the ad valorem-levy would have to be 130 percent of net sale prices to achieve the same 25 percent reduction in pesticide use that France is aiming for by 2020.

For the 50 percent reduction in pesticide use by 2025, which France also aims for, the simulated levy rate would have to be at least 200 percent in both scenarios. In general, the authors find that the higher the levy rate, the smaller the differences between the two scenarios. From a pesticide reduction of 40 percent onwards, the reduction effects in both scenarios converge strongly, as agricultural enterprises can only minimise pesticide use at the cost of further yield and profit losses, even if they largely adapt low-input practices.

Overall, according to the authors, a 35-percent ad valorem-levy on net sales prices results in the greatest effect on cost benefit, as here the profit loss from a conversion to low-input practices is largely offset by the envisaged full reimbursement of the revenues from the ad valorem-levy in the form of a flat rate per hectare.[137] This explains why, in the model, a 35-percent ad valorem-levy results in a 90 percent conversion to low-input practices. The conversion not only reduces pesticide use by 25 percent[138] but also fertiliser use by 14 percent.[139] If the savings effects in crop protection are exhausted because of a conversion to low-input management, any further increase in the ad valorem-levy reduces per hectare-profits in the model.

5.3 The Danish Risk-based Quantity Levy since 2013

With the amendment of the tax on plant protection products in summer 2013, the previously existing ad valorem-levy was transformed into a risk-based quantity levy with a more than doubling of the level of taxation (see also Section 4.1). The tax level per kilogram or litre of plant protection product now depends on the number of active substances contained and the specific risks of those active substances for the environment and human health, which are made manifest in a pesticide load index by the unit load.[140] The specific total load

135 In the study, the cost of pesticide use increases by 35 percent for agricultural businesses, which corresponds to a payment burden of 35 percent on the sales prices excluding VAT, as professional users get the paid VAT back as input tax.

136 Femenia/Letort 2016, p. 33.

137 Femenia/Letort 2016, p. 34 Table 8b.

138 In Table 8b, the authors incorrectly equate the decline in pesticide use with the decline in pesticide expenditure (see pp. 33 et seq. of the paper), although the levy increases the prices of pesticides by 35 percent; thus, the ratio of expenditure to usage does not remain the same. On the contrary, due to the tax increase, a 25-percent decrease in pesticide use is even accompanied by a slight increase in pesticide expenditure of 1.25 percent. Conversely, a 25-percent decrease in pesticide expenditure should actually reduce pesticide use by 44.44 percent due to the levy of 35 percent.

139 Femenia/Letort 2016, p. 34 Table 8b; here the authors also conclude from their modelling that a tax-induced increase of pesticide prices increases the use of fertilisers (p. 33 f, Table 7), but that this effect only cancels out part of the savings due to low-input practices. Unlike the ratio pesticide expenditure-pesticide use (see previous footnote), the fertiliser expenditure-fertiliser use ratio remains the same in the model, as no levy is applied to fertilisers.

140 Miljøministeriet / Miljøstyreslen 2013; Pedersen/Nielsen/Daugbjerg 2020, p. 5 et seq.; Möckel et al. 2015, p. 70 et sqq.

of an active substance (L_{total}) is determined on the basis of three main indicators, each of which is assessed by means of a point system for specific properties determined within the authorisation process (see Table 6).[141]

The main indicators are:

- *Human health:* assesses the pollution to which the user of the plant protection products is exposed to during processing and application (e.g., spraying);
- *Environmental performance:* is determined by the half-life of degradation of the plant protection products in the soil, the potential for bioaccumulation in food chains and transfer through the soil to groundwater; and
- *Environmental toxicity:* is estimated based on the toxicity the active substances show on selected non-target organisms.

The total load is the sum of the loads of the three main indicators, which in turn are determined using a complex assessment system with several sub-indicators.[142] For plant protection products authorised exclusively for use in greenhouses and indoors (e.g., storage facilities), the loads for environmental performance and toxicity are omitted. Lower weighting factors for certain ecotoxicological properties are applied as seed dressing.

The tax amount per kilogram or litre of active substance consists of a general flat rate of 50 DKK (6.70 EUR) and the respective product of 107 DKK (14.37 EUR) and total load L_{total}.[143] The tax payable per kilogram or litre of plant protection product is then the sum of the tax amounts for the active substances contained, depending on the quantitative share of each active substance (see Table 7).

Table 6 Main and sub-indicators for calculating pesticide exposure (unit load = L)

Main Indicator	Sub-indicator and Unit	Subject of Assessment
Human Health	*L per kg Active Substance*	Risk rates for the product or its formula
Environmental Performance	*L per kg Active Substance*	
	Degradation (Persistence) Bioaccumulation Leaching behaviour (Mobility)	Degradability of the active substance Potential for bioaccumulation (BCF) Potential for groundwater contamination
Environmental Toxicity	*L per kg Active Substance*	
	Mammals Birds Bees Earthworms Aquatic environment Fish Daphnia Aquatic Plants Algae	Short-term effects Short-term effects Short-term effects Short- and long-term effects Short- and long-term effects Short- and long-term effects Short-term effects Short-term effects

141 § 1 LBK nr 595 af 29/04/2020.

142 A detailed outline of how the three main indicators were calculated is given in Möckel et al. 2015, p. 72-76.

143 § 1 LBK nr 595 af 29/04/2020.

Table 7 Calculation of the payment burden per kilogram or litre of a plant protection product in Denmark

Total tax payable per $PPP_{sales\ unit}$	=	Tax payable per active $substance_1$ in $PPP_{sales\ unit}$ + Tax payable per active $substance_2$ in $PPP_{sales\ unit}$ + Tax payable per active $substance_3$ in $PPP_{sales\ unit}$ etc.…
Tax payable per active $substance_x$ in $PPP_{sales\ unit}$	=	Tax rate per kg active $substance_x$ × level active $substance_x$ in $PPP_{sales\ unit}$
Tax rate per kg active $substance_x$	=	50 DKK (6.72 EUR) + 107 DKK (14.38 EUR) × Total load L_{total} per kg active $substance_x$
Total load L_{total} per kg active $substance_x$	=	$L_{human\ health}$ per kg active $substance_x$ + $L_{environmental\ performance}$ per kg active $substance_x$ + $L_{\mathit{environmental\ toxicity}}$ per kg active $substance_x$

Source: Möckel et al. 2015, p. 71 et seq.

The respective tax revenue averaged 520 million DKK (69.9 million EUR) between 2014 and 2017.[144] After 2013, the level of tax revenue has not changed significantly.[145] Around 75 million DKK (10 million EUR) of the revenue is reserved for the Pesticide Action Plan. The remaining revenue is refunded to agricultural enterprises through various channels (among others via a reduction in other taxes).[146]

The extent to which the new Danish tax has also achieved the objectives of reducing pesticide use and substituting hazardous substances is outlined in detail in Chapter 4. Regardless of the impact achieved after 2013, the following criticisms can be noted for the Danish model:[147]

- The calculation of the total load per active substance repeats the evaluation conducted during the respective approval procedure and is thus very complex and in practice also prone to errors.
- Risks for groundwater and aquatic plants as well as bees enter the load calculation with a much higher score than other sub-indicators.
- The concept does not take into account that plant protection products and their active substances are authorised with very different application doses per hectare and frequency of application per year (see Chapter 2.1 and Table 9 in Section 5.4), which is why highly effective products with very small application doses per hectare and year are financially incentivised in the Danish tax. In practice, this can lead to the effect that products with high application doses are replaced by highly effective agents with very low products. On the other hand, the intended overall reduction in the use of plant protection

144 Miljøstyrelsen 2018, p. 8.
145 Ørum et al. 2018, p. 23.
146 Pedersen/Nielsen/Andersen 2015.
147 Cf. Möckel et al. 2015, p. 74-85, 97-100.

products is smaller, if the tax hardly increases costs per hectare and year for highly effective products allowing users therefore to switch to these products in order to avoid the tax.

- Because the tax is designed as a quantity levy, inflationary changes in the price of plant protection products reduce the steering effect of the tax.

5.4 Risk-based Ad Valorem-Levy According to the 2015 UFZ Proposal

In a comprehensive study commissioned by the state of Schleswig-Holstein, an interdisciplinary team of scientists from the Helmholtz Centre for Environmental Research (UFZ) developed in 2015 a proposal for a risk-based levy on plant protection products as defined in Art. 2 para. 1 of the EU Regulation on Plant Protection Products (with the exception of inert gases for stock protection).[148] If possible, the levy should be imposed as an excise tax on domestic manufacturers and importers or wholesalers and retailers, so that they can then pass on the levy to users via sales prices – as is common in excise taxation. The levy is first calculated as a quantity levy with a risk-based payment charge per kilogram or litre of a plant protection product and related to the sales unit (see Table 8, steps 1 to 3), and then converted into a payment charge related to the sales price as a percentage, so that a specific ad valorem-levy emerges for each plant protection product (see Table 8, step 4).

The aim was to develop a risk-based levy that is as simple as possible in terms of its calculation and collection and which, in addition to an overall reduction in the use of plant protection products, also promotes the substitution of high-risk plant protection products with less hazardous ones. As in the case of the Danish tax, the UFZ concept, therefore, charges plant protection products with high environmental or health risks with a higher levy. However, the complex assessment structure of the Danish tax was simplified so that the levy is linked to the most important findings of the authorisation procedure instead of assessing the individual assessment factors of the authorisation procedure for active substances and plant protection products in detail for tax purposes.

The two most important points established in the authorisation procedure are the maximum application dose per hectare specified for each plant protection product and the maximum number of applications per year for all crops applied for.[149] The product of both specifications then results in the maximum permissible application dose for a plant protection product in relation to one hectare and one year, whereby year refers to a vegetation period of 12 months and not to a calendar year. Both the dose and the number of applications is set by the authorities and are based on an assessment made in the authorisation procedure between the still sufficient efficacy of the product and the minimisation of negative effects and risks for the environment and health as far as possible (see Chapter 2.1). The determined dose takes into account both the active substance level in a plant protection product and the efficacy of the respective active substances contained. The determined number of applications takes into account, among other things, the performance of the active substance in the environment (including persistence, mobility) as well as the specific requirements of the respective crop. Due to different properties, there are large differences between the plant protection products with regard to the application dose and number of applications and thus the maximum permissible application dose per hectare and year. For plant protection products with highly effective active substances, the application dose is many times lower than for active substances that only develop the desired effects at higher doses. The application dose can differ by a factor of up to a thousand due to the different dose-time-dependent effects of the respective active substances. For example, in the case of highly effective herbicides with metsulfuron, only 5-8 g per hectare and year are

[148] Möckel et al. 2015.
[149] Cf. BVL 2020b.

permitted, depending on the area of application, whereas with glyphosate between 1.8 and 3.6 kg are permitted, depending on the crop (see Table 9), which means a difference of 1:225 (= percentage difference of 22,400 percent) to 1:720 (= percentage difference of 71,900 percent). There is also a continuing trend toward increasingly effective insecticides.[150] Even within the highly effective insecticide group of pyrethroids, there can be major differences in the maximum permissible application dose for the same crop and the same pests.

Since the maximum permissible application dose per hectare and year reflects the highly different modes of action of the plant protection products and their active substances with regard to both the intended plant protection and undesirable effects in the environment, the UFZ concept proposes that the application dose specified in the authorisation be charged at a uniform rate of 20 EUR ('basic price per hectare').[151] This would place the same burden on low-dose plant protection products as on high-dose products.

In the UFZ model, the assessment of environmental impacts is supplemented by a human toxicological factor, which is calculated on the basis of the European ADI and AOEL classification of the individual active substances contained in the respective plant protection product and expresses the respective risk potential for consumers of products and users of plant protection products.[152] Furthermore, two supplementary additional factors are proposed, which increase the total levy payable for certain plant protection products.[153] For all substitution candidates an increase of 50 percent is recommended (factor 1.5), as these plant protection products are no longer to be authorised in the medium term due to their high risks for humans and the environment according to Art. 24 EU Regulation 1107/2009/EC. For home and allotment garden products, the levy payable should be increased by 300 percent (factor 4), as there are increased environmental and health risks during application due to the insufficient expertise of non-professional users, and pesticide use is here not carried out for economic reasons.

The proposed base price per hectare as well as the weighting factor for the ADI and AOEL classification and the level of the additional factors rest on the authors' evaluations and the objective of achieving a similarly high levy level as in Denmark. The individual weight of environmental impacts and human toxicological risks or additional factors for substitution candidates and home and small garden products can also be set differently depending on political preferences.

To ensure that inflation does not diminish the levy's steering effect over time, the UFZ concept provides for a conversion of the quantity-based payment burden into a percentage price mark-up on the market price of plant protection products. The entire formula for calculating the risk-based ad valorem-levy is displayed in Table 7.

In 2015, the UFZ estimated that the steering effect of the expected median price increase per plant protection product of more than 40 percent per hectare and year (for frequently used plant protection products even more than 50 percent) leads to an average reduction in the use of plant protection products of 20 percent in the short term, which increases to 35 percent in the long term due to the triggered structural changes; however, a significantly lower steering effect of 5 percent was assumed for special crops in the short term.[154] The payable levy of an estimated average of 59 EUR per hectare of agricultural land and year was seen as economically viable and legally proportionate for agriculture.[155] The revenue from the pesticide levy could be around 1 billion EUR per year, depending on the design and quantity changes triggered.[156] The authors of the study suggest that the funds be used to compensate for excessive burdens caused by the levy on certain crops and, in

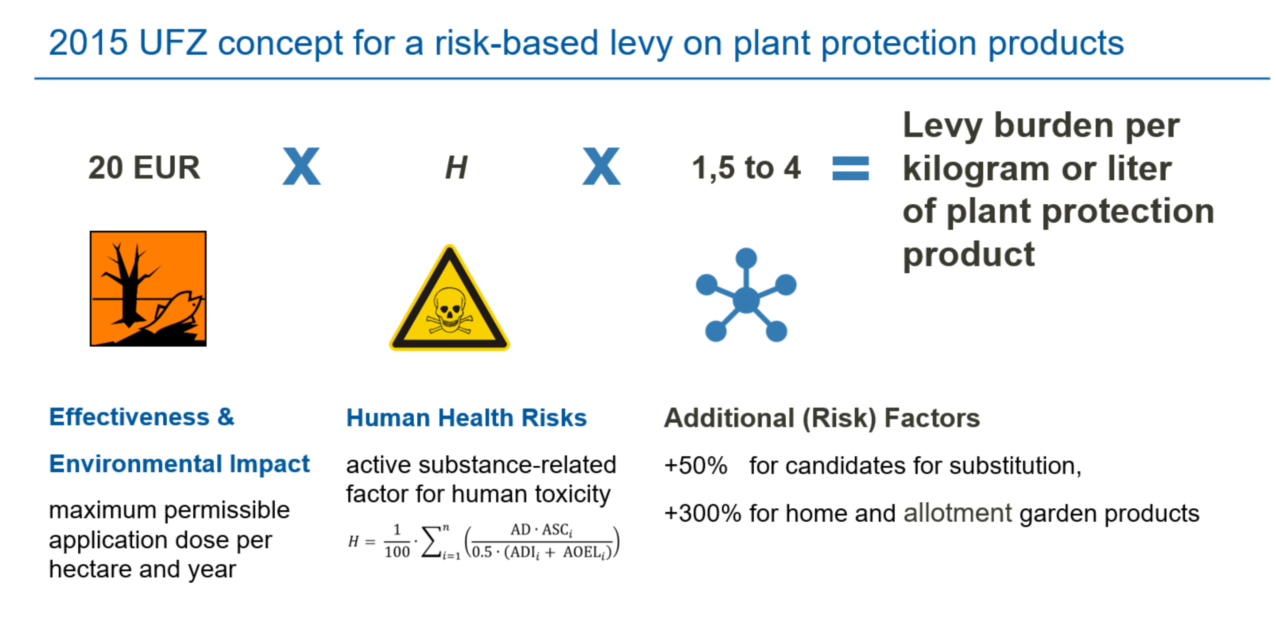
---

150 Cf. Schulz et al. 2021; Goulson/Thompson/Croombs 2018.
151 Möckel et al. 2015, p. 105-114.
152 Möckel et al. 2015, p. 115-119.
153 Möckel et al. 2015, p. 119-122.
154 Möckel et al. 2015, p. 136-181, 194 et seq.
155 Möckel et al. 2015, p. 181-188, 226-235, 249-251.
156 Möckel et al. 2015, p. 188-190.

addition, to finance measures to protect the environment and human health from pesticides or to compensate for remaining negative environmental effects increasing the acceptance of the levy and strengthening the positive effects for humans and the environment.[157] A respective earmarking could be included in the levy legislation.

Table 8 The 2015 UFZ concept: Overview and full tariff formula

Overview



Tariff formula

Step 1		
Tax burden T_{ha} per hectare and year and PPP [EUR/(ha·a)]	=	$t[\frac{EUR}{ha \cdot a}] \cdot (1 + H) \cdot AF$ with ***t*** **= basic levy rate** [EUR/(ha a)] as standard price per hectare and year **(= general environmental impact component)** ***H*** **= general toxicity surcharge** [dimensionless] calculated by taking the sum of the human health risks of all active substances *i* contained in a PPP. The sum is calculated from the ratio of the maximum permissible dose of active substance per hectare and year (composed of PPP active substance and active substance dose) and the average of the ADI and AOEL values of an active substance. The sum of the risks is corrected by a factor of 100, since the ADI and AOEL values are very small (and thus the sum of risk potential ends with very large values). The factor 1/100 includes a weighting. *n* – Number of active substances *i* in a PPP $H = \frac{1}{100} \cdot \sum_{i=1}^{n} \left(\frac{AD \cdot ASC_i}{0.5 \cdot (ADI_i + AOEL_i)} \right)$ **AD = application dose** [l/(ha·a)] or [kg/(ha·a)] respectively maximum permissible application dose of a PPP per hectare and year, which is the maximum dose per use

[157] Möckel et al. 2015, p. 262-283.

	and the maximum number of uses for the main crop specified in the authorisation of a PPP. **ASC_i = active substance content** [kg/l] or [kg/kg] respectively per active substance *i* in a litre or kilogram of PPP, as specified in the authorisation **AF = additional (risk) factors** [dimensionless] **1.5**: for candidates for substitution **4.0**: PPPs that are approved and intended for use in the home and allotment garden sector
Step 2 Tax burden *T* per kg or l PPP [EUR/kg_{PPP} or EUR/l_{PPP}]	= $T_{ha}[\frac{EUR}{ha \cdot a}] \cdot \frac{1}{AD\,[\frac{kg}{ha \cdot a}]}$ AD = application dose (see step 1)
Step 3 Total tax burden per PPP per sales unit [EUR/SU]	= tax burden per kg or l PPP_x [EUR/kg_{PPP}] × quantity of PPP per sales unit [kg_{PPP}/SU]
Total tax burden	= amount of money a trader must pay per PPP sales unit (EUR/SU)
SU	= sales unit: trading unit of the respective pesticide (e.g., canister, container, tablets)
Step 4 Mark-up factor in percent of the net sales price	= Total tax burden per PPP [EUR/SU]/net sales price per PPP [EUR/SU]

Source: Möckel et al. 2015, p. 108 et seq.

Table 9 Maximum permissible application dose per hectare and vegetation period, and other parameters for selected plant protection products

Product name	**Active substances contained**	**App**	**AS**	**Active substance levels (g)**	**CfS**	**C**	**Maximum permissible product application dose per ha and year (kg; l)**	**Maximum permissible active substance application dose per ha and year (kg)**
DIFCOR	Difenoconazol	F	1	250	1	1	0.30	0,08
CHORUS	Cyprodinil	F	1	500	1	1	0.45	0.23
NARITA	Difenoconazol	F	1	250	1	1	0.50	0.13
Vegas	Cyflufenamid	F	1	51.3		7	0.96	0.05
ELATUS ERA	Benzovindiflupyr Prothioconazol	F	2	225	1	4	1.00	0.23
Luna Sensation	Fluopyram Trifloxystrobin	F	2	500		12	1.60	0.80
Luna Experience	Tebuconazol Fluopyram	F	2	400	1	13	1.80	0.72
REVUS TOP	Mandipropamid Difenoconazol	F	2	500	1	4	1.80	0.90
AMISTAR GOLD	Azoxystrobin Difenoconazol	F	2	250	1	3	2.00	0.50

AMISTAR	Azoxystrobin	F	1	250		5	2.00	0.50
Tilmor	Tebuconazol Prothioconazol	F	2	240	1	1	2.40	0.58
Input Classic	Prothioconazol Spiroxamine	F	2	460		4	2.50	1.15
Ascra Xpro	Fluopyram Bixafen Prothioconazol	F	3	260		5	3.00	0.78
Folicur	Tebuconazol	F	1	250	1	27	3.00	0.75
Pronto Plus	Tebuconazol Spiroxamine	F	2	383	1	3	3.00	1.15
REVUS	Mandipropamid	F	1	250		16	3.20	0.80
Folpan Gold	Metalaxyl-M|Folpet	F	2	450		3	7.20	3.24
Folpan 80 WDG	Folpet	F	1	800		1	12.80	10.24
FOLPAN 500 SC	Folpet	F	1	500		2	19.20	9.60
Delan WG	Dithianon	F	1	700		10	20.00	14.00
ARTUS	Carfentrazone Metsulfuron	H	2	469	1	7	0.05	0.02
Alliance	Diflufenican Metsulfuron	H	2	658	2	2	0.10	0.07
CONCERT SX	Thifensulfuron Metsulfuron	H	2	423	1	7	0.15	0.06
Runway	Aminopyralid Picloram Clopyralid	H	3	360		1	0.20	0.07
Primus Perfect	Florasulam Clopyralid	H	2	325		3	0.20	0.07
Runway VA	Aminopyralid	H	1	30		1	0.27	0.01
Cadou SC	Flufenacet	H	1	500	1	9	0.50	0.25
Belkar	Picloram Halauxifen-methyl	H	2	58		1	0.50	0.03
Mais-Banvel WG	Dicamba	H	1	700		4	0.50	0.35
Spectrum	Dimethenamid-P	H	1	720		30	1.40	1.01
ARIANE C	Fluroxypyr Florasulam Clopyralid	H	3	183		5	1.50	0.27
MaisTer power	Thiencarbazone Iodosulfuron Foramsulfuron	H	3	40.6		1	1.50	0.06
Callisto	Mesotrione	H	1	100		5	1.50	0.15
U 46 D Fluid	2.4-D	H	1	500		2	1.50	0.75
Fusilade MAX	Fluazifop-P	H	1	107		50	2.00	0.21
U 46 M-Fluid	MCPA	H	1	500		13	2.00	1.00
Spectrum Gold	Dimethenamid-P Terbuthylazin	H	2	530		1	3.00	1.59
Spectrum Plus	Dimethenamid-P Pendimethalin	H	2	463	1	7	4.00	1.85
Gardo Gold	S-Metolachlor Terbuthylazin	H	2	500		4	4.00	2.00

Successor T	Pethoxamid Terbuthylazin	H	2	488		1	4.00	1.95
Bandur	Aclonifen	H	1	600	1	24	4.00	2.40
Kyleo	Glyphosat 2.4-D	H	2	400		5	5.00	2.00
Boxer	Prosulfocarb	H	1	800		22	5.00	4.00
Metafol SC	Metamitron	H	1	696		1	6.00	4.18
Stomp Aqua	Pendimethalin	H	1	455	1	63	7.00	3.19
Roundup PowerFlex	Glyphosat	H	1	480		24	7.50	3.60
KARATE FORST flüssig	lambda-Cyhalothrin	I	1	100	1	2	0.08	0.0075
Karate Zeon	lambda-Cyhalothrin	I	1	100	1	62	0.15	0.015
Nexide	gamma-Cyhalothrin	I	1	60		2	0.16	0.01
Trebon 30 EC	Etofenprox	I	1	288	1	4	0.40	0.115
Mavrik Vita	tau-Fluvalinat	I	1	240		19	0.40	0.096
Pirimor Granulat	Pirimicarb	I	1	500	1	44	2.50	1.25
MODDEVO	Trinexapac	G	1	222		6	0.60	0.13
Countdown	Trinexapac	G	1	222		5	0.80	0.18
Moddus	Trinexapac	G	1	222		11	1.50	0.33
CCC720	Chlormequat	G	1	558		5	2.10	1.17

Explanation of the table header: App = application (F = Fungicide, H= Herbicide, I = Insecticide und Acaricide; G = growth regulator); AS = active substances; CfS = candidate for substitution (according to Art. 24 Regulation 1107/2009/EC); C = number of approved crops.

Source: Lars Neumeister (see appendix).

5.5 The Modified UFZ Concept

The 2015 UFZ concept for a levy on plant protection products offers various opportunities for modification:

1. The basic price per hectare of 20 EUR for the maximum permissible application dose of a plant protection product per hectare and year can be increased or reduced in order to raise (greater incentive effects and revenue) or lower (lower incentive effects and revenue) the overall tax level.
2. The weighting of human toxicological risks can be increased or decreased in order to take these risks into account to a greater or lesser extent when differentiating the tax burden.
3. The weight of additional factors for substitution candidates (factor 1.5 = +50 percent) and for home and small garden products (factor 4 = +300 percent) can be increased or reduced in order to raise (greater steering effects) or lower (lesser steering effects) the tax level for these specific plant protection products.
4. Other additional factors may be included to take into account certain environmental risks identified in the authorisation, as in the case of the Danish tax (cf. Table 8 in Section 5.4). As explained in Section 5.4, the 2015 UFZ levy proposal builds on the decisions made in the authorisation regarding application dose per hectare and number of applications per year. A year here refers to a vegetation period of 12 months and not to a calendar year. The assessment decision on the maximum permissible

application dose per hectare and year takes account of environmental risks identified. The subsequent special weighting of certain environmental risks within the framework of a levy requires special reasons justifying such higher weighting.

5. The levy proposal allows introducing further additional factors for certain groups of plant protection products (herbicides, fungicides, insecticides, germination and growth regulators, seed products), with which the level of taxation for these plant protection products can be increased in order to achieve greater steering effects and to stimulate increased substitution by non-chemical plant protection measures (e.g., preventive adapted management as well as biological, mechanical, agro-ecological measures)[158].

In this study, only one of these five options will be considered in more detail so that the specific effect of this modification can be compared to the 2015 UFZ levy proposal. We see the greatest ecological steering effects in an additional factor of 1.5 (corresponding to an increase of 50 percent) for herbicides and insecticides (including acaricides), as both groups of pesticides have major direct and indirect environmental impacts, especially on insects and birds (see overview in Figure 30). At the same time, an extensive study in France showed that the majority of arable farms could do without 42 percent of treatments (–37 percent herbicides, –47 percent fungicides, –60 percent insecticides) without a loss of productivity.[159]

Herbicides are used for the cost-effective suppression and elimination of undesirable wild weeds and other undesirable plants on arable land, permanent grassland or in speciality crops. Since wild herbs are the basic food resource for a large number of animal groups (among others insects, birds, small mammals, soil organisms), their large-scale removal from agricultural landscapes contributes significantly to declining biodiversity.[160] At the same time, the necessity to chemically remove wild weeds is often not given or not given to the extent that justifies ongoing practices, since:

- wild weeds do not or only insignificantly impact on cultivation,
- uncovered soil is exposed to higher risks of erosion and drying out, and
- there is a wide range of preventive measures to keep weed growth in areas low,
- there are still technical possibilities to remove the seeds and separate other parts of the weeds from the cultivated plants in the field or the harvest.[161]

Where the elimination of wild weeds and other undesirable plants is unavoidable, a variety of preventive or non-chemical measures exist to prevent, eliminate, or suppress undesirable plants (e.g., adapted crop rotation and fertilisation, currying, thermal treatment, cultivation of dominant under or catch crops).[162] Preventive measures are usually more effective, cost-neutral, and environmentally friendly.

Insecticides are used to suppress and eliminate or deter pests. Damage to crops is caused by a variety of insect species, small mammals and also, for example, wild boar. However, insects and small mammals are also important components of functioning ecosystems as well as food sources for birds and mammals and are therefore essential for maintaining biodiversity. For crops, the level of pressure exerted by a pest also depends

[158] Cf. Möhring et al. 2020; Niggli et al. 2020, 14 et seq., 18 et sqq.; Dorninger et al. 2020.

[159] Lechenet et al. 2017.

[160] Cf. Niggli et al. 2020, 4 et sqq., 9 et sqq.; BfN 2018, p. 3 et sqq.; SRU/WBBGR 2018, p. 19 et sqq.; Schäffer et al. 2018, p. 19 et seq.; UBA 2016, s. 8 et sqq.; SRU 2016, p. 386; Petit et al. 2015.

[161] Cf. BVL Fachbeirat Nachhaltiger Pflanzenbau 2019.

[162] Cf. Möhring et al. 2020; Niggli et al. 2020, 14 et seq., 18 et sqq.; Dorninger et al. 2020; BVL Fachbeirat Nachhaltiger Pflanzenbau 2019, p. 6 et seq.; Lechenet et al. 2017; Petit et al. 2015; Möckel et al. 2015, p. 58-61.

on the respective crop rotation and the level of fertilisation.[163] The sowing date can also be decisive. Is winter barley sown too early, for example, aphid populations can build up, which then transmit viruses – later sowing is recommended as a preventive measure. Without sufficient crop rotation, high populations of pests build up, while high fertiliser applications make crops more attractive to natural enemies (e.g., aphids) and pathogens (e.g., mildew in cereals) (see chapter 1). The damage caused by leaf blight (*Phythophtora infestans*) in conventional potato production, for example, is much less severe in organic production because the lower nitrogen fertiliser application allows the crop to mature before leaf blight occurs.[164] In addition, when non-selective insecticides are used, they decimate not only the undesirable target species but also non-pests and beneficial insects (e.g., pollinating insects, antagonists or natural enemies of the target species).[165] The reduction of beneficial insects means that the natural antagonists of pests are missing, so that their population and harmful effects increase and insecticide use rises further.[166] Finally, the growing capabilities of biocontrol offer more and more alternatives to chemical insecticides.[167]

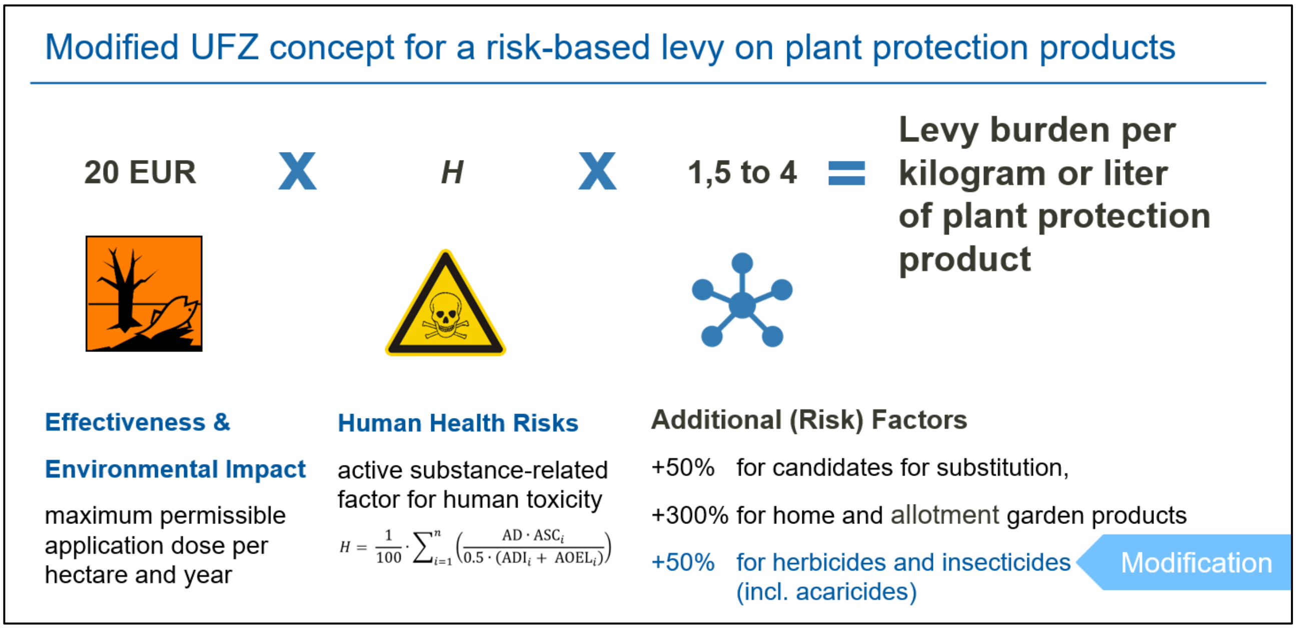


Figure 30 Modified UFZ concept for a risk-based levy on plant protection products

[163] Cf. Finckh/Van Bruggen/Tamm 2015; Huber/Haneklaus 2007; Hofmeester 1992 et sqq.; Culliney/Pimentel 1986 et sqq.
[164] Ghorbani et al. 2004.
[165] Cf. Calvo-Agudo et al. 2020; Uhl/Brühl 2019; Schäffer et al. 2018, p. 17 et sqq.; SRU 2016, p. 384 et sqq.
[166] Cf. Brzozowski/Mazourek 2018 et sqq.; Altieri/Ponti/Nicholls 2012.
[167] Hulot/Hiller 2021; Chaplin-Kramer et al. 2019.

6 A Simulation of the Potential Effects of a Plant Protection Product Levy for Germany

For the study, a dynamic and relational database model was generated (Figure 31) and utilised to model and analyse changes in sales of plant protection products and active substances as well as the potentially treatable area in Germany for the following levy proposals:

- the 2015 UFZ proposal with a base price of 20 EUR for the maximum permissible application dose of a plant protection product per hectare and year (vegetation period of 12 months) and an active substance-specific factor for human toxicity according to ADI and AOEL classification as well as an increase of 50 percent for active substances classified as substitution candidates (see Section 5.4);[168]
- a modified UFZ proposal that supplements the above proposal with an additional 50 percent increase for herbicides and insecticides (including acaricides) (see Section 5.5);
- the Danish concept (see Section 5.3) based on data from the Pesticide Property Database (PPDB) and the hazard warnings of the Federal Office of Consumer Protection and Food Safety (BVL) on plant protection products[169] and
- an undifferentiated ad valorem-levy of 35 percent on the net price of each plant protection product (see Section 5.2).

The database model allows to analyse and compare the steering effects of different levy concepts on the demand for plant protection products. However, it does not allow to investigate or establish the economic or operational effects on users or on possible adaptations, e.g., in the area of agricultural management.

6.1 Preliminary Methodological Remarks

The database system consists of different databases, which in turn contain different tables (see Figure 31 and Appendix) and conduct different partial calculations. The databases and tables are linked via IDs (e.g., approval numbers, active substance numbers).

The current net prices for all authorised plant protection products (as of autumn 2020) were collected in a price database in order to calculate the levy increases. Also very important is the authorisation database of the BVL with all relevant information on the authorised products. This database contains a large number of tables from which further tables were generated. One of these tables, for instance, calculates the active substance application doses for all applications and application conditions of all products.

For the calculation of a pesticide levy according to the Danish concept, the authorisation database was linked to the Pesticide Property Database. In this database, the Pesticide Burden Indicators (PBI) for environmental performance and toxicity are calculated for all active substances (see Chapter 5.3). The Danish substance database and the Danish authorisation database are linked to the PPDB for validation and the comparison of results.

---

[168] Note: Proposed in the 2015 UFZ concept, the additional factor of 4 for house and allotment garden products was excluded from the modelling, as no pure home and allotment garden products (i.e., products that are not also approved as agricultural products) were included in the modelling.

[169] However, without a differentiation for 'greenhouse products', which are taxed to a somewhat lower degree in Denmark since this strict differentiation between 'greenhouse products' and 'outdoor products' does not exist in the German authorisation process and can therefore not be applied to a German levy.

For the calculation of the levy according to the UFZ proposal, the EU pesticide database was also used. This database contains, among other things, the ADI and AOEL values for all active substances and their status as candidates for substitution (CfS).[170]

In order to convert the expected changes in the quantities of the taxed substances into the turnover of active substances, the authorisation database remains linked to the sales database. The latter contains the active substance-specific sales data and the potentially treatable area for each active substance (for data sources see the Appendix). The potentially treatable area is the area that could be treated with the sold quantity of an active substance, if the maximum permissible application doses per hectare and year were exhausted (see Chapter 2.1).

Since the maximum permissible application doses for a plant protection product vary with respect to individual crops, we have used the highest permissible application dose of all the crops for which a product is approved in the model, both for the calculation of the levy burden in the UFZ proposal and for the calculation of the potentially treatable areas.[171] This reduces the levy burden for pesticide use on all crops for which a lower application dose is permitted for the pesticide in question (see also No. 13 Figure 32).

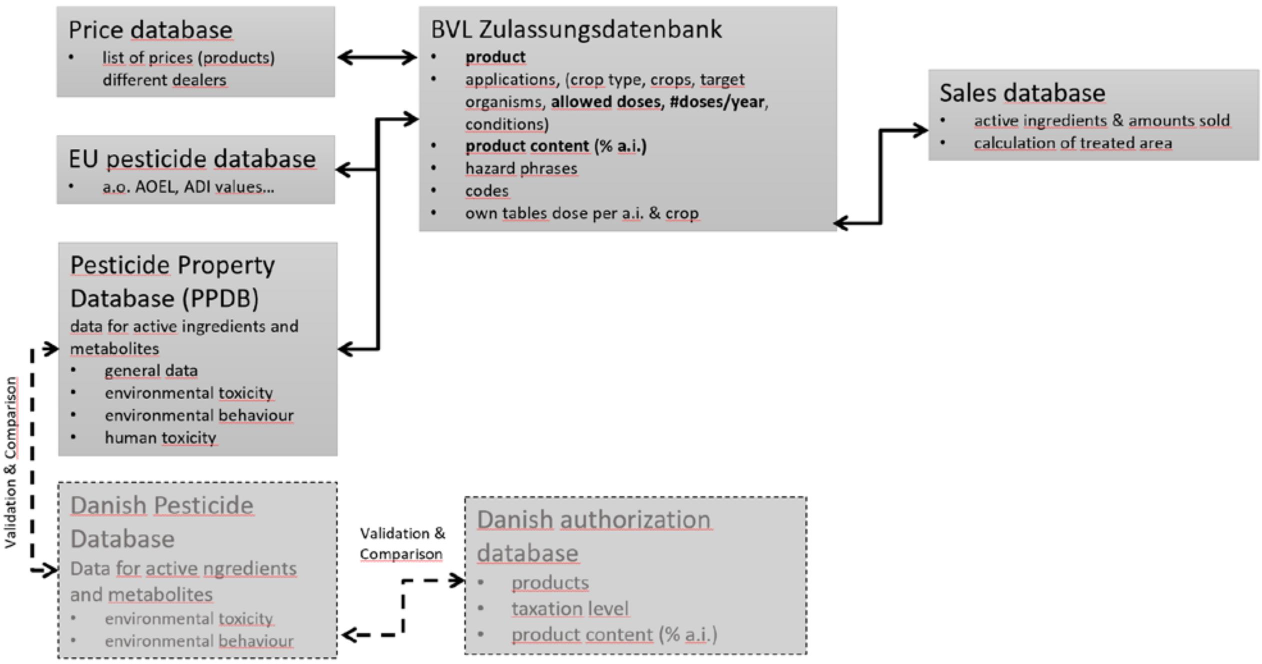


Figure 31 Simplified data model for calculating levy concepts

Plant protection products for which no application dose per application and no applications per hectare and year are specified in the authorisation were not included in the model calculations, as the UFZ levy concept is linked to the maximum permissible application dose. This concerns some plant protection products that are only approved as storage protection products and some products that are only approved as home and small garden products (HUK) or for seed dressing.

[170] Substitution candidate according to Article 24, 50 Regulation 1107/2009/EG.

[171] The 2015 UFZ proposal still referred to the application dose for the main crop (the most common crop in terms of area for which a product is approved) (see Table 8, Step 1 in Chapter 5.4). However, the main crop can change from year to year. The latter avoids reference to the highest application dose of all approved crops. Alternatively, it would also be possible to refer to the average of all maximum authorised application doses of a plant protection product. This would increase the tax burden for the average application dose per hectare and year.

Also excluded were all products whose active substances have lost their EU approval, and which will therefore soon also lose their national approval. The findings for the different levy concepts always refer to the same selection of plant protection products.

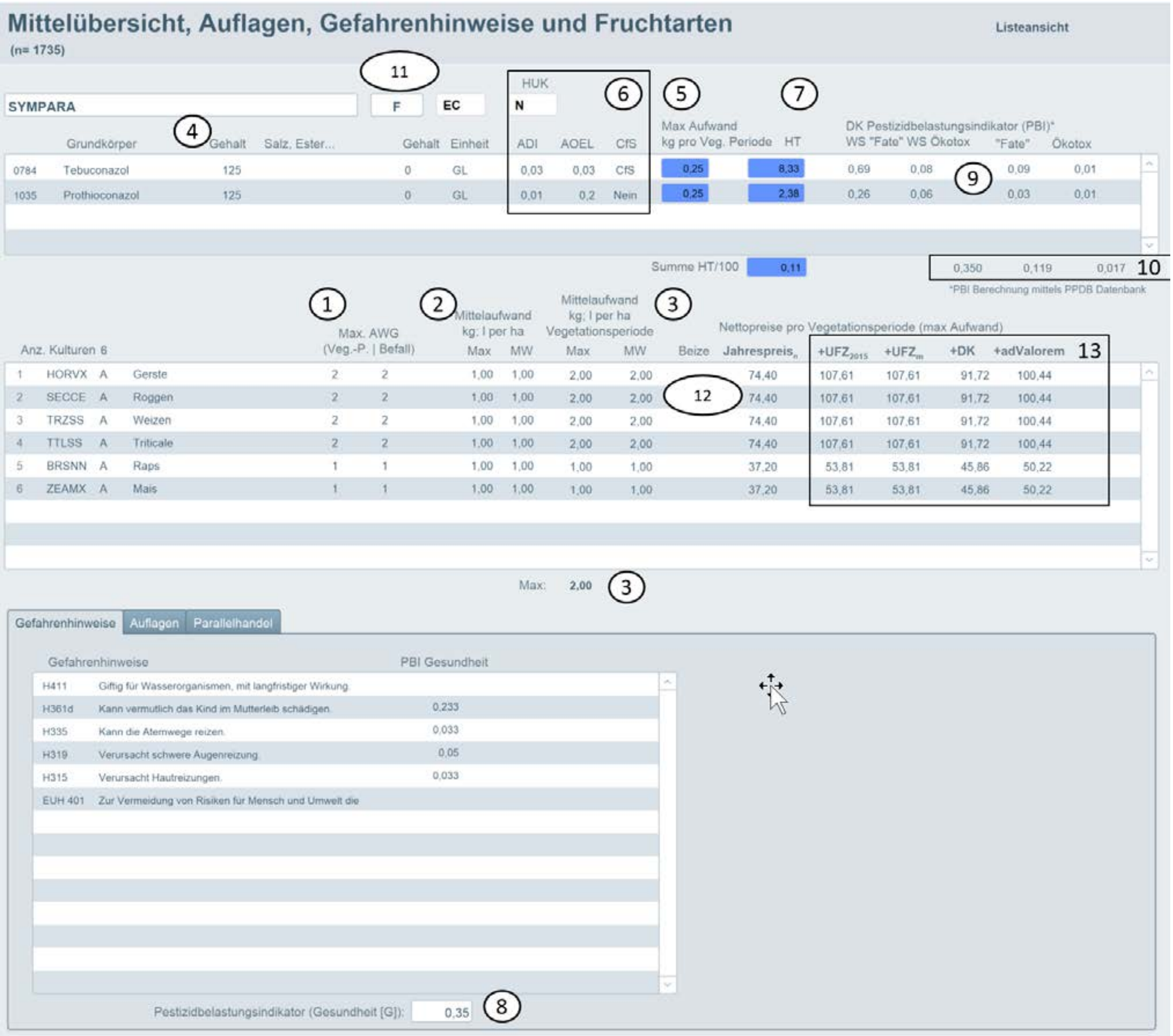


Figure 32 Example: database entry for the plant protection product 'Sympara' with the relevant information

Figure 32 displays the relevant parameters of the database using the example of the fungicide 'Sympara'. The parameters are explained below according to the introduced number labels:

1. *Maximum number of permitted applications* (max. App.) for the respective crop per year (= vegetation period of 12 months).
2. *Maximum permitted dose per application* in the respective crop type (always converted into kilograms or litres per hectare).
3. *Maximum permitted application dose* per year in the respective crop (no. 1 x no. 2).

4. *Active substance level* for each active substance in the product 'Sympara'.
5. *Maximum permitted application dose of active substance* under all crop types per growing season (No. 3 x No. 4).
6. Information for calculations according to the UFZ concept (AOEL, ADI values, status as substitution candidate (CfS), HUK = private garden pesticide).
7. Humantox factor (HT) in the *UFZ concept* derived from the AOEL/ADI values (mean) and No. 5. The sum (HT) is divided by 100.
8. *Pesticide exposure indicator (Danish concept)* for human health as the sum of load points per active substance (AS) due to official health hazard statement in the approval, multiplied by the AS share in the product.
9. *Pesticide exposure indicators (Danish concept*) for environmental performance and toxicity of the active substance as the sum of load points per active substance due to official hazard statement in the approval, multiplied by the AS share in the product.
10. *Sum of the individual pesticide load indicators (Danish concept),* which are further multiplied by 14.37 EUR (107 DKK) and supplemented by the basic flat rate of 6.70 EUR.
11. *Mode of action* (e.g.: F = fungicide).
12. *Annual price* for the respective crop type in relation to one hectare and year, calculated on the basis of the mean for all prices charged for a plant protection product multiplied by the maximum permissible application dose per crop type (No. 3).
13. *Annual price* including the respective levy for the respective crop type related to one hectare and year.

Based on the average price per kilogram or litre or on the maximum permissible application dose, the *annual price*[172] is the basis for the further calculations. The payment burden derived from the respective levy concept is added to this annual price (no. 13 in Figure 32).

In the next step, the relative effect of the (simplified) *levy-induced price increase* on the short- and long-term product sales is calculated for each product for which price data was available. For this purpose, *price elasticitie*s (ε) of –0.4 for herbicides and –0.2 for all other products were used for short-term product sales. For long-term product sales, on the other hand, price elasticities (ε) of –0.8 for herbicides and –0.4 for all other products were applied.

Numerous individual and meta-studies are available on the price elasticities of demand for crop protection products.[173] Overall, the results are remarkably consistent compared to other goods.[174] The elasticities are almost always between –1 and 0 with a barycentre in the middle range. Formally, we are dealing with a (relatively) inelastic demand with a disproportionately low quantity response to price stimuli; however, such disproportionately low responsiveness should not be confused with 'rigid' or 'unresponsive' demand (see Chapter 3 above).

---

172 The price refers to the growing season but is denoted as annual price for simplicity's sake.

173 See especially the meta-studies by Skevas et al. 2009 and Böcker/Finger 2017 with numerous references to the assessed individual studies. Dazu im Übrigen auch Möckel et al. 2015, p. 136 et sqq.

174 This applies, for instance, in contrast to the price elasticity of water demand. There, the findings are much more scattered depending on region or price level– cf. instead of many Gawel et al. 2011, p. 127; Ansmann 2010.

It is clear from the empirical data that the *price elasticities* of crop protection products vary significantly in two relevant dimensions:

(1) There are different price elasticities depending on *maturity*. It is generally observed that demand is more elastic in the long term than in the short term.[175] The literature on crop protection products also provides evidence for this well-known economic phenomenon. Long-term studies typically arrive at values between –1 and –0.5. For example, in his long-term analysis Dubgaard arrives at values of –0.7 or –0.8 respectively.[176] Conversely, short-term studies typically arrive at elasticity values between –0,5 and 0. In practice, the transition between short-term and long-term effects of a levy is fluid, as different adjustment measures are taken at different times depending on the plant protection product, crop and user; hence, the transition from short- to long-term steering effects is faster or slower depending on the plant protection product. The price elasticities for short- and long-term steering effects take this into account as a generalised assumption, without being able to determine a precise point in time.

(2) Price elasticity also varies depending on the *type of crop protection product*. This is due in particular to the different substitution possibilities. Insecticides, for example, are less elastic overall than herbicides.[177] This means that a price increase induced by a levy would lead to a higher elasticity on average, if the levy were specified in each case by type of plant protection product. For the purposes of this study, we follow the more recent meta-evaluation by Böcker/Finger with the above-mentioned mean for the price elasticities of demand. A distinction is made between short- and long-term demand responses (–0.2 in the short term and –0.4 in the long term) and a doubled value is applied for herbicides (–0.4 in the short term and –0.8 in the long term).

The *relative changes in quantity* in percent then result from the respective price elasticities (PE), the initial price (p_0) and the (calculated) price change induced by the levy (Δp):[178]

$$\varepsilon \cdot \Delta p \,/\, (p_0) \times 100.$$

In the context of this study, *relative* changes in quantity are considered, since calculations on absolute changes in the quantity of the individual plant protection products require data on their previous sales, yet this data is not published by the Federal Office of Consumer Protection and Food Safety or made available on request. Furthermore, the effects of internal substitution cannot be simulated in the model, as there is no data on the extent to which users switch due to price changes from one product to a product that is cheaper per kilogram or litre or per maximum permissible application dose per hectare.

[175] Cf. Hoevenagel/Van Noort/De Kok 1999, p. 40.

[176] Cf. Dubgaard 1991.

[177] Cf. Hoevenagel/Van Noort/De Kok 1999, p. 46.

[178] This follows as equivalent from the definitory equation of price elasticity, which relates relative quantity change to relative price change – in addition fundamentally Gawel 2009, p. 49 et sqq.

6.2 Comparative Presentation of the Modelling Results for the Four Levy Variants for Germany

6.2.1 Change in the Sale of Plant Protection Products and their Active Substances

Table 10 below shows the relative quantity change in the different application areas for sales of plant protection products depending on the levy concept. The UFZ proposals reduce herbicide sales the most. The Danish concept would reduce insecticides the most compared to the other levy concepts. The sales data from Denmark (see Chapter 4) indicate this change.

The Danish concept would reduce total sales in the model by 24 percent in the short term and by 36 percent in the long term; this is below the reduction actually achieved in Denmark. The modified UFZ concept would achieve a similarly high reduction. An ad valorem-levy of 35 percent on net sales prices, on the other hand, would trigger the smallest reduction.

Due to the higher assumed price elasticities (demand responsiveness), in the long term a reduction of up to approximately 50 percent could be achieved depending on levy concept. An ad valorem-levy of 35 percent again achieves only the smallest reduction.

Table 10 Mean of the relative change in quantity for plant protection products by area of application and levy concept

	Mean of the Relative Change in Quantity for Plant Protection Products in %							
	Short-term Change				**Long-term Change**			
Mode of Action	**UFZ 2015**	**UFZ 2015 modified**	**Danish Concept**	**35 % ad valorem**	**UFZ 2015**	**UFZ 2015 modified**	**Danish Concept**	**35 % ad valorem**
Herbicide	–40	–54	–31	–14	–65	–78	–45	–28
Fungicide	–9	–9	–17	–7	–18	–18	–27	–14
Growth Regulators	–18	–18	–10	–7	–31	–31	–15	–14
Insecticide and Acaricide	–20	–28	–32	–7	–33	–40	–47	–14
Molluscicide	–7	–7	–4	–7	–13	–13	–7	–14
Nematicide	–6	–6	–25	–7	–12	–12	–50	–14
Rodenticide	–32	–32	–8	–7	–65	–65	–16	–14
All assessed plant protection products	**–25**	**–32**	**–24**	**–10**	**–42**	**–49**	**–36**	**–20**

For the following figure, the relative changes in quantity were presented using the aggregated sales data on plant protection products taken from the BVL annual reports on domestic sales. For this purpose, the sales data for each area of application were multiplied by the calculated relative quantity changes in Table 10.

On average, approximately 100,000 tonnes of plant protection products (excluding inert gases) were sold between 2014 and 2018. Herbicides have the highest share and are reduced the most in the modified UFZ concept. Therefore, the short-term overall reduction is highest in this concept.

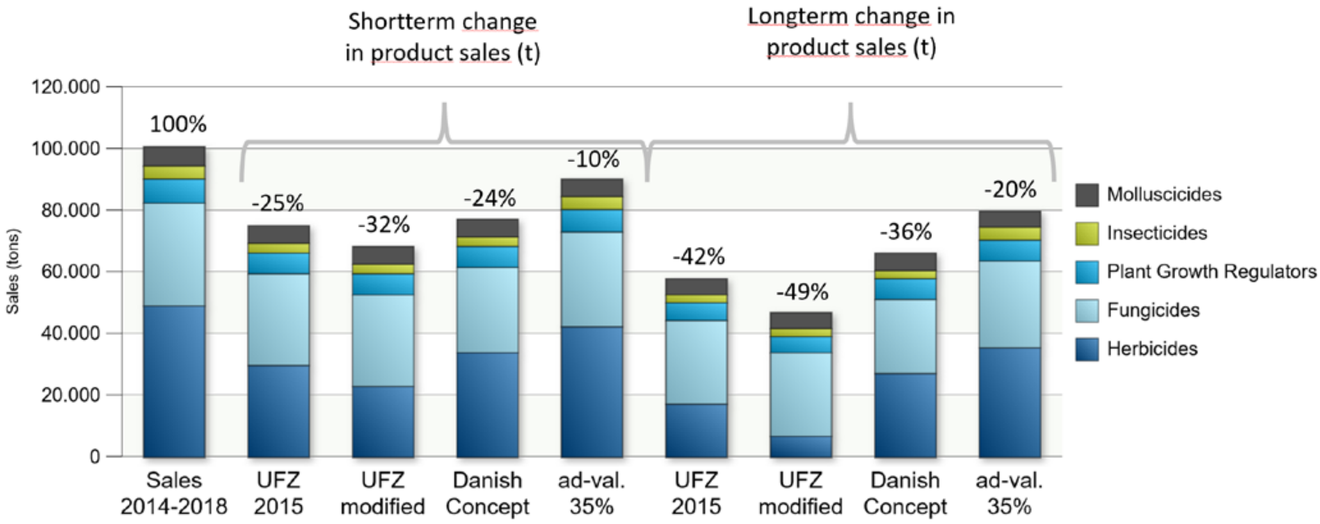


Figure 33 Modelled quantity changes in sales of plant protection products (without inert gases) depending on the levy concept

The aggregated data on sales of plant protection products by area of application only allow limited evaluation. For a more precise calculation, sales data for the individual plant protection products would be required. This data is considered a trade secret and was not made available to the authors by the BVL. In addition, these aggregated data also include sales of products that are no longer approved, which represented very large volumes in sales from 2014 to 2018 (see chapter 4.2.4).

In order to show the effect of the levy concepts on the treated area, the relative quantity changes of the products were applied to the associated active substances. For this purpose, the average relative change in quantity for all plant protection products of an active substance was used. Due to the assumed price elasticities, negative sales volumes can occur in the model for some active substances with very high levy payment burdens due to the associated risk.[179] In order to exclude negative sales as an unrealistic market event, all negative sales volumes were therefore set to zero.

As with products, active substances that have lost their EU approval since 2014 were also excluded from all calculations. Active substances whose application dose cannot be related to the area (e.g., active substances for stock protection and for seed treatment) were also excluded. The reference quantity (mean of sales from 2014 to 2018) is approximately 27,300 tonnes.

[179] Negative sales occur when the levy burden is higher than 500 percent of the price given a price elasticity of -0.2 or higher than 250 percent with a price elasticity of -0.4. This happens, if a) the previous sales price of the product was very low (e.g., in the case of Life Scientific Lamda) or b) the levy burden is very high (e.g., in the case of Herold SC) due to high risks to human health (= high human toxicity factors in the UFZ concept as well as the Danish concept).

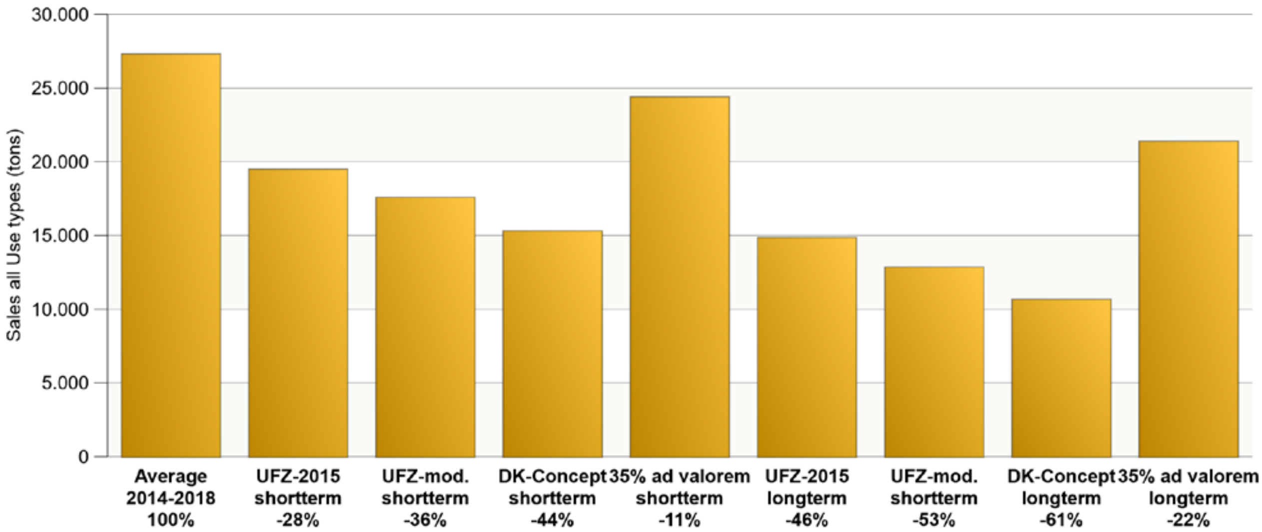


Figure 34 Modelled volume change in sales of active substances depending on the levy concept

Figure 34 shows the results of applying the average relative change in quantity of plant protection products to the corresponding active substances. The percentage change in the short-term change of active substance sales is similar to the percentage changes in the evaluated plant protection products for the ad valorem concept and the UFZ concepts. Regarding the long-term change, the deviations between plant protection product and active ingredient sales are somewhat larger.

Only when applying the Danish approach, there are larger deviations in the mean of the relative quantity changes (see also Table 11). These differences result from the fact that the number of authorised plant protection products per active substance or active substance group is not proportional to their sales volume. There is a high number of low-dose plant protection products with highly effective active substances, which are only charged a small amount under the Danish levy concept. Due to their number, they strongly influence the average relative change in quantity of all assessed plant protection products (mean of Table 10), although in terms of quantity they only account for a small sales volume. This effect does not apply when calculating the mean of the modelled active substance sales, as here the significantly lower total number of active substances is taken as a basis and thus high-dosage active substances with correspondingly higher number loads (e.g., glyphosate, prosulfocarb, pendimethalin) are taken into account according to their actual share in the average relative quantity change of the total active substance sales. The reduction of active substances induced by the Danish concept (–44 percent) is therefore much more similar to the empirical data from Denmark than the calculated average quantity changes for the evaluated plant protection products (–24 percent).

Table 11 Mean of the relative quantity changes for plant protection products and active substances depending on the levy concept

	Mean of the Relative Quantity Changes in %							
	Short-term Changes				Long-term Changes			
	UFZ 2015	UFZ 2015 modified	Danish Concept	35 % ad valorem	UFZ 2015	UFZ 2015 modified	Danish Concept	35 % ad valorem
Plant Protection Product	–25	–32	–24	–10	–42	–49	–36	–20
Active Substance	–28	–36	–44	–11	–46	–53	–61	–22
Deviation	*3*	*4*	*20*	*1*	*4*	*4*	*25*	*2*

If the active substance-specific sales volume is divided by the maximum permissible active substance application dose per hectare and year (vegetation period with 12 months), the potentially treatable area can be calculated. Figure 35 shows the results of this calculation for the simulated total sales of all active substances.

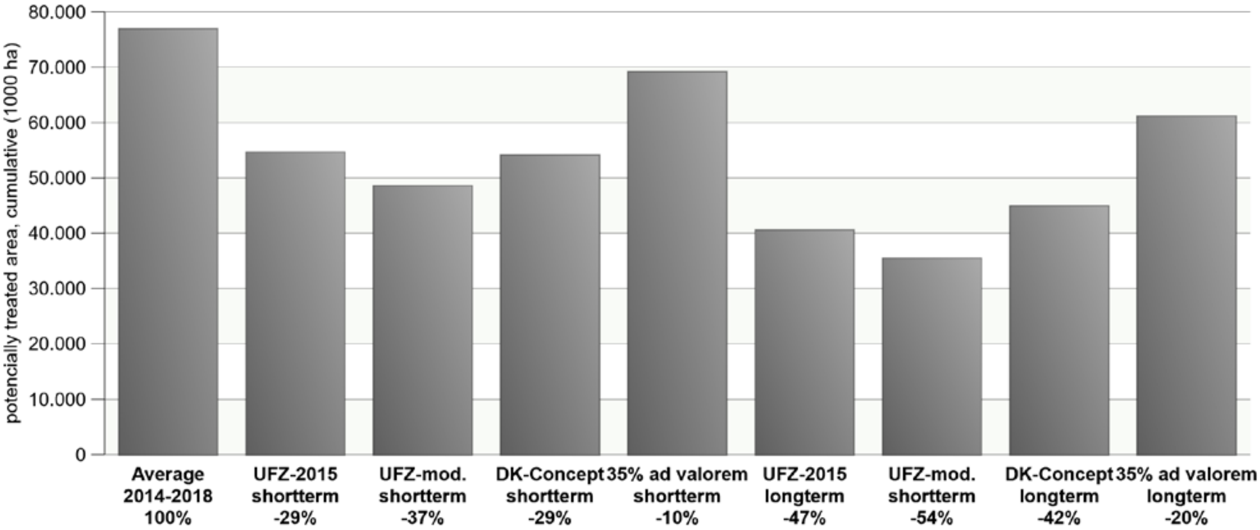


Figure 35 Changes in potentially treatable area (1000ha) for modelled sales of active substances depending on levy concept

The calculation shows that the UFZ levy concepts have a stronger steering effect on the potentially treatable area than the Danish concept and a 35-percent ad valorem-levy. Although the reduction in sales volume is lower for the UFZ concepts than for the Danish concept, the area reduction is similar or higher. The following table summarises the findings.

Table 12 Change in sales volumes of active substances and the area potentially treatable with them depending on levy concept

	Quantity (t)	%	Potentially Treatable Area (1000 ha)	%
Mean 2014-2018	27324	100	76906	100
Short-term change				
UFZ Concept 2015	19542	–28	54781	–29
UFZ Concept modified	17567	–36	48613	–37
Danish Concept	15307	–44	54234	–29
35 % ad valorem	24375	–11	69117	–10
Long-term change				
UFZ Concept 2015	14888	–46	40569	–47
UFZ Concept modified	12821	–53	35429	–54
Danish Concept	10703	–61	44913	–42
35 % ad valorem	21425	–22	61329	–20

The different levy concepts exert different effects on the active substances of different areas of application. The Danish concept shows the strongest steering effect for insecticides and acaricides; this is well compatible with empirical observations in Denmark. The modified UFZ concept has an equally high steering effect on insecticides and acaricides. The modified UFZ concept has the strongest steering effects on herbicides. Growth regulators are also steered more strongly by the UFZ concepts. Fungicides are only moderately reduced by the levy concepts. The Danish levy concept reduces fungicides the most, but the differences in treatable area are small. Table 13 and the subsequent figures unpack the detailed results for the simulated total sales of the respective modes of action. Due to the very small quantities of molluscicides (slug pesticides), these are no longer displayed in the table and figures.

Table 13 Change in sales volumes and thus potentially treatable area

	Quantity	%	Potentially Treatable Area (1000 ha)	%
Herbicide Mean 2014-2018	14946	100	**34496**	100
Herbicide – short-term change				
UFZ Concept 2015	9512	–36	**20347**	–41
UFZ Concept modified	7558	–49	**15241**	–56
Danish Concept	7448	–50	**21098**	–39
35 % ad valorem	12865	–14	**29676**	–14
Herbicide – long-term change				
UFZ Concept 2015	6143	–59	**11706**	–66
UFZ Concept modified	4102	–73	**7284**	–79
Danish Concept	4412	–70	**16536**	–52
35 % ad valorem	10783	–28	**24857**	–28
Fungicide Mean 2014-2018	8664	100	**27720**	100
Fungicide – short-term change				

UFZ Concepts	7989	–8	**25057**	–10
Danish Concept	5753	–34	**24204**	–13
35 % ad valorem	8058	–7	**25780**	–7
Fungicide – long-term change				
UFZ Concepts	7314	–16	**22394**	–19
Danish Concept	4774	–45	**21512**	–22
35 % ad valorem	7451	–14	**23839**	–14
Growth Regulators Mean 2014–2018	3022	100	**7250**	100
Growth Regulators – short-term change				
UFZ Concepts	1411	–53	**4815**	–34
Danish Concept	1611	–47	**5397**	–26
35 % ad valorem	2809	–7	**6742**	–7
Growth Regulators – long-term change				
UFZ Concepts	855	–72	**3693**	–49
Danish Concept	1134	–62	**4708**	–35
35 % ad valorem	2596	–14	**6235**	–14
Insecticide and Acaricide Mean 2014-2018	335	100	**6580**	100
Insecticide and Acaricide – short-term change				
UFZ Concept 2015	291	–13	**3764**	–43
UFZ Concept modified	272	–19	**2703**	–59
Danish Concept	217	–35	**2707**	–59
35 % ad valorem	312	–7	**6119**	–7
Insecticide and Acaricide – long-term change				
UFZ Concept 2015	257	–23	**2041**	–69
UFZ Concept modified	233	–30	**1323**	–80
Danish Concept	171	–49	**1361**	–79
35 % ad valorem	288	–14	**5659**	–14

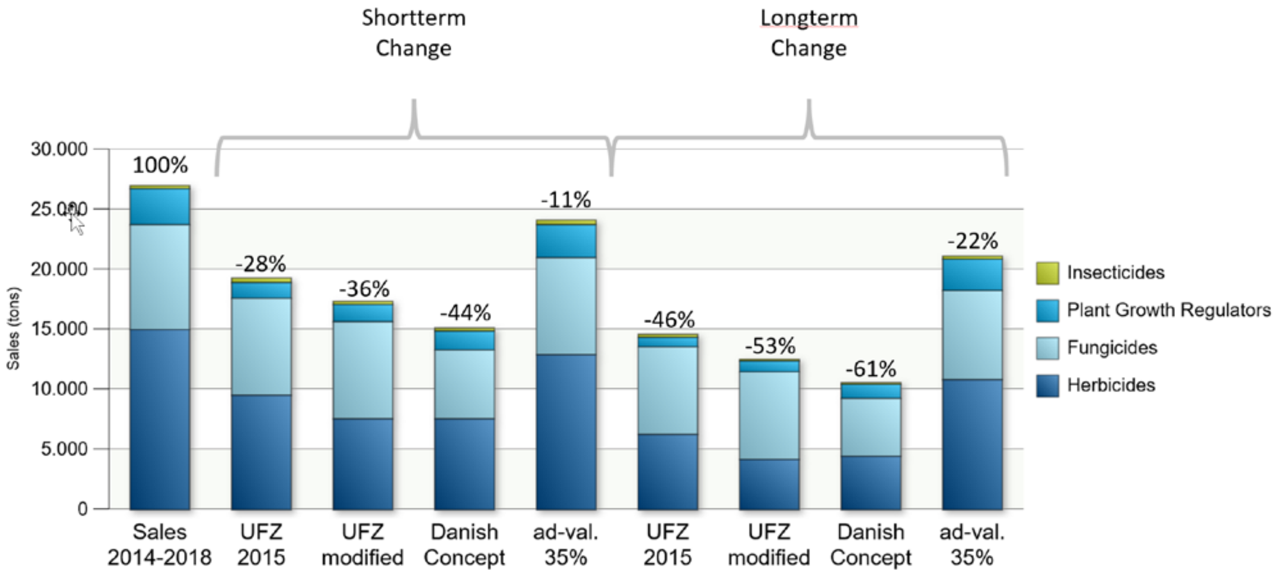


Figure 36 Changes in active substance sales depending on levy concept and pesticide area of application

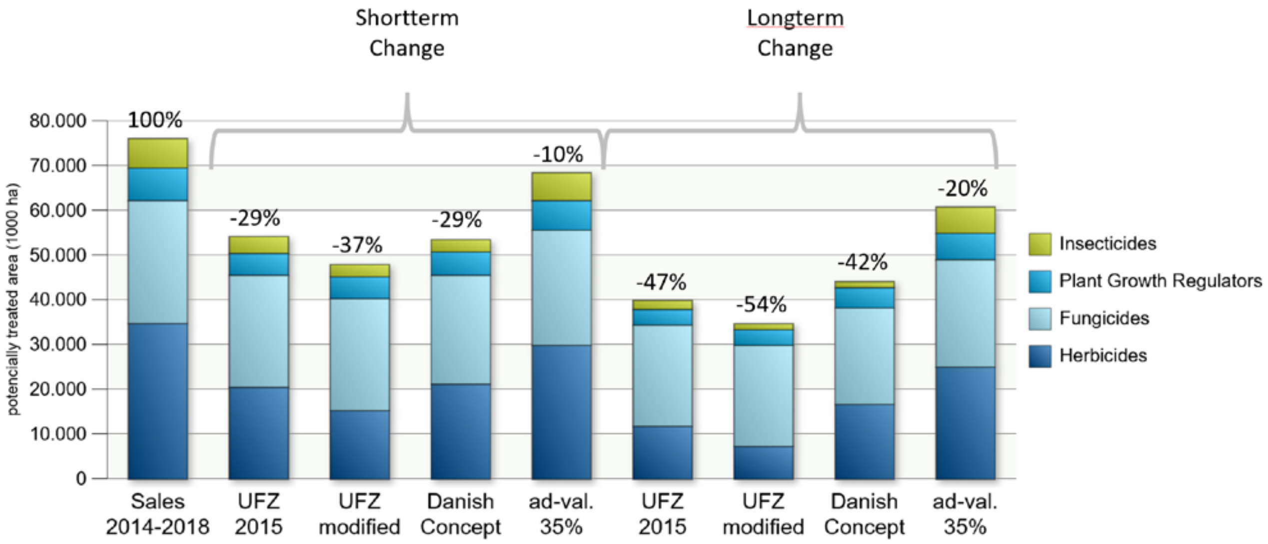


Figure 37 Changes in potentially treatable area depending on levy concept and pesticide area of application

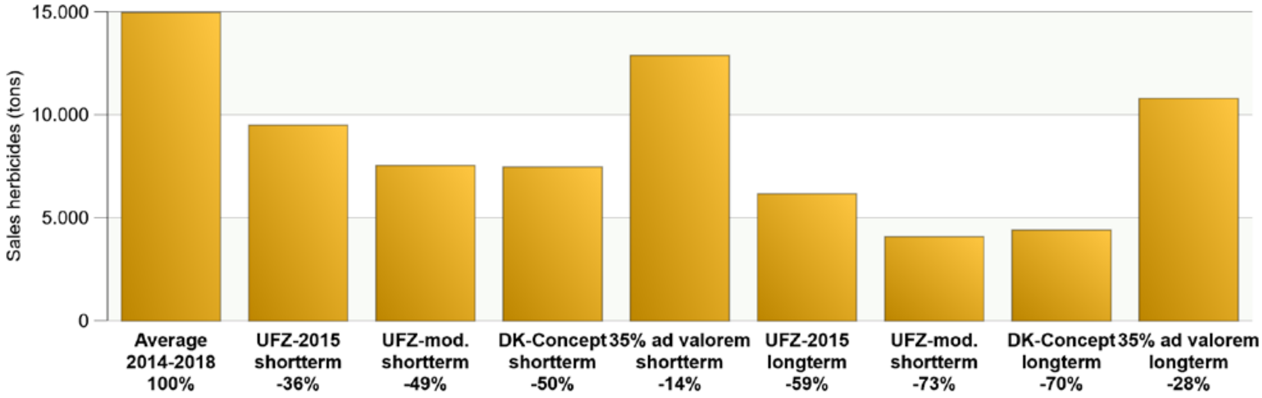


Figure 38 Herbicides – changes in active substance sales according to levy concept

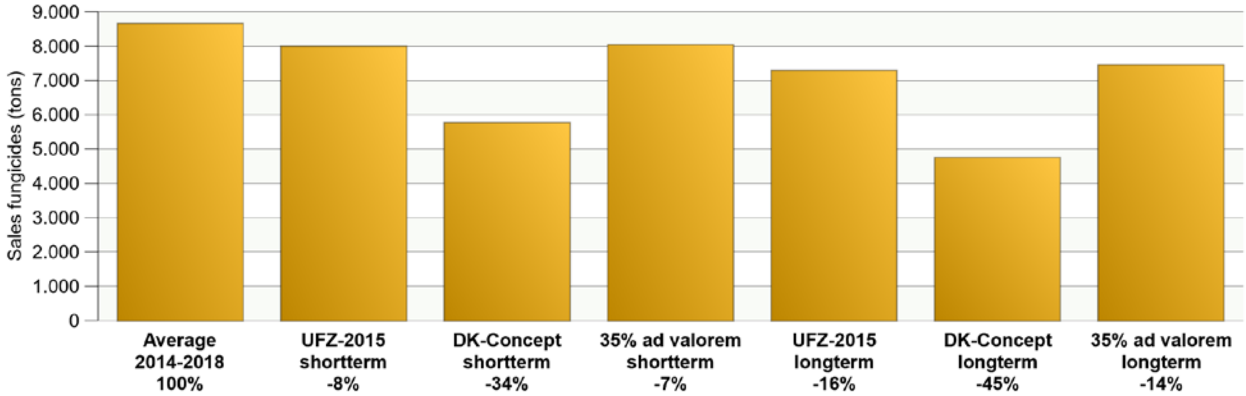


Figure 39 Fungicides – changes in active substance sales according to levy concept

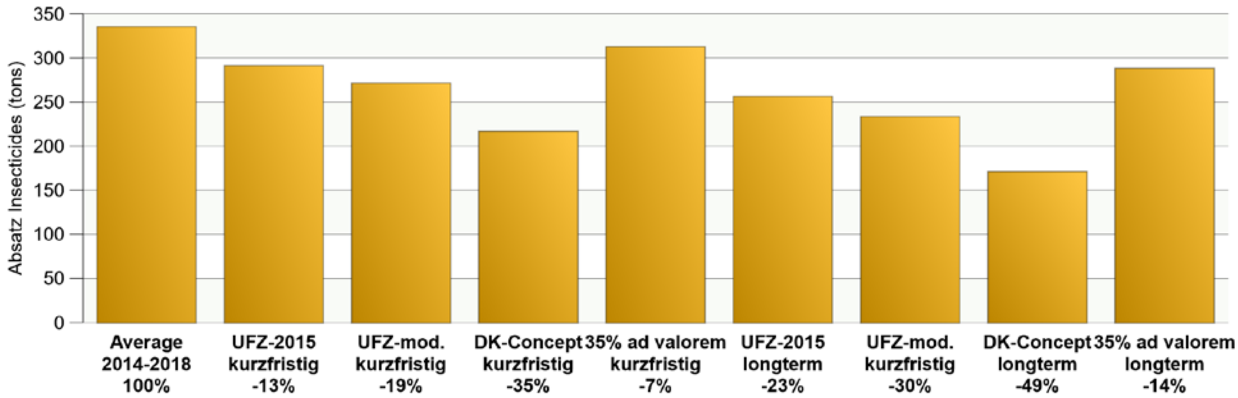


Figure 40 Insecticides and acaricides – changes in active substance sales according to levy concept

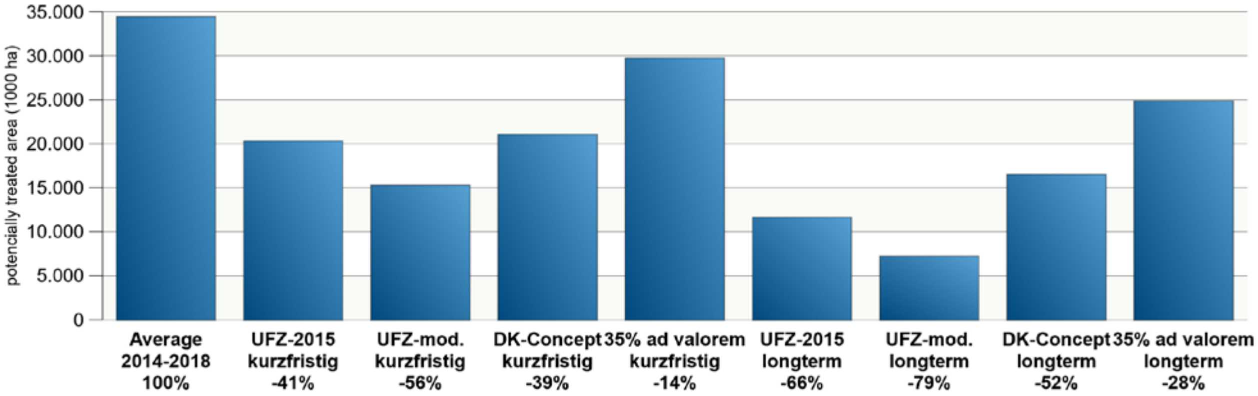


Figure 41 Herbicides – changes in the potentially treatable area depending on the levy concept

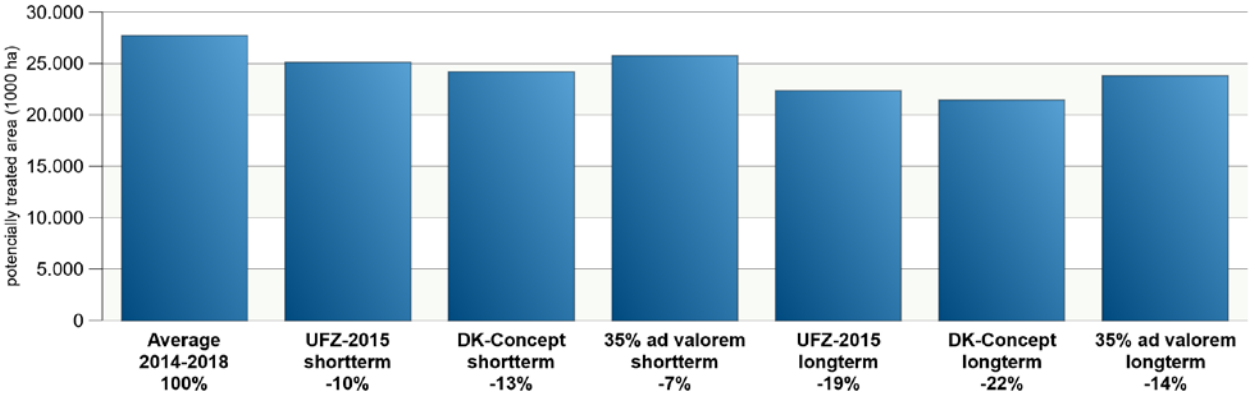


Figure 42 Fungicides – changes in the potentially treatable area depending on the levy concept

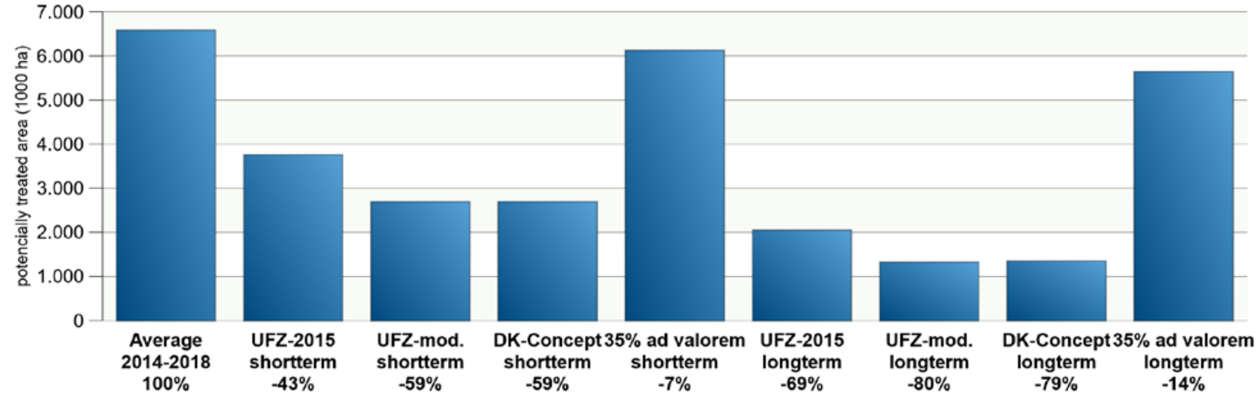


Figure 43 Insecticides and acaricides – changes in the potentially treatable area depending on the levy concept

6.2.2 Changes in Pesticides with Certain Hazard Potentials

The modelled sales volume and the potentially treatable areas derived from it are evaluated according to the same indicators for specific risks to human health and the environment as the Danish sales data (further explanations in Chapter 4.3). The following properties/ classifications were considered:

- high bee toxicity (< 0,2 µg/bee)
- low AOEL < 0.01 mg/kg × body weight
- low ADI < 0.01 mg/kg × body weight
- Candidate for Substitution – CfS
- UBA priority 1 for potential groundwater hazard

For the results, the mean relative quantity change was generated in each case. The results are listed in Table 14 (highest values in bold).

The Danish concept would affect plant protection products with high bee toxicity the most. Otherwise, the modified UFZ concept results in higher or similarly high changes in the other indicators. An ad valorem-levy would always have the lowest effect.

Table 14 Mean of the relative quantity changes for plant protection products with active substances with special hazard potentials depending on the levy concept (highest values marked in bold)

Active Substance	Mean of the Relative Change in Quantity for Plant Protection Products in %							
	Short-term Change				Long-term Change			
	UFZ 2015	UFZ 2015 modified	Danish Concept	35 % ad valorem	UFZ 2015	UFZ 2015 modified	Danish Concept	35 % ad valorem
with high acute bee toxicity (< 0,2 µg/bee)	–32	–44	**–48**	–7	–51	–59	**–67**	–14
with low AOEL (< 0,01 mg/kg × bw)	–38	**–50**	–33	–10	–58	**–68**	–50	–19
with low ADI (< 0,01 mg/kg × bw)	–42	**–54**	–42	–10	–67	**–75**	–57	–21
Candidate for Substitution (CfS)	–37	**–46**	–36	–10	–58	**–62**	–50	–20
Potential hazard to groundwater	–24	**–32**	**–32**	–10	–43	**–50**	–42	–21

The transposition to active substance-specific sales data shows a slightly different ranking when it comes to the effect of the concepts on sales volumes. The Danish concept would reduce active substance quantities of substitution candidates (CfS), active substances hazardous to groundwater and those with high acute bee toxicity more strongly in the short term than the modified UFZ concept, whereby the effects align in the long term. With regard to the sale of active substances with higher health risks for users and residents or consumers of agricultural products (AOEL and ADI), the modified UFZ concept shows the greatest reduction effects in the short and long term.

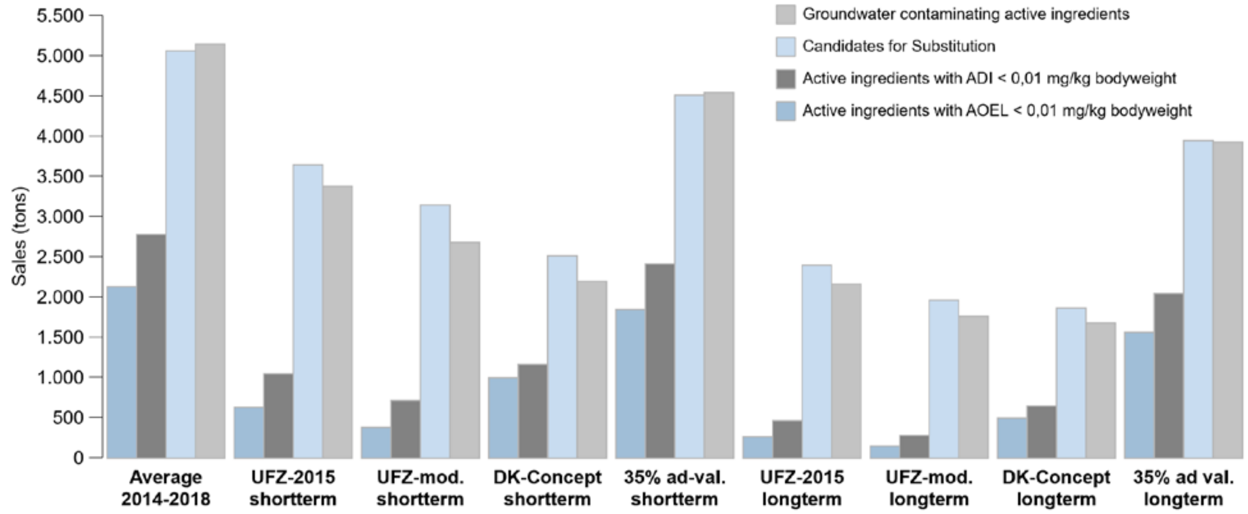


Figure 44 Modelled changes in quantities of active substances with certain hazard potentials depending on the levy concept

Based on the respective modelled total sales of the relevant groups of active substances, the calculation of the potentially treatable area again shows the stronger steering effect of the UFZ concepts.

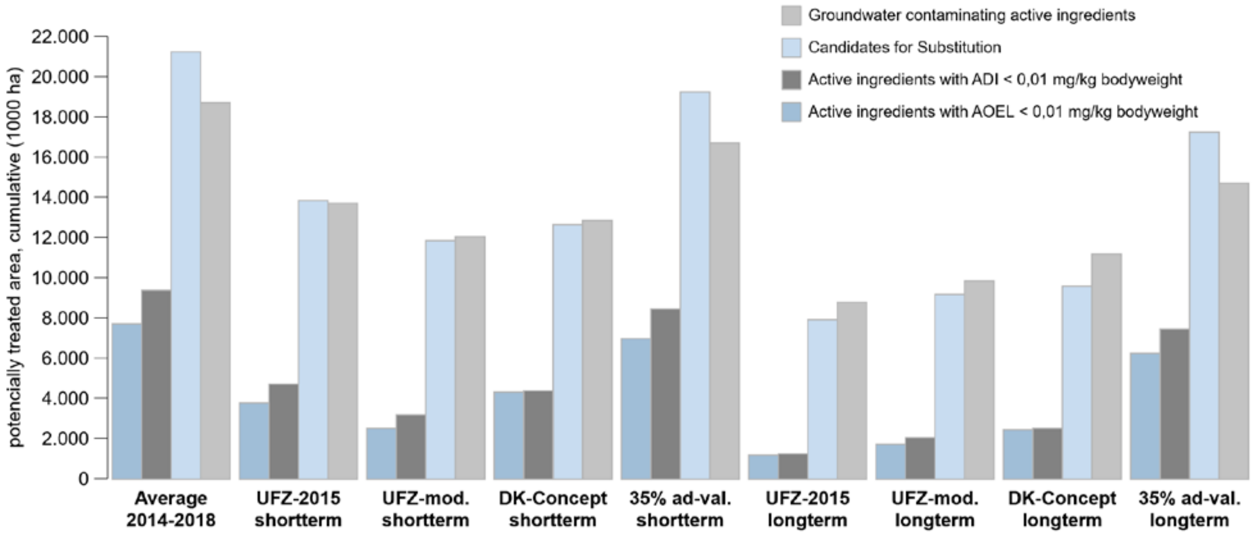


Figure 45 Changes in the potentially treatable area for active substances with certain hazard potentials depending on the levy concept

Table 15 Change in sales volumes and thus potentially treatable area depending on the levy concept and hazard potential of the active substances

	Quantity	%	Potentially Treatable Area (1000 ha)	%
Active substance with high acute bee toxicity mean 2014-2018	110	100	5661	100
Short-term change				
UFZ Concept 2015	72	–35	2920	–48
UFZ Concept modified	56	–49	1896	**–67**
Danish Concept	25	**–77**	1857	**–67**
35 % ad valorem	102	–7	5265	–7
Long-term change				
UFZ Concept 2015	44	–60	629	–89
UFZ Concept modified	26	–77	1271	–78
Danish Concept	12	**–89**	580	**–90**
35 % ad valorem	94	–14	4868	–14
Active substances with low AOEL (<0,01 mg/kg × bw) – mean 2014-2018	2130	100	7690	100
Short-term change				
UFZ Concept 2015	626	–71	3753	–51
UFZ Concept modified	381	**–82**	2484	**–68**
Danish Concept	995	–53	4281	–44
35 % ad valorem	1847	–13	6956	–10
Long-term change				
UFZ Concept 2015	263	–88	1143	**–85**
UFZ Concept modified	145	**–93**	1731	–77
Danish Concept	488	–77	2456	–68
35 % ad valorem	1564	–27	6221	–19
Active substances with low ADI (<0,01 mg/kg × bw) – mean 2014-2018	2770	100	9399	100
Short-term change				
UFZ Concept 2015	1040	–62	4689	–50
UFZ Concept modified	716	**–74**	3138	**–67**
Danish Concept	1164	–58	4368	–54
35 % ad valorem	2406	–13	8404	–11
Long-term change				
UFZ Concept 2015	462	–83	1209	**–87**
UFZ Concept modified	271	**–90**	2018	–79
Danish Concept	642	–77	2507	–73
35 % ad valorem	2043	–26	7409	–21
Candidates for substitution (CfS) – mean 2014-2018	5064	100	21249	100
Short-term change				
UFZ Concept 2015	3642	–28	13808	–35
UFZ Concept modified	3136	–38	11866	**–44**

Danish Concept	2503	**–51**	12611	–41
35 % ad valorem	4507	–11	19230	–10
Long-term change				
UFZ Concept 2015	2398	–53	7874	**–63**
UFZ Concept modified	1958	–61	9169	–57
Danish Concept	1862	**–63**	9557	–55
35 % ad valorem	3949	–22	17210	–19
Substances hazardous to groundwater – mean 2014-2018	5144	100	18680	100
Short-term change				
UFZ Concept 2015	3381	–34	13693	–27
UFZ Concept modified	2672	–48	12013	**–36**
Danish Concept	2190	**–57**	12823	–31
35 % ad valorem	4538	–12	16697	–11
Long-term change				
UFZ Concept 2015	2161	–58	8752	**–53**
UFZ Concept modified	1754	–66	9858	–47
Danish Concept	1676	**–67**	11149	–40
35 % ad valorem	3932	–24	14713	–21

6.2.3 Expected Revenue from a Levy on Plant Protection Products

The estimated revenue T of the plant protection product levy is based on the basic formula

$$T = \bar{t} \times X_0 \left(1 - |\varepsilon| \times \frac{\Delta p}{p}\right)$$

with $\bar{t}$ as the average levy rate per tonne of plant protection products (calculated as the median of the payment surcharge per tonne), X_0 as the initial quantity of plant protection product used before levy collection (mean value of the domestic sales of plant protection products 2014 to 2018 in Germany), ε as the average price elasticity and $\Delta p/p$ as the average relative price increase due to the levy.

Table 16 summarises the variables and assumptions used to calculate the total revenue of a plant protection product levy. The estimated total revenue is then obtained using the following formula:

$$T = \bar{t} \times 101.152 \left(1 - |\varepsilon| \times \frac{\Delta p}{p}\right)$$

Table 16 Basis for the calculation of the total revenue of a plant protection product levy

Parameter	Value	Source
X_0	101.152 [t]	BVL (2015-2019); mean of domestic sales (tonnes) of PPPs 2014-2018 (without inert gases)
ε	–0,2 [dimensionless] –0,3 [dimensionless] (mean of–0,2 and –0,4) –0,4 [dimensionless]	Own estimate based on state of the studies
$\bar{t}$	Median of all PPPs assessed	Own calculations
$\Delta p/p$	Median of all PPPs assessed	Own calculations

Table 17 Levy burden and relative price change (median) in EUR

Levy concept	Median levy burden pro kg	Median of relative price change ([initial prices + levy burden]/initial price)
UFZ 2015	15.60	1.55
UFZ modified	18.50	1.69
Danish concept	10.90	1.34
35 % ad valorem	10.35	1.35

Depending on the concept and price elasticity, the revenue from the pesticide levy could therefore range between around 479 million EUR and 1.2 billion EUR per year. The modified UFZ concept would generate the highest revenues. The lowest revenues would be generated by an ad valorem-levy with a price surcharge of 35 percent. At the same time, the UFZ's 2015 calculations are confirmed:[180] This time again a total revenue of approximately 1 billion EUR was calculated for the 2015 UFZ levy concept.

Table 18 Total revenue in Germany depending on the levy concept with different price elasticities in million EUR

	Revenue in million EUR			
Price elasticity	UFZ 2015	UFZ 2015 modified	Danish concept	35 % ad valorem
–0.20	1,091	1,237	808	760
–0.30	847	922	660	619
–0.40	602	606	513	479

180 Möckel et al. 2015, p. 190.

If the total revenue is related to the agricultural land that is regularly treated with pesticides in Germany, average payment burdens per hectare emerge of 41 to 106 EUR per year (see Table 19), whereby the pesticide use on non-agricultural land (e.g., railway facilities) was added to the agricultural pesticide use. This calculation is a rough estimate of the burden a levy on pesticides would exert on an average conventional agricultural enterprise. Given the different price elasticities, it is assumed that the average farm reduces pesticide use twice as much in the long term as in the short term. In practice, both the exact amount of the reduction and the remaining levy burden would therefore differ for each agricultural enterprise, each pesticide, and each crop.

If one relates the payment burden per hectare to the other overall farm expenditures in Germany, which average 2,000 EUR/ha in arable farming and up to 10,000 EUR/ha for permanent crops (e.g., grapes and apples),[181] then the average levy burden amounts to between 0.4 and 5.5 percent of the total farm expenditure in agriculture, depending on the levy concept and the short- or long-term view. A levy would increase the average expense for chemical crop protection shown in Table 20, whereby currently these expenses account for 1 to 30 percent of direct and labour costs (excluding, e.g., lease and capital costs) per hectare and year, depending on the respective crop.

Table 19 Revenue in EUR per hectare depending on levy concept average expenditure on chemical crop protection in Germany

	Revenue in EUR per hectare			
Price elasticity	**UFZ 2015**	**UFZ 2015 modified**	**Danish concept**	**35 % ad valorem**
–0,20	94	106	69	65
–0,30	73	79	57	53
–0,40	52	52	44	41
	Mean acreage between 2014 and 2018 of 11.7 million hectares for arable land and permanent crops (excluding permanent grassland and brownfields)			

Table 20 Average expenditure on chemical crop protection in Germany for selected crop types and their share in the sum of direct and labour costs for selected crops (according to KTBL data)

Cultivation	**Application (Intensity level)**	**Chemical crop protection €/ha year**	**Sum of direct and labour costs €/ha year**	**Share of chemical crop protection (%) ×**
New potatoes	Fungicide (3)	280	**4,631**	**6.05**
Starch potatoes	Fungicide (2)	230		
Starch potatoes	Herbicide (2)	120		
Starch potatoes	Insecticide (2)	32		
Starch potatoes	Defoliation (2)	40	**3,197**	**1.25**
Maize biogas	Herbicide (2)	110	**999**	**11.02**
Silage maize (feed)	Herbicide (3)	110	**1,757**	**6.26**
Winter barley (feed)	Fungicide (2)	70		
Winter barley (feed)	Herbicide (2)	58		
Winter barley (feed)	Growth regulator (2)	25	**1,038**	**14.8**
Summer barley (malting barley)	Fungicide (2)	65		

181 See Möckel et al. 2015, p. 181 - 184 (Figures 35 and 36).

Summer barley (malting barley)	Herbicide (2)	36		
Summer barley (malting barley)	Insecticide (2)	1.4		
Summer barley (malting barley)	Growth regulator (2)	1.4	**920**	**11.2**
Winter wheat (baking wheat)	Fungicide (2)	86		
Winter wheat (baking wheat)	Herbicide (2)	59		
Winter wheat (baking wheat)	Insecticide (2)	5.8		
Winter wheat (baking wheat)	Growth regulator (2)	11	**1,136**	**14.2**
Winter oilseed rape	Fungicide (2)	51		
Winter oilseed rape	Herbicide (2)	110		
Winter oilseed rape	Insecticide (2)	28		
Winter oilseed rape	Growth regulator (2)	13	**1,063**	**19.0**
Sugar beets	Fungicide (2)	76		
Sugar beets	Herbicide (2)	320	**1,576**	**27.7**
Lettuce (harvest belt, 1,2 m bed)	Fungicide	107		
Lettuce (harvest belt, 1,2 m bed)	Insecticide	109	**22,626**	**1.0**
Lettuce (manual harvest, 1,2 m bed)	Fungicide	107		
Lettuce (manual harvest, 1,2 m bed)	Insecticide	109	**18,511**	**1.2**
Broccoli	Fungicide	62		
Broccoli	Herbicide	91		
Broccoli	Insecticide	85	**8,979**	**2.7**
Asparagus 3rd-7th crop year	Fungicide	334		
Asparagus 3rd-7th crop year	Herbicide	98		
Asparagus 3rd-7th crop year	Insecticide	71	**28,575**	**1.8**
Carrots	Fungicide	368		
Carrots	Herbicide	84		
Carrots	Insecticide	73	**23,750**	**2.2**
Field size always 10 ha, arable farming: non-rotational, rotary harrows cultivation × Own calculations: Total chemical crop protection (F+H+I etc) x 100/total				

Source: Own representation based on KTBL data (Leistungs-Kostenrechnung Pflanzenbau, https://daten.ktbl.de/).

6.3 Discussion of the Findings

For the present study, a database system was developed with which different concepts of pesticide levies can be modelled on the basis of empirical data. Three different concepts (Danish concept, UFZ concept and an ad valorem-levy with a 35-percent price surcharge) were assessed using the same data. The UFZ model was calculated in two variants (the 2015 concept and its modification). The modified UFZ concept considers indirect ecological effects from the use of herbicides and insecticides (including acaricides).

Depending on the levy concept, a quantity reduction of up to 44 percent can be achieved in the short term. This is also supported by the developments in Denmark, where the sales volume fell by around 38 percent in the short term (2014 to 2018). The smallest reduction of about 10 percent (in the short term) would be achieved by an ad valorem-levy of 35 percent. The literature also discusses an ad valorem-levy of 50 percent.[182] However, a further surcharge of 15 percent would only generate a small additional reduction (see Figure 46) but would increase the total revenue considerably.[183]

The figure below shows the results of all modelled concepts plus a 50 percent ad valorem-variant for the modelled active substance quantities[184]. The additional 15 percent surcharge for an ad valorem-levy produces only a 4 percent (short-term) to 6 percent (long-term) higher reduction.

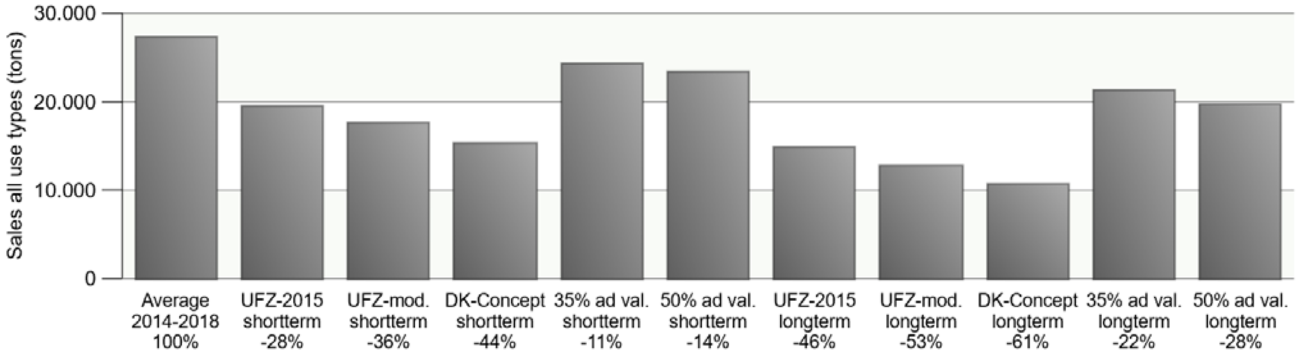


Figure 46 Modelled changes in quantity for sales of active substances under different levy concepts

In order to test the effect of the concepts on the potentially treatable area, the relative quantity changes of the plant protection products were related to the sales of the associated active substances. Quantity changes could be modelled for almost all relevant active substances. Only for two active substances (lenacil and alpha-cypermethrin) with an area share of 0.6 percent of the cumulatively treated area (mean 2014 to 2018), no data could be collected because no prices could be determined. Products with lenacil are only sold together with the corresponding 'safener', i.e., an individual price cannot be determined. Products with alpha-cypermethrin were no longer offered by internet traders during the study period, although they are still authorised for use. Overall, the modelling was carried out with almost 100 percent of the active substances sold in 2014 to 2018, whereby only active substances that still have an EU approval were modelled.

The levy concepts differ significantly in their area effect: The Danish concept taxes the use of highly effective, low-dose plant protection products much lower than the UFZ concepts, where higher effectiveness also results

182 Bareille/Gohin 2020.

183 By approximately 240 million EUR in the short term. Assuming a price elasticity of –0.2 or –0.4 for herbicides, a further price increase of 15 percentage points translates only into low single-digit relative quantity reduction.

184 For this purpose, the variable in the dynamic database model was set from 35 percent to 50 percent.

in a higher payment burden per kilogram of plant protection product. The Danish concept thus promotes a switch from high-dose to low-dose products, so that as result the potentially treatable area would decrease less than with the UFZ concepts. The developments in Denmark confirm this substitution effect.

The present database model neither allows investigating nor determining both economic or operational impacts on users or possible adaptation reactions, e.g., in the field of agricultural management. This also applies to internal substitution, in which users replace a plant protection product with a cheaper one. The per-hectare burden per area of arable land and special crops in Germany, converted from the total revenue, is therefore only an approximation of the additional expenses of an average conventional agricultural enterprise, given one of the levy concepts discussed above is introduced (see 6.2.3). Since the profitability of pesticide use is most strongly challenged by a levy when it comes to marginal agricultural sites[185], the greatest reductions or even a complete abandonment of pesticide use and thus the greatest positive effects for biodiversity and the environment can be expected there.[186]

The database model also does not compare prices. A generic product from a parallel trader, for example, can be up to two thirds cheaper than the identical 'branded' product. The model calculates a greater relative change in quantity for the inexpensive drug, if the *price change* induced by the levy burden is greater in this case than for a more expensive drug. This is the case with levies with absolute base rates like the UFZ concepts and the Danish concept, while with the ad valorem-concept the relative price mark-up of 35 percent of net prices remains the same.

Furthermore, with regard to the adjustments by users, it should be noted that there are other factors besides prices that affect sales (see also Chapter 3). In particular, developments in Denmark show that a similarly large price increase is not necessarily followed by a similarly large reduction (see Chapter 4.2). In Denmark, Pederson et al. (2020) investigated the demand of agricultural enterprises for crop protection products by dint of surveys. According to this study, prices were not the main decision criterion for all agricultural enterprises. Rather, other criteria were also important or even more important. This can have various reasons, e.g., because pesticide use only accounts for a small proportion of farm expenditure per hectare or product (factor costs). Economic incentives that are too small can therefore only have weak effects. Furthermore, non-economic objectives – such as weed-free ('clean') cropland and/or high yields per hectare – have high priority for many agricultural enterprises.

With regard to these non-economic decision-making factors, a levy can set less of an incentive and have more of a financing effect by using the revenue to offer objective and well-founded advice or further training on sustainable plant protection by state agencies. In this way, information can be provided on the economic benefits and ecological costs of certain plant protection measures and management methods.

185 Marginal yield sites are particularly relevant for biodiversity conservation, as they are regularly located in less intensively used agricultural landscapes or even in protected areas.

186 Cf. Mußhoff 2017, p. xiv, 63-77.

7 Introduction of a Levy on Plant Protection Products by the European Union

The following Chapter examines the question of whether and to what extent the European Union (EU) – formerly European Community – can introduce its own tax on plant protection products or oblige the Member States to introduce a corresponding levy or tax (both in the following: introduction of an EU-wide levy).

The EU is an institutionalised association of sovereign states and can only act independently and enact legal provisions to the extent that the Member States have granted the EU corresponding competences in its founding treaties. So far, there has been no general transfer of competences that would authorise the EU to act comprehensively. Instead, the Member States limited the EU's authority to specific tasks and areas of regulation.

The principle of conferral applies which is laid down in Art. 5(1) of the Treaty on European Union (TEU). The relevant authorisations can be found in the Treaty on the Functioning of the EU (TFEU). Art. 352 TFEU contains a subsidiary general clause for the case that action by the EU is necessary to achieve its objectives without there being a specific competence. In addition, there are the doctrines of 'implied power' and 'effet utile' developed by the European Court of Justice (ECJ)[187], which can justify a supplementary regulatory competence of the EU, if, without it, the Treaty provisions cannot be applied in a reasonable and expedient manner.[188]

On the other hand, the Member States have generally limited the EU's competence through the so-called principle of subsidiarity in Art. 5(2) TEU. According to this principle, in all areas where the EU does not have exclusive competence according to Art. 2 to 6 TFEU, the EU may only act if and insofar as the objectives cannot be sufficiently achieved by the Member States themselves and can therefore, by reason of the scale or effects of the action, be better achieved by the EU. Furthermore, according to Art. 5(4) TEU, the EU institutions must observe the principle of proportionality in their action, according to which the measures of the EU may not go beyond what is necessary, in substance or in form, to attain the objectives of the Treaties. Further details are set out in the Protocol (No. 2) on the application of the principles of subsidiarity and proportionality.[189] The EU institutions have a margin of appreciation with regard to both principles, while the European Court of Justice has so far criticised violations of the principles, especially in the case of obvious misjudgements.[190]

With regard to an EU-wide introduction of a levy on plant protection products, no violation of the subsidiarity principle can be assumed. Firstly, plant protection products as well as agricultural and forestry products treated with them are traded in the EU, which is why a national levy on plant protection products influences the competitive situation of domestic users in the EU. Admittedly, a levy is only one competition-relevant aspect among many ecological, economic, and legal differences between the Member States. However, this would no longer apply within the EU, if all Member States had to introduce a levy or if a European tax were imposed. Secondly, taxes and levies as steering and internalisation instruments are not specific to a particular location and are therefore unsuitable for taking regional characteristics into account. Thirdly, a European introduction would have a much greater impact on health and environmental protection than a pesticide levy in only a few Member States.

---

[187] Note: All ECJ decisions can be located based on their case number and can be freely accessed and er: curia.europa.eu/juris/recherche.jsf?language=en.

[188] ECJ, adjudication of 29.11.1956 – 8/55, Fédération Charbonnière de Belgique, Coll. 1955/56, p. 197 (p. 311 et seq.); adjudication of 27.09.1988 – C-165/87, Commission/Council, margin number 7 et sqq.

[189] OJ EU no. L 115 of 09.05.2008, p. 206-209.

[190] Cf. ECJ, adjudication of 13.05.1997 – C-233/94. Germany/Parliament-Council, margin number 26 et seq. 55 et seq.; adjudication of 12.11.1996 – C-84/94, United Kingdom/Council, margin number 55 et sqq.

Ultimately, EU competence was also assumed for the European regulation of approval law (EU Regulation 1107/2009) and the Community Action Framework for the Sustainable Use of Pesticides (EU Directive 2009/128). The introduction of an EU-wide levy would complement European pesticide legislation and in particular promote the implementation of the integrated pest management prescribed therein (cf. Art. 55 EU Regulation 1107/2009 and Art. 14 and Annex III EU Directive 2009/128) as well as help to achieve the European objectives of the Farm to Fork Strategy. Finally, a European regulation on a pesticide levy is also proportionate as long as the levy does not completely throttle the use of pesticides in the Member States.[191]

According to the case-law of the European Court of Justice, it is not the EU legislature that decides which enabling rule is to be applied. Rather competence is determined on the basis of objective criteria that are subject to judicial review and which, in addition to speciality and subsidiarity clauses under primary law, include in particular the objective and substance of the legislative act.[192] If the regulation pursues several purposes, the respective competence is determined by the focus of the measure ('predominant purpose' approach).[193] In the case of inseparably balanced purposes, the measure is to be based on all relevant legal frameworks (doctrine of the 'dual legal basis'), unless this is inadmissible due to differences in the legislative procedure, especially when it comes to the participation of the Parliament.[194]

When analysing the competences of the EU, a distinction must be made between:

- the substantive competence to regulate the use of plant protection products and to protect the environment and human health from pesticides and their direct and indirect effects, and
- the instrumental competence to introduce a tax or levy on plant protection products at European or Member State level.

7.1 Competences in the Area of the Internal Market, Plant Protection Products and the Environmental and Health Risks they Pose

The taxation of plant protection products in the EU does not fall into areas of exclusive EU competence exhaustively listed in Art. 3 TFEU. It is true that such taxation affects the free movement of goods (in this case plant protection products) in the internal market.[195] However, it is not a competition rule necessary for the functioning of the internal market. Relevant or affected by an EU-wide pesticide tax are the policy areas of the harmonisation in the internal market, agriculture, environment, consumer protection and public health, for which, according to Art. 4(2) TFEU, the European Union has shared competence with the Member States. This means that the EU and the Member States may legislate and adopt binding rules in this area, but the Member States may only exercise their competence, if and to the extent that the EU has not exercised its competence

[191] Cf. Möckel et al 2015, p. 226 et sqq., regarding the German Federal Constitutional Court's interpretation of the principle of proportionality in taxes and levies.

[192] ECJ, adjudication of 26.11.2014 – C-103/12 and C-165/12, margin number 51; adjudication of 23.10.2007 – C-440/05, margin number 60 – Commission/Council; adjudication of 28.06.1994 – C-187/93, Parliament/Council, margin number 17; adjudication of 26.03.1987 – C-45/86, Commission/Council, margin number 11; adjudication of 11.6.1991 – C-300/89, margin number 10 – Commission/Council (Titanium dioxide); adjudication of 23.02.1988 – C-131/86, United Kingdom/Council, margin number 29.

[193] ECJ, adjudication of 23.02.1999 – C-42/97, Parliament/Council, margin number 39-42; adjudication of 28.06.1994 – C-187/93, Parliament/Council, margin number 25; adjudication of 17.03.1993 – C-155/91, Commission/Council, margin number 19 with further references.; adjudication of 11.06.1991 – C-300/89, Commission/Council (Titanium dioxide), margin number 13, 17 et sqq.; adjudication of 27.09.1988 – C-165/87, Commission/Council, margin number 11 et sqq.

[194] ECJ, adjudication of 23.02.1999 – C-42/97, Parliament/Council, margin number 38 et sqq.; adjudication of 11.06.1991 – C-300/89, Commission/Council (Titanium dioxide), margin number 13, 17 et sqq.; adjudication of 27.09.1988 – C-165/87, Commission/Council, margin number 11 et sqq.

[195] About the term see Article 26(2) TFEU.

(Art. 2(2) TFEU). The scope of EU competences and the details of their exercise as well as the relevant legislative or decision-making procedure result from the provisions made for the respective policy area.

7.1.1 The Harmonisation of Different Member State Regulation to improve the Internal Market (Art. 113 to 115 TFEU)

In the TFEU, the EU has been granted extensive competences to improve the internal market and to harmonise Member State regulations that hinder it. Art. 114 TFEU as basic norm authorises the EU extensively to adopt measures that promote the establishment and functioning of the internal market. However, the contracting parties have limited this extensive power insofar as they expressly excluded taxes in Art. 114(2) TFEU and bind competence norms with an unanimity requirement (Art. 113, 115 and 192(2) TFEU).

In German legal studies, it is controversial whether special levies, which unlike fees and contributions do not have a concrete equivalent relationship to a state service such as approval, access and use of public infrastructures, are also excluded by Art. 114(2) TFEU.[196] In part, one wants to apply the distinction between taxes and non-tax special levies laid down in the German Basic Law to European law and assign special levies to Art. 114(1) TFEU.[197] However, such a restriction of the concept of taxation under European law and of Art. 114(2) TFEU is not very convincing.[198] The exemption to competence is intended to protect the fiscal sovereignty of the Member States, so that EU measures in this area are not to be taken by majority decision but unanimously. Fiscal sovereignty also includes the levying of non-reciprocal special levies, since these, like taxes, serve to finance general welfare purposes, even if they do not flow into the general budget but into special funds.[199] Furthermore, in the TFEU (and here in particular in other language versions) the terms tax and levy are used synonymously.[200] This is particularly clear in Art. 110 to 113 TFEU, which speak of ‘domestic charges of whatever nature’ and ‘excise duties and other indirect taxes’, although the chapter itself is entitled ‘Tax Provisions’. Overall, these are terms of European law that are not defined by national legal systems.[201]

According to Art. 113 TFEU, the EU is authorised and obliged to harmonise the indirect taxes and duties of the Member States insofar as this is necessary for the establishment and functioning of the internal market and the avoidance of distortions to competition. Indirect taxes and duties are characterised by the fact that they are charged on products or services and are regularly passed on from the taxpayer to the actual tax debtor. To protect the tax sovereignty of the Member States, Art. 113 TFEU provides for a special legislative procedure in which the Council must decide unanimously, and the European Parliament needs only to be consulted. However, according to Art. 17(2) TEU, only the European Commission may introduce legislative proposals. In addition to harmonising value-added tax[202] (also called turnover tax), the European Union has also prescribed the EU-wide introduction of taxes on alcohol, tobacco products and energy on the basis of Art. 113 TFEU (or the predecessor competences respectively).[203]

---

196 Cf. the overview at Ohler 1997, p. 206 et seq.; Wasmeier 1995, p. 227 et sqq.

197 Grabitz 1989, p. 636; Hilf 1992, p. 107.

198 Cf. the critique at Ohler 1997, p. 206 et seq.; Wasmeier 1995, p. 227 et sqq.

199 Wasmeier 1995, p. 228; Ohler 1997, p. 206 et seq.

200 Cf. ECJ, adjudication of 18.6.1975 – 94/74; adjudication of 14.6.1988 – 29/87, Denkavit, margin number 36.

201 Cf. ECJ, adjudication of 13.02.1996 – C-197/94 and C-252/94, Bautiaa, margin number 39.

202 Directive 2006/112/EC of 28.11.2006 on the common system of value added tax, OJ. L 347, 11.12.2006, p. 1 et sqq.

203 Cf. Directive 92/83/EEC of 19.10.1992 on the harmonization of the structures of excise duties on alcohol and alcoholic beverages, OJ L 316, 31.10.1992, p. 21 et sqq.; Directive 2011/64/EU of 21.06.2011 on the structure and rates of excise duty applied to manufactured tobacco, OJ L 176, 05.07.2011, p. 24 et sqq.; Directive 2003/96/EC of 27.10.2003 restructuring the Community framework for the taxation of energy products and electricity, OJ L 283, 31.10.2003, p. 51 et sqq.

In order to ensure the free movement of goods, persons, services, and capital in accordance with Art. 26(2) TFEU, the differences between the Member States that lead to distortions of competition must be eliminated through harmonisation.[204] Art. 113 TFEU therefore not only contains the mandate to abolish tax borders and, in particular, border controls, but is also intended to promote the harmonisation of tax bases and tax rates. Reducing distortions of competition does not mean that disruptive national taxes and levies must be abolished or lowered but can also involve the EU-wide introduction of corresponding taxes and the establishing of a specific taxation concept.[205] In doing so, the European Union can, but does not have to, orient itself towards the existing taxation concepts of the Member States. Furthermore, Art. 113 TFEU allows for an ecological or health-related orientation of indirect taxes and charges, since, according to Art. 9 and 11 TFEU, the requirements of public health and environmental protection are to be taken into account in other EU policies.[206] Art. 110 to 112 TFEU are to be observed in the way this is arranged.[207]

Art. 115 TFEU generally authorises the approximation of the provisions laid down by law, regulation or administrative action in Member States which directly affect the establishment or functioning of the internal market. This also includes provisions of a fiscal nature, since Art. 115 TFEU, unlike Art. 114(2) TFEU, does not exclude provisions on taxation. Since Art. 113 TFEU, as a special provision for indirect taxes, takes precedence over Art. 115 TFEU, the latter can only be considered for direct taxes and duties which, like income tax, are borne by natural or legal persons, provided they have a direct impact on the establishment or functioning of the internal market. As in the case of Art. 113 TFEU, harmonisation measures require a Commission proposal and a unanimous Council decision.

7.1.2 Agriculture (Art. 38 to 44 TFEU)

The Member States have granted the European Union extensive competence to regulate agriculture in Art. 38 et seq. TFEU.[208] The legal basis for the adoption of legal acts is Art. 43(2) and (3) TFEU.[209] The measures must serve the objectives listed in Art. 39 TFEU and are further specified in Art. 40, 41, 43(4) and (5) and Art. 44 TFEU. The objectives of the common agricultural policy include increasing productivity, securing incomes in the agricultural sector, and ensuring a secure supply of food to the population at reasonable prices. The protection of the environment and the health of the population are not objectives of agricultural policy but are to be taken into account in the respective measures in accordance with the general clauses in Art. 9 and 11 TFEU.

Since the Lisbon Treaty, the ordinary legislative procedure according to Art. 289(1) and 294 TFEU also applies to measures of the Common Agricultural Policy according to Art. 43(2) TFEU. According to this procedure, the European Commission submits the legislative proposal, which can then be adopted by the European Parliament with a majority of the votes cast and by the Council with a qualified majority (if necessary, also in amended form). However, in the case of measures pursuant to Art. 43(3) TFEU (inter alia, with regard to the fixing of prices, levies, aid, and quantitative restrictions), the Council continues to decide solely on the basis

---

[204] ECJ, adjudication of 11.06.1991 – C-300/89, (Titanium dioxide), margin number 14 et seq.

[205] Cf. ECJ, adjudication of 09.08.1994 – C-359/92, margin number 34; ECJ, adjudication of 15.07.1982 – C-270/81, Felicitas, margin umber 14.

[206] Cf. ECJ, adjudication of 05.10.2000 – C-376/98, Germany/Parliament and Council, margin number 88; adjudication of 11.6.1991 – C-300/89, Commission/Council (Titanium dioxide), margin number 22.

[207] ECJ, adjudication of 05.05.1982 – C-15/81, Schul, margin number 21, 42; adjudication of 17.06.1999 – C-166/98, Socridis, margin number 13-21.

[208] ECJ, adjudication of 19.11.1989 – C-11/88, Commission/Council; adjudication of 05.05.1998 – C-180/96, United Kingdom/Commission, marginal number 134 et seq.

[209] ECJ, adjudication of 23.02.1988 – C-68/86, United Kingdom/Council, margin number 14; adjudication of 05.05.1998 – C-180/96, United Kingdom/Commission, marginal number 133.

of the Commission's proposal and, pursuant to Art. 293 TFEU, the Council can only amend the Commission's proposal unanimously.

The demarcation between the bases of competence in paragraphs 2 and 3 has so far been decided by the European Court of Justice to the effect that paragraph 2 is relevant for measures "involving a political choice reserved to the EU legislature due to the fact that they are necessary for the pursuit of the objectives of the common agriculture and fisheries policies", whereas paragraph 3 applies to regulations of a primarily technical nature which are adopted to implement the provisions adopted under paragraph 2.[210]

Art. 43 TFEU stands on an equal footing with the other competences (e.g., for harmonisation of the internal market or environmental protection), provided that these, like Art. 168(4)(b) TFEU, do not establish an explicit precedence.[211] In accordance with the 'predominant purpose' approach, agricultural competence is always the relevant competence, if a legal act focuses on improving the production and marketing of agricultural products or on protecting agricultural production potential and thus has as its main purpose the achievement of one or more of the objectives listed in Art. 42 TFEU.[212]

7.1.3 Environment (Art. 191 to 193 TFEU)

With Art. 191 et seq. TFEU, the Member States have comprehensively authorised the EU to adopt measures in the field of environmental protection. According to Art. 191(1) TFEU, the measures are to serve the preservation and protection of the environment, the improvement of its quality, the prudent and rational utilisation of natural resources as well as the protection of human health. According to Art. 191(2) TFEU, EU measures shall be based on the precautionary principle and on the principles that preventive action should be taken, that environmental damage should as a priority be rectified at source and that the polluter should pay. The polluter-pays principle, as a principle of responsibility, requires in particular that polluters should partake in covering the costs of the environmental damage they cause.[213] Environmental taxes and duties, with their steering incentives, serve the principles of precaution and the priority of combating causes, and help to implement the polluter-pays principle with the general internalisation of external costs.

Legislative acts within the framework of European environmental policy, as is the case with Art. 43(2) TFEU, are adopted jointly by the European Parliament and the Council following a proposal by the Commission in the ordinary legislative procedure pursuant to Art. 294 TFEU. Other provisions only apply if, pursuant to Art. 192(2)(a) TFEU, the regulations are predominantly of a fiscal nature. In this case, the Council alone has the competence, and provisions must be adopted unanimously, while the Parliament must only be consulted. Corresponding legislative proposals can only be submitted by the European Commission pursuant to Art. 17(2) TEU. This corresponds to the procedural provisions for tax harmonisation according to Art. 113 TFEU (see 7.1.1).

This raises two questions: To what extent can tax regulations also be enacted under Art. 192(1) TFEU and how far reaches the competence under Art. 192(2)(a) TFEU?

---

210 ECJ, adjudication of 07.09.2016 – C-113/14, margin number 54 et seq.; ECJ, adjudication of 26.11.2014 – C-103/12 and C-165/12, margin number 50.

211 Cf. Kahl in: Streinz 2018, Article 192 TFEU, margin number 99.

212 ECJ, adjudication of 25.02.1999 – C-164/97 and C-165/97, Parliament/Council, margin number 13 et sqq., 16 et sqq.; adjudication of 23.02.1988 – C-68/86, United Kingdom/Council, margin number 14; adjudication of 23.02.1988 – C-131/86, United Kingdom/Council, margin number 9, 14; adjudication of 24.11.1993 – C-405/92, Mondiet, margin number 26 et sqq.

213 ECJ, adjudication of 29.04.1999 – C-293/97, Standley, margin number 51.

According to a widespread opinion in the literature, Art. 192(2)(a) TFEU is to be interpreted narrowly as an exception to paragraph 1.[214] From this interpretation is deduced that the provision applies firstly only to taxes and not to non-tax service-in-return levies such as fees and contributions.[215] This corresponds to the concept of taxation under European law, to which all non-service-in-return levies (taxes and special levies) are to be assigned.[216] Secondly, European legislative acts in the environmental area, which only marginally affect or co-regulate tax provisions, still fall under Art. 192(1) TFEU.[217] The European Court of Justice and arguments in the literature do not see paragraph 2 as an exception, but as an independent basis of competence, and draw a distinction between paragraphs 1 and 2 according to the 'predominant purpose' approach.[218]

It is disputed whether the EU, based on Art. 192(2)(a) TFEU, may not only harmonise existing types of taxes but also introduce new EU-wide taxes (e.g., a CO_2 or energy tax) and allocate the respective revenue only to the Member States or also to the EU budget.[219] The reservations are partly based on peculiarities of the German financial constitution, the dogmatics of which are being applied to European competences.[220] However, this ignores the fact that in the TFEU there is no separation between fiscal and substantive powers – unlike, for example, in the German Basic Law – as Art. 192 TFEU and Art. 44 TFEU make clear. According to the case law of the Court of Justice,[221] the view is also outdated that all regulations that in any way affect competition or the internal market cannot fall under Art. 192 TFEU. Rather, the delimitation of the bases of competence depends on the respective focus of the measure at hand.

Furthermore, it is argued that according to Art. 192 TFEU, the EU is not authorised to raise revenue for itself or for the Member States that flow into the general budget, since, according to this view, Art. 311 TFEU and Art. 113 TFEU, which are considered more specific, do not authorise the adoption of new taxes.[222] The only permissible tax regulation is one in which the revenue is used for a specific environment-related task, which would be equivalent to the German model of a special levy.[223] This view is questionable on two accounts.

Firstly, although Art. 311 TFEU regulates the financing of the EU from its own resources, it recognises 'other revenue' in paragraph 1. Secondly, the exclusion of taxes under EU law, which would benefit the financial budgets of the Member States, is also not convincing in several respects. The precedence provision in Art. 192(2) TFEU is limited to Art. 114 TFEU, which, according to paragraph 2, does not authorise the harmonisation of taxes. Since Art. 192 TFEU, in contrast to Art. 113 to 115 TFEU, empowers the EU to take measures that do not only serve the harmonisation and realisation of the internal market, Art. 113 to 115 TFEU and 192 TFEU do not have the same regulatory substance. The relevant competence basis is therefore to be determined according to the focus of the objective of the European tax provision (environmental protection or harmonisation).[224]

---

214 E.g. Nettesheim in: Grabitz/Hilf/Nettesheim 2021, Article 192 TFEU, margin number 68; Krämer in: Groeben, von der/Schwarze/Ludwig 2015, Article 192 TFEU, margin number 30.

215 E.g. Wasmeier 1995, p. 37 et sqq., 229 et seq.; Nettesheim in: Grabitz/Hilf/Nettesheim 2021, Article 192 TFEU, margin number 72; Calliess in: Calliess/Ruffert 2016, Article 192, TFEU margin number 29.

216 Wasmeier 1995, p. 228 et sqq. Cf. ECJ, adjudication of 19.11.1991 – C-235/90, Aliments Morvan, margin number 2.

217 Nettesheim in: Grabitz/Hilf/Nettesheim 2021, Article 192 TFEU, margin number 73; Calliess in: Calliess/Ruffert 2016, Article 192 TFEU, margin number 29.

218 Cf. ECJ, adjudication of 30.01.2001 – C-36/98, Spain/Council, margin number 46, 58 et seq.; Krämer 2011, p. 40; Kahl in: Streinz 2018, Article 192 TFEU, margin number 18.

219 Cf. Hilf 1992, p. 109 et seq.; Schröder 1993, p. 93; Birk 1995, § 11 margin number 15.

220 E.g. Birk 1995, § 11 margin number 15.

221 ECJ, adjudication of 28.06.1994 – C-187/93, Parliament/Council, margin number 25; adjudication of 17.03.1993 – C-155/91, Commission/Council, margin number 19 with further references.

222 Schröder 1993, p. 93; P. Kirchhof 1993, p. 26 et seq.; Hilf 1992, p. 107.

223 Hilf 1992, p. 107; Schröder 1993, p. 93.

224 Cf. Kahl in: Streinz 2018, Article 192 TFEU, margin number 90 et sqq.

It cannot be argued against environmental taxes that flow into the general budget that their revenue does not benefit the environment, since many environmental measures are financed by the general budget. Moreover, environmental taxes do not only serve to finance but also or above all to internalise ecological costs and to set incentives. The environmental protection effect thus already emanates from the taxable event and not only from the use of revenue. However, it is not evident that Art. 192(2) TFEU would restrict tax measures to the financing function alone.

As a result, both the wording and the sense and purpose of the authorisation show that it is a competence that permits incentive taxes that accrue to the EU budget or the budgets of the Member States. Depending on the focus of the objective, Art. 192(2) TFEU or Art. 113 TFEU is relevant. If a tax inseparably and equally serves both the functioning of the internal market and the protection of the environment in terms of its objective and substance, it is to be based on Art. 192(2) and 113 TFEU.

7.1.4 Human Health (Art. 168 TFEU)

According to Art. 9 and 168(1) TFEU, a high level of human health protection shall be ensured when determining and implementing all Union policies and activities.[225] This also includes the elimination of causes of danger to physical and mental health. The EU's primary role is to support the policies and actions of the Member States. In particular, the EU promotes cooperation and coordination of Member States' health policies and measures.

However, in Art. 168(4) and (5) TFEU, the EU was also granted its own regulatory competences in the area of public health protection. This explicitly applies to measures in the area of plant protection, which have the direct aim of protecting public health (Art. 168(4)(b) TFEU). The measures are adopted jointly by the European Parliament and the Council following a proposal by the Commission in the ordinary legislative procedure pursuant to Art. 294 TFEU.

This raises the question of the relationship to the other provisions that establish competences.

- According to part of the literature, Art. 168(4)(b) TFEU is the more specific competence norm for measures than Art. 43 TFEU, as long as the protection of human health is not merely an indirect purpose of the EU measure.[226] Others see both competences as being of equal rank, since the Treaty of Lisbon also applies the ordinary legislative procedure to Art. 43(2) TFEU.[227]
- Regarding Art. 192 TFEU, no special relationship is evident, since according to Art. 191(1) TFEU, the protection of human health is also an objective of EU environmental policy. Thus, the delimitation of competence is to be determined according to the focus of the measure. In the case of inseparably equivalent purposes, both competence standards are to be applied in principle, provided that the legislative procedures are comparable.

Art. 168(4) TFEU, like Art. 192(1) TFEU, provides for the procedure of co-decision pursuant to Art. 294 TFEU with a Council and Parliament decision. In the case of predominantly fiscal provisions, a unanimous Council decision is required according to Art. 192(2) TFEU, and the Parliament is only to be consulted. When weighing up the stronger participation of Parliament and consideration for the tax sovereignty of the Member States, greater importance is to be attached to the procedure with stronger parliamentary participation, since tax sovereignty is already impaired by the transfer of competence per se and the distinction between majority

225 Cf. ECJ, adjudication of 05.10.2000 – C-376/98, Germany/Parliament and Council, margin number 88.

226 Lurger in: Streinz 2018, Article 168 TFEU, margin number 37; Niggemeier in: von Groeben/Schwarze/Hatje 2015, Article 168 TFEU, margin number 40 et seq.

227 Schmidt am Busch in: Grabitz/Hilf/Nettesheim 2021, Article 168 TFEU, margin number 105.

or unanimity decision is only of subordinate importance. In accordance with the arguments in the *titanium dioxide* ruling of the ECJ[228], Art. 168(4) TFEU is to be regarded as a preferable basis for competence due to the stronger participation of the Parliament.

- With regard to the tax harmonisation competences in Art. 113 and 115 TFEU, a similar balancing is necessary, provided that a measure has an equally strong focus on the protection of health and the improvement of the internal market. Here too, due to the stronger involvement of the European Parliament, Art. 168(4)(b) TFEU is to be regarded as having priority insofar as the measure directly protects public health.

7.2 Competences Regarding a Levy on Plant Protection Products

Given the powers outlined above, the EU has various competences to introduce an EU-wide levy on chemical plant protection products in order to reduce the use of pesticides in the EU and to diminish the associated negative impacts on and risks to the environment and human health.

The EU has already enacted regulations to achieve these goals. Firstly, EU Regulation 1107/2009 directly regulates the authorisation and placing on the market of plant protection products and their active substances under European law. The Regulation was based on “the Treaty establishing the European Community, and in particular Article 37(2), Article 95 and Article 152(4)(b)” and thus on today’s Art. 43(2), 114 and 168(2)(b) TFEU. On the other hand, based on Art. 192(1) TFEU (formerly Art. 175(1) TEC), Directive 2009/128 Establishing a Framework for Community Action to Achieve a Sustainable Use of Pesticides was adopted, which, among other things, obliges the Member States to take measures to reduce the use of chemical plant protection products and to ensure the principles of integrated pest management standardised in Annex III.

A levy on chemical plant protection products is also subject to various competence provisions.

Taxes on plant protection products are currently levied in Denmark, Sweden, and at a low tax level even in France. Their design differs both in the tax rate and in terms of their reference points and taxation system. The different provisions in the Member States could justify a harmonisation measure on the part of the European Union. Before 2000, the European Commission had already commissioned corresponding studies on a tax on plant protection products.[229] Since national taxes on plant protection products are indirect taxes, Art. 113 TFEU would be the apposite harmonisation competence.

The Europe-wide introduction of taxes on fertilisers and plant protection products would have to be necessary as a harmonisation measure for the establishment and functioning of the internal market. This can be assumed, since different taxation leads to distortions of competition within the internal market, since users in countries with a levy have higher costs, for instance, when it comes to agricultural production. In the context of harmonisation, the EU does not have to follow the majority of Member States and abolish taxes throughout Europe. On the contrary, on the basis of Art. 9 and 11 TFEU, the EU must observe the requirements of environmental and health protection within the framework of harmonisation measures. Likewise, it does not have to implement a system that already exists in a Member State but can establish a new independent tax model.

In addition to Art. 113 TFEU, a tax on chemical plant protection products could also be based on Art. 192(2) TFEU, as it serves both the objectives mentioned in Art. 191 TFEU (protection of the environment and human health) and the implementation of the principles mentioned there (in particular the precautionary principle and

---

[228] ECJ, adjudication of 11.06.1991 – C-300/89, Commission/Council (Titanium dioxide), margin number 17 et sqq.

[229] Hoevenagel/van Noort/de Kok 1999; Oskam/Vijftigschild/Graveland 1997.

the polluter-pays principle). Due to the similar legislative procedures (unanimous Council decision), it would be permissible to base the tax cumulatively on Art. 113 and 192(2) TFEU. Both provisions have precedence over the competence in the agricultural sector (Art. 43(2) TFEU), since a tax on plant protection products is primarily intended to protect the environment and health or, depending on the political weighting, to harmonise existing pesticide levies in the EU. The associated improvement in agricultural production or the marketing of agricultural products, on the other hand, is only a secondary objective.

Insofar as the tax on plant protection products explicitly and directly serves the protection of human health, it is to be based on Art. 168(4)(b) TFEU, as this is the most specific competence in the area of plant protection and takes precedence over Art. 43 TFEU in this respect. Since Art. 168(4) TFEU still provides for the ordinary legislative procedure with co-decision by the European Parliament, this basis of competence is also to be regarded as having precedence over Art. 113 and 192(2) TFEU, even though Art. 168(4) TFEU only requires a qualified Council decision.[230] Direct protection of public health can be assumed in particular, if the taxation concept takes into account the human-toxic risks of active substances, so that the respective products that are hazardous to human health would bear a higher tax burden. This is the case with the examined concepts by Denmark and the UFZ. These concepts could therefore be based on Art. 168(4)(b) TFEU. In the case of the concepts of a generalised quantity levy as in Sweden or a generalised ad valorem-levy according to Femenia/Letort 2016, however, immediate health protection is less pronounced, which is why a cumulative reliance on Art. 113 and 192(2) TFEU is more advisable in these cases.

7.3 Conclusion

The European Union can only act within the framework of the individual competences conferred on it. The Treaty establishing the EU encompasses various competences that allow an EU-wide introduction of a levy on plant protection products. On the one hand, the EU could introduce its own tax, which would flow into the EU budget, which currently marshals the billions in agricultural subsidies of the Common Agricultural Policy. On the other hand, the EU could legally stipulate that a tax or non-tax levy be imposed on plant protection products in all Member States, and also prescribe a specific taxation concept there.

Depending on the main objectives of an EU-wide pesticide tax and the design of the taxation concept, different bases of competence with partly different requirements for the legislative procedure could be considered. If the protection of human health is one of the main objectives and if the taxation concept takes account of the different degrees of human toxicity, so that plant protection products with active substances that are more dangerous to health are taxed more heavily, then Art. 168(4)(b) TFEU is the relevant competence basis. The tax could then be introduced in the ordinary legislative procedure by the European Parliament and the Council following a proposal by the European Commission.

If the tax serves primarily to protect the environment and human toxicity risks are not specifically taken into account in the taxation concept (e.g., in the case of generalised quantity levy or ad valorem-levy), then Art. 192(2)(a) TFEU would be the relevant basis of competence. Since an EU-wide introduction would also require the harmonisation of the already existing taxes or levies on plant protection products in Denmark, France, and Sweden, such a tax should also be based on Art. 113 TFEU. Both bases of competence provide for a special legislative procedure. According to the Commission's proposal, the tax would have to be adopted unanimously by the Council, with the Parliament only having to be consulted. Due to this, from a democratic point of view, limited participation of the Parliament directly elected by the citizens, Art. 168(4)(b) TFEU is preferable as a competence provision, provided that the pesticide tax also has the direct objective of protecting public health.

[230] Cf. ECJ, adjudication of 11.06.1991 – C-300/89, Commission/Council (Titanium dioxide), margin number 17 et sqq.

References

Ansmann, T. (2010), Simulation der Haushaltswassernachfrage im Elbegebiet: Ein mikrobasierter, mesoskaliger Modellansatz, Berliner Beiträge zur Ökologie, Band 7, Berlin, Weißensee-Verlag, 221 p.

Altieri, M. A., Ponti, L., Nicholls, C. I. (2012), Soil fertility, biodiversity and pest management, in: Geoff M. Gurr, Steve D. Wratten, William E. Snyder, Donna M.Y. Read. (Hrsg.), Biodiversity and insect pests: key issues for sustainable management, Wiley Online Library, p. 72-84.

Bareille F., Gohin A. (2020), Simulating the Market and Environmental Impacts of French Pesticide Policies: A Macroeconomic Assessment, in: Annals of Economics and Statistics, p. 1-28.

Beketov, M. A., Kefford, B. J., Schäfer, R. B., Liess, M. (2013), Pesticides reduce regional biodiversity of stream invertebrates, in: Proceedings of the National Academy of Sciences, p. 11039-11043.

Bergmann, G. E. (2019), Impacts of Pesticide Pollution on Soil Microbial Communities, Ecosystem Function and Human Health, in: Earth Systems and Environmental Sciences, p. 1-5.

BfN - Bundesamt für Naturschutz (2018), Auswirkungen von Glyphosat auf die Biodiversität, https://www.bfn.de/fileadmin/BfN/landwirtschaft/Dokumente/20180131_BfN-Papier_Glyphosat.pdf, 13 p.

Birk, D. (1995), Handbuch des europäischen Steuer- und Abgabenrechts, Herne/Berlin Verlag Neue Wirtschaftsbriefe 1169 p.

Böcker, T., Finger, R. (2016), European Pesticide Tax Schemes in Comparison: An Analysis of Experiences and Developments, in: Sustainability, p. 1-22.

Böcker, T. G., Finger, R. (2017), A meta-analysis on the elasticity of demand for pesticides, in: Journal of Agricultural Economics, p. 518-533.

Boily, M., Sarrasin, B., DeBlois, C., Aras, P., Chagnon, M. (2013), Acetylcholinesterase in honey bees (Apis mellifera) exposed to neonicotinoids, atrazine and glyphosate: laboratory and field experiments, in: Environmental Science and Pollution Research, p. 5603-5614.

Brewer, M. J., Goodell, P. B. (2012), Approaches and Incentives to Implement Integrated Pest Management that Addresses Regional and Environmental Issues, in: Annual Review of Entomology, p. 41-59.

Brzozowski, L., Mazourek, M. (2018), A Sustainable Agricultural Future Relies on the Transition to Organic Agroecological Pest Management, in: Sustainability, p. 2023.

Buijs, J., Mantingh, M. (2020), Forschungsbericht: INSEKTENSCHWUND UND PESTIZIDBELASTUNG IN NATURSCHUTZGEBIETEN in Nordrhein-Westfalen und Rheinland-Pfalz, https://www.wecf.org/de/wp-content/uploads/2018/10/DPL_Pestizide_DE_2020.pdf, WECF e.V. München, 215 p.

BVL - Bundesamt für Verbraucherschutz und Lebensmittelsicherheit (2020a), Absatz an Pflanzenschutzmitteln in der Bundesrepublik Deutschland: Ergebnisse der Meldungen gemäß § 64 Pflanzenschutzgesetz für das Jahr 2019, Braunschweig, 20 p.

BVL - Bundesamt für Verbraucherschutz und Lebensmittelsicherheit (2020b), Pflanzenschutzmittel-Verzeichnis 2020: Teil 1 Ackerbau – Wiesen und Weiden, Hopfenbau – Nichtkulturland, Braunschweig, Saphir-Verlag, 476 p.

BVL - Bundesamt für Verbraucherschutz und Lebensmittelsicherheit (2020c), Zur Information für die Öffentlichkeit: Machbarkeitsanalyse für ein Monitoring über Rückstände in unbehandelten Flächen und auf unbehandelten Kulturen über die Verfrachtung von Pflanzenschutzmittelwirkstoffen, https://www.bvl.bund.de/SharedDocs/Downloads/04_Pflanzenschutzmittel/00_fachmeldungen/Machbarkeitsanalyse_Luftmonitoring_2020.pdf, 74 p.

BVL Fachbeirat Nachhaltiger Pflanzenbau (2019), Mehr Verunkrautung wagen: Plädoyer für einen Perspektivwechsel in der Unkrautbekämpfung im Ackerbau, https://www.uni-goettingen.de/de/document/download/d4971cca330e3956032cde79cf3cb383.pdf/fachbeirat_nachpflbau_positionspapier2019.pdf, BVL, Positionspapier des Fachbeirats Nachhaltiger Pflanzenbau, 11 p.

Calliess, C., Ruffert, M. (2016), EUV/AEUV – EUV/AEUV - Das Verfassungsrecht der Europäischen Union mit Europäischer Grundrechtecharta, 5. Aufl., München, C. H. Beck, 3140, 3140 p.

Calvo-Agudo, M., González-Cabrera, J., Sadutto, D., Picó, Y., Urbaneja, A., Dicke, M., Tena, A. (2020), IPM-recommended insecticides harm beneficial insects through contaminated honeydew, in: Environmental Pollution, 10.1016/j.envpol.2020.115581: https://doi.org/10.1016/j.envpol.2020.115581, p. 10.

Chaplin-Kramer, R., O'Rourke, M., Schellhorn, N., Zhang, W., Robinson, B. E., Gratton, C., Rosenheim, J. A., Tscharntke, T., Karp, D. S. (2019), Measuring What Matters: Actionable Information for Conservation Biocontrol in Multifunctional Landscapes, in: Frontiers in Sustainable Food Systems, 10.3389/fsufs.2019.00060: https://doi.org/10.3389/fsufs.2019.00060, p. 1-10.

Chiu, M.-C., Hunt, L., Resh, V. H. (2016), Response of macroinvertebrate communities to temporal dynamics of pesticide mixtures: a case study from the Sacramento River watershed, California, in: Environmental Pollution, p. 89-98.

Culliney, T. W., Pimentel, D. (1986), Ecological effects of organic agricultural practices on insect populations, in: Agriculture, ecosystems & environment, p. 253-266.

de Vries, F. T., Griffiths, R. I., Bailey, M., Craig, H., Girlanda, M., Gweon, H. S., Hallin, S., Kaisermann, A., Keith, A. M., Kretzschmar, M., Lemanceau, P., Lumini, E., Mason, K. E., Oliver, A., Ostle, N., Prosser, J. I., Thion, C., Thomson, B., Bardgett, R. D. (2018), Soil bacterial networks are less stable under drought than fungal networks, in: Nature Communications, p. 3033.

Dorninger, C., Abson, D. J., Apetrei, C. I., Derwort, P., Ives, C. D., Klaniecki, K., Lam, D. P. M., Langsenlehner, M., Riechers, M., Spittler, N., von Wehrden, H. (2020), Leverage points for sustainability transformation: a review on interventions in food and energy systems, in: Ecological Economics, p. 106570.

Dubgaard, A. (1991), Pesticide Regulation in Denmark, in: Hanley (Hrsg.), Farming and the Countryside: An Analysis of External Costs and Benefits, Wallingford, CAB International, p. 48-58.

ECOTEC et al. (2001), Study on the Economic and Environmental Implications of the Use of Environmental Taxes and Charges in the European Union and its Member States - Final Report, http://ec.europa.eu/environment/enveco/taxation/environmental_taxes.htm, Europäische Kommission, 387 p.

EFSA - European Food Safety Authority (2005), Conclusion regarding the peer review of the pesticide risk assessment of the active substance glufosinate, EFSA Scientific Report 27, Parma.

EFSA - European Food Safety Authority (2008), Conclusion regarding the peer review of the pesticide risk assessment of the active substance epoxiconazole, EFSA Scientific Report 138, Parma.

EFSA - European Food Safety Authority (2015), Conclusion on the peer review of the pesticide risk assessment of the active substance diquat, in: EFSA Journal 13, Parma.

EFSA - European Food Safety Authority (2018), Peer review of the pesticide risk assessment of the active substance chlorothalonil, in: EFSA Journal 16, Parma.

European Commission (2021), EU Ecosystem Assessment: Summary for policymakers, https://publications.jrc.ec.europa.eu/repository/bitstream/JRC123783/jrc123783_-_eu_ecosystem_assessment_-_spm_-_2021_-_online_facing_pages.pdf, Publications Office of the European Union, 49 p.

European Commission (2002), Communication from the Commission to the Council, the European Parliament, the European Economic and Social Committee and the Committee of the Regions -

Towards a Thematic Strategy on the Sustainable Use of Pesticides, COM Band (2002) 349 final, 40 p.

European Commission - Communication from the Commission to the Council, the European Parliament, the European Economic and Social Committee and the Committee of the Regions (2006), A Thematic Strategy on the Sustainable Use of Pesticides, COM Band (2006) 373 final, 13 p.

European Commission - COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE EUROPEAN COUNCIL, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS (2019), The European Green Deal, Brussels, COM(2019) 640 final, 24 p.

European Commission - COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE EUROPEAN COUNCIL, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS (2020a), EU Biodiversity Strategy for 2030 - Bringing nature back into our lives, Brussels, COM(2020) 380 final, 27 p.

European Commission - COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE EUROPEAN COUNCIL, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS (2020b), A Farm to Fork Strategy for a fair, healthy and environmentally-friendly food system, Brussels, COM(2020) 381 final, 20 p.

European Court of Auditors (2020a), Biodiversity on farmland: CAP contribution has not halted the decline, Luxembourg, https://www.eca.europa.eu/Lists/ECADocuments/SR20_05/SR_ Pesticides_EN.pdf, Special Report Band 13, 58 p.

European Court of Auditors (2020b), Sustainable use of plant protection products: limited progress in measuring and reducing risks, Luxembourg, https://www.eca.europa.eu/Lists/ECADocuments/SR20_05/SR_Pesticides_EN.pdf, Special Report Band 05, 49 p.

European Court of Auditors (2021), Common Agricultural Policy and climate - Half of EU climate spending but farm emissions are not decreasing, Luxembourg, https://www.eca.europa.eu/Lists/ECADocuments/SR21_16/SR_CAP-and-Climate_EN.pdf, Special Report Band 16, 65 p.

Ewringmann, D., Schafhausen, F. (1985), Abgaben als ökonomischer Hebel der Umweltpolitik, Umweltbundesamt, Berichte 8/85, Berlin, Erich Schmidt Verlag.

Femenia, F., Letort, E. (2016), How to significantly reduce pesticide use: An empirical evaluation of the impacts of pesticide taxation associated with a change in cropping practice, in: Ecological Economics, p. 27-37.

Finckh, M. R., Junge, S. M., Schmidt, J. H., ŞIŞIÇ, A., Weedon, O. D. (2021), Intra- and interspecific diversity: the cornerstones of agroecological crop health management, in: Aspects of Applied Biology.

Finckh, M. R., Van Bruggen, A. H. C., Tamm, L. (2015), Plant diseases and their management in organic agriculture, American Phytopathological Society, 414 p.

Finger, R., Böcker, T., Möhring, N., Dalhaus, T. (2017a), Lenkungsabgaben auf Pflanzenschutzmittel, in: Agrarforschung Schweiz, p. 176-183.

Finger, R., Möhring, N., Dalhaus, T., Böcker, T. (2017b), Revisiting Pesticide Taxation Schemes, in: Ecological Economics, p. 263-266.

FÖS - Forum Ökologisch-Sozial Marktwirtschaft (2018), Eine Pflanzenschutzmittelabgabe für Deutschland, https://foes.de/publikationen/2018/2018-03-FOES-Pestizidsteuer.pdf, FÖS-Themenpapier Band 03/2018, 5 p.

Freier B., Gummert A., Peters M. (2014), Modellvorhaben „Demonstrationsbetriebe integrierter Pflanzenschutz“. Tischvorlage zu TOP 4. Sitzung des Forums Nationaler Aktionsplan zur nachhaltigen Anwendung von Pflanzenschutzmitteln, 3. und 4. Dezember 2014, Bundesministerium für Ernährung und Landwirtschaft.

Gawel, E. (2009): Grundzüge der mikroökonomischen Theorie, Bergisch Gladbach/Köln.

Gawel, E., Köck, W., Kern, K., Möckel, S., Robert, H., Fälsch, M., Völkner, T. (2011), Weiterentwicklung von Abwasserabgabe und Wasserentnahmeentgelten zu einer umfassenden Wassernutzungsabgabe, Umweltbundesamt, UBA-Texte Band 67/2011, Dessau, Umweltbundesamt, 387 p.

Grovermann, C., Schreinemachers, P., Riwthong, S., Berger, T. (2017), 'Smart' policies to reduce pesticide use and avoid income trade-offs: An agent-based model applied to Thai agriculture, in: Ecological Economics, p. 91-103.

Ghorbani R, Wilcockson SJ, Giotis C & Leifert C (2004), Potato late blight management in organic agriculture.August 2004Outlooks on Pest Management 15(4):176-180 DOI: 10.1564/15aug12.

Goulson, D., Thompson, J., Croombs, A. (2018), Rapid rise in toxic load for bees revealed by analysis of pesticide use in Great Britain, in: PeerJ, 10.7717/peerj.5255: https://doi.org/10.7717/peerj.5255, p. e5255.

Grabitz, E. (1989), Handlungsspielräume der EG-Mitgliedstaaten zu Verbesserung des Umweltschutzes, in: Recht der internationalen Wirtschaft, p. 623-636.

Groeben, H. v. d., Schwarze, J., Hatje, A. (2015), EUV/AEUV – Europäisches Unionsrecht - Vertrag über die Europäische Union, Vertrag über die Arbeitsweise der Europäischen Union, Charta der Grundrechte der Europäischen Union, 7. Aufl., Baden-Baden, Nomos, Vol. 1 2128 p., Vol. 2 2252 p., Vol. 3 1872 p., Vol. 4 2120 p.

Hallmann, C. A., Foppen, R. P. B., Turnhout, C. A. M. v., Kroon, H. d., Jongejans, E. (2014), Declines in insectivorous birds are associated with high neonicotinoid concentrations, in: nature, p. 341-344.

Hilf, M. (1992), Umweltabgaben als Gegenstand von Gemeinschaftsrecht und -politik, in: Neue Zeitschrift für Verwaltungsrecht, p. 105-111.

Hoevenagel, R., van Noort, E., de Kok, R. (1999), Study on a European Union wide regulatory framework for levies on pesticides, Europäische Kommission, EIM/Haskoning, Zoetermeer, http://ec.europa.eu/environment/enveco/taxation/pdf/eimstudy.pdf.

Hofmann, F., Kruse-Plaß, M., Schlechtriemen, U., Wosniok, W. (2020), Pestizid-Belastung der Luft - Eine deutschlandweite Studie zur Ermittlung der Belastung der Luft mit Hilfe von technischen Sammlern, Bienenbrot, Filtern aus Be- und Entlüftungsanlagen und Luftgüte-Rindenmonitoring hinsichtlich des Vorkommens von 500 Pestizid-Wirkstoffen, insbesondere Glyphosat (durchgeführt von TIEM Integrierte Umweltüberwachung, Dortmund), https://www.ackergifte-nein-danke.de/wp-content/uploads/2020/09/Studie_final_niedrig.pdf, Bündnis für eine enkeltaugliche Landwirtschaft e. V. und Umweltinstitut München, 143 p.

Hofmeester, Y. (1992), Effects of fertilization on pests and diseses, in: Netherlands Journal of Plant Pathology, p. 257-264.

Hötker, H., Dierschke, V., Flade, M., Leuschner, C. (2014), Diversitätsverluste in der Brutvogelwelt des Acker- und Grünlands, in: Natur und Landschaft, p. 410-416.

Huber, D. M., Haneklaus, S. (2007), Managing nutrition to control plant disease, in: Landbauforschung Volkenrode, p. 313-322.

Hulot, J. F., Hiller, N. (2021), Exploring the benefits of biocontrol for sustainable agriculture – A literature review on biocontrol in light of the European Green Deal, https://ieep.eu/uploads/articles/attachments/dd5ba87b-172b-44d2-ac39-782b17589b88/IEEP%20-%20Exploring%20the%20benefits%20of%20biocontrol%20for%20sustainable%20agriculture%20(2021).pdf, Institute for European Environmental Policy, 42 p.

Hunt, L., Bonetto, C., Marrochi, N., Scalise, A., Fanelli, S., Liess, M., Lydy, M. J., Chiu, M. C., Resh, V. H. (2017), Species at Risk (SPEAR) index indicates effects of insecticides on stream invertebrate communities in soy production regions of the Argentine Pampas, in: Science of the Total Environment, p. 699-709.

Jacquet, F., Butault, J.-P., Guichard, L. (2011), An economic analysis of the possibility of reducing pesticides in French field crops, in: Ecological Economics, p. 1638-1648.

JRC et al. - Joint Research Centre, European Environment Agency, DG Environment, European Topic Centre on Biological Diversity, European Topic Centre on Urban, Land and Soil Systems (2020), Mapping and Assessment of Ecosystems and their Services: An EU ecosystem assessment, https://publications.jrc.ec.europa.eu/repository/handle/JRC120383, Publications Office of the European Union, JRC Science for Policy Report, 452 S

Kiefer K., Müller A., Singer H., Hollende J. (2019), New relevant pesticide transformation products in groundwater detected using target and suspect screening for agricultural and urban micropollutants with LC-HRMS, in: Water Research, 114972.

Kirchhof, P. (1993), Verfassungsrechtliche Grenzen von Umweltabgaben, in: Paul Kirchhof (Hrsg.), Umweltschutz im Abgaben- und Steuerrecht, Deutsche Steuerjuristische Gesellschaft Band 15, Köln, Verlag Dr. Otto Schmidt, p. 3-31.

Knillmann, S., Liess, M. (2019), Pesticide effects on stream ecosystems, in: M. Schröter, A. Bonn, S. Klotz, R. Seppelt, C. Baessler (Hrsg.), Atlas of Ecosystem Services, Cham, Springer, p. 211-214.

Knillmann, S., Liess, M., Scholz-Starke, B., Daniels, B., Ottermanns, R., Schäffer, A., Sybertz, A., Roß-Nicko, M. (2021), Environmental risks of pesticides between forecast and reality: How reliable are results of the environmental risk assessment for individual products in the light of agricultural practice (tank mixtures, spray series)?, UBA-Texte 82/2021, https://www.umweltbundesamt.de/sites/default/files/medien/5750/publikationen/2021-05-26_texte_82-2021_combitox_pesticides.pdf, Uumweltbundesamt - German Environmental Agency, 196 p.

Krämer, L. (2011), Droit de l'environnement de l´Union européenne, Basel, Helbing Lichtenhahn, 256 S.

Krüger, M., Shehata, A. A., Schrödl, W., Rodloff, A. (2013), Glyphosate suppresses the antagonistic effect of Enterococcus spp. on Clostridium botulinum, in: Anaerobe, p. 74-78.

Landbrugsstyrelsen - Miljø- og Fødevareministeriet (2020), Statistik over økologiske jordbrugsbedrifter 2019, https://lbst.dk/fileadmin/user_upload/NaturErhverv/Filer/Tvaergaaende/Oekologi/Statistik/Statistik_over_oekologiske_jordbrugsbedrifter_2019.pdf, 56 p.

Lechenet, M., Bretagnolle, V., Bockstaller, C., Boissinot, F., Petit, M. S., Petit, S., Munier-Jolain, N. M. (2014), Reconciling Pesticide Reduction with Economic and Environmental Sustainability in Arable Farming, in: Plos One, p. 10.

Lechenet, M., Dessaint, F., Py, G., Makowski, D., Munier-Jolain, N. (2017), Reducing pesticide use while preserving crop productivity and profitability on arable farms, in: Nature Plants, p. 1-6.

Lee, R., den Uyl, R., Runhaar, H. (2019), Assessment of policy instruments for pesticide use reduction in Europe; Learning from a systematic literature review, in: Crop Protection, p. 104929.

Lefebvre, M., Langrell, S. R. H., Gomez-y-Paloma, S. (2015), Incentives and policies for integrated pest management in Europe: a review, in: Agronomy for Sustainable Development, 10.1007/s13593-014-0237-2: https://doi.org/10.1007/s13593-014-0237-2, p. 27-45.

Lekberg, Y., Koide, R. T. (2005), Is plant performance limited by abundance of arbuscular mycorrhizal fungi? A meta-analysis of studies published between 1988 and 2003, in: New Phytol, p. 189-204.

Liess, M., Ohe, P. C. V. D. (2005), Analyzing effects of pesticides on invertebrate communities in streams, in: Environmental Toxicology and Chemistry, p. 954-965.

Liess, M., Schäfer, R. B., Schriever, C. A. (2008), The footprint of pesticide stress in communities – Species traits reveal community effects of toxicants, in: Science of The Total Environment, p. 484-490.

Liess, M., Liebmann, L., Vormeier, P., Weisner, O., Altenburger, R., Borchardt, D., Brack, W., Chatzinotas, A., Escher, B., Foit, K., Gunold, R., Henz, S., Hitzfeld, K. L., Schmitt-Jansen, M., Kamjunke, N., Kaske, O., Knillmann, S., Krauss, M., Küster, E., Link, M., Lück, M., Möder, M., Müller, A., Paschke, A., Schäfer, R. B., Schneeweiss, A., Schreiner, V. C., Schulze, T., Schüürmann, G., von Tümpling, W., Weitere, M., Wogram, J., Reemtsma, T. (2021), Pesticides are the dominant stressors for vulnerable insects in lowland streams, in: Water Research, 10.1016/j.watres.2021.117262: https://doi.org/10.1016/j.watres.2021.117262, p. 117262.

Mbanaso, F. U., Coupe, S. J., Charlesworth, S. M., Nnadi, E. O., Ifelebuegu, A. O. (2014), Potential microbial toxicity and non-target impact of different concentrations of glyphosate-containing herbicide (GCH) in a model pervious paving system, in: Chemosphere, p. 34-41.

Meyer, S., Wesche, K., Krause, B., Leuschner, C. (2013), Dramatic losses of specialist arable plants in Central Germany since the 1950s/60s-a cross-regional analysis, in: Diversity and Distributions, p. 1175-1187.

Milanovic, J., Milutinovic, T., Stojanovic, M. (2014), Effects of three pesticides on the earthworm Eisenia fetida (Savigny 1826) under laboratory conditions: Assessment of mortality, biomass and growth inhibition, in: European Journal of Soil Biology, p. 127-131.

Miljøministeriet / Miljøstyreslen - Environmental Ministery - Danish Environmental Protection Agency (2013), Background and content of the new pesticide tax, Kopenhagen, 18 p.

Miljøstyrelsen - Miljø- og Fødevareministeriet (2018), Evaluering af den differentierede pesticidafgift, https://www2.mst.dk/Udgiv/publikationer/2018/05/978-87-93710-28-3.pdf, Orientering fra Miljøstyrelsen nr. 26, 54 p.

Miljøstyrelsen - Miljø- og Fødevareministeriet (2020): Bekæmpelsesmiddelstatistik 2018. Behandlingshyppighed og pesticidbelastning baseret på salg og forbrug, https://www2.mst.dk/Udgiv/publikationer/2020/09/978-87-7038-233-5.pdf, Orientering fra Miljøstyrelsen nr. 45, 102 p.

Möckel, S. (2006), Umweltabgaben zur Ökologisierung der Landwirtschaft, Schriften zum Umweltrecht Band 146, Berlin, Duncker & Humblot, 375 p.

Möckel, S., Köck, W., Schramek, J., Rutz, C. (2014), Rechtliche und andere Instrumente für vermehrten Umweltschutz in der Landwirtschaft, UBA-Texte Band 42/2014, Dessau, http://www.umweltbundesamt.de/sites/default/files/medien/378/publikationen/texte_42_2014_rechtliche_und_andere_instrumente.pdf, Umweltbundesamt, 596 p.

Möckel, S., Gawel, E., Kästner, M., Knillmann, S., Liess, M., Bretschneider, W. (2015), Einführung einer Abgabe auf Pflanzenschutzmittel in Deutschland, Berlin, Duncker&Humblot, 305 p.

Möckel, S. (2016), Verhältnis ordnungs- und beihilferechtlicher Mindestanforderungen im Agrarumweltrecht, in: Zeitschrift für Umweltrecht, p. 655-665.

Möckel, S., Gawel, E., Liess, M., Neumeister, L. (2021), Wirkung verschiedener Abgabenkonzepte zur Reduktion des Pestizideinsatzes in Deutschland – eine Simulationsanalyse, https://www.gls.de/media/PDF/Presse/Studie_Pestizid-Abgabe_in_Deutschland_2021.pdf, GLS Bank, 136 p.

Möhring, N., Ingold, K., Kudsk, P., Martin-Laurent, F., Niggli, U., Siegrist, M., Studer, B., Walter, A., Finger, R. (2020), Pathways for advancing pesticide policies, in: Nature Food, 10.1038/s43016-020-00141-4: https://doi.org/10.1038/s43016-020-00141-4, p. 535-540.

Mußhoff, O. (2017), Bewertung einer Steuer auf Pflanzenschutzmittel aus betriebs- und volkswirtschaftlicher Perspektive (i.A. Industrieverband Agrar e.V.), HFFA Research Paper Band 6/2017, Berlin, HFF A Research GmbH, 125 p.

Neumeister, L. (2010), Millionen für ungewollte Gifte. Wie die staatliche Kontrolle von Pestiziden in Lebensmitteln und im Grundwasser die deutschen Steuerzahler belastet (i.A. Greenpeace e.V.), Hamburg, 69 p.

Neumeister, L. (2019), Hat die dänische Pestizidsteuer die dortige Landwirtschaft ruiniert?, PAN Germany Pestizid-Brief 1 – 2019, https://pan-germany.org/pestizide/hat-die-daenische-pestizidsteuer-die-dortige-landwirtschaft-ruiniert/.

Niggli, U., Riedel, J., Brühl, C., Liess, M., Schulz, R., Altenburger, R., Märländer, B., Bokelmann, W., Heß, J., Reineke, A. (2020), Pflanzenschutz und Biodiversität in Agrarökosystemen, in: Berichte über Landwirtschaft, p. 1-39.

Ohler, C. (1997), Die fiskalische Integration in der Europäischen Gemeinschaft, Baden-Baden, Nomos, 472 p.

Oppenheimer, Wolff, Donnelly (1997), Possibilities for future EC environmental policy on plant protection products - Synthesis Report, https://ec.europa.eu/environment/archives/ppps/synth/complete.pdf, European Commission, 129 p.

Ørum, J. E., Ståhl, L., Kudsk, P., Jørgensen, L. N. (2018), Analyser til brug for evaluering af pesticidafgiften: En beskrivelse af ændringer i pesticidernes priser, salg, forbrug og belastning, IFRO Udredning Band 2018 / 01, Frederiksberg, https://static-curis.ku.dk/portal/files/189738161/IFRO_Udredning_2018_01.pdf, Institut for Fødevare- og Ressourceøkonomi Københavns Universitet, 77 p.

Oskam, A. J., Vijftigschild, R. A. N., Graveland, C. (1997), Additional EU policy instruments for plant protection products, Teil der Studie für die Europäische Kommission, Possibilities for future EC environmental policy on plant protection products, 1997, www.europa.eu.int, http://ec.europa.eu/environment/archives/ppps/pdf/addeupol.pdf, Europäische Kommission, 256 p.

Pedersen, A. B. (2016), Pesticide Tax in Denmark, https://ieep.eu/uploads/Art.s/attachments/504788d7-db01-4dd8-bece-ee7b9e63979e/DK%20Pesticide%20Tax%20final.pdf?v=63680923242, 11 p.

Pedersen, A. B., Nielsen, H. Ø., Andersen, M. S. (2011), WP3 EX-POST Case studies: The Danish Pesticide Tax, Fondazione Eni Enrico Mattei (FEEM), EIP Water - Evaluating Economic Policy Instruments for Sustainable Water Management in Europe, http://www.feem-project.net/epiwater/docs/d32-d6-1/CS4_Denmark.pdf, FEEM, 41 p.

Pedersen, A. B., Nielsen, H. Ø., Andersen, M. S. (2015), The Danish Pesticide Tax, in: Manuel Lago, Jaroslav Mysiak, Carlos M. Gómez, Gonzalo Delacámara, Alexandros Maziotis (Hrsg.), Use of Economic Instruments in Water Policy Springer, p. 73-134.

Pedersen, A. B., Nielsen, H. Ø., Christensen, T., Hasler, B. (2012), Optimising the effect of policy instruments: a study of farmers' decision rationales and how they match the incentives in Danish pesticide policy, in: Journal of Environmental Planning and Management,, p. 1094-1110.

Pedersen, A. B., Nielsen, H. Ø., Daugbjerg, C. (2020), Environmental policy mixes and target group heterogeneity: Analysing Danish farmers’ responses to the pesticide taxes, in: Journal of Environmental Policy & Planning, p. 608-619.

Pe’er, G., Zinngrebe, Y., Moreira, F., Sirami, C., Schindler, S., Müller, R., Bontzorlos, V., Clough, D., Bezák, P., Bonn, A., Hansjürgens, B., Lomba, A., Möckel, S., Passoni, G., Schleyer, C., Schmidt, J., Lakner, S. (2019), A greener path for the EU Common Agricultural Policy, in: Science, 10.1126/science.aax3146: https://doi.org/10.1126/science.aax3146, p. 449-451.

Petit, S., Munier-Jolain, N., Bretagnolle, V., Bockstaller, C., Gaba, S., Cordeau, S., Lechenet, M., Meziere, D., Colbach, N. (2015), Ecological Intensification Through Pesticide Reduction: Weed Control, Weed Biodiversity and Sustainability in Arable Farming, in: Environmental Management, p. 1078-1090.

Schmölders, G., Hansmeyer, K.-H. (1980), Allgemeine Steuerlehre, 3. Aufl., Berlin, Duncker & Humblot, 312 p.

Schäfer, R. B., Liess, M., Altenburger, R., Filser, J., Hollert, H., Roß-Nickoll, M., Schäffer, A., Scheringer, M. (2019), Future pesticide risk assessment: narrowing the gap between intention and reality, in: Environmental Sciences Europe, p. 5.

Schäfer, R. B., von der Ohe, P. C., Kühne, R., Schüürmann, G., Liess, M. (2011), Occurrence and Toxicity of 331 Organic Pollutants in Large Rivers of North Germany over a Decade (1994 to 2004), in: Environmental Science & Technology, p. 6167-6174.

Schäffer, A., Filser, J., Frische, T., Gessner, M., Köck, W., Kratz, W., Liess, M., Nuppenau, E.-A., Roß-Nickoll, M., Schäfer, R., Scheringer, M. (2018), Der stumme Frühling – Zur Notwendigkeit eines umweltverträglichen Pflanzenschutzes, Diskussion Band Nr. 16, Halle (Saale), Leopoldina, 65 p.

Schröder, M. (1993), Zusammenwirken von Gemeinschaftsrecht und nationalem Recht auf dem Gebiet der Umweltabgaben, in: Paul Kirchhof (Hrsg.), Umweltschutz im Abgaben- und Steuerrecht, Deutsche Steuerjuristische Gesellschaft Band 15, Köln, Verlag Dr. Otto Schmidt, p. 87-102.

Schulz, R., Bub, S., Petschick, L. L., Stehle, S., Wolfram, J. (2021), Applied pesticide toxicity shifts toward plants and invertebrates, even in GM crops, in: Science, 10.1126/science.abe1148: https://doi.org/10.1126/science.abe1148, p. 81-84.

Silva, V., Mol, H. G. J., Zomer, P., Tienstra, M., Ritsema, C. J., Geissen, V. (2019), Pesticide residues in European agricultural soils – A hidden reality unfolded, in: Science of The Total Environment, 10.1016/j.scitotenv.2018.10.441: https://doi.org/10.1016/j.scitotenv.2018.10.441, p. 1532-1545.

Skevas, T. A./Stefanou, S. E./Lansink, A. O. (2009): Economic Sustainability, Biodiversity Loss and Socially Optimal Pesticide Use, Literature Review, Wageningen University.

SRU - Sachverständigenrat für Umweltfragen (2016), Umweltgutachten 2016 - Impulse für eine integrative Umweltpolitik, Berlin, 472 p.

SRU/WBBGR - Sachverständigenrat für Umweltfragen / Wissenschaftlicher Beirat für Biodiversität und Genetische Ressourcen (2018), Für einen flächenwirksamen Insektenschutz, https://www.umweltrat.de/SharedDocs/Downloads/DE/04_Stellungnahmen/2016_2020/2018_10_AS_Insektenschutz.pdf?__blob=publicationFile&v=17, 54 p.

Steffen, K., Becker, T., Herr, W., Leuschner, C. (2013), Diversity loss in the macrophyte vegetation of northwest German streams and rivers between the 1950s and 2010, in: Hydrobiologia, p. 1-17.

Storck, V., Karpouzas, D. G., Martin-Laurent, F. (2017), Towards a better pesticide policy for the European Union, in: Science of The Total Environment, p. 1027-1033.

Streinz, R. (2018), EUV/AEUV – EUV/AEUV - Vertrag über die Europäische Union, Vertrag über die Arbeitsweise der Europäischen Union, Charta der Grundrechte der Europäischen Union, 3. Aufl., München, C. H. Beck, 2873, 2873 p.

UBA - Umweltbundesamt (2016), 5-point programme for sustainable plant protection, Dessau, Position, https://www.umweltbundesamt.de/sites/default/files/medien/1968/publikationen/161024_uba_position_pflanzenschutz_barrierefrei.pdf, 36 p.

Uhl, P., Brühl, C. A. (2019), The Impact of Pesticides on Flower-Visiting Insects: A Review with Regard to European Risk Assessment, in: Environmental Toxicology and Chemistry, 10.1002/etc.4572: https://doi.org/10.1002/etc.4572, p. 2355-2370.

Van Bruggen, A. H. C., Goss, E. M., Havelaar, A., van Diepeningen, A. D., Finckh, M. R., Morris, J. G. (2019), One Health - Cycling of diverse microbial communities as a connecting force for soil, plant, animal, human and ecosystem health, in: Sci. Total Environ, p. 927-937.

Verschuur, G. W., van Well, E. A. P. (2001), Stimulating organic farming in the EU - With economic and fiscal instruments, Utrecht, https://www.griequity.com/resources/industryandissues/PrimarySector/study-organic-farming-503.pdf, clm Centre for Agriculture and Environment, 58 p.

Wasmeier, M. (1995), Umweltabgaben und Europarecht : Schranken des staatlichen Handlungsspielraumes bei der Erhebung öffentlicher Abgaben im Interesse des Umweltschutzes, München, C.H. Beck, 360 p.

Weisner, O., Frische, T., Liebmann, L., Reemtsma, T., Roß-Nickoll, M., Schäfer, R. B., Schäffer, A., Scholz-Starke, B., Vormeier, P., Knillmann, S., Liess, M. (2021), Risk from pesticide mixtures – The gap between risk assessment and reality, in: Science of The Total Environment, 10.1016/j.scitotenv.2021.149017: https://doi.org/10.1016/j.scitotenv.2021.149017, p. 149017.

Wintermantel, D., Odoux, J.-F., Decourtye, A., Henry, M., Allier, F., Bretagnolle, V. (2020), Neonicotinoid-induced mortality risk for bees foraging on oilseed rape nectar persists despite EU moratorium, in: Science of the Total Environment, p. 135400.

Appendix: Data Sources

The EU approval status and other information can be found in the EU Commission's Pesticides Database[231]. This Database has been available for over 10 years and is downloaded and integrated by Lars Neumeister several times a year.

‘Mode of actions’ often result from the class of chemical substances used and can also be looked up in internet databases (e.g., of the FRAC, IRAC, HRAC). Lars Neumeister has linked all relevant data to the evaluation database (see below).

A1. Germany

A1.1 Data on the Domestic Sale by the Federal Office of Consumer Protection and Food Safety (BVL)

Since a ruling of the Braunschweig administrative court in February 2019[232], sales data specific to the sales of active substances in Germany are no longer considered a trade secret under law. As a result, this data is available for the period of 2005 to 2019.

A1.2 Application Data by the Julius Kühn Institute (JKI)

The Julius Kühn Institute (JKI) has been collecting crop-specific data on the nationwide use of pesticides since 2000. In the past, surveys were not conducted annually. The arable crops that are significant in terms of area (e.g., cereals, rapeseed) were, for example, only recorded in 2000 and then again in 2011. Since 2011, however, there have been annual surveys of the most important arable crops, winter wheat, winter barley, winter rye, maize, potatoes, and sugar beet as well as the three permanent crops, dessert apples, hops and grapes. Complete data is available from the 2011 to 2018 surveys.

The crops surveyed represent about 80 percent of German arable land and about 70 percent of national pesticide use. The number of test farms ranges from 80 (hops) to 400 (sugar beet) farms. The results are considered representative and serve as reference in the National Action Plan for Plant Protection (NAP).

The JKI publishes the following results for each crop surveyed and for the relevant application types (herbicides, fungicides, insecticides and so on):

- treatment frequency,
- treatment index,
- ranking of active substances,
- quantity applied (estimated value in kg) per active substance (available for 2011 to 2018) and
- area treated (estimated value in ha) per active substance (available for 2011 to 2018).

The treatment index, the quantities of active substances used, and the area treated per active substance are the most important data for evaluating pesticide use. The treatment index describes the intensity of pesticide use.

[231] https://ec.europa.eu/food/plant/pesticides/eu-pesticides-database.

[232] Neumeister vs the Federal Office of Consumer Protection and Food Safety.

With data on the quantities of active substances used and areas treated, assessments can be made in conjunction with active substance properties (toxicity, environmental behaviour) about the respective risk potential.

A1.2.1 Usage Quantity

The Federal Office of Consumer Protection and Food Safety (BVL) provides paid access to a complete database of current authorisations as an MS Access database. Among other pieces of information, the author (Neumeister L) possesses the BVL database in various versions (March 2005, December 2010, December 2015, July, and August 2020). The BVL database contains inter alia the usage quantities for every active substance and the indication for each regular authorisation. For each product, the active substances are listed. For so-called emergency authorisations under Art. 53 of Regulation 1107/2009/EC, the BVL publishes specific guidelines containing usage quantities and active substance levels.

A1.2.2 Acreage

The Federal Statistical Office publishes reports on growth and harvest for the various agricultural crops both for Germany as a whole and for individual federal states at www.destatis.de. Annually published are data on the cultivation of field crops, grassland, tree fruit and grapes (vineyards). Detailed data on organically farmed areas are published by Eurostat and the Federal Statistical Office.

A2 Denmark

A2.1 Data on the Domestic Sale and Usage of Pesticides

The Danish Environmental Protection Agency publishes very detailed annual reports on the sale and use of pesticides and biocides. These reports contain, among other things, data on the

- treatment frequency (national and per main crop),
- pesticide burden indices (PBI) (national and per main crop),
- sold quantities per active substance and
- usage quantity per hectare for the main crops.

Sales to private households and for seed treatment are listed separately.

A2.2 Data on the Pesticide Tax

On its webpage, the Danish Environmental Protection Agency provides reference values for environmental exposure (half-lives, etc.) and environmental effects (endpoints).

Upon request, the authors were sent an Excel file with over 3,000 formulas (plant protection products) previously and currently authorised in Denmark. This file lists, among other things, the tax burden for the respective product, its composition (active substances and their concentration) and the timeframe of authorisation (start, end).

A3 Prices for Plant Protection Products

In *Germany*, none of the major distributors (e.g., Baywa, Raiffeisen, Beiselen) publishes price lists for crop protection products. As a rule, the trader must be contacted to get a specific offer. Requests for current price lists were not answered by Baywa, Beiselen and AGRO Holdorf.

From three larger online traders

https://www.myagrar.de/Pflanzenschutzmittel/Kulturen;

https://www.ag.supply/Pflanzenschutzmittel

https://avagrar.de/pflanzenschutzmittel/

and the Landhandel Schweiger, prices (2020) were imported into a database in autumn 2020 and compared with the BVL database in order to determine the authorisation number[233].

In *Denmark*, 'middledatabasen' exist which merge a great deal of data on plant protection products authorised in Denmark. Since 2010, prices of the most common plant protection products have been collected and published annually. The price data is based on the invoices received from agricultural enterprises for purchases of plant protection products, of which a seasonal price is averaged.

For the 2010/11 to the 2018/19 growing season, prices for 321 plant protection products are available. Since availability and preferences have changed as a result of authorisation practice and the pesticide tax, complete time series are not available for all products.

233 In the case of online traders, the authorisation number usually also appears in the product description.