Broader impact of criteria for endocrine disrupting properties for crop protection products in Europe

TOP-LEVEL EU28 RESULTS AND COUNTRY CHAPTERS

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steward redqueen

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About The Authors

Company profile

Steward Redqueen is a strategy consultancy firm that aims to make business work for society. It is represented in Amsterdam, Barcelona and New York and executes projects around the world. Specialists since 2000, Steward Redqueen's team focuses on integrating sustainability, quantifying impact and facilitating change. Clients appreciate our rigorous analysis, ability to solve complex problems, and being ahead of the curve. We work for (multinational) corporations, (development) financials and public sector organisations.

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Pesticides have been a source of controversy for many decades. Supporters point to the benefits of controlling risks of pests, increasing the yield per hectare, contributing to stable supply of basic foods and at the same time supporting agricultural incomes. Detractors assert environmental implications and are concerned about human health. Our socio-economic impact assessments go beyond assertions in an effort to quantify the direct and indirect impacts of pesticide use, adding a quantitative dimension to the discussions.

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Track record SEIA

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EXECUTIVE SUMMARY

As a result of the EU moving towards hazard-based legislations, several substances for plant protection used in the EU are at risk of being withdrawn. This study aims to shed light on the current value of these substances for the viability of European agriculture.

While a broader group of substances is potentially affected, this study focusses on 16 active substances which may be captured by the EU criteria for endocrine disruptors (ED). This scope results from the overlap between the EU Commission's Impact Assessment that identified 26 substances likely to be effected by the draft ED criteria and the substances studied by the previous Steward Redqueen Cumulative Impact Assessment.

A total of 400 substances with varying effectivity are currently available on the EU market. However, some of the 16 substances are amongst the most efficient substances in the farmer's toolbox. As part of Integrated Pest Management (IPM), diversity of available substances is crucial in facing immediate pest pressure and in preventing long-term resistance effects. Looking ahead, withdrawn substances are not likely to be easily replaced. There are two reasons for this: Firstly, it takes approximately 11 years, and 280$ million to bring a substance from development to market. Secondly, the pipeline of products waiting for approval on the European market is also diminishing due to rising Research and Development (R&D) time and costs (i.e. 70 substances in the pipeline in the 2000, down to 28 in 2012).

Against this background, this study aims to shed light on the current value of the 16 substances for European agriculture. It focuses on seven staple crops at the EU level and selected crops across five EU member states, representing 42% of crop value produced in the EU28 and 47% of harvest volume of these crops. The various crops are studied individually; possible effects of pesticide use in specific crop rotations (or any significant change in the rotations) have not been taken into consideration. The analysis is based on a five year average of productivity and costs (2009-2013) in order to average out yearly variations:

- The team largely builds on Steward Redqueen's previous assessment of the cumulative impact assessment (CIA) of hazard-based legislation on crop protection products in Europe[1]. That assessment, also known as "Low Yield' published by the ECPA, investigates the current added value of 75 substances as identified by the Andersons Centre[2] for various staple crops across the nine largest agricultural markets in Europe;
- Another important pillar for this study is the EU Commissions' report published in June 2016[3] that identified 26 substances likely to be effected by the draft ED criteria. 16 of these 26 substances overlap with the CIA's list of the 75 substances;
- We studied various staple crops across five of the largest EU agricultural markets (together representing 47% of the total crop value of the staple crops generated in the EU) and extrapolated these effects to the EU level;
- The selection of crops included in the scope of the study is based on relevance of various crops at country level and extrapolated based on their relative share to show of the total European output;
- We use the best available national and EU databases on crop production and cost structures (e.g. EUROSTAT, FAOSTAT, FADN, WUR, Teagasc, DEFRA).

The study's focus is the immediate effects on yields.

[1] "Cumulative impact of hazard-based legislation on crop protection products in Europe"; 2016; Steward Redqueen

[2] "The Effect of the Loss of Plant Protection Products on UK Agriculture and Horticulture and the Wider Economy", The Andersons Centre supported by AIC, NFU, CPA; 2014. The Andersons Centre also draws on insights from the ADAS report on 'The Impact of Changing Pesticides Availability on Horticulture' from 2010. This study's methodology and substance list are in line with these previous analyses.

[3] "Defining criteria for identifying endocrine disruptors in the context of the implementation of the plant protection products regulation and biocidal products regulation"; June 2016; The European Commission

Against this background, the assessment leads to the following quantitative insights:

- Use of the 16 substances in the cultivation of seven key staple crops in the EU (potatoes, barley, wheat, sugar beet, rapeseed, maize and grapes) contributes to between 34 and 69 million tons or between €4.1 and €8.3bn of crop value:
- Wheat, barley, maize could face 1-7% lower yield if the 16 substances were no longer available;
- Yield for rapeseed, potatoes, sugar beets and grapes might decrease by between 5% to 31% if the 16 substances were no longer available;
- If these substance were no longer available, the EU's trade balance could be negatively affected: the volumes imported into the EU could quadruple: from currently 7 Mt of maize, OSR and sugar beet to some 28 Mt
- At the current speed of technological progress, it would take 5-8 years[4] to make up for this loss;
- Higher short-term yields for these crops support farmer income of between €4.1 and €8.3bn;
- With the 16 substances, overall farm profitability is up to 20% higher (€8.3bn of a total of €44bn);
- In value, grapes and wheat benefit the most with between €0.8 and €1.9bn revenues from using the 16 substances, while oilseed rape and sugar beet have the largest profitability surplus (between 10 and 100%);

- The 16 substances support rural employment:
  - In the five countries a total of 2.7 million people are directly engaged in crop agriculture. Out of them, 0.8m jobs are contingent upon the seven staple and four specialty crops covered in this study. Based on the farm-revenue changes, the immediate job security risk seems limited.
- At current crop demand, the EU-substances support the EU's self-sufficiency for wheat, barley, potatoes and grapes, while limiting the import levels of rapeseed, sugar beet and maize:
  - In contrast to the current situation with a positive trade balance, without the 16 substances, the exported volume for wheat could halve. Overall, the EU's imported crop volume is likely to quadruple from 7Mt to 28Mt, from 1.6% to up to 6.2% of its staple crop demand[5];
  - Meeting the demand for staples crops with imported crops entails the risk of selling crops on the European market produced with non-EU standards;
  - Meeting the demand for specialty crops seems even more challenging as sufficient import amounts are not always readily available;

[4] Assuming 2-3 substances coming to the EU market per year as stated by the Austrian Industriegruppe Pflanzenschutz to be the case for Austria

[5] Total annual EU28 demand for staple crops is 460 million ton in the period 2009-2013 (Eurostat)

1 INTRODUCTION

Building on our previous assessment of the socio-economic effects of current hazard-based legislation for Crop Protection Products (CPPs) at EU farms and the wider economy, ECPA along with their respective national organisations commissioned Steward Redqueen to assess the specific effects related to the EU's criteria for endocrine disruptors (EDs).

The objective of this study is to determine the economic effects of the hazard-based regulation for crop protection products containing substances which may be considered to have 'endocrine disrupting properties' for the European agriculture. Concretely, this study focusses on 16 active substances which may be captured by the EU criteria for endocrine disruptors (ED). This scope results from the overlap between the EU Commission's Impact Assessment that identified 26 substances likely to be effected by the draft ED criteria and the substances studied by the previous Steward Redqueen Cumulative Impact Assessment.

European farmer organizations, agri-cooperatives, technical institutes as well as ECPA's national associations have contributed in acquiring the best available data on farm level changes:

- The study covers the effects on crop production levels, farmer incomes, farm profitability and crop agriculture employment;
- These insights should complement other socio-economic work and research undertaken on local environmental and health effects of CPPs to obtain a complete picture of the potential societal effects.

The study provides insights that can add to the current debate on how to define scientific criteria for regulating substances believed to have these properties.

1.1 Endocrine Disruptors and EU Legislation

According to the WHO/IPCS (2002) 'an endocrine disruptor is an exogenous substance or mixture that alters function(s) of the endocrine system and consequently causes adverse health effects in an intact organism, or its progeny, or (sub)populations'. And 'a potential endocrine disruptor is an exogenous substance or mixture that possesses properties that might be expected to lead to endocrine disruption in an intact organism, or its progeny, or (sub)populations'[6]. Concerns regarding exposure to these endocrine disrupting chemicals are due primarily to:

- The reported increased incidence of certain endocrine-related human diseases;
- Adverse effects observed in certain wildlife species;
- Endocrine disruption observed in laboratory experimental animals exposed to certain environmental chemicals.

Following the harmonisation of the EU market, the pesticide approvals legislation European Union Plant Protection Products (PPP) Regulation (1107/2009) has been implemented. The purpose of this Regulation is to ensure a high level of protection for both human and animal health, and the environment. Therefore, only active substances considered to be safe are approved. According to the 'cut-off criteria', active substances will not be approved in cases where they bear the following characteristics (i) are mutagenic, (ii) are carcinogenic or present reproductive toxicity, (iii) are considered to have endocrine disrupting properties, (iv) are persistent organic pollutants, (v) are persistently bio-accumulative and toxic and (vi) are very persistent/very bio-accumulative. The EU's ED-criteria are likely to affect natural or synthetic substances that have a potentially harmful effect on human or non-target populations by altering the functioning of the hormone system, causing irreversible change or illness[7]. The regulation states that any active substance with endocrine disrupting properties that may cause adverse effects in humans or non-target populations cannot be approved for marketing and use unless the exposure of humans or non-target

[6] 'Global assessment of the state-of-the-science of endocrine disruptors; WHO/IPCS (2002)

[7] Extended impact assessment study of the human health and environmental criteria for endocrine disrupting substances proposed by HSE, CRD; January 2013

populations under realistic proposed conditions of use is negligible. The European Commission was required to develop by December 2013 a set of scientific criteria to define 'endocrine disrupting properties'.

Several studies have published substance lists that might fall under the criteria. The main ones include the 'Extended impact assessment study of the human health and environmental criteria for endocrine disrupting substances', HSE and CRD; 2012) and the 'Agronomic and economic impact assessment for possible human health and ecotoxicology criteria for endocrine disrupting substances' by the Food and Environment Research Agency (FERA; June 2013). However, the Commission has not yet adopted a definition of endocrine disruptors (see below for the definition used in this study).

1.2 Scope

This study aims to shed light on the current value of 16 substances used in pesticides that might fall under the EU criteria for endocrine disrupting properties for European agriculture. This analysis is performed by investigating the implications of a withdrawal of these substances. Table 1 provides an overview of substances considered.

Table 1: Active substances considered

Substance	Type	Substance	Type
Cyproconazole	Fungicides	Tebuconazole	Fungicides
Epoxiconazole	Fungicides	Tepraloxydim	Herbicides
Ipodrione	Fungicides	Tetraconazole	Fungicides
Lenacil	Herbicides	Thiophanate-methyl	Fungicides
Mancozeb	Fungicides	Thiram	Fungicides
Maneb	Fungicides	Triflusulfron	Herbicides
Metiram	Fungicides	Tralkoxydim	Herbicides
Myclobutanil	Fungicides	Pendimethalin (PBT)	Herbicides

This list of the above mentioned substances is based on the Commission's impact assessment published in June 2016, whereby almost all EU registered active substances where screened against the proposed policy options for the criteria for endocrine disrupting properties. Most of these policy options are based on the WHO/IPCS (2002) definition of an endocrine disruptor. Please note that the results for Poland are based on an alternative list as the ED analysis was finalized in February 2016, a few months before the latest EC publication. The substances included in Poland are: 22 fungicides[8] and 14 herbicides[9]. For the UK[10] the results for wheat, potatoes and OSR are based on 10 fungicides[11], three herbicides[12] and four insecticides[13].

[8] Mandipropamid, Fluazinam, Prochloraz, Prothioconazole, Metconazole, Thiophanate, Bupirimate, Myclobutanil, Difenoconazole, Mancozeb, Thiram, Triadimenol, Folpet, Metiram, Propiconazole, Tetraconazole, Tebuconazole, Fluquinconazole, Fenbuconazole, Epoxiconazole, Cyproconazole, Hymexazol
[9] Glufosinate, Fluazifop-P-Butyl, Picloram, Dimethenamid P, Lenacil, Tepraloxydim, Triflusulfuron, Ethofumesate, S-Metolachlor, Linuron, Metribuzin, Terbuthylazine, Tralkoxydim, Pinoxaden
[10] ADHB: Endocrine disruptors – collation impacts across all sectors to give clear messages on impacts of changing availability on farmers and production, 2014
[11] Mancozeb, Iprodione, Myclobutanil, Prochloraz, Tebuconazole, Cyproconazole, Epoxiconazole, Fenbuconazole, Maneb, Metconazole
[12] Ioxynil, Linuron, Amitrole
[13] Abamectin, Thiacloprid, Cypermethrin and Fenoxycarb

Table 2: Geographical scope & crops

Member State	Crop 1	Crop 2	Crop 3	Crop 4	Crop 5	Crop 6	Crop 7
France	Wheat	Barley	Potatoes	Maize	Sugar beet	-	-
UK	Wheat	Potatoes	Peas	OSR	-	-	-
Germany	Wheat	Barley	Potatoes	Sugar beet	OSR	-	-
Poland	Wheat	Maize	OSR	Sugar beet	Potatoes	Apples	Blackcurrants
Italy	Maize	Tomatoes	Vines	-	-	-	-

In terms of crops considered, the study focuses on seven staple crops across five EU member states. The implications on national levels are extrapolated to EU28 totals. Altogether, the study covers 47% of the total EU crop value and 53% of the harvested EU volume of the crops considered.

1.3 Methodology & Data

1.3.1 Methodology

To quantify agronomic and economic implications, the study works with the following general assumptions:

- Withdrawal effects of the 16 active substances are compared to their best currently available alternative solutions in the farmers' toolbox and the Good Agricultural Practices (including chemical, biological, mechanical and cultural practices);
- All substances are withdrawn from the market at the same time and no alternatives will be introduced over the next five years. Given lengthy R&D and approval processes this might not be an unrealistic scenario;
- The various crops are studied in isolation; crop rotation (or any significant change in the rotations) or other changes in the production area have not been taken into consideration;
- The analysis is based on a five year average of productivity and costs (2009-2013) thereby averaging yearly variations in weather conditions and related pest pressure. Furthermore, we look at the average effects for all farmers per crop in each country to obtain a conservative insight at the national and EU levels. However, we recognize volatility in yields and prices are important aspects of agriculture, and the results might therefore be rather conservative;
- Yield and variable costs per hectare are subject to change ceteris paribus, i.e. the utilised area and farm-gate prices are presumed fixed.

Bearing these assumptions in mind, the subsequent approach consists of several steps including (1) the analysis of main threats for the cultivation of various crops, (2) the currently used and possibly remaining alternative substances, and (3) the extent to which substances are applied. Ultimately, these three steps lead to an estimation of the related yield, and where possible cost-effects.

The first step is to investigate which weeds, pests and diseases are the main threats to the cultivation of a particular crop. Consequently, the study establishes which substances farmers currently apply to fight these threats. An analysis of the alternatives which remain available after withdrawing the 16 substances leads to the new farming toolbox. It includes Good Agricultural Practices, comprising of chemical, biological, and mechanical approaches as well as cultural practices. The resulting estimations are based on expert's judgement as well as field tests. In the third step, the study corrects for the share of the total arable hectare to which an active substance is currently applied. This depends on the share of organic production and areas where pest pressures are low.

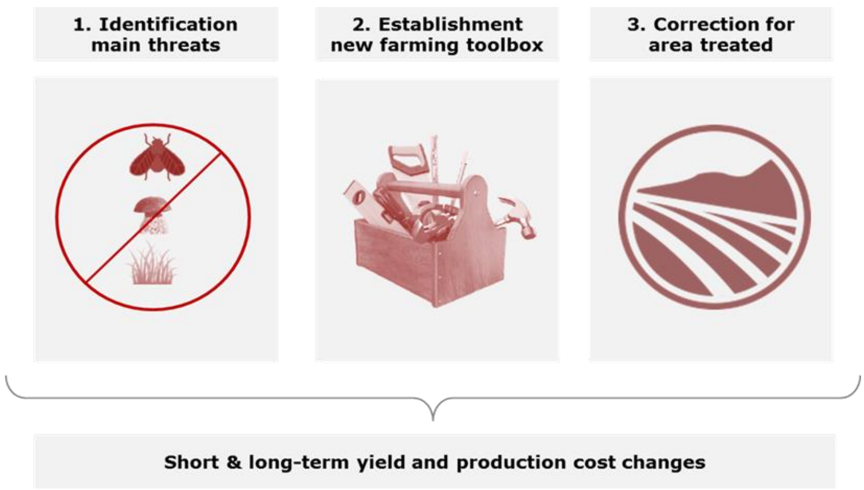

Exhibit 1: Overview of approach

The effects resulting from this analysis are presented in a range and comprise of the cumulative implications of fungicides, herbicides and insecticides together: the estimations take into account that pesticides applied to crops already infected by one pest add less value than ones applied to 'healthy' crops. The reason for expressing results in a range is to control for year-to-year changes given different degrees of pest pressure.

The research further distinguishes the short-run substitution and long-run resistance effects of not having the 16 substances available. The former refers to the immediate effects of shifting to treatments considered to be the best alternative. Long-term resistance effects might occur over time once weeds, diseases and pests have built up a certain degree of resistance against their fewer alternative substances. This is a particular issue for specialty crops, due to the often limited remaining alternatives, with expected future resistance therefore being an important factor. Agronomists fear that the risk of resistance could spark a chain reaction: reduced availability of control solutions implies more resistance risk, which implies less efficiency of remaining alternatives. A lack of strong pest control measures could therefore result in losses greater than predicted.

Next to yields, the availability of substances also influences the variable costs of production. Variances in efficiency of the remaining substances might lead to farmers changing the treatment frequency and applying pesticides that are more or less expensive. Consequently, farm input costs may vary. Where data availability allows, the study presents expected production costs changes.

In addition, for some crops the quality of the output might be affected, meaning the crop output can no longer be sold as premium quality. However, as the farm-gate price is assumed to be fixed (see above) this is not explicitly taken into account but stated if information on it is available.

To summarize, while recognizing other possible effects, the study focuses on and differentiates between:

- Short-term substitution effect on yields; and
- Farm-level implication of these (harvested volume, farm-revenues, crop agriculture employment).

1.3.2 Data

The study uses data provided by technical institutes and representatives of farmers' organisations of the various countries (the table below depicts all parties involved).

Table 3: Overview of contributing parties

France	Germany	UK	Italy	Poland
UIPP	IVA	CPA	Agrofarma	PSOR
FNSEA	DBV	NFU	Coldiretti	Kleffmann Group
Arvalis Institute	LK NRW	AHDB	Confi-agricoltura	Research Institute of Horticulture (IO)
Institut Technique de la Betterave	Bavarian State Research Center for Agriculture	PGRO		Institute of Plant Protection (IOR)
	University of Göttingen			Poznań University of Life Sciences
				National farmer Associations and unions[14]

The execution of this study included intensive contact with the various parties mentioned above. These experts followed the steps outlined in Exhibit 1 and also provided information regarding the yield, the farm-gate price and area affected in the current situation. The experts were already familiar with the methodology as they collaborated in our cumulative impact assessment of overall hazard based legislation as well.

After having provided this background on the methodology, the report describes the farm-level income, harvest volume and employment effects at the EU level. The study also elaborates on the value of the 16 substances with regard to the EU's self-sufficiency for the crops considered.

[14] Farmer associations and unions involved in Poland: National Council of Agricultural Chambers, Federation of Agricultural Producers Unions (FBZPR), Polish Fruit Growers Association, National Association of Blackcurrant Growers, National Association of Rapeseed and Protein Crops Producers, National Association of Sugar Beet Growers, Polish Association of Potato and Agricultural Seed Growers, Polish Association of Cereal Growers, and Polish Association of Maize Producers

2 EU RESULTS

This section analyses the effects of the withdrawal of the 16 substances for the staple crops covered in the study on an EU level.

EU-level results are based on a weighted average of the national estimation of implications of a withdrawal. Exhibit 2 below depicts the countries per crops that have been taken into account. The country selection is based on the main producing member states for the various crops so that the basis for the extrapolation is as accurate as possible.

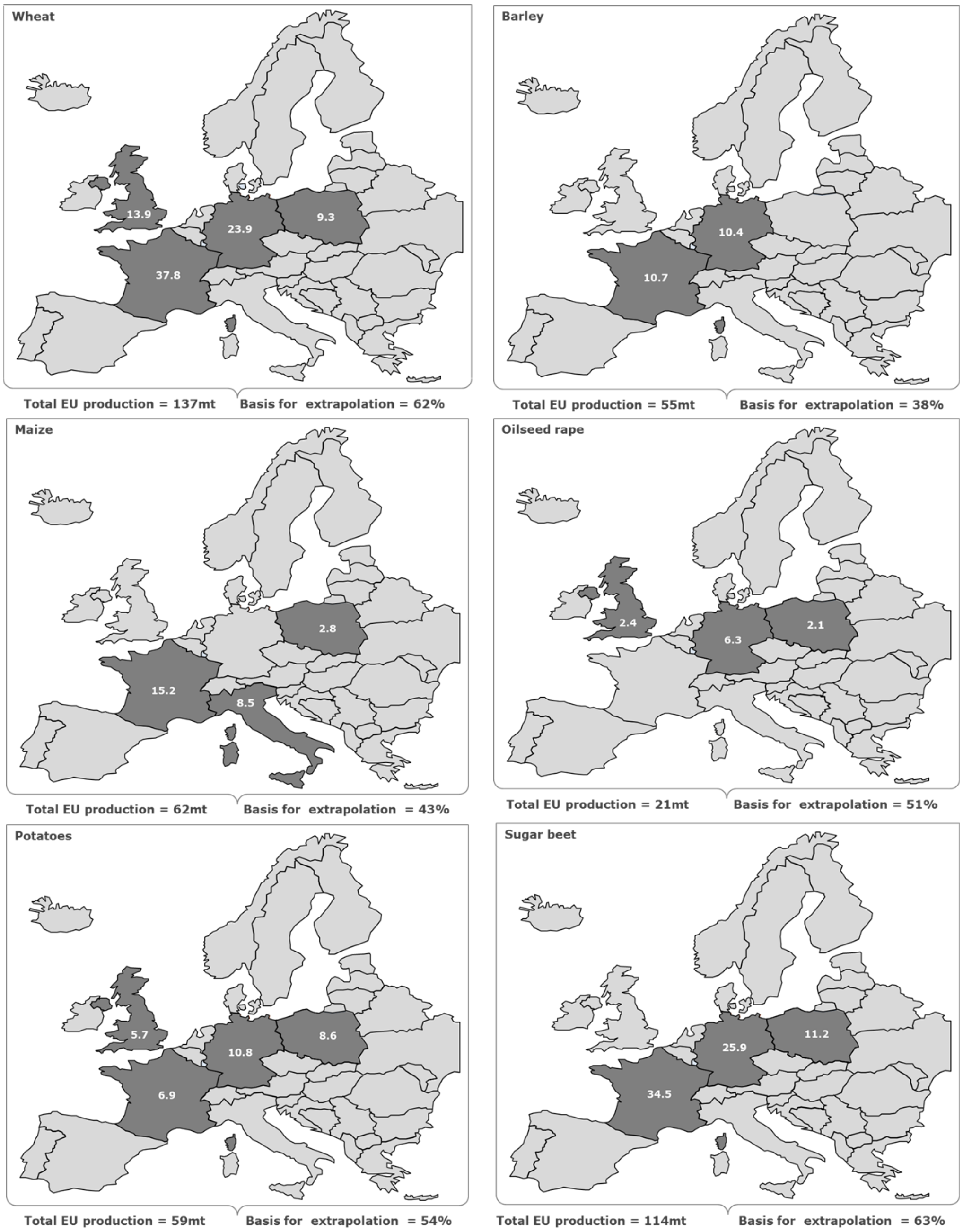

Exhibit 2: EU crop production basis for extrapolation (in million ton)

The farm-level data for wheat, barley, maize, oilseed rape (OSR hereafter), potatoes and sugar beets cover between 40% and 60% of the total EU production for the particular crop. For grapes (not depicted in Exhibit 2) the percentage is somewhat lower: 28% and based on information from Italy. The higher the percentage of output covered on a country-by-country level, the more likely the extrapolation will be representative for the EU as a whole.

Applying the weighted average effects to the current situation, the assessment estimates the implications related to a possible withdrawal of the 16 substances. Table 4 below summarizes the total crop production as well as how much land is cultivated in EU28 for an average year[15]. This official information forms the baseline for our comparison.

Table 4: Overview crop agriculture in EU28

Crop	Area (million ha)	Yield (t/ha)	Output (million tons =Mt)	Price (€/ton)
Wheat	25,8	5,3	136,7	171
Barley	12,6	4,4	55,4	152
Maize	9,0	6,8	61,5	175
Oilseed rape	6,4	3,3	21,3	333
Potato	1,9	31,7	58,8	170
Sugar beet	1,6	70,4	114,0	31
Grapes	3,2	7,1	23,1	714

2.1 Short-term yield, output and income effects

Exhibit 3 below provides an overview of the immediate variations in tons harvested per hectare. The potential short-term yield effects in this table are depicted in ranges as received from the experts (see also Section 2). For sugar beet the range (17-31%) is the largest. The range for grapes is based on information from one member state (Italy).

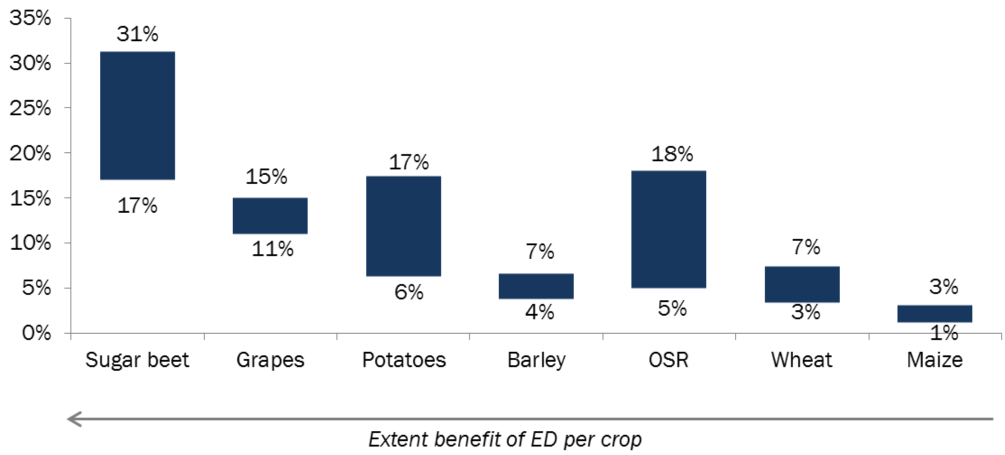

Exhibit 3: EU-level short-term yield change (range %/ha)

Similar to the results found in the overall cumulative impact assessment, the extent of the expected yield change varies for the crops considered. The 16 substances seem to be most beneficial for the cultivation of sugar beet (up to 31 % additional yield) and grapes (between 5 and 15% additional yield).

[15] Based on EUROSTAT farm statistics 2009-2013

For cereals, the effects are mainly driven by withdrawal of the affected azoles (cyproconazole, epoxiconazoleas, tebuconazole, tetraconazole) as well as pendimethalin. For wheat, the loss of the herbicides amongst the 16 substances alone will have a significant impact as alternatives are limited. Whereas with mancozeb, for which alternatives are available, the direct immediate losses will be limited, but critically negative consequences are likely to develop over time as it is an important part of the resistance management strategy for this crop. For potatoes mancozeb and maneb are of particular value. For sugar beet azoles, as well as treatment with thiram, have large effects on the yields achieved.

In the longer term, given the occurrence of resistance effects, yield effects are likely to be significantly larger. For maize cultivation in Italy, for example, the additional long-term yield loss is estimated to be some 10%.

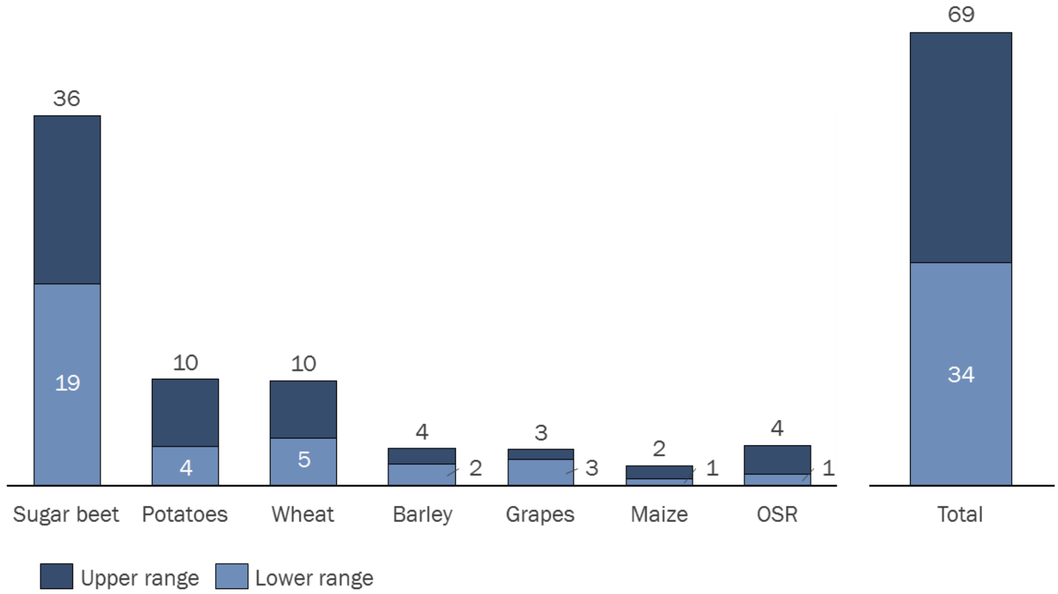

Exhibit 4: Output changes (in million tons per year)

In total, EU crop output is currently between 34 and 69 million tons (=Mt) more than would be possible without the use of the 16 substances. In other words, having these active substances in the farming toolbox equates to between 32 and 63 million additional tons of crop output, 19 to 36 million tons of which are sugar beets. These results are driven by the yield change (see Exhibit 3) as well as the area on which they are typically cultivated (see Table 4: Overview crop agriculture in EU28).

Output changes differently affect farm revenues and the economic viability of cultivating the crops. The exhibit below focuses on the range of possibly foregone farm revenues[16]. The economic viability of sugar beet cultivation is the most affected (54 to 99%) gross margin change and in absolute terms grape and wheat cultivation experiences the largest losses. For grapes this is mainly driven by a possible high yield effect, whereas for wheat the size of the cultivated area is a major factor.

[16] Input from Italy/maize, France/cereals and France/potatoes has already been verified with local experts

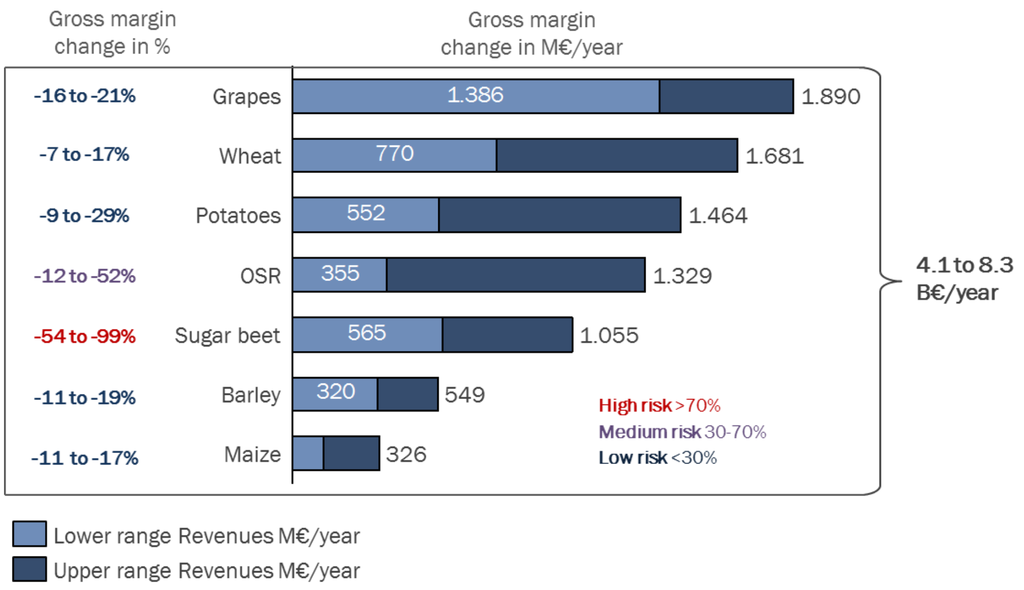

Exhibit 5: EU-wide changes in farm revenues and gross margins

While not shown in Exhibit 5, evidence from Italy for maize indicates that withdrawal of the 16 substances would lead to an additional production cost of €90 per hectare, with yield losses as well as a reduction in the harvest's quality. This lower quality maize would cause farmers to lose between €10 to €50/ton. Given a market price of maize of €175/ton, that would be an additional reduction of between 5-30% of farm revenues.

2.2 Farm-employment effects

According to official statistics for the five countries selected, 2.7 million jobs rely on crop agriculture. Allocating these 2.7 million jobs to the various crops based on the value of the crops reveals that 0.8m jobs are contingent upon the seven staple and four specialty crops[17] in the scope of this study (see Exhibit 6). As Exhibit 5 shows, the 16 substances influence the economic viability of the cultivation of certain crops to different extents. This also translates into various degrees of job security for employment related to these crops. We observe some deterioration in the financial sustainability of farm businesses without these substances, but in the short-term this does not seem to translate into employment loss for these crops as gross margin losses are mostly below 20%. However, the results represent the averages for each agricultural crop sector. Individual farm businesses might be pushed beyond their limits and put some jobs at a substantial risk.

[17] Tomatoes, olives, citrus fruits, peas

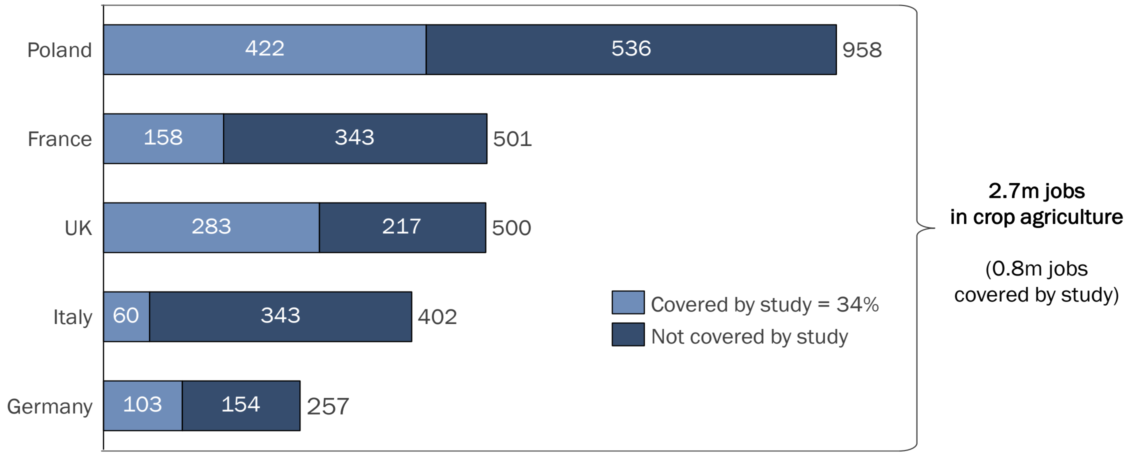

Exhibit 6: Total employment in crop agriculture

2.3 Self-sufficiency and trade effects

Given these farm-level changes, the changes to yields and costs described above also affect the competitiveness of EU agriculture and thus EU's self-sufficiency and trade balance of agricultural commodities.

The EU is currently a net exporter of wheat, barley and potatoes. On average, ca. 13.5 Mt of wheat, 3.4 Mt of barley and 0.7 Mt of potatoes are exported to countries outside of the EU. Withdrawal of the 16 substances would lead to a situation in which the trade balance worsens and for some crops becomes negative. For wheat for example the estimated yield reduction of between 3 and 7% would cause the exported volume to halve. For barley, potatoes and grapes the EU would move from net exporter to net importer to fulfil its demand.

To conclude, with the 16 substances on the market the EU is less dependent on imports. It is important to keep in mind that, while for cereals imports are readily available, importing potatoes depends on world market availability and transportation which is not straightforward for this crop.

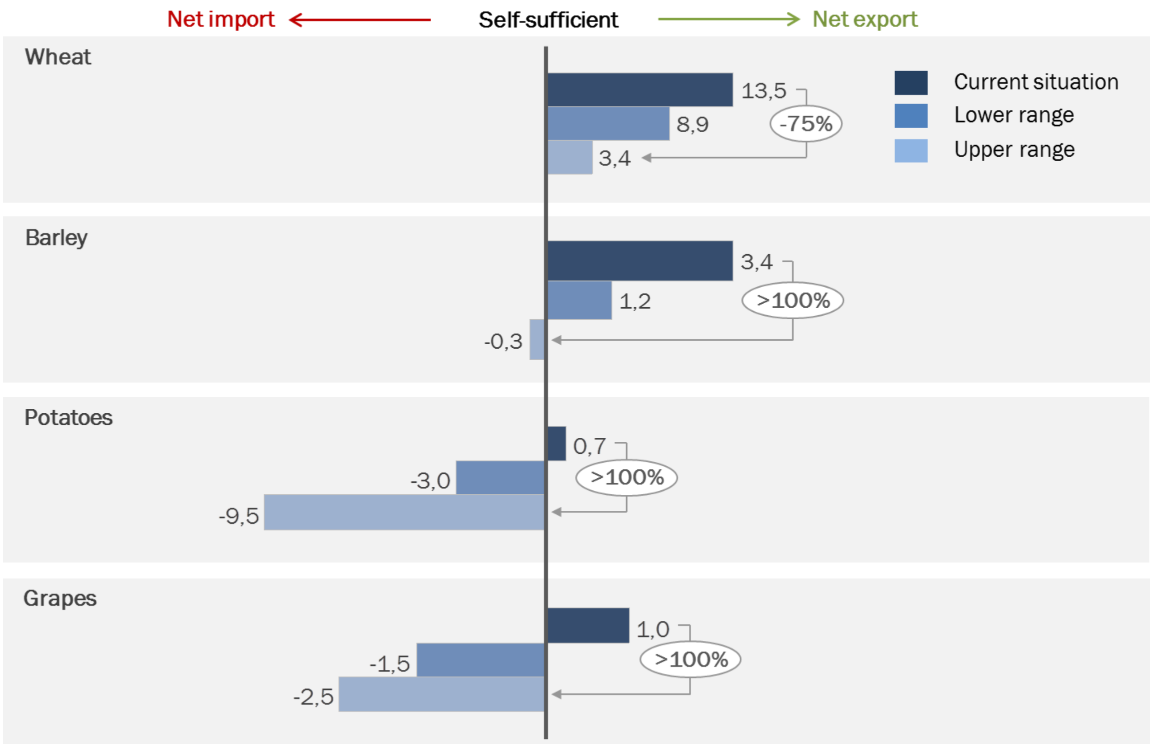

Exhibit 7: Trade balance shift for currently net exported crops (million tons=Mt)

Currently, with the 16 substances being available, the EU's demand for maize and oilseed rape is already partially fulfilled by imports. Out of the 65 Mt of maize consumed in the EU annually, around 4 Mt are currently imported from outside the EU. Based on the analysis of yield changes, we estimate that this will increase to up to 6 Mt to be imported with withdrawal of the 16 substances. For OSR the situation would be similar. For sugar beet, the EU would not be self-sufficient anymore after the withdrawal and would need to import 36 Mt to fulfil its demand.

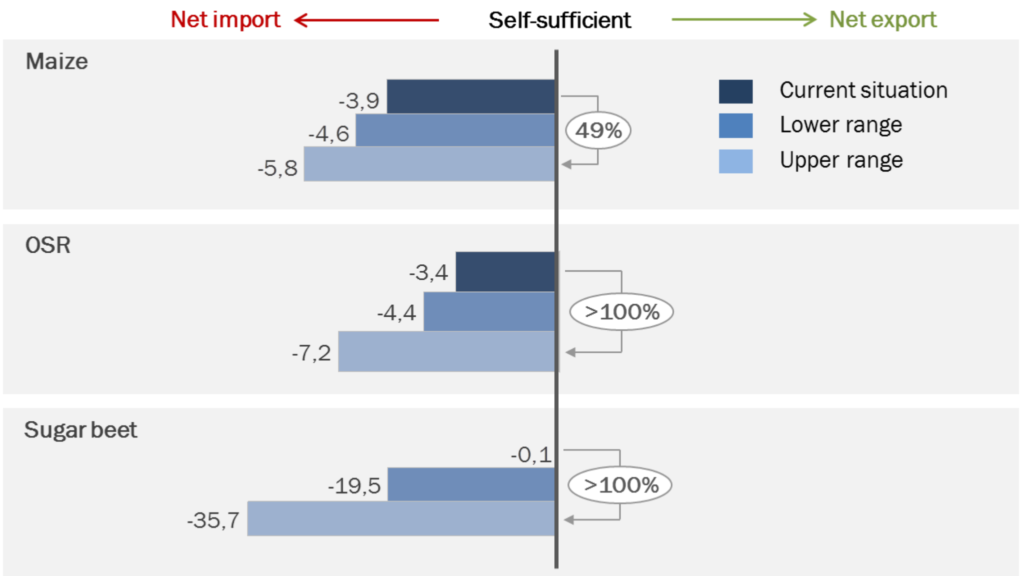

Exhibit 8: Trade balance shift for currently net imported crops (Mt)

Taking the information from the two exhibits above, this increase in imported volumes implies that for the EU as a whole the imported volumes might quadruple: the currently imported volume of maize, OSR and sugar beet is some 7 Mt which could rise to some 28 Mt (lower range).

3 FRANCE

With the ED substances being available as part of the farming toolbox, the French production of the **staple crops analysed**[18] is between **9 to 13 Mt higher** and generates between **€0.6 to 0.7 billion value** per year.

These results are based on the following estimations:

- Sugar beet would face 20-30% lower yields, while the yield of wheat, barley, maize and potatoes would decrease by 1-4%;
- Sugar beet (between 7 and 10Mt volume loss) and wheat (between 1 and 2 Mt volume loss) would be most affected and up to € 0.3 billion of value loss each;
- In terms of viability, sugar beets would also show the largest decrease in profitability.

The study focusses on the staple crops wheat, barley, grain maize, oilseed rape, potatoes and sugar beets. The selection is based on data availability and relevance of the crops. Table 5 provides the basic information for the crops investigated.

Table 5: Overview French crops[19]

Crop	Area (1000 ha)	Yield (t/ha)	Output (million ton)	Price (€/ton)
Wheat	5.404	7,0	37,8	178
Barley	1.666	6,4	10,7	153
Grain maize	1.687	9,0	15,2	176
Potato	159	43,4	6,9	237
Sugar beet	387	89,2	34,5	29

Against this background, the study compares the benefits of using the 16 substances in French agriculture. These are estimated based on the methodology described before, and expressed in terms of short-term yield changes as depicted in Exhibit 9. At the same time, variable production costs and the quality of the agricultural output are likely to be subject to change for most of the crops as well. There was however no information available on these aspects.

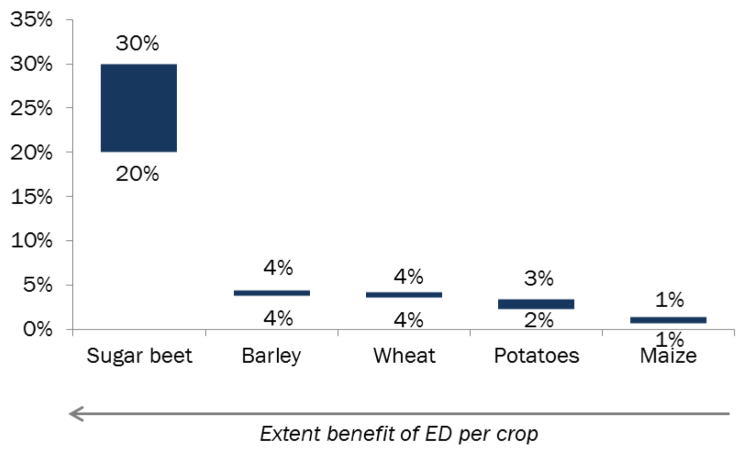

Exhibit 9: French short-term yield changes (in %/ha)

Combining the yield effects per hectare with the overall area used to cultivate the various crops (see Table 5) makes it possible to estimate the total revenue and production volume effects for France as a whole. This leads to less tons of output produced and fewer revenues for the farmers.

[18] Wheat, barley, potato, grain maize and sugar beet
[19] Eurostat; Farm statistics, average 2009-2013

The lower yields (see Exhibit 9), given a fixed arable area, imply that the overall crop production in France will decrease without the 16 substances. As Exhibit 10 shows, in total French farm output is currently between 9 and 13 million Mt higher for the staple crops investigated.

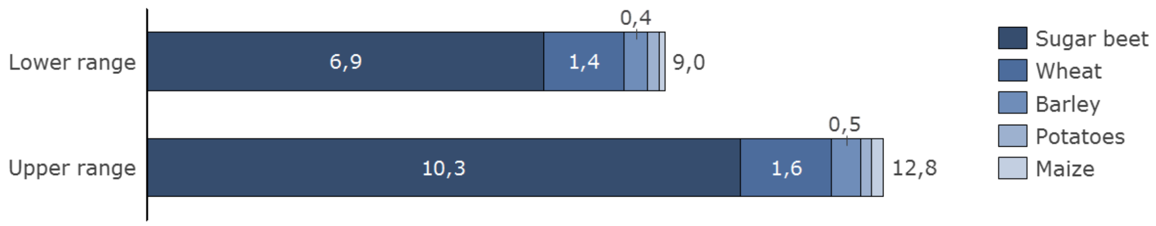

Exhibit 10: Output changes (in million tons per year)

Compared to other crops, the 16 substances have the largest influence on the amount of sugar beet produced in France. This is driven by the large value that the substances add to sugar beet cultivation (20 to 30% extra yield) and to a lesser extent also by the size of the area where sugar beets are cultivated in France (387.000 ha).

Depending on farm-gate prices of the output produced and the changes in the yields per hectare, the gross margins earned by cultivating these crops are also affected.

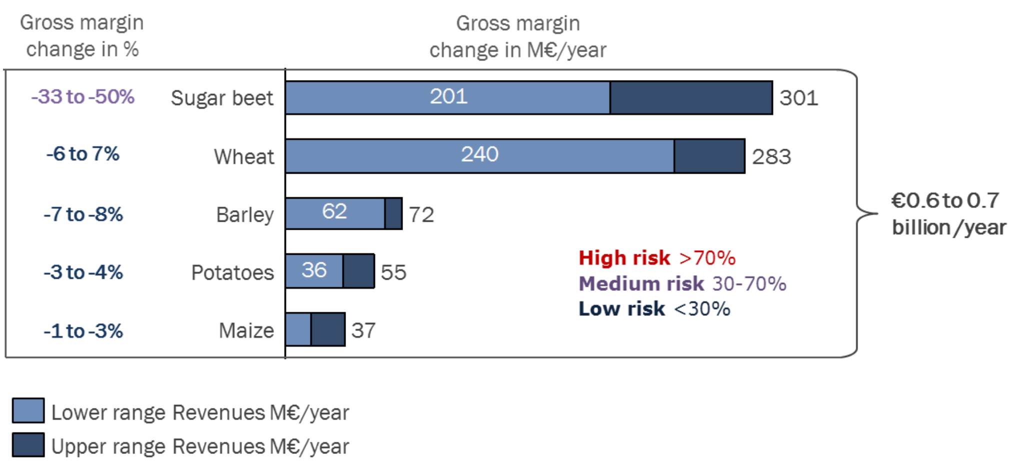

Exhibit 11: Changes in farm revenues and gross margins in France

As shown, French farmers earn a total of between €0.6 and €0.7 billion gross margins per year as a result of the benefits of the 16 substances. These changes include the lower revenues only. It is likely that the 16 substances also affect the production costs[20]. Gross margin gains in sugar beet and wheat make up the majority of the overall effect. The largest overall profitability effect occurs in sugar beet.

Please refer to the overall EU chapter for effects on jobs and self-sufficiency.

[20] Due to limited data availability not included into the scope of the assessment

4 Germany

With the 16 substances being available as part of the farming toolbox, the German production of the **crops analysed**[21] is between **6 to 11 Mt higher** and generates between **€0.5 to 1 billion value** per year.

These results are based on the following estimations:

- Sugar beet would face up to 25% lower yields, while the yield of potatoes, barley, wheat and OSR would decrease by 4-13%;
- In terms of volume, sugar beet (between 4.1 and 6.4 Mt) and wheat (up to 1.7 Mt) would be the most affected and in terms of value it would be wheat (up to € 0.3 billion);
- In terms of viability, the gross margin would change for the crops studied by up to 30%.

The study focusses on the staple crops wheat, barley, maize, OSR, potatoes, and sugar beet. The selection is based on data availability and relevance of the crops. Table 6 provides the basic information for the crops investigated.

Table 6: Overview German crops[22]

Crop	Area (1000 ha)	Yield (t/ha)	Output (million ton)	Ex-farm price (€/ton)
Wheat	3.197	7,5	23,9	163
Barley	1.673	6,2	10,4	150
Maize	488	9,8	4,8	169
OSR	1.471	4,3	6,3	308
Potato	252	42,9	10,8	134
Sugar beet	381	67,9	25,9	26

Against this background, the study compares the benefits of using the 16 substances in German agriculture. These are estimated based on the methodology described before, are expressed in terms of short-term yield changes and depicted in Exhibit 12. At the same time, variable production costs and the quality of the agricultural output are likely to be subject to change for most of the crops. However, not all the information for all of the aspects covered was available for all of the crops.

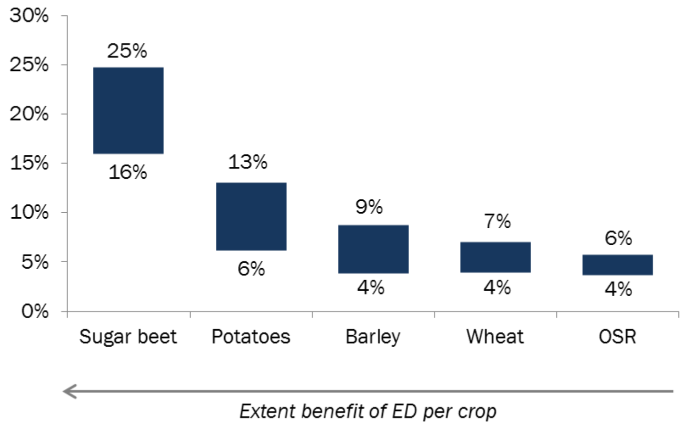

Exhibit 12: German short-term yield changes (in %/ha)

In addition to the yield effect in Exhibit 12, for sugar beet the loss of the 16 substances would result in higher production costs of some €149/ha and reduce the quality by 13%. The higher production costs arise mainly from the loss of triflusulfuron and the quality effects are due to the loss of thiram.

[21] Wheat, barley, potato, OSR and sugar beet
[22] Eurostat; Farm statistics, average 2009-2013

Combining the yield effects per hectare with the overall area used to cultivate the various crops (see Table 6) makes it possible to estimate the total revenue and production volume effects for Germany as a whole. This leads to less tons of output produced and fewer revenues for the farmers.

The lower yields (see Exhibit 12), given a fixed arable area, imply that the overall crop production in Germany will decrease without the 16 substances. As Exhibit 13 shows, in total German farm output is currently between 6 and 11 Mt higher for the crops investigated.

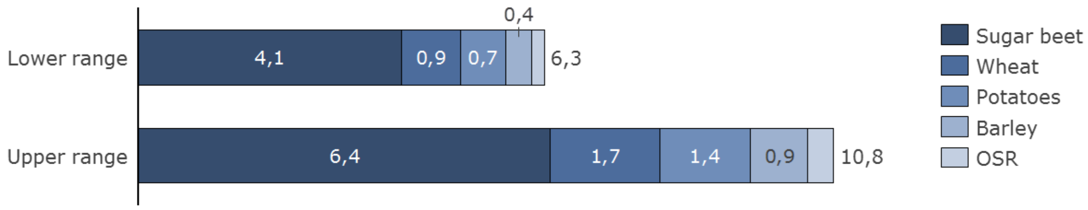

Exhibit 13: Output changes (in million tons per year)

Compared to other crops, the 16 substances have the largest influence on the amount of sugar beet and wheat produced in Germany. This is driven by the large value that these substances add to sugar beet cultivation (between 16% and 25% extra yield), while for wheat it is mainly due to the size of the area on which the crop is cultivated in Germany (3.197.000 ha).

Depending on farm-gate prices of the output produced and the changes in the yields per hectare, the gross margins earned on cultivating these crops are also affected.

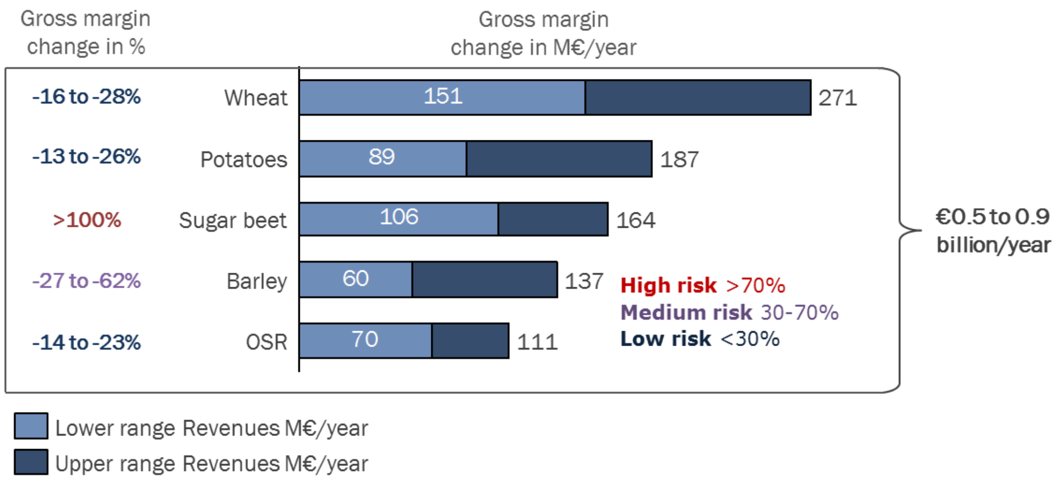

Exhibit 14: Changes in farm revenues and gross margins in the Germany

As shown, German farmers earn a total of between €0.5 and €0.9 billion gross margins per year as a result of the benefits of the 16 substances. These changes include the lower revenues only. It is likely that the 16 substances would also affect the production costs[23]. Gross margin gains in wheat and potatoes make up the majority of the overall effect. The largest overall profitability effect occurs in sugar beet.

Please refer to the overall EU chapter for effects on jobs and self-sufficiency.

[23] Due to limited data availability not included into the scope of the assessment

5 UK

With the 16 substances being available as part of the farming toolbox, the British production of the **crops analysed**[24] is between **0.5 to 2 Mt higher** and generates between **€ 0.2 to 0.5 billion value** per year.

These results are based on the following estimations:

- Peas would face about 10% lower yields, the yield of staple crops OSR, potatoes and wheat would decrease by 1-20%;
- In terms of volume, wheat (between 0.1 and 1 Mt) and OSR (up to 0.5 Mt) would be the most affected, whereas in terms of value it would be OSR (up to € 0.2 billion);
- In terms of viability, the gross margin would change for the crops studied by up to 30%.

The study focusses on the staple crops wheat, oilseed rape, potatoes and peas. The selection is based on data availability and relevance of the crops. Table 1 provides the basic information for the crops investigated.

Table 7: Overview British crops[25]

Crop	Area (1000 ha)	Yield (t/ha)	Output (million ton)	Price (€/ton)
Wheat	1.858	7,5	13,9	165
Oilseed rape	648	3,6	2,4	398
Potatoes	143	40,1	5,7	154
Peas	32	3,6	0,1	5

Against this background, the study compares the benefits of using the 16 substances in British agriculture. These are estimated based on the methodology described before, are expressed in terms of short-term yield changes and depicted in Exhibit 15. At the same time, variable production costs and the quality of the agricultural output are likely to be subject to change for most of the crops. There was however no information available on these aspects.

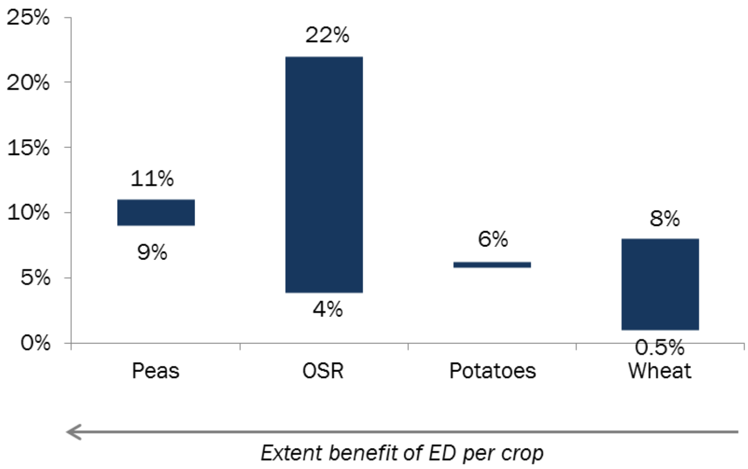

Exhibit 15: British short-term yield changes (in %/ha)

Combining the yield effects per hectare with the overall area used to cultivate the various crops (see Table 7: Overview British crops) makes it possible to estimate the total revenue and production volume effects for UK as a whole. This leads to less tons of output produced and lower revenues for the farmers.

[24] Wheat, potatoes, OSR and peas
[25] Eurostat; Farm statistics, average 2009-2013

The lower yields (see Exhibit 15), given a fixed arable area, imply that the overall crop production in UK would decrease without the 16 substances. As Exhibit 16 shows, in total British farm output is currently between 0.5 Mt and 2 Mt higher for the crops investigated.

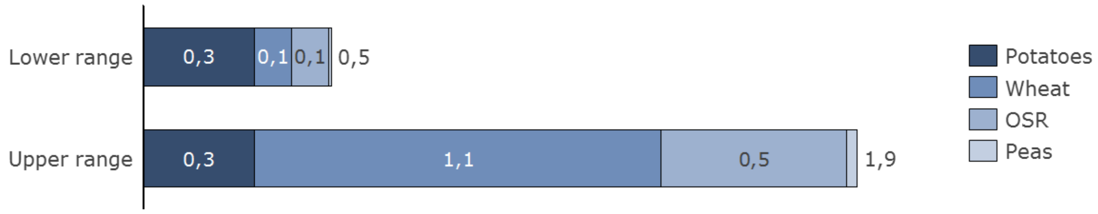

Exhibit 16: Output changes (in million tons per year)

Compared to other crops, the 16 substances have the largest influence on the amount of wheat and OSR produced in UK. This is driven by the large value that these substances add to wheat and OSR cultivation (between 1% and 20% extra yield) and for wheat also because of the size of the area where wheat is cultivated in UK (1.858.000 ha).

Depending on farm-gate prices of the output produced and the changes in the yields per hectare, the gross margins earned by cultivating these crops would also be affected.

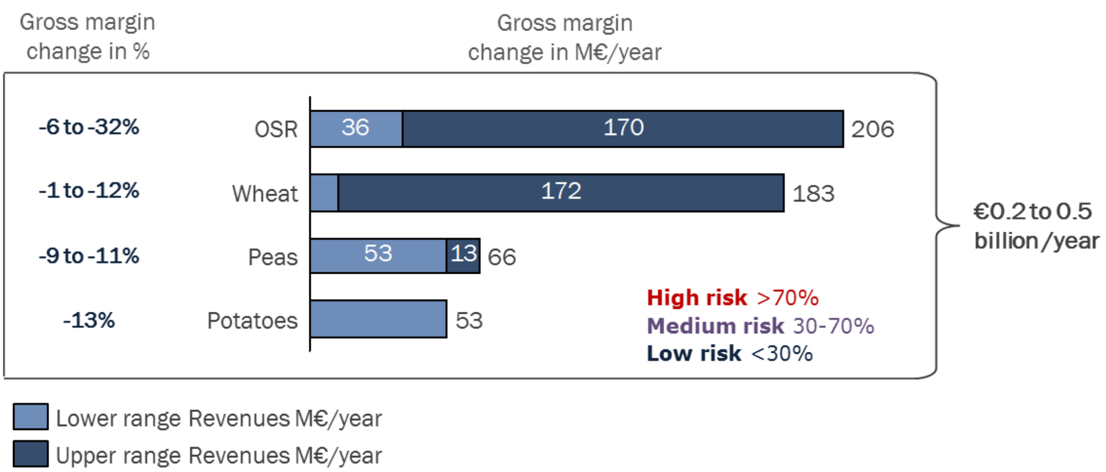

Exhibit 17: Changes in farm revenues and gross margins in the UK

As shown, British farmers earn a total of between €0.2 and €0.5 billion gross margins per year as a result of the benefits of the 16 substances. These changes include the lower revenues only. It is likely that the 16 substances would also affect production costs[26]. Gross margin gains in OSR and wheat make up the majority of the overall effect. The largest overall profitability effect occurs in sugar beet.

Please refer to the overall EU chapter for effects on jobs and self-sufficiency.

[26] Due to limited data availability not included into the scope of the assessment

6 POLAND

With the 16 substances being available as part of the farming toolbox, the Polish production of the **crops analysed**[27] is between **3.1 to 13.8 Mt higher** and generates between **€0.4 to 1.6 billion value** per year.

These results are based on the following estimations:

- Sugar beet, OSR, potatoes, apples and black currants would face between 10% and 50% lower yields and wheat yields would decrease by 5-20%;
- In terms of volume, sugar beet (between 1.1 Mt and 5.6 Mt) and potatoes (0.9 to 3.4 Mt) would be the most affected and in terms of value it would be OSR (€0.1 to 0.4 billion);
- In terms of viability, the gross margin would change for the crops studied from 9 to 100%.

The study focusses on the staple crops wheat, maize, OSR, sugar beet, potatoes, apples and blackcurrants. The selection is based on data availability and relevance of the crops. Table 8 provides the basic information for the crops investigated.

Table 8: Overview Polish crops[28]

Crop	Area (1000 ha)	Yield (t/ha)	Output ('000 ton)	Price (€/ton)
Wheat	2,245	4.2	9,342	156
Maize	420	6.7	2,826	145
OSR	779	2.7	2,134	355
Sugar beet	203	55.2	11,216	32
Potatoes	396	21.6	8,566	101
Apples	176	14.7	2,589	215
Blackcurrants	34	4.3	147	615

Against this background, the study investigates the current value of the 16 substances for the Polish agriculture. It is estimated based on the methodology described above, and is expressed in terms of short-term yield changes and depicted in Exhibit 18. At the same time, (variable) production costs are likely to be subject to change for most of the crops. For the maize, potatoes, apples and blackcurrants total production costs are expected to increase by 5-10%, while for wheat, sugar beet and OSR this might well be 12-26% of the total costs.[29]

[27] Wheat, maize, OSR, sugar beet, potatoes, apples and blackcurrants
[28] Eurostat; Farm statistics, average 2009-2013
[29] Kleffmann group, 2016

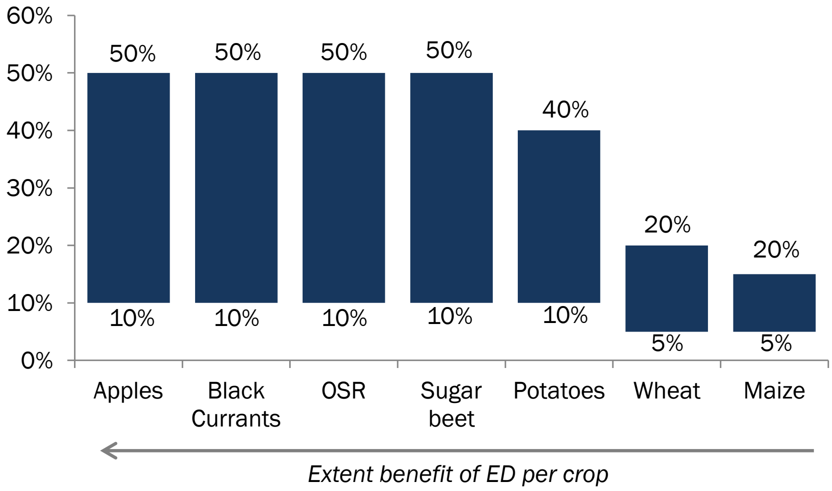

Exhibit 18: Polish short-term yield changes (in %/ha)

Combining the yield effects per hectare with the overall area used to cultivate the various crops (see Table 8) makes it possible to estimate the total revenue and production volume effects for Poland as a whole. This leads to fewer tons of output produced and lower revenues for the farmers.

The lower yields (see Exhibit 18), given a fixed arable area, imply that the overall crop production in Poland will decrease without the 16 substances. As Exhibit 19 shows, in total Polish farm output is currently between 3.1 and 13.8 Mt higher for the crops investigated.

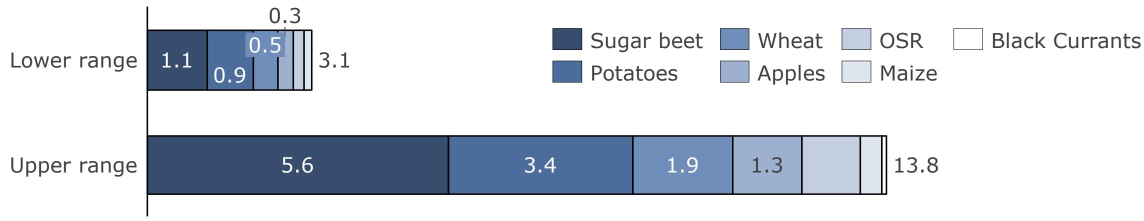

Exhibit 19 : Output changes in Poland (in million tons per year)

Compared to other crops, the 16 substances have the largest influence on the amount of sugar beet and potatoes produced in Poland. This is driven by the large value that the substances add to the cultivation of these crops (between 10% and 50% extra yield).

Depending on farm-gate prices of the output produced and the changes in the yields per hectare, the gross margins earned by cultivating these crops would also be affected.

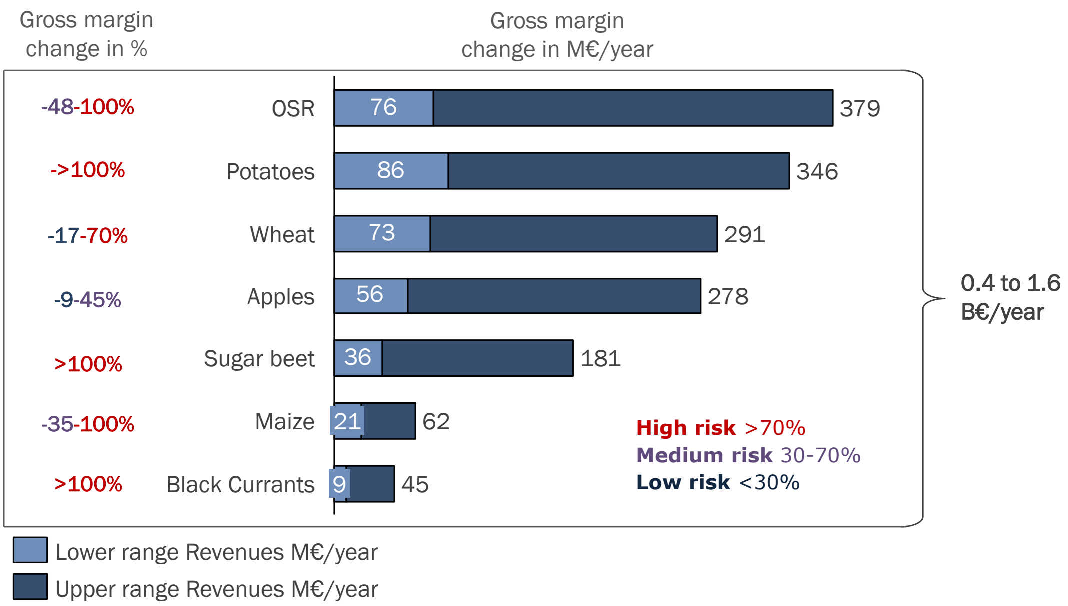

Exhibit 20: Changes in farm revenues and net margins in Poland

As shown, Polish farmers earn a total of between €0.4 and 1.6 billion gross margins per year as a result of the benefits of the 16 substances. These changes include the lower revenues only. Gross margin gains in OSR and potatoes make up the majority of the overall effect. The largest overall profitability effect occurs in sugar beet, potatoes and black currants. It is likely that the 16 substances would also affect production costs[30]. Based on the Kleffmann group report (2016), we estimate the total effects for these seven crops at €0.4 and 0.7 billion.

Please refer to the overall EU chapter for effects on jobs and self-sufficiency.

[30] Due to limited data availability not included into the scope of the assessment

7 ITALY

With the 16 substances being available as part of the farming toolbox, the Italian production of the **crops analysed**[31] is between **1.5 to 3.0 Mt higher** and generates between **€0.04 to 0.3 billion value** per year.

These results are based on the following estimations:

- Tomatoes would face up to 15-25% lower yields, grapes 11-15% lower yields, and maize yields would decrease by 1-2%;
- In terms of volume, tomatoes (between 0.8 and 1.8 Mt) and wheat (0.7 up to 1.8 Mt) would be the most affected and in terms of value it would be tomatoes (€0.1 up to 0.3 billion);
- In terms of viability, the gross margin would change for the crops studied from 48% up to 100%.

The study focusses on the staple crops vines and maize, and the specialty crop tomatoes (for sauce production). The selection is based on data availability and relevance of the crops. Table 9 provides the basic information for the crops investigated.

Table 9: Overview of Italian crops[32]

Crop	Area (1000 ha)	Yield (t/ha)	Output (million ton)	Price (€/ton)
Maize	952	8.9	8,505	195
Tomato (sauce)	84	61.3	5,153	169
Grapes	698	9.2	6,400	111

Against this background, the study investigates the benefits of the 16 substances in Italian agriculture. These are estimated based on the methodology described before, are expressed in terms of short-term yield changes and depicted in Exhibit 21. At the same time, variable production costs are likely to be subject to change for most of the crops and are estimated to increase by €90-250/ha for these crops.

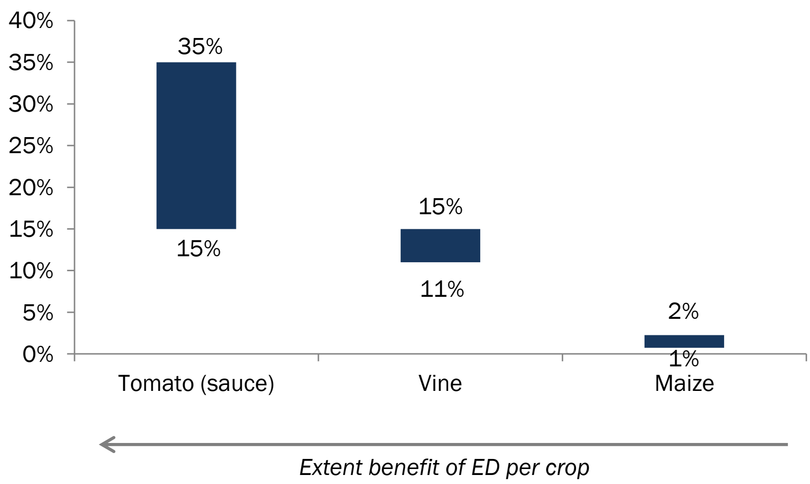

Exhibit 21: Italian short-term yield changes (in %/ha)

Combining the yield effects per hectare with the overall area used to cultivate the various crops (see Table 9) makes it possible to estimate the total revenue and production volume effects for Italy as a whole. This leads to less tons of output produced and lower revenues for the farmers.

The lower yields (see Exhibit 22), given a fixed arable area, imply that the overall crop production in Italy would decrease without the 16 substances. As Exhibit 22 shows, in total Italian farm output is currently between 1.5 and 3.0 Mt higher for the crops investigated.

[31] Tomato (sauce), grapes and maize
[32] ISTAT – agricultural statistics 2009-2013, INEA 2009-2013 average prices

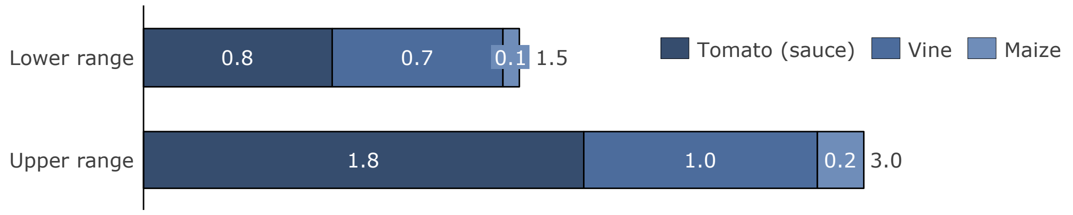

Exhibit 22 : Output changes in Italy (in million tons per year)

Compared to other crops, the 16 substances have the largest influence on the amount of tomatoes produced in Italy. This is driven by the large value that the 16 substances add to their cultivation (between 15% and 25% extra yields).

Depending on farm-gate prices of the output produced and the changes in the yields per hectare, the gross margins earned by cultivating these crops would also be affected.

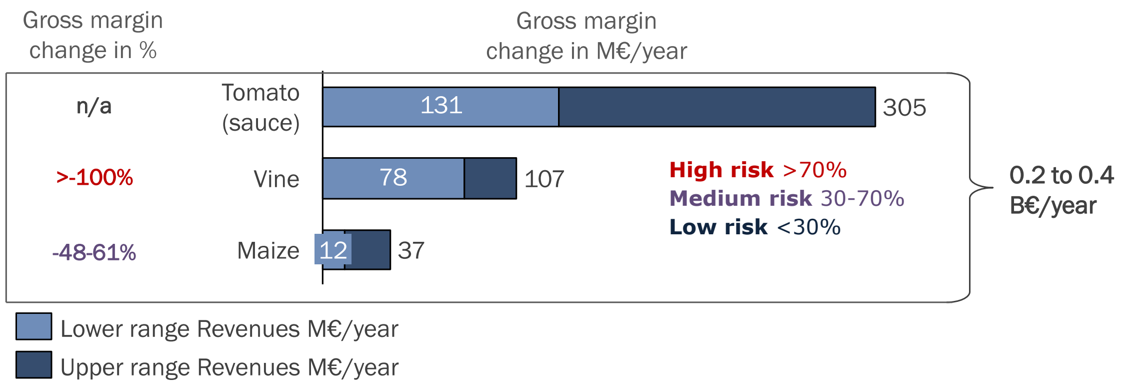

Exhibit 23: Changes in farm revenues and net margins in Italy

As shown, Italian farmers earn a total of between €0.2 and 0.4 billion gross margins per year as a result of the benefits of the 16 substances. These changes include the lower revenues only with the gross margin gains in tomatoes making up the most of the overall effect. The largest overall profitability effect occurs in grapes (>100%). It is likely that the 16 substances would also affect the production costs[33]. Crop experts of local farmer organizations estimate these at an €0.2 billion increase for these three crops.

Please refer to the overall EU chapter for effects on jobs and self-sufficiency.

[33] Due to limited data availability not included into the scope of the assessment

ANNEX: DATA PER COUNTRY

Country	Crop	Pests	Substance	Area affected	Short-term yield (change %) LOW	Short-term yield (change %) HIGH	Additional long term resistance effects	Additional quality effects	Cost (change EUR/ha)	Source
UK	**Wheat**		**16 substances Total**		-0,5%	-8%				ADHB[34]
			Pendimethalin	75%	-20%					
			Azoles		-3%					
			Epoxiconazole (£9M – 0.4%)		0,4%					
			13 ED fungicides		-1,4%					
UK	**Potatoes**		**16 substances Total**		-6%		-6%		€ 41	AHDB34
			Mancozeb	80%			-7%			ADHB[34]
			Maneb							
			Pendimethalin	95%	-1%					
UK	**OSR**		**16 substances Total**		-4%	-22%				ADHD[34]
			Tebuconazole (£2M loss)		-0,5%					
			Thiram							
UK	**Peas**		**16 substances Total**		-9%	-11%				PGRO[35]
			Pendimethalin	90%	-25%					
			Thiram	30%	-30%					

[34] ADHB: Endocrine disruptors – collation impacts across all sectors to give clear messages on impacts of changing availability on farmers and production
[35] The UK Excellence Centre for Peas and Beans

Country	Crop	Pests	Substance	Area affected	Short-term yield (change %) LOW	Short-term yield (change %) HIGH	Additional long term resistance effects	Additional quality effects	Cost (change EUR/ha)	Source
GER	Wheat		16 substances Total		-4%	-7%				Landwirtschaftskammer Nordrhein-Westfalen
			Cyproconazole, Epoxiconazole, Tebuconazole, Teraconazole		-9%					
		Nachtschatten	Pendimethalin	25%	0%					
		Ehrenpreisarten, Mohn, Windhalm und Rispe	Pendimethalin	5%	-5%					
GER	Barley		16 substances Total		-4%	-9%				Landwirtschaftskammer Nordrhein-Westfalen
			Cyproconazole, Epoxiconazole, Tebuconazole, Teraconazole		-9%					
		Nachtschatten	Pendimethalin	25%	0%					
		Ehrenpreisarten, Mohn, Windhalm und Rispe	Pendimethalin	5%	-5%					
GER	Potatoes		16 substances Total		-6%	-13%				Landwirtschaftskammer Nordrhein-Westfalen & University of Göttingen
			Cyproconazole, Epoxiconazole, Tebuconazole, Teraconazole		-13%					
GER	OSR		16 substances Total		-4%	-6%				Landwirtschaftskammer Nordrhein-Westfalen
			Cyproconazole, Epoxiconazole, Tebuconazole, Teraconazole		-5%					
			Pendimethalin		0%					
			Triflusulfuron	20%	-2%					
GER	Sugar beet		16 substances Total		-16%	-25%	-23%	-13%	€ 149	Landwirtschaftskammer Nordrhein-Westfalen
		Fungizid	Cyproconazole	2%	-4%	-7%	-3%	-1%	10	
		Fungizid Premium	Epoxiconazol	30%	-7%	-9%	-5%	-2%	20	
		Fungizid Premium	Tetraconazol	3%	-7%	-9%	-5%	-2%	20	
		Fungizid Mischpartner	Thiophanat-methyl	5%	-2%	-3%	-2%	-0,5%	5	
		Beize	Thiram	100%	-10%	-15%	-15%	-10%	25	
		Herbizid Mischpartner	Lenacil	50%	-2%	-3%	-2%	-1%	5	
		Herbizid Mischpartner	Triflusulfuron	50%	-5%	-10%	-10%	-5%	64	

Country	Crop	Pests	Substance	Area affected	Short-term yield (change %) LOW	Short-term yield (change %) HIGH	Additional long term resistance effects	Additional quality effects	Cost (change EUR/ha)	Source
France	Wheat		16 substances Total		-4%	-4%				Arvalis
			Azoles		-2%					
			Pendimethalin		-5%					
France	Barley		16 substances Total		-3,8%	-4,4%				
France	Potatoes		16 substances Total		-2%	-3%				Arvalis
			Maneb/Mancozeb							
France	Maize		16 substances Total		-0,6%	-1,4%				
France	Sugar beet		16 substances Total		-20%	-30%	-10%			Institut Technique de la Betterave
			Cyproconazole/Epoxiconaxol/Tetraconazole		-20%	-30%	-10%			
Italy	Maize		16 substances Total	15%	-1%	-2%	-8%	-10 to -50 EUR/ton	€ 90	Confagricoltura
			Tebuconazole	15%	-5%	-15%	0%			
			Pendimethalin	15%	0%	-5%	-5%			
Italy	Tomato (sauce)		16 substances Total	100%	-15%	-35%	-10%	-5 to -25 EUR/ton	€ 250	Confagricoltura
			Metiram	100%	-25%	-35%	-10%			
			Pendimethalin	10%	-15%	-35%	-5%			
Italy	Vine[36]		16 substances Total		-11%	-15%			€ 120	Coldiretti
Poland	Apples		16 substances Total		-10%	-50%				Kleffmann Group
Poland	Black Currants		16 substances Total		-10%	-50%				Kleffmann Group
Poland	OSR		16 substances Total		-10%	-50%				Kleffmann Group
Poland	Maize		16 substances Total		-5%	-15%				Kleffmann Group
Poland	Sugar beet		16 substances Total		-10%	-50%				Kleffmann Group
Poland	Potatoes		16 substances Total		-10%	-40%				Kleffmann Group
Poland	Wheat		16 substances Total		-5%	-20%				Kleffmann Group

[36] Taking into account the following substances: Iprodione, Mancozeb, Maneb, Metiram, Myclobutanil, Tebuconazole, Tetraconazole, Thiram, Pendimethalin (PBT).