# Cumulative impact of hazard-based legislation on Crop Protection Products in Europe

***Report***

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steward redqueen

# Contents

## 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. As specialists since 2000, Steward Redqueen focuses on integrating sustainability, quantifying impact and facilitating change. Clients appreciate our rigorous analysis, our ability to solve complex problems, and being ahead of the curve. We work for (multinational) corporations, (development) financials and public sector organizations.

*Socio-economic impact assessments (SEIA)*

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 basis food 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.

*The Authors*

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*Track record SEIA*

Since 2006 Steward Redqueen has completed more than 70 socio-economic impact studies for multinational mining companies, development finance institutions, multinational food & beverage firms, banks and recreational organisations, in Asia, Africa, Latin America and Europe.

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## Foreword

*Commissioner Hogan, DG AGRI: "feeding the world is a global necessity and we must support our producers using all the instruments at our disposal", December 2015*

EU farmers use a wide range of cultivation techniques, planting choices and crop rotations to protect their crops, including pesticides. As the EU is striving towards greener agriculture, the role of pesticides is sometimes not fully understood. Their use is therefore largely debated and increasingly put under pressure . This has also led to a shift from risk to hazard-based legislation adopted by policy-makers.

The EU is one of the world's largest agricultural producers. Ranging from wheat to tomatoes and citrus fruits, it supplies European consumers and industry but also many regions outside the EU. EU legislation therefore not only affects Europeans but also others.

In this light, the development of next generation substances gains importance. But the pipeline of new crop protection products is drying up; every year it takes longer to market new products and the number of available products has halved in 15 years' time.

In this report, we address the socio-economic effects of hazard-based legislation on farmers and the European food chain. Compared to best alternative technologies, how does it affect the economic viability of crop production in Europe? How will it alter the EU's trade balance and the carbon footprint of crop production? And finally, what are the ripple effects in the food chain?

This study contributes to similar work that has been conducted by Wageningen University, The Andersons Centre, the Humboldt Forum and Teagasc at the national or product level. It is a first attempt to gain insights on the Europe-wide effects of all substances at risk on farmers and the food chain covering 49% of EU crop value. These insights are complementary to other societal assessments on health and environmental aspects. Future research could further contribute to gain cumulative insights at the EU level by investigating specific active ingredients and countries.

We believe that all societal aspects should be included in shaping the optimal conditions for agriculture and sustainable supply of affordable and safe food in Europe. And, at the end of the day, support decision-making on what is the best use of European (agricultural) land.

## 1 Summary

The viability of European agriculture is put under pressure. As a result of the EU moving towards hazard-based legislations, several substances for plant protection used in the EU are at risk. While no definite decision on which active substances face withdrawal has been taken yet, earlier research identified some 75 out of the total 400 substances currently available to be phased out.

This would imply that for the cultivation of various staple as well as specialty crops no alternative method might remain on the market to treat specific common diseases, pest or weed. As part of Integrated Pest Management (IPM), diversity in substances available is crucial to face immediate pest pressure and prevent long-term resistance effects. Looking ahead, the substances withdrawn are not likely to be easily replaced. There are two reasons for that: first, the development of new active ingredients up to market introduction takes about 11 years and costs over €280 million[1]. Secondly, the pipeline of products waiting for approval for the European market is also getting emptier due to rising Research and Development (R&D) time and costs (i.e. 70 substances in pipeline in 2000, down to 28 in 2012)[2].

In this background, the study aims to shed light on the current value of the 75 substances for European agriculture. It focuses on 7 staple crops at the EU level and 24 specialty crops across 9 EU member states. Together this represents 49% (in value)[3]. The various crops are studied by themselves; possible effects on pesticide use of specific crop rotations (or any significant change in the rotations) have not been taken into consideration. The analysis is based on 5-year average productivity and costs (2009-2013) in order to average out yearly variations:

- The team builds largely on the risk list of 87 substances that has been drafted by Andersons[4] with DEFRA as key source. 12 substances have been taken out as these are based on UK-specific regulation or at low risk, thereby aiming to get to likely EU-wide conclusions;
- We studied the nine largest EU agricultural markets (representing 62% of EU crop value of the staple crops[5]) and extrapolated these effects to the EU level;
- Within the nine country studies, the crop coverage ranges from a minimum of 25% in the Netherlands up to 70% in France of national crop value;
- The selection of crops included in the scope of the study is based on relevance of various crops and data availability for the countries covered;

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[1] Phillips McDougall, Agrochemical Research and development: The Costs of New Product Discovery, Development and Registration, 2016

[2] Phillips McDougall, R&D trends for chemical crop protection products, Sept 2013

[3] Total volume of EU crop output is €204bln, FOASTAT

[4] "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.

[5] Stable crops include: wheat, barley, maize, oilseed rape, potatoes, sugar beet and vine. Specialty crops include: durum wheat, carrots, apples, beans, hops, onions, brassica, mushrooms, rice, tomatoes (open & glass), pears, peaches/nectarines, soy, hazelnut, olives, tulip bulbs, apple trees, bell pepper, black currants, citrus fruits, cherry, sunflower and peas for selected countries

- We use the best available national and EU databases on crop production, cost structures (e.g. EUROSTAT, FAOstat, FADN, WUR, Teagasc, DEFRA).

The study focus is the immediate effects on yields in line with the WUR 2008 and Andersons' study, and expected long-term (resistance) effects are stated separately.

*Key findings*

1. Using the 75 substances identified for the production of 7 key staple crops in the EU (potato, barley, wheat, sugar beet, rapeseed, maize and vine) contributes to 96 million ton or €15b in crop value:
   - Barley, wheat, rapeseed and maize could face 10-20% lower yields, while potato and sugar beet might decrease by up to 30-40%; vine yields will decrease of 20%;
   - At current speed of technological progress, it would take 15-20 years to make up for this loss[6];
   - Higher yields and lower production costs for these crops support farmer income by €17b (i.e. €15b additional revenue, €2b lower costs);
   - Overall farm profitability is with the 75 substances 40% higher (€17b of a total of €44b)[7];
   - In value, wheat benefits the most with €4b of value, while sugar beet shows the largest profitability surplus (+100%);
   - The 7 staple crops relate to 1.2m direct jobs. Of these, 30% face a medium or high risk of job loss due to relatively 'thin' margins these crops.

2. The 75 substances are crucial for the economic viability of the 24 specialty crops in scope:
   - The yield supported ranges from 40-100%, a total of 12 million tons[8];
   - The size of the crop protection toolbox of many specialty crops is already limited and is the key driver of the high potential yield losses;
   - These 24 specialty crops relate to 300,000 direct jobs of which almost 60% are at high risk of job loss due to relatively large loss of margins.

3. At current crop demand, the 75 substances support the EU's self-sufficiency for wheat, barley, potato and sugar beet, while limiting the import levels of rapeseed and maize:
   - In contrast to the current situation with a positive trade balance, without the substances the EU is likely to depend on imports for more than 20% of its staple crop demand;
   - Matching the demand with imported crops bears the risk of selling crop produced with non-EU standards on the European market;
   - Meeting the demand for specialty crops seems even more challenging as sufficient import amounts are not always readily available;
   - An additional 9 million ha farmland might need to be integrated to feed Europe. This is equal to half of the total used agricultural area of the UK[9];

[6] "The technology challenge", FAO, High Level Expert Forum, 2009
[7] Profitability based on gross margin changes. Gross margin is defined as the difference of total revenues and total variable costs. The choice to report on gross margins has been made due to data availability: while the official sources on variable costs in various countries provide estimates in the same range information on fixed costs lack consistency
[8] Includes durum wheat, carrots, apples, beans, hops, onions, brassica, mushrooms, rice, tomatoes (open & glass), pears, peaches/nectarines, soy, hazelnut, olives, tulip bulbs, apple trees, bell pepper, black currants, citrus fruits, cherry, sunflower and peas for selected countries
[9] Total used agricultural area in the UK was 17,326,990 ha in 2013, Eurostat

- This would increase the carbon emissions with up to 49 million t $CO_2$-eq (i.e. 10% EU agriculture, 1% of EU, similar to the total emissions of Denmark[10] or twice the international aviation emissions of Germany[11]), putting the $CO_2$ aims of European legislation at risk;[12]
- In monetary terms, that might mean additional emissions worth €500 million[13].

4. Mediterranean crops analysed benefit from using the 75 active substances because they have a wide range of pest diseases and most of them are minor crops that currently benefit of a strict number of registered active substances:
   - In a short term overview, vine yields will decrease of 20% (-22% in France, -13% Spain, -20% Austria and Italy even -30%) and overall farm profitability will be 11% lower;
   - The EU is currently self-sufficient for vine. Lossing the active substances will require the EU to import some 4Mt vine from third countries;
   - Yields are expected to decrease by –92% in carrots, -60% in apples, -65% in pears, -40% in olives, -36% in tomato, -36% in citrus fruit, -15% in cherry.

5. Smaller local crop supply will also affect EU value chains with higher costs and less jobs:
   - Primary crop processors in the EU could face difficulties with their supplies, e.g. if tomatoes indeed become economically unviable to be cultivated locally, the long-term perspective for the processors is uncertain;
   - Effects are likely to trickle down the value chain up to the consumer but also to affect trading partners of the EU.

[10] Total Danish greenhouse gas emissions (including international aviation and excluding LULUCF) in 2013 were 57.1 million ton CO2eq., Eurostat
[11] German greenhouse gas emissions related to international aviation in 2013 were 25.7 million ton CO2eq., Eurostat
[12] Agriculture makes up 10% of European total emissions in 2012 of a total 4,683 million tons, Eurostat
[13] €10 per ton, average 2009-2013 ETS prices

# 2 Introduction

ECPA along with their respective national organizations commissioned Steward Redqueen to examine the socio-economic effects of current hazardous legislation for Crop Protection Products (CPPs) at EU farms and the wider economy. Copa and Cogeca welcome this research as a valid addition to confirm the negative effects of the loss of Plant Protection Products.

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

- The study covers the effects on crop production levels, farmer incomes & profitability, jobs, carbon footprint and land use;
- These insights should complete other socio-economic work and research that has been done on local environmental and health effects of CPPs to obtain a complete picture of the societal effects.

The objective of this study is to determine the economic and environmental effects of the hazard-based regulation for crop protection products in Europe. The insights provided can be used to proactively inform stakeholders, engaging into fruitful debates based on factual arguments.

## 2.1 EU legislation

Before the 1990s, prior to Directive 91/414/EEC, individual member states were responsible for pesticide approval. From then onwards substances had to meet specific safety and efficacy criteria before approved for the EU market as a whole. The harmonisation following this regulation has led to a first round of active substances reduction available for EU farmers. In the years thereafter, a couple of additional legislations have been implemented. The main ones include:

- The Water Framework Directive 2000/60/EC[14]
- Regulation 1107/2009[15]
- Regulation 485/2013[16]

The Water Framework Directive 2000/60/EC aims for all rivers, lakes, ground, coastal and drinking water in the EU to reach good ecological and chemical standards. It does so by setting limits on amounts of pesticides allowed and introducing quality requirements for groundwater.

Regulation 1107/2009came into force in 2011 and governs the approval or re-approval of substances. The purpose of this Regulation is to ensure a high level of protection of both

[14] Directive 2000/60/EC establishing a framework for Community action in the field of water policy

[15] Regulation (EC) No 1107/2009 concerning the placing of plant protection products on the market and repealing Council Directives 79/117/EEC and 91/414/EEC

[16] Commission Implementing Regulation (EU) No 485/2013 amending Implementing Regulation (EU) No 540/2011, as regards the conditions of approval of the active substances clothianidin, thiamethoxam and imidacloprid, and prohibiting the use and sale of seeds treated with plant protection products containing those active substances

human and animal health and the environment. Therefore, only safe active substances are approved. According to the 'cut-off criteria', active substances will not be approved in case they classify as having the following characteristics (i) mutagenic, (ii) carcinogenic or reproductive toxicity, (iii) endocrine disruptor, (iv) persistent organic pollutants, (v) persistent bio-accumulative and toxic and (vi) very persistent/very bio-accumulative. For substances identified as 'candidates of substitution', initial approval can be deemed and products containing these substances might be removed if a safer alternative becomes available.

With the introduction of 1107/2009, the EU shifted from a risk-based to a more hazard-based legislation. While these terms are often used interchangeably, in research they refer to different degrees of pre-caution taken. Hazard becomes a risk depending on exposure: watching a shark from the beach is a hazard but becomes a risk if swimming. This shift towards risk evaluation of crop protection substances from a hazard based perspective has implications for the farming toolbox, the amount of solutions available with which they can threat pests. This is believed to have contributed to the list of substances drop down from over 800 in the 1990s to fewer than 400 active substances available for European farmers today[17].

Regulation 485/2013 imposes restrictions on three neonicotinoid substances. While it remains possible to use these substances on crops like sugar beet, the restriction remains for flowering and spring planted crops until a full review of all new scientific data.

## 2.2 Integrated Pest Management & Resistance

Before farmers consider the use of pesticide products and even before sowing, farmers carefully employ Integrated Pest Management (IPM) measures to limit the impact of pests and diseases on crops. Crop rotation, seed and variety selection, cultivation practise, planting dates or planting densities are some of the different strategies that farmers apply.

Farmers adapt the above practices to account for seasons, soil conditions and with weather forecast which, in their experience, is most likely to maximise their crop yield. In this respect, to effectively fight against pests and diseases requires a wide range of solutions (including all kinds of pesticides) in order to allow correct choices at farm level and avoid resistances.

This is in particular highlighted by the European and Mediterranean Plant Protection Organization in its Guidance on comparative assessment (PP 1/271). It states that in case there is evidence of medium risk of resistance in the target organism, at least three modes of action are recommended. With evidence of high risk, at least 4 modes of action are recommended. Maintaining a broad range of crop protection modes of action is therefore essential to reduce the risk of resistance.

IPM is not a new concept, as this is based on good farming practices that have evolved over time. In this respect, in order to give wherever possible priority to non-chemical methods, cultural management strategies are always the first point of call for all farmers growing crops.

The over-whelming majority of pests and diseases in crops are controlled with cultural, or physical, measures. Examples of cultural measures include crop rotation, timing, cultivation,

[17] Development of approved active substances, Source: European Commission, Healthy Harvest, NFU

drainage, plant breeding and irrigation. These measures form one part of what has become known as IPM, which seeks to control pests and diseases through a holistic approach including the aforementioned cultural means, as well as mechanical, biological and chemical controls.

Further, under Directive 129/2008/EC establishing a framework for Community action to achieve the sustainable use of pesticides (SUD), farmers who rely on pesticide products are required to consider the principles of Integrated Pest Management (IPM) [18].

## 2.3 Scope of this study

This study aims to shed light on the current value of 75 substances used in pesticides for European agriculture. This is done by investigating the implications of losing those 75 substances currently at risk of being banned at the same moment of time. Put differently, the study establishes a hypothetical 'new normal' situation of the crop protection toolbox available for farmers for the coming 5-years.

Exhibit 1 depicts the implications that can be expected from the change in substance availability, distinguishing between consequences at farm-level agronomic implications and broader ripple effects. This study, while recognizing effects on biodiversity and health, focuses on economic and carbon foot print implications. Building on existing research, this study attempts to depict socio-economic consequences of EU legislation on the EU level.

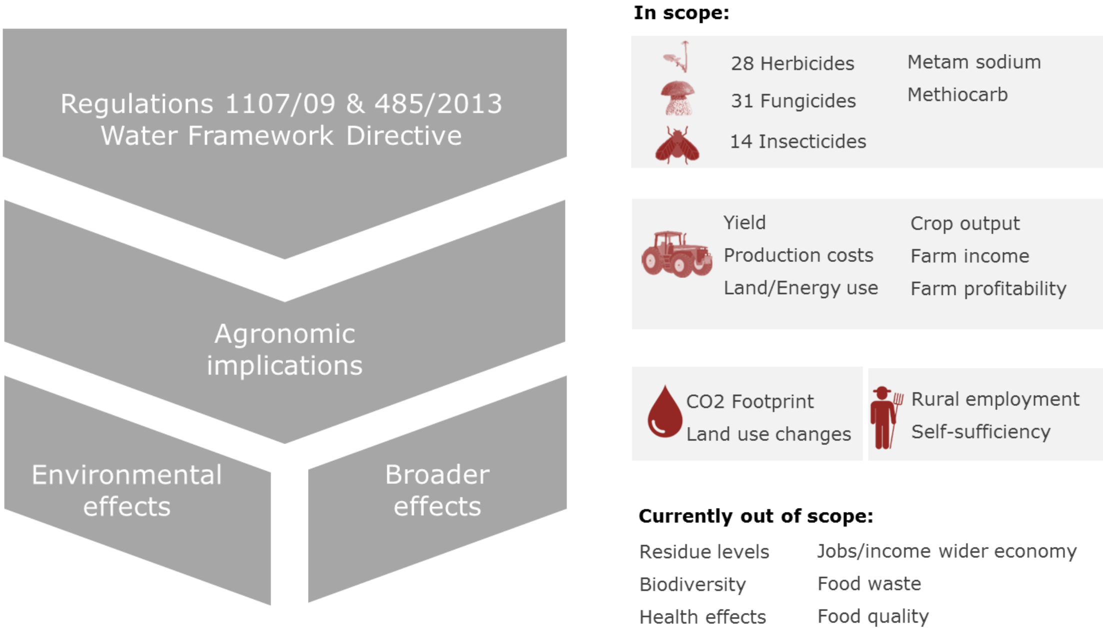



***Exhibit 1: Overview of indicators in scope of the assessment***

[18] According to Directive 2009/128/EC establishing a framework for Community action to achieve the sustainable use of pesticides 'integrated pest management' means careful consideration of all available plant protection methods and subsequent integration of appropriate measures that discourage the development of populations of harmful organisms and keep the use of plant protection products and other forms of intervention to levels that are economically and ecologically justified and reduce or minimise risks to human health and the environment. 'Integrated pest management' emphasises the growth of a healthy crop with the least possible disruption to agro-ecosystems and encourages natural pest control mechanisms;

In terms of crops considered, the study focuses on 7 staple crops[19] and 24[20] specialty crops across 9 EU member states[21]. For the staple crops, implications on national level are extrapolated to EU totals. Altogether, the study covers 49% of the total EU crop value.

[19] Winter wheat, winter barley, grain maize, oilseed rape, sugar beet, potatoes and vine
[20] Depending per country, based on data availability and relevance: includes durum wheat, carrots, apples, beans, hops, onions, brassica, mushrooms, rice, tomatoes (open & glass), pears, peaches/nectarines, soy, hazelnut, olives, tulip bulbs, apple trees, bell pepper, black currants, citrus fruits, cherry, sunflower and peas
[21] France, Germany, UK, Poland, Spain, Italy, the Netherlands, Austria and Ireland

## 2.4 Method, data & process

### *Method*

Regulations 1107/09 and 485/2013 as well as the Water Framework Directive (WFD) as outlined above might lead to reduced availability of active substances for EU agriculture. While due to ongoing dialogue it is not yet possible to produce a definite list, this study makes use of existing academic literature to establish a list of active substances at risk. In particular, it uses a list of 87[22] overall and 75 non-UK specific or low risk active substances drafted by The Andersons Centre. Andersons bases their list on ADAS research with DEFRA, the UK's HSE-CRD and the European Commission as original sources[23]. The 75 substances identified this way form the starting point for the analysis.

The 75 non-UK specific active substances comprise the following:

| Category | Substance name | Likelihood to be lost | Legislation/cut-off criteria | Source[23] |
|---|---|---|---|---|
| **Insecticides** | abamectin | High | 1107/09 - Endocrine Disruption | WRc 2013 |
| **Insecticides** | beta-cyfluthrin | Medium | 1107/09 - Endocrine Disruption | WRc 2013 |
| **Insecticides** | bifenthrin | High | 1107/09 - PBT /vPvB | CRD 2008 2C |
| **Insecticides** | clothianidin | High (by crop) | Bee Health - Neonicotinoids | EU Restriction |
| **Insecticides** | deltamethrin | Medium | 1107/09 - Endocrine Disruption | CRD 2009 |
| **Insecticides** | dimethoate | Medium | 1107/09 - Endocrine Disruption | CRD 2009 |
| **Insecticides** | esfenvalerate | High | 1107/09 - PBT CRD | 2008 2C |
| **Insecticides** | imidacloprid | High (by crop) | Bee Health - Neonicotinoids | EU Restriction |
| **Insecticides** | lambda-cyhalothrin | Medium | 1107/09 - Endocrine Disruption | WRc 2013 |
| **Insecticides** | spinosad | Medium | 1107/09 - Endocrine Disruption | WRc 2013 |
| **Insecticides** | spiromesifen | Medium | 1107/09 - Endocrine Disruption | WRc 2013 |
| **Insecticides** | spirotetramat | Medium | 1107/09 - Endocrine Disruption | WRc 2013 |
| **Insecticides** | thiacloprid | High | 1107/09 - Endocrine Disruption | CRD 2009 |
| **Insecticides** | thiamethoxam | High (by crop) | Bee Health - Neonicotinoids | EU Restriction |
| **Fungicides** | bupirimate | Medium | 1107/09 - Endocrine Disruption | WRc 2013 |
| **Fungicides** | captan | Medium | WFD - Article 7 | ADAS 2010 |
| **Fungicides** | carbendazim | High | 1107/09 - Mutagenic | CRD 2008 2C |
| **Fungicides** | cyproconazole | High | 1107/09 - Endocrine Disruption | CRD 2009 |
| **Fungicides** | difenoconazole | Medium | 1107/09 - Endocrine Disruption | CRD 2009 |
| **Fungicides** | dinocap | High | 1107/09 - Endocrine Disruption | CRD 2009 |
| **Fungicides** | epoxiconazole | High | 1107/09 - Endocrine Disruption | CRD 2009 |
| **Fungicides** | fenbuconazole | High | 1107/09 - Endocrine Disruption | CRD 2009 |
| **Fungicides** | fluazinam | High | 1107/09 - Endocrine Disruption | WRc 2013 |
| **Fungicides** | fluquinconazole | Medium | 1107/09 - Endocrine Disruption | CRD 2009 |
| **Fungicides** | folpet | Medium | 1107/09 - Endocrine Disruption | CRD 2009 |
| **Fungicides** | hymexazol | Medium | 1107/09 - Endocrine Disruption | WRc 2013 |
| **Fungicides** | iprodione | High | 1107/09 - Endocrine Disruption | CRD 2009 |
| **Fungicides** | mancozeb | High | 1107/09 - Endocrine Disruption | WRc 2012 |
| **Fungicides** | mandipropamid | Medium | 1107/09 - Endocrine Disruption | WRc 2013 |

[22] 12 substances (chlorpyrifos, cypermethrin, permethrin, chlorothalonil, 2,4-D, bentazone, bifenox, MCPA, mecoprop, metazachlor, propyzamide and metaldehyde) have been taken out as these are based on UK-specific regulation, aiming to get to EU-wide conclusions resulting in 75 substances

[23] Extended impact assessment study of the human health and environmental criteria for endocrine disrupting substances proposed by HSE, CRD; NEED FOR A PROPER QUOTE
Water Framework Directive implementation in England and Wales: new and updated standards to protect the water environment;NEED FOR A PROPER QUOTE
Regulation (EC) No 1107/2009 concerning the placing of plant protection products on the market and repealing Council Directives 79/117/EEC and 91/414/EEC;
Commission Implementing Regulation (EU) No 485/2013 amending Implementing Regulation (EU) No 540/2011, as regards the conditions of approval of the active substances clothianidin, thiamethoxam and imidacloprid, and prohibiting the use and sale of seeds treated with plant protection products containing those active substances

| | | | | |
|---|---|---|---|---|
| **Fungicides** | maneb | High | 1107/09 - Endocrine Disruption | CRD 2009 |
| **Fungicides** | metconazole | High | 1107/09 - Endocrine Disruption | CRD 2009 |
| **Fungicides** | metiram | Medium | 1107/09 - Endocrine Disruption | CRD 2009 |
| **Fungicides** | myclobutanil | Medium | 1107/09 - Endocrine Disruption | CRD 2009 |
| **Fungicides** | penconazole | Medium | 1107/09 - Endocrine Disruption | CRD 2009 |
| **Fungicides** | prochloraz | Medium | 1107/09 - Endocrine Disruption | WRc 2013 |
| **Fungicides** | propiconazole | Medium | 1107/09 - Endocrine Disruption | CRD 2009 |
| **Fungicides** | prothioconazole | Medium | 1107/09 - Endocrine Disruption | WRc 2013 |
| **Fungicides** | quinoxyfen | High | 1107/09 - vPvB | CRD 2008 2C |
| **Fungicides** | silthiofam | Medium | 1107/09 - Endocrine Disruption | WRc 2013 |
| **Fungicides** | tebuconazole | Medium | 1107/09 - Endocrine Disruption | WRc 2013 |
| **Fungicides** | tetraconazole | Medium | 1107/09 - Endocrine Disruption | CRD 2009 |
| **Fungicides** | thiophanate-meythl | Medium | 1107/09 - Endocrine Disruption | WRc 2013 |
| **Fungicides** | thiram | Medium | 1107/09 - Endocrine Disruption | WRc 2013 |
| **Fungicides** | triademenol | Medium | 1107/09 - Endocrine Disruption | CRD 2009 |
| **Fungicides** | triticonazole | Medium | 1107/09 - Endocrine Disruption | CRD 2009 |
| **Herbicides** | amitrole | High | 1107/09 - Endocrine Disruption | CRD 2009 |
| **Herbicides** | asulam | Medium | WFD - Article 7 | ADAS 2010 |
| **Herbicides** | carbetamide | High | 1107/09 - Endocrine Disruption | EA Compliance |
| **Herbicides** | chlorotolurun | Medium | WFD - Article 7 | EA Compliance |
| **Herbicides** | chlorpropham | Medium | 1107/09 - Endocrine Disruption | WRc 2013 |
| **Herbicides** | clopyralid | Medium | WFD - Article 7 | EA Compliance |
| **Herbicides** | dimethenamid-P | Medium | 1107/09 - Endocrine Disruption | WRc 2013 |
| **Herbicides** | ethofumesate | Medium | 1107/09 - Endocrine Disruption | WRc 2013 |
| **Herbicides** | fluazifop-p-butyl | Medium | 1107/09 - Endocrine Disruption | WRc 2013 |
| **Herbicides** | flumioxazine | High | 1107/09 - Endocrine Disruption | CRD 2009 |
| **Herbicides** | fluometuron | Medium | 1107/09 - Endocrine Disruption | CRD 2009 |
| **Herbicides** | fluroxypyr | Medium | WFD - Article 7 | ADAS 2010 |
| **Herbicides** | glufosinate | Medium | 1107/09 - Endocrine Disruption | WRc 2013 |
| **Herbicides** | glyphosate | Medium | WFD - UK Spec. Poll'nt (candidate) | DEFRA List |
| **Herbicides** | ioxynil | High | 1107/09 - Endocrine Disruption | WRc 2013 |
| **Herbicides** | linuron | High | 1107/09 - Endocrine Disruption | CRD 2009 |
| **Herbicides** | lenacil | Medium | 1107/09 - Endocrine Disruption | WRc 2013 |
| **Herbicides** | MCPB | Medium | WFD - Article 7 | ADAS 2010 |
| **Herbicides** | metribuzin | Medium | 1107/09 - Endocrine Disruption | WRc 2013 |
| **Herbicides** | molinate | High | 1107/09 - Endocrine Disruption | CRD 2009 |
| **Herbicides** | pendimethalin | High | 1107/09 - PBT | CRD 2009 |
| **Herbicides** | picloram | Medium | 1107/09 - Endocrine Disruption | CRD 2009 |
| **Herbicides** | pinoxaden | Medium | 1107/09 - Endocrine Disruption | WRc 2013 |
| **Herbicides** | S-metolachlor | High | 1107/09 - Endocrine Disruption | WRc 2013 |
| **Herbicides** | tepraloxydim | Medium | 1107/09 - Endocrine Disruption | WRc 2013 |
| **Herbicides** | terbuthylazine | High | 1107/09 - Endocrine Disruption | WRc 2013 |
| **Herbicides** | tralkoxydim | Medium | 1107/09 - Endocrine Disruption | CRD 2009 |
| **Herbicides** | triflusulfuron | Medium | 1107/09 - Endocrine Disruption | CRD 2009 |
| **Other** | metam sodium | Medium | 1107/09 - Endocrine Disruption | CRD 2009 |
| **Other** | methiocarb | High | 1107/09 - Bird Safety | EU Restriction |

Active substances labelled ‘high risk’ are likely to be withdrawn in the short-to medium run, for some substances (e.g. neonicotinoids) this might be for certain crops only (stated as ‘by crop’ in the table above). ‘Medium risk’ indicates substances around which there is larger uncertainty or the withdrawal could happen over the longer-run.

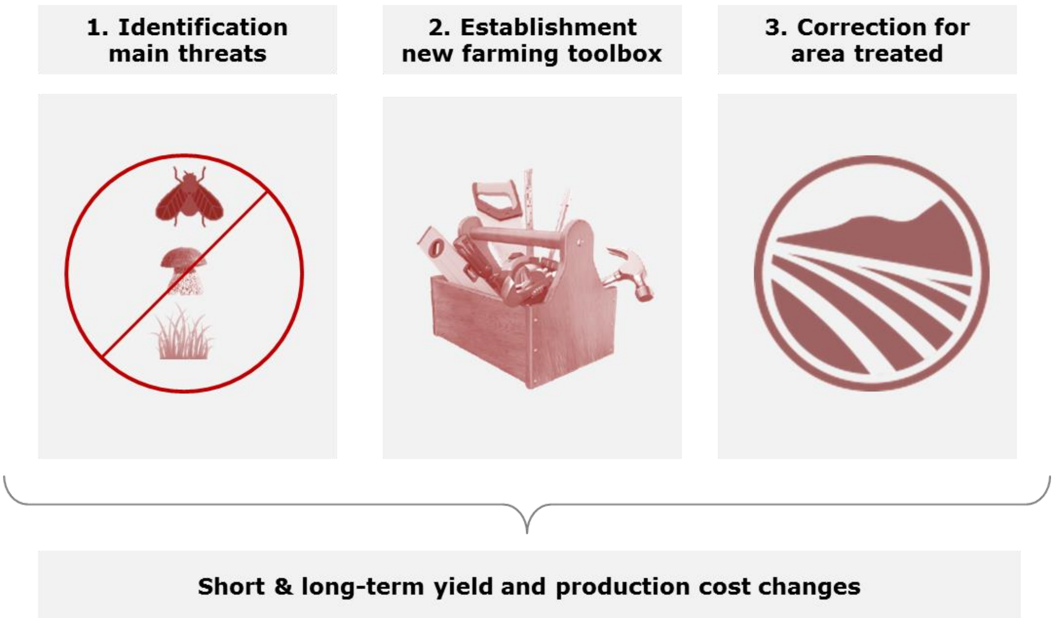
Having established the 75 substances with high or medium risk to be removed from the market, the study works with several general assumptions:

- The removal of the 75 active substances is compared to the best currently available alternative solution in the farmers’ toolbox and the Good Agricultural Practices (including chemical, biological, mechanical and cultural practices);

- All substances are removed from the market at once and no other substances are introduced in 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[24]) or other changes in the production area have not been taken into consideration;
- The analysis is based on 5-year average productivity and costs (2009-2013) thereby averaging out yearly variations in weather conditions and related pest pressure. Further, we look at the average effects for all farmers per crop in each country to obtain a conservative insight at the national and EU level. However, we recognized volatility in yields and prices are important aspects in agriculture. Therefore the results might be rather conservative;
- Yield and variable costs per hectare are subject to change *ceteris paribus*, that means the utilised area and ex-farm prices are assumed to be fixed.

Baring these assumptions in mind, the subsequent approach consists of several steps including (1) the analysis of main threats for the cultivation of the various crops, (2) the currently used and the possibly remaining alternative substances, as well as (3) the extent to which substances are applied. Ultimately, this leads to an estimation of the related yield and costs 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 75 substances leads to the new farming toolbox. It includes Good Agricultural Practices, comprising chemical, biological, mechanical approaches as well as cultural practices. The resulting effect estimations are based on expert's judgement as well as field test. In a 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.




[24] Under current Common Agricultural Policy (2014-2020), greening measures include mandatory crop rotation depending on the size of the holding

*Exhibit 2: Overview of approach*

The effects resulting from this analysis represent the lowest value of a possible range of the cumulative implicatations of fungicides, herbicides and insecticides together: the estimations take into consideration that pesticides applied to crops already affected by one pest add less value than once applied to 'healthy' crops.

The research further distinguishes the short-run substitution and the long-run resistance effects of not having the 75 substances available. The former refer to immediate effects from shifting to treatment with best alternatives. Long-term resistance effects might occur over time once weeds, diseases and pest will have built a certain degree of resistance against the remaining alternative substances. Especially for specialty crops, given the often few remaining alternatives, expected future resistance is 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 the references taken into account.

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.

Summarizing, the study focuses on and differentiates between:

- Short-term substitution effect on yields and costs of production
- Long-term resistance effect on yields

In addition, for some crops the quality of the output might be affected as the crop output cannot be sold anymore as premium quality. However, as the ex-farm price is assumed to be fixed (see above) this is not explicitly taken into account[25].

Building on Exhibit 2, the section below illustrates the approach, using the example of wheat in France. The study does this by applying the yield and costs changes as identified by farm experts[26] to the actual base figures[27].

[25] This may be a conservative approach, non-compliance with marketing standards will vary ex-farm prices
[26] Yield and production costs changes as identified by Arvalis, France
[27] Average production and costs data for French wheat 2009-2013, Eurostat & Farm Accounting Data Network

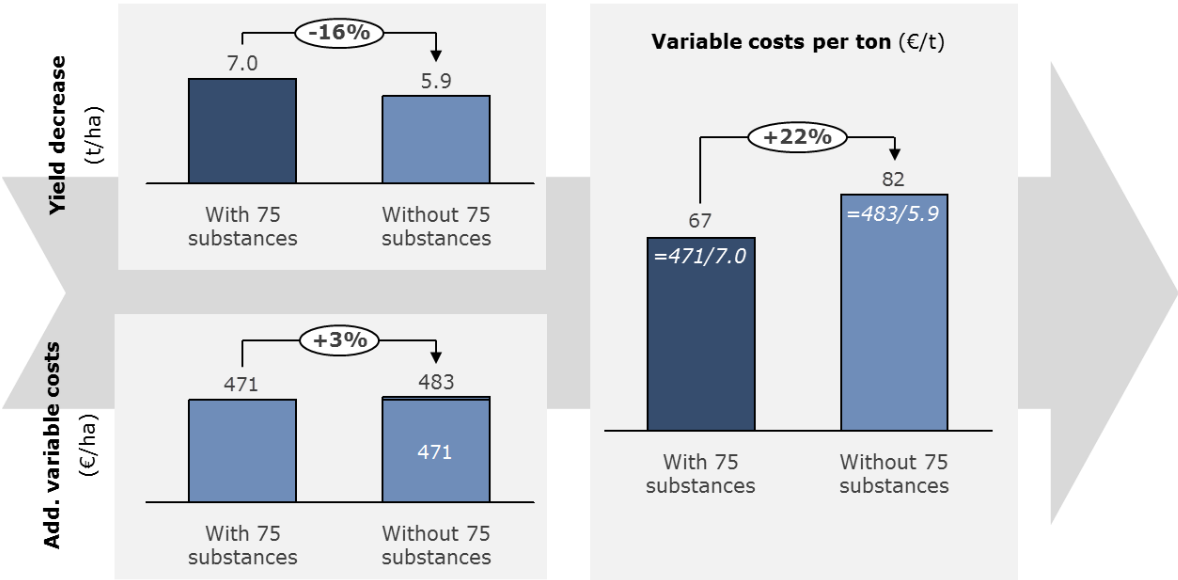



*Exhibit 3: Farm-level effects - French wheat*

Farmers in France currently harvest 7.0 tons of wheat per hectare. Without the 75 substances (see Appendix for full list) the yield is 16% lower, 5.9 tons per hectare. At the same time, production costs rise by 3% from the current €471/ha to €483/ha. That is mainly due to additional treatment to protect the crops against pests. Taking these two effects together, the costs per ton increase with 22%.

We subsequently apply the effects per hectare to the total agricultural production area of wheat in France[28].

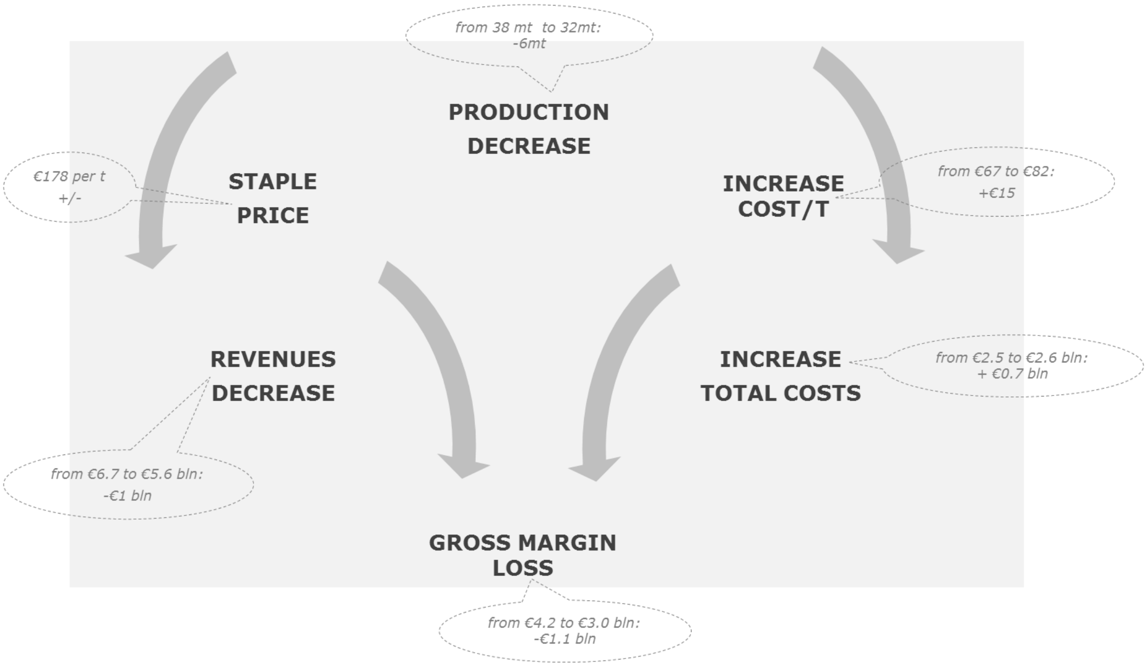



*Exhibit 4: Changes in farm income, costs & gross margins for French wheat*

The average annual production of wheat in France of the last five years was 38 million tons. A yield change of -16% (see Appendix for details) is expected to lead to a decrease of output, lowering the annual production without the 75 substances to 32 million tons. This

[28] This is possible as changes of yield effects incorporate national average levels of pests threats based on the experience of 2009-2013

affects farmers on the revenues as well as on the costs side. Assuming that the price that farmers receive for a ton of wheat is €178[29], the total revenues of French wheat farmers decreases from €6.7 billion to €5.6 billion. This is a loss of €1 billion. On the other hand, costs per ton rise due to additional crop protection and application costs of a total of €0.1 billion. The two effects taken together imply that French wheat farmers' gross margins[30] decrease by €1.1 billion from €4.2 billion to €3 billion. Put differently, due to the changing availability of crop protection substances, French wheat farmers are expected to lose out on €1.1 billion of gross margins.

### *Data & process*

The study uses data provided by technical institutes and representatives of farmers' organisations of the various countries (the table below depicts all parties involved). For a full list of sources please refer to the Appendix.

***Table 1: Overview of contributing parties***

| France | Germany | UK | Poland | Spain | Italy | NL | Austria | Ireland |
|---|---|---|---|---|---|---|---|---|
| UIPP | IVA | CPA | PSOR | AEPLA | Agrofarma | NEFYTO | FCIO | APHA |
| FNSEA | DBV | NFU | Kleffmann Group | AVA-ASAJA | Coldiretti | LTO | LK Oberöstrreich | CPA |
| Arvalis Institute | LK NRW | The Andersons Centre | Research Institute of Horticulture (IO) | UPA | Confi-agricoltura | Wageningen University | LK Niederösterreich | Teagasc |
| Institut Technique de la Betterave | Humboldt Forum | | Institute of Plant Protection (IOR) | Coorperativas Agro-Alimentarias | | Agrifirm | LK Steiermark | |
| Institut Français de la Vigne et du Vin | Bavarian State Research Center for Agriculture | | Poznań University of Life Sciences | AIMCRA | | KAVB, Agrodis | LK Burgenland | |
| CTIFL | DLR Rheinpfalz | | National farmer associations & unions[31] | COEXPHAL | | LTO-glaskracht, Agrodis | AWI-BMLFUW | |
| UNILET/ANPLC | Center for Hop research Hüll | | | ACOPAEX | | ZLTO | | |
| Cénaldi | | | | DCOOP | | IRS | | |
| Terres Inovia | | | | | | | | |

The execution of this study included intensive contact with the various parties[32] mentioned above. These experts followed the steps outlined in Exhibit 2 and also provided information regarding the yield, the ex-farm price and area affected in the current situation. In order to ensure consistency of data input from the various countries we held several face-to-face data validation and, at a later stage, result verification sessions.

After having provided this background on the methodology, the report first describes the farm-level income effects on EU-level and subsequently has separate country chapters for

[29] The price could be negatively affected by an additional loss in quality and could be positively affected by decrease in supply; for simplicity we assume a stable price

[30] Gross margin is defined as the difference of total revenues and total variable costs. The choice to report on gross margins has been made due to data availability: while the official sources on variable costs in various countries provide estimates in the same range information on fixed costs lack consistency

[31] 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

[32] Except from the UK were we used the insights from Anderson's "The effect of the loss of plant protection products on UK agriculture and horticulture in the wider economy"

all countries included in the scope of the study. On EU-level the study also elaborates on the value of the 75 substances with regard to employment, trade & competitiveness, land use and carbon footprint. In the appendix more details on the effects per crop/country as well as a detailed methodology description, substance list and references are presented.

# 3 EU-level impact

This section provides insights into the effects of banning the 75 crop protection substances on EU level for the staple crop covered in the study.

## 3.1 EU Farm-level income effects

EU-level results are based on weighted averages of the national figures. Exhibit 5 below depicts for which countries national information was available for the various staple crops analysed.

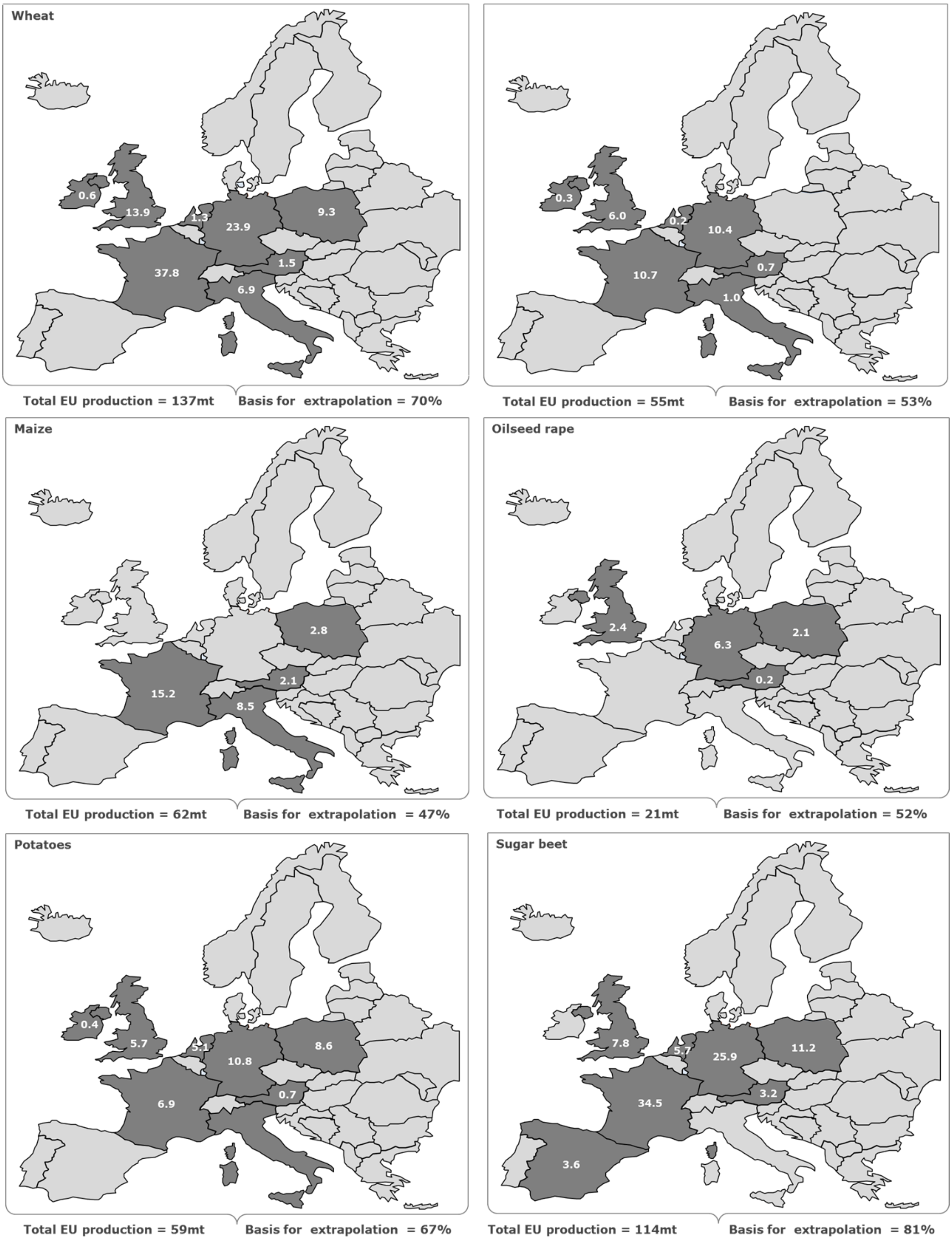



***Exhibit 5: EU-crop production basis for extrapolation (in million ton)***

The farm-level data for wheat, barley, oilseed rape, potato, sugar beet and maize on which the analysis is based, cover between some 50% and 80% of the total EU production of the particular crops. The higher the percentage of output covered on a country-by-country level, the more likely the extrapolation is representative for the EU as a whole. For details on the extrapolation please refer to the Appendix. Table 2 below summarizes the total crop production as well as the typical area a crop is cultivated on in EU28 for an average year[33]. These official information form the basis against which the changes are compared to.

*Table 2: Overview crop agriculture in EU28[34]*

| Crop | Area (million ha) | Yield (t/ha) | Output (million ton =Mt) | Price (€/ton) |
|---|---|---|---|---|
| **Wheat** | 25,8 | 5,3 | 136,7 | 172 |
| **Barley** | 12,6 | 4,4 | 55,4 | 152 |
| **Maize** | 9,0 | 6,8 | 61,5 | 180 |
| **Oilseed rape** | 6,4 | 3,3 | 21,3 | 349 |
| **Potatoes** | 1,9 | 31,7 | 58,8 | 170 |
| **Sugar beet** | 1,6 | 70,4 | 114,0 | 31 |
| **Vine** | 3,2 | 7,1 | 23,1 | 721 |

Table 3 below provides an overview of the immediate relative changes of tons harvested per hectare compared to a situation in which the best remaining alternative are used for the main European stable crops. You might notice that for some crops the yield changes for the UK are lower than in other countries. This is because for the UK we drew on The Andersons Centre's study. While we used the same substance list as that study, The Andersons Centre focused on substances at high risk to be lost only.

*Table 3: Overview short-term yield effect per country/staple crop*

| | EU average | France | Germany | UK | Poland | Spain | Italy | NL | Austria | Ireland |
|---|---|---|---|---|---|---|---|---|---|---|
| **Wheat** | -15% | -16% | -18% | -12% | -5% | X | -14% | -18% | -15% | -20% |
| **Barley** | -17% | -19% | -18% | -10% | X | X | -14% | -18% | -20% | -20% |
| **Maize** | -10% | -8% | -2%[35] | X | -5% | X | -14% | X | -10% | X |
| **OSR** | -18% | -5%[35] | -17% | -18% | -20% | X | X | X | -25% | X |
| **Potatoes** | -20% | -10% | -29%[36] | -12% | -20% | X | -40% | -15% | -25% | -25% |
| **Sugar beet** | -37% | -35% | -49% | -12% | -30% | -44% | X | -36% | -35% | X |
| **Vine** | -22% | -22% | X | X | X | -13% | -30% | X | -20% | X |

We analysed the added value of the 75 substances for all crops and countries in scope of this study following the approach discussed above. Exhibit 6 presents the results for farmers in the EU. All details for crops/countries can be found in the Appendix.

[33] Based on Eurostat farm statistics 2009-2013
[34] Average prices for EU in 5-year period
[35] note the yield effect refers to banning NNIs only
[36] given data availability, compared to untreated situation

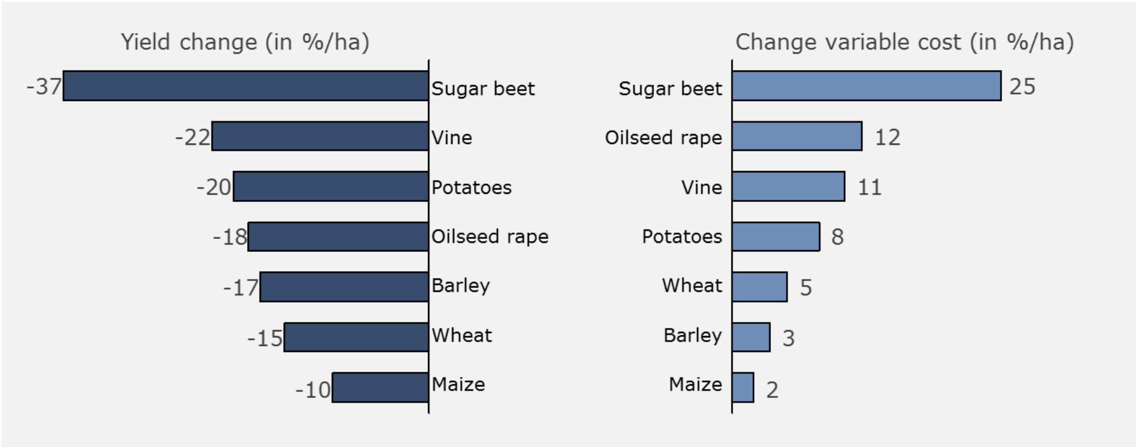



***Exhibit 6: Yield and variable costs changes (in %/ha)***

Depending on the crop, the utilisation of the 75 substances allows EU farmers to harvest from 10% to some 40% more tons per hectare than without the substances. With the 75 substances weed, disease and pest pressure on the crops is lower, allowing the crops to grow larger. At the same time, variable costs are with the utilisation of the 75 substances up to 25% lower than without.

Considering long-term resistance effects (not shown in Exhibit 6) the value of the 75 substances is expected to be even higher. Depending on the number of alternatives that remain available as well as their effectiveness, pests might become immune to the treatment with the remaining alternatives. According to the national farm experts, for cereals this long-term effect is estimated to add an additional 5% of yield change. For sugar beet, potatoes and vine this is about 20% additional yield effect (for full reference of farm experts refer to the Appendix).

The other effect of changes in the farming toolbox concerns the variable production costs. The 75 substances reduce the variable production costs by amongst others improved effectiveness. For most staple crops the effect adds less than 10% additional variable costs, however for sugar beet production costs can increase by some 26% per hectare.

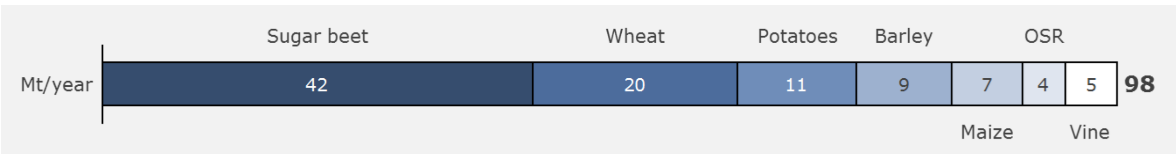



***Exhibit 7: Output changes (in million ton per year)***

In total, EU crop output is currenty 98 million ton (=Mt) more than in a situation without the use of the 75 substances. In other words, the benefit of having the 75 substances in the farming toolbox is 98 million ton additional crop output, 42 million tons of which are sugar beet. These results are driven by the yield change (see Exhibit 6) as well as the area on which they are typically cultivated (see Table 2).

To provide some perspective, the 98 million ton crop output at risk represents 21% of the EU's current total production of the 7 key crops of in total 471 million tons.

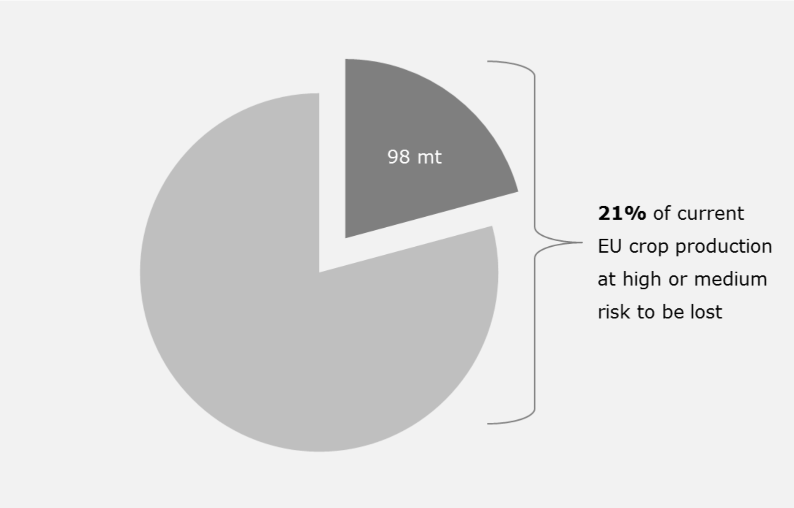



*Exhibit 8: Share of EU production (volume) of 7 staple crops at risk*

Applying the short-term yield and costs changes discussed above to the current situation provides insights into the changes in terms of the gross margin of EU farmers.

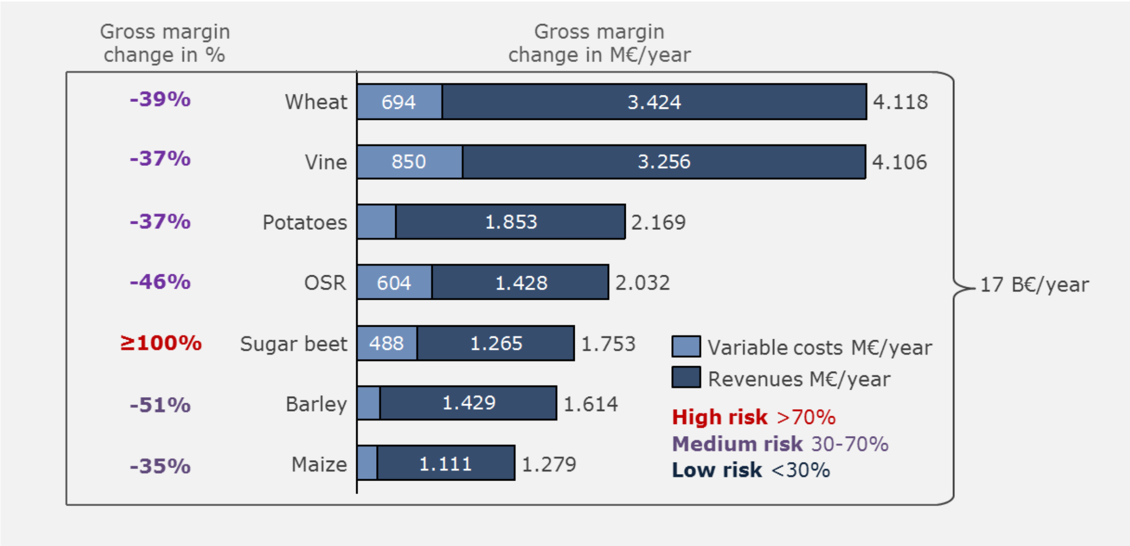



*Exhibit 9: EU-wide changes in revenues, costs & gross margins*

To summarize, in the short run EU-farmers of the crops considered in this study would lose €17 billion gross margin. Vine and wheat are the crops that lose out most, both ca. €4 billion per year. In terms of profitability, sugar beet cultivation is most affected. The total change is mainly driven by reductions in farm income (€14 billion) consequently to fewer output generated. To a lesser extent, additional variable costs of €3 billion influence the total result as well. The results further imply that farmers lose between 35% and 100% of gross margin. Especially for sugar beet, it is questionable whether the crop would still be cultivated in the EU for purposes other than for crop rotations.

To elaborate on the farm income results above, farmers put a lot of effort into stabilizing their yields and anticipating on price changes but incomes are subject to volatility. Among others, pest pressure has a large impact on annual yields. Its degree and variation is largely driven by weather conditions and therefore vary widely per year. Also changing climate conditions add to the extent and variation.

The current crop protection toolbox helps farmers to react fast and effective on upcoming pests and keep yield volatility under/in control. Several crop experts involved in the assessments indicated that an increase in yield volatility and therefore crop prices is an important additional effect. This is not examined in detail in this assessment, but the Exhibit below exemplifies the case of winter wheat in Ireland. Research from Teagasc, Irish public agricultural research, show that not only average yield vary each year, but also break-even yield. This, as the prices of farm inputs and its use vary each year depending on weather conditions and pest pressure. A smaller crop protection toolbox will not only affect the extent of the yields, but also downward volatility during years with challenging farm conditions.

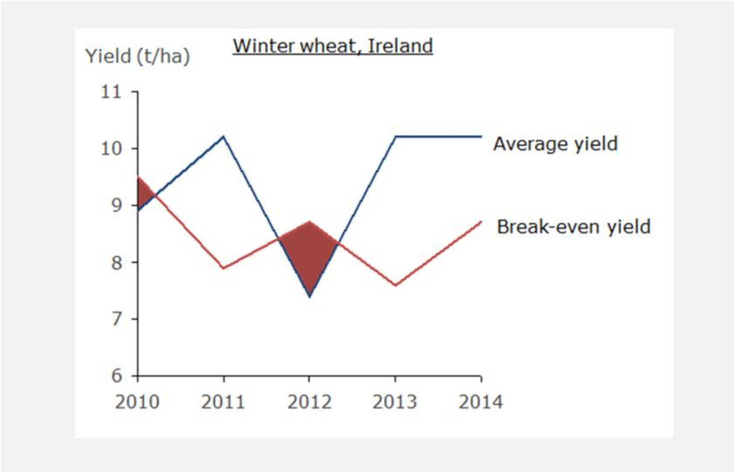



***Exhibit 10: relation between prices of cereals and cereal-based products***[37]

## 3.2 EU Farm-level employment effects

Within the 9 countries in the study, according to official statistics 3.5 million jobs relate to crop agriculture[38]. Allocating these 3.5 million jobs to the various crops based on the value of the crops reveals that 1.5m jobs relate to the 7 staple and 24 specialty crops in scope of the study (see Exhibit 11).

[37] Crop Production in Ireland and impacts of Regulation 1107/2009, Teagasc 2015
[38] Source: Eurostat, for the Netherlands LEI/ WUR

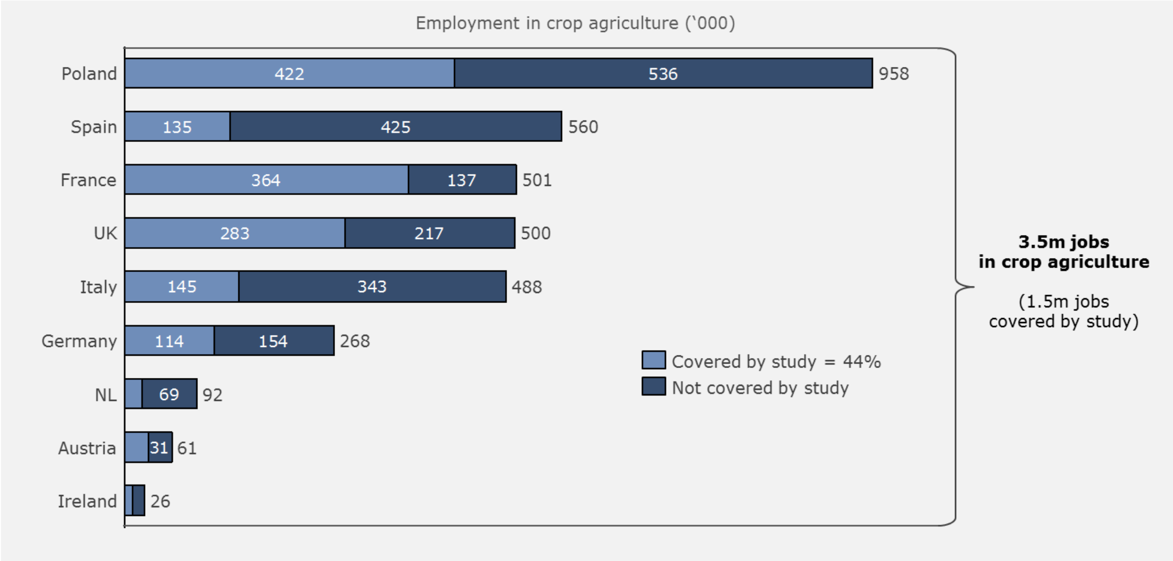



***Exhibit 11: Total employment in crop agriculture (in '000)***

As Exhibit 9 shows, the 75 substances have a large influence on the economic viability of the cultivation of certain crops. This also translates into certainty of employment for jobs related to these crops. Exhibit 12 combines the impact on economic viability from Exhibit 9 and the amount of jobs in crop agriculture from Exhibit 11. For jobs related to the crops and nice countries covered by the study the exhibit consequently provides an overview of the contribution of the 75 substances to the certainty of employment. Three risk categories are distinguished: low, medium, high[39]. This depends on the crop's gross margin variation. The results show that some 45% of crop agriculture employment or some 670.000 jobs are at high or medium risk. Of the 1.5m jobs in scope, 313.000 or some 17% have a high risk of job loss. Most of the jobs at high risk are at German and Spanish farms. In Spain, this is driven by the high yield losses in tomato, citrus, olives and cherry, while the 'thin' margins in Germany for wheat, barley and sugar beet underline the contribution of the 75 substances.

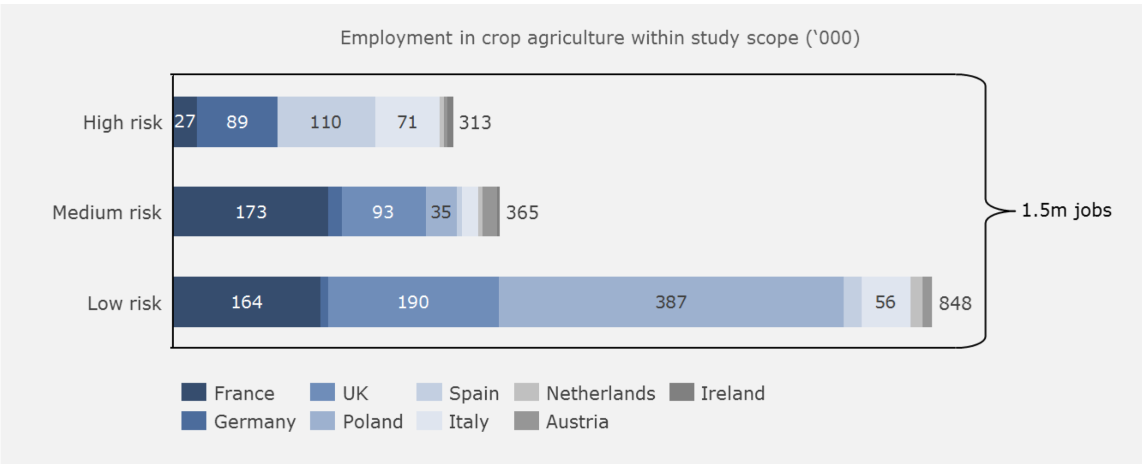



***Exhibit 12: Dependency of crop agriculture employment on 75 substances***

The risk of job loss per crop depends also on the ability of the farmers to shift to alternative crops and the impact the 75 substances have on the economic viability of these alternatives. E.g. if the profitability of cultivating wheat is reduced to a large extent,

[39] high=above 70%, medium=30-70%, low=up to 30% gross margin loss

cultivating barley might still be profitable. In that case jobs related to wheat cultivation might not be affected. This might be different for specialty crops where first of all switching involves higher costs and secondly also alternative crops might greatly be affected by changes in the farming toolbox. To illustrate this point, the alternatives for producing fruit trees, bell pepper and tulip bulbs in the Netherlands use similar crop protection toolboxes. Therefore, we expect that producers of these crops have limited ability to move to other crops, which underlines the high risk of job loss.

### 3.3 EU- self-sufficiency & trade effects

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

The EU is currently a net exporter of wheat, barley and potatoes. On average, every year some 13Mt of wheat, 3Mt of barley and 1Mt of potatoes are exported to countries outside the EU. Banning the 75 substances leads to a situation in which, instead of exporting, the EU will need to import these crops to satisfy its consumption needs. As on average the yield for wheat decreases by 14%, the total wheat production decreases from 137Mt to some 117Mt. This implies that the EU will have to import 5Mt to cover the local demand of 123Mt. For barley and potatoes the trade deficits would be 6Mt and 10Mt respectively.

With the 75 substances on the market the EU is consequently less dependent on imports. It is important to keep in mind that while for cereals imports are readily available, importing potatoes is given availability on the world market and transportation issues with this crop less straight forward.

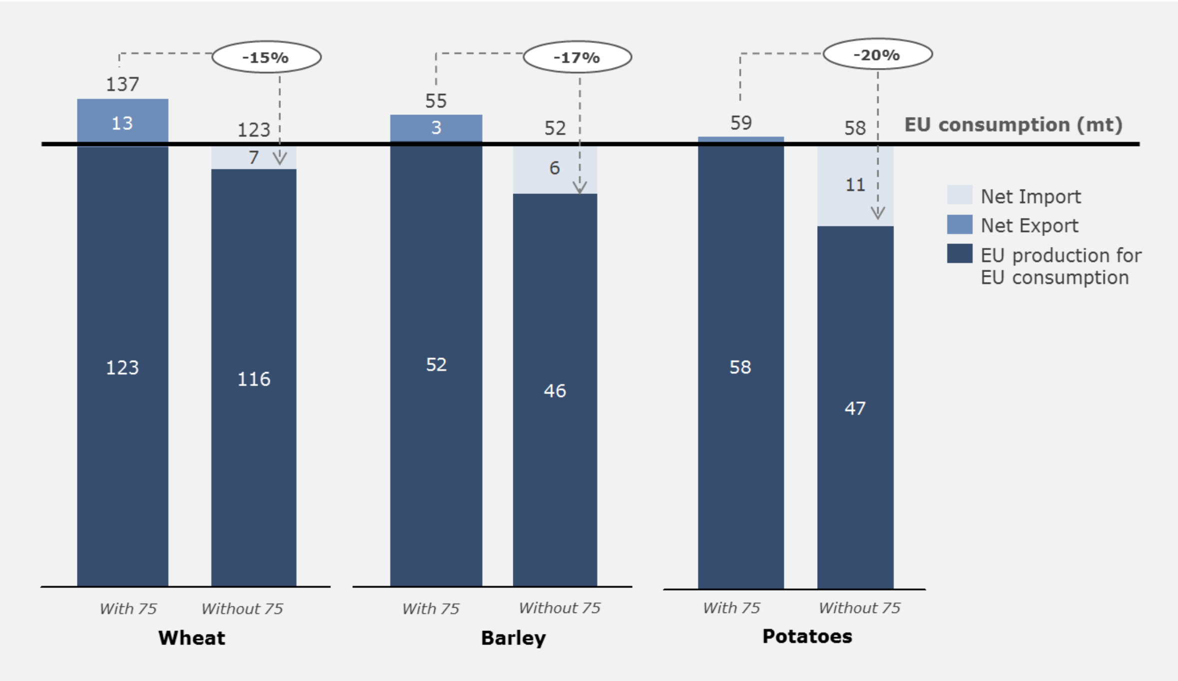



*Exhibit 13: Trade balance shift for currently net exported crops (Mt)*

The EU's demand for maize and oilseed rape is even with the 75 substances partly fulfilled by imports. Out of the 65Mt of maize consumed in the EU annually some 4Mt are currently imported from outside the EU. Based on the analysis of yield changes we estimate that this will increase by 6Mt to a total of 10Mt needed to be imported in case the 75 substances are banned. This implies that imports more than double. For oilseed rape, removing the 75 substances from the farming toolbox leads to an additional consumption gap of 4Mt, summing to a total of 7Mt of imports (+115%). The EU is currently self-sufficient for sugar beet and vine. This will change in case the 75 substances are not available anymore, requiring the EU to import some 42Mt sugar beet and 4Mt vine from outside.

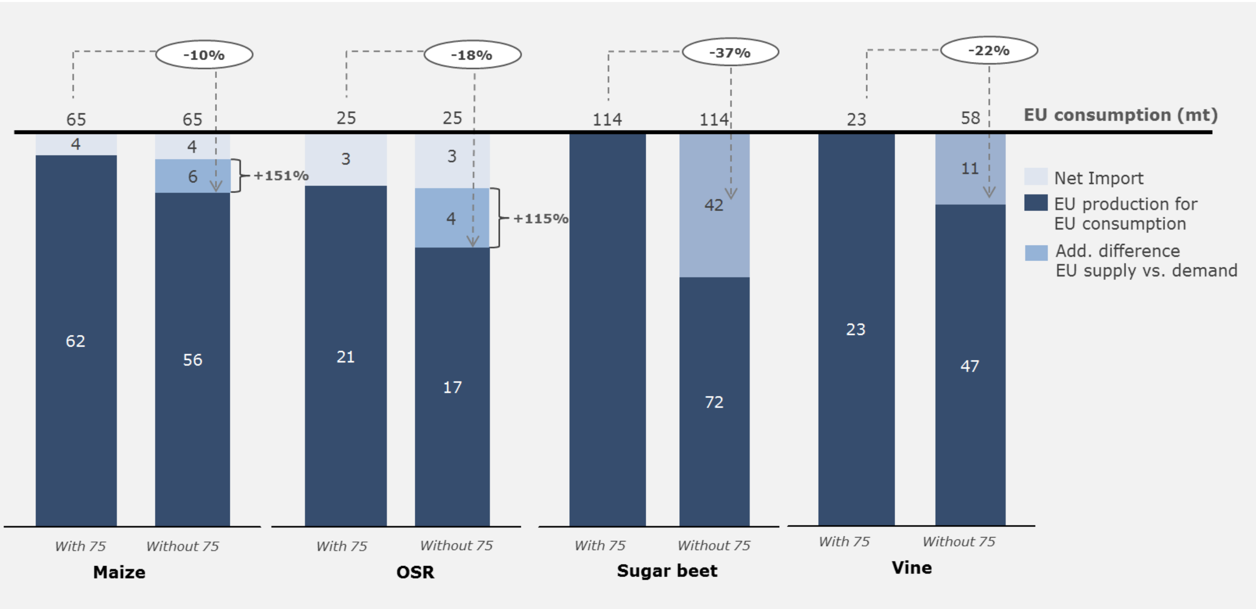



***Exhibit 14: Trade balance shift for net imported crops (in million ton)***

### 3.4 Broader ripple effects

Lower production and the trade balance shifts of EU's largest crops presented in Exhibit 13 and Exhibit 14 will affect both EU and worldwide trade of agro-commodities. On their turn, these consequences will also trickle down the agri-food chain up to the consumers. Based on other research, we zoom in on cereals to explain some of the potential broader effects in Europe.

The crops wheat, barley and maize represent two-thirds of all cereal crops produced and consumed in the EU[40]. Of these, wheat is also EU's largest crop, while the EU is also the largest producer globally (20% of total). Therefore 21 Mt less EU wheat (-15% EU yield) has a significant effect by decreasing global production by 3%. This has implications in as well as outside the EU.

[40] European Commission, Eurostat

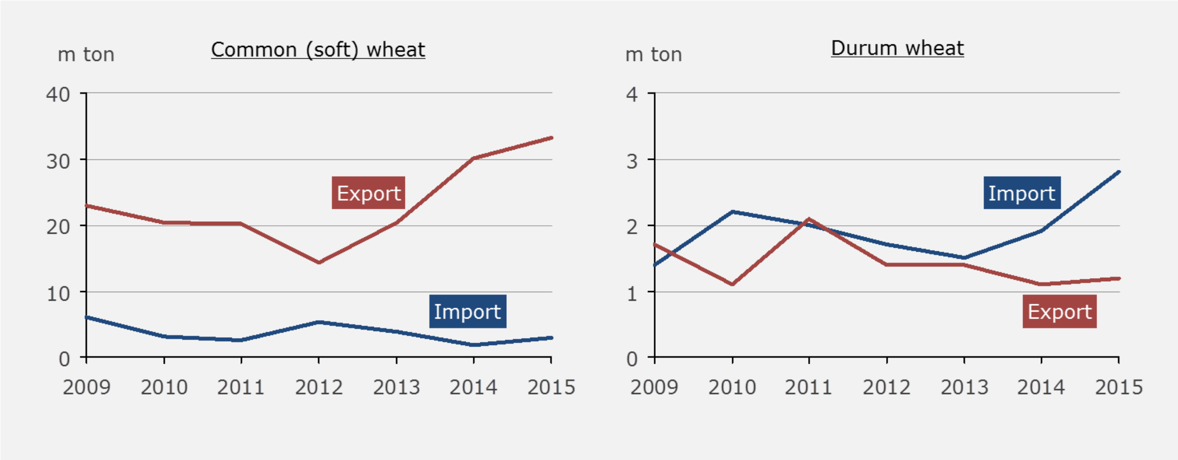



**Exhibit 15: Common and durum wheat trade in the EU**

The exhibit above shows the EU trade of two key types of wheat: durum and common (soft) wheat. Without the 75 substances, the EU will be move from net export to net import in soft wheat for mostly food and fees use. Regarding durum, the EU will increase its current imports for mostly human consumption.

In reality, export and import situation varies widely per EU country. The two main soft wheat 'surplus countries' Germany and France represent 76% of all EU wheat exports and supply many other EU countries[41]. The 75 substances support more than half of France exports and all exports in Germany[42]. Without these, France will be the only significant exporter in Europe and most other EU countries will be more dependent on producers outside the EU. Currently, half of EU soft wheat exports are provided to Middle East & Northern Africa (see the exhibit). These countries could face higher import prices by switching to other sources.

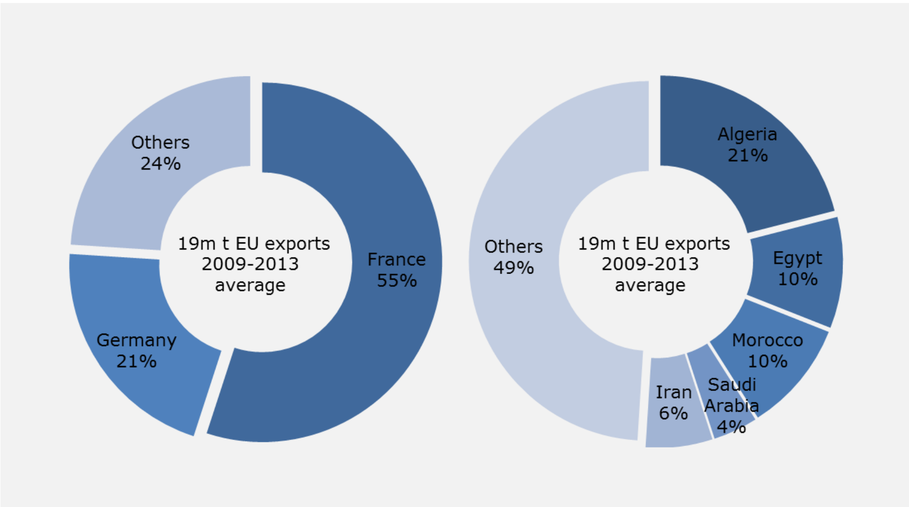



**Exhibit 16: Common wheat exports by EU exporting countries (left) and destinations (right)**

Lower durum wheat production will mostly affect Italy, the main producer and consumer in EU. Currently, the country imports 30% of its durum for producing its pastas and other food

[41] DG Agri, HGCA 2013
[42] See Exhibit 16, average 2009-2013 exports of France is 10.5 m t (55% of 19m t), Germany is 4 m tons (19% of 19m t). The 75 substances support 6 m t in France (see Chapter 4) and 4 m t in Germany (see Chapter 5).

products, and represent almost all imports of the EU's total durum wheat imports (1.5 Mt, 80% of EU imports).

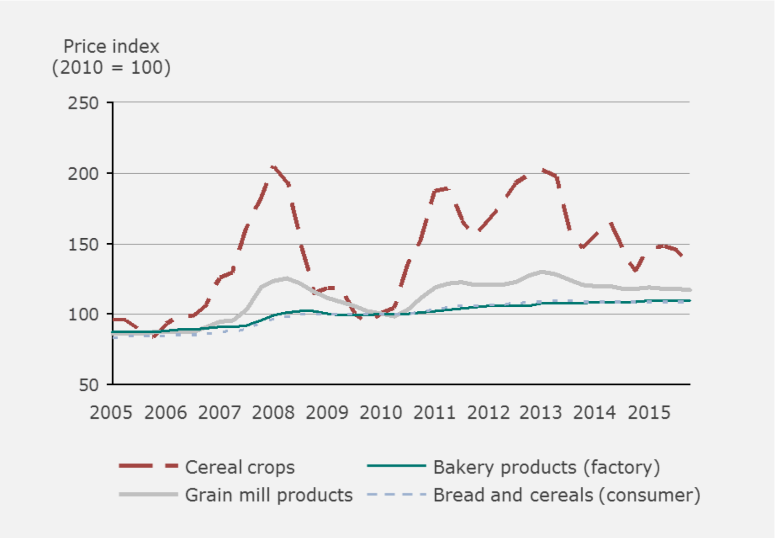



***Exhibit 17: relation between prices of cereals and cereal-based products***

In the EU, 44% of wheat is used for food products, 41% for feed and the other 15% mostly for industrial use[43]. As its main users, the wheat procurement costs for the livestock sector and food processors (millers) will increase as both local and imported prices are likely to rise with 3% less global production. Furthermore, wheat import prices could be higher in the short run before the wheat market balances out the changes and price differences in the market.

The Berlin-based Humboldt Forum researched the potential price changes of cereals in EU in case of lower productivity. Based on this, 15% lower EU yield translates into 5-7% higher wheat prices[44]. IFPRI, a leading food policy research body, expects that all cereal prices and other key agro-commodity will steadily increase in the next decades. Any price increase implies an extra increase on top of the current trend.

According to EC food price monitoring, prices typically trickle down to consumers. However, the relative share of wheat in cereal-based products is relatively small. For example, wheat price represents about 10-15% of the average bread price for the consumer. In total, every wheat price increase of EUR 10 could potentially increase EU consumer costs for bread by EUR 700 m and leaking out of the European economy.[45]

### 3.4 Land use

The previous section discussed the implication of having the 75 substances available for farm income and self-sufficiency of the EU. This section elaborates on the land use effects.

Farmers in the EU28 cultivated 176 million hectares of land (the utilised agricultural area) in 2010. This represents two fifths (40%) of the total land area of the EU28[46]. The key staple

[43] DG Agri, cereals balance
[44] HFFA 2013
[45] EUR 10/t wheat price change is ±5% of the wheat price. The wheat price represents 10-15% of the average bread price of EUR1.50/bread. Therefore, a wheat price increase could add 1cents per 500 grams bread. In total, this sums up to EUR 700m for 38m t bread in Europe (AIBI Bread Market Report 2013, Jan 2015).
[46] Eurostat, Agricultural Census 2010

crops wheat, barley, maize, sugar beet, oil seed rape, potatoes and vine make up some 61 million hectares of the total area used for agriculture.

With lower average yields per hectare (see above) additional land would be needed in order to produce the same amount of output. Using the new average EU-yields as starting point, this means that 9 million additional hectares would be needed to produce the same tons of staple crops, an increase of 15% compared to the current situation. This equals one third of the total agriculturally used area in France or the current areas used for cultivation of the key staple crops in the UK and Poland together.

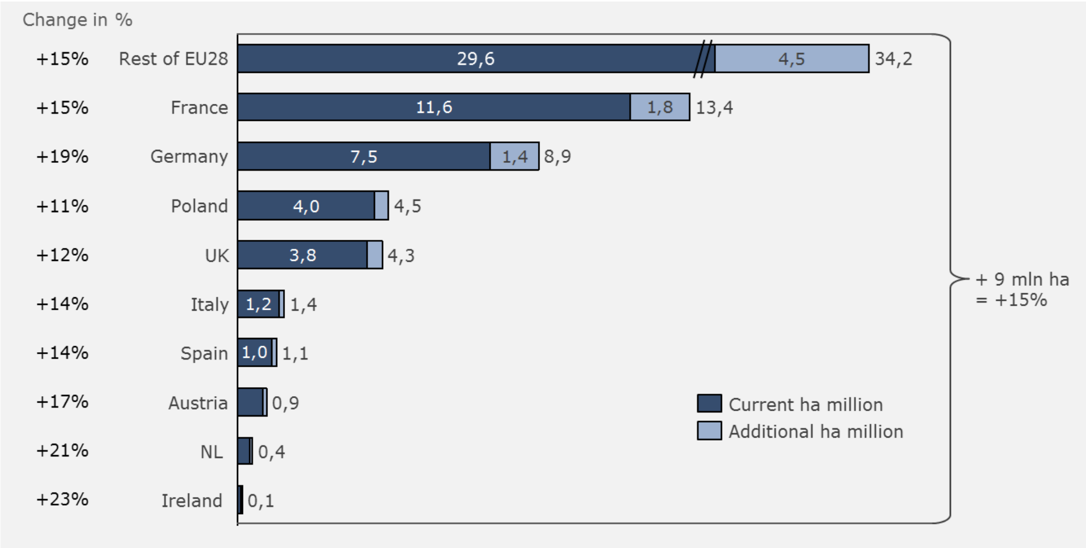



***Exhibit 18: Current & additional area for key staple crops (in million hectares)***

The relative change per country depends amongst others on the share of the total agricultural area of a country of the key staple crops analysed in this study.

Given the limited availability of farmland in the EU it is uncertain whether this additional farmland would be on EU territory. Also in other areas of the world farmland is competing against the construction of roads, houses and other urban needs as well as being lost due to erosion[47]. Decreases in productivity per hectare hence add pressure on the competition for land.

It is also important to note that the most productive land is currently already been exploited. Most probably the additional land, if any, will not be so productive unless the technology allows so.

## 3.5 Carbon footprint

In the recent discussions around climate change carbon footprint is gaining more and more attention of the public.  In light of this study, carbon footprint goals of the European Union are helped made possible by the use of pesticides. That is for two reasons: the effect of the 75 substances on land use and the treatment frequencies are important drivers of the carbon footprint of crop cultivation.

Looking forward, with the 75 substances phasing out, there are two possible scenarios regarding the way in which any gap between local production and local demand can be filled. Firstly, more land within the EU28 could be made available to produce the crop

[47] Problems of agriculture – loss of land and decreased varieties

outputs and secondly, additional amount of crop output could be imported from outside of the EU. Both scenarios have implications for the footprint of the crops consumed in the EU28. Exhibit 19 provides an overview of relevant sources of emissions for both scenarios.

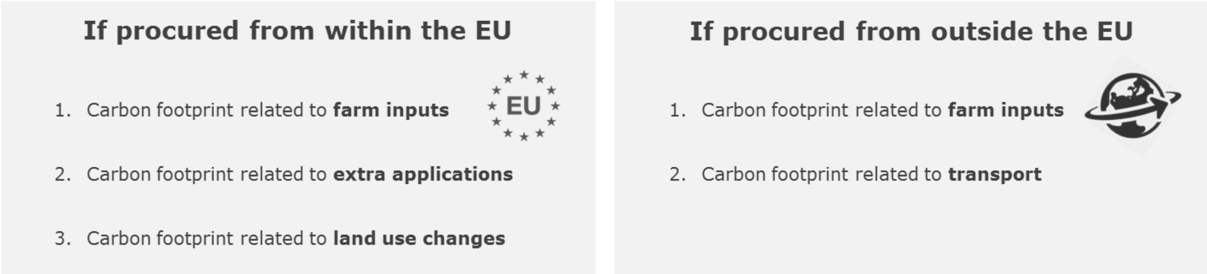



***Exhibit 19: Carbon footprint effects related to changes in farming toolbox***

Currently, the cultivation of wheat, barley, maize, oilseed rape, potatoes, sugar beet and vine in the EU causes the emission of 83 million ton CO2 equivalent. The two main drivers for this are the use of fertilizers and diesel use. The other emissions on the current area arise from other farm-inputs e.g. when crops are dried. This constitutes the current situation without the 75 and is depicted on the left hand side of Exhibit 20 marked as 'current area'.

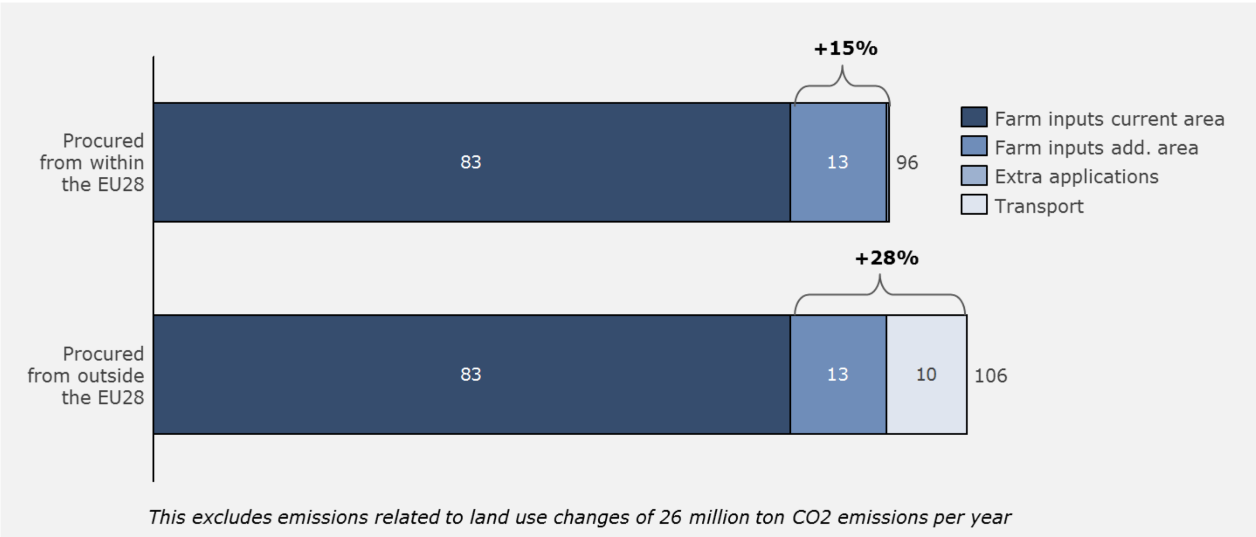



***Exhibit 20: Carbon footprint of key staple crops related to changes in toolbox (in million ton CO2 eq.)***

In the upper scenario in which additional land within the EU is used to compensate for lower yields per hectare the footprint of the key staple crops could rise by 15% from using a larger area, changes in the amount of farm inputs and the treatment frequency. These are annual effects. In addition, if extra land has to be converted to agricultural area there would be annual emissions of additional 26 million tons for the coming 20 years[48]. The total change in the overall footprint of the 7 key staple crops would consequently rise by about the half (47%[49]).

The other option to fulfil European crop demand is to import. In that case the emissions of crop output would rise by 28%, some 23 million ton. We assumed that all crops are to be

[48] 57 t CO2 eq. emissions for biomass on one hectare with conversation factor of 20 years (IPCC Guidelines Vol. 4: Agriculture, Forestry and Other Land Use (AFOLU))
[49] 47% = (83+13+26)/83

imported from the US[50]. In terms of yield per hectare and farm inputs used, crop production in the US is similar to the EU. The main difference between the footprints of crop produced in the US and in the EU and then also the emissions related to transport. This might be different for crop imports from other parts of the world (e.g. different fertilizer use in Brazil). If additional land has to be converted to agricultural area to fulfil the EU's additional demand, total annual emissions of imported crops including emission from land use changes might increase by 59%[51] or 49 million ton. For details on the methodology please refer to the Appendix.

To provide some perspective, the EU's carbon footprint would increase by 1%. The total annual carbon emissions of the EU sums to some 4,600 million ton CO2 eq.[52]. Agriculture constitutes some 10% or 443 million ton of that, non-livestock agriculture relates to 295 million ton. This study focuses on the key staple crops, good for about 30% of all non-livestock agricultural emissions. This corresponds with the share of key staple crops of total agricultural area used in the EU (see description land use). In case of the lower yield being compensated by more yet to be converted agricultural area in the EU, emissions for these crops would rise by 45% or if imported by 57%.

In monetary terms, given a price of €10 per ton of carbon, the additional emission could sum to €500 million[53] for imported crop output produced on converted agricultural land.

After elaborating on socio-economic and environmental implications on EU level, the sections that follow present the key effects on country level.

[50] Distance of 7.895km with 14g of emissions per km/ton
[51] 47% = (83+13+10+26)/83
[52] Eurostat Greenhouse gas emission statistics
[53] €10 x 50 (13+11+26) million ton CO2 eq. = €500 million; €10 per ton of carbon might be a conservative estimate; average ETS price 2009-2013

# 4 France

## 4.1 French key effects

With the current farming tool box available, the French production of **7 key staple crops**[54] is **23Mt higher** and generates **€5 billion more value** per year if the 75 substances at risk are not included.

In addition, the **economic viability** of the production of **specialty crops**[55], **2Mt** of output and **€1 billion** would be challenged without the 75 substances.

Further results include:

- In the short run, wheat, barley, maize, potato and vine would face 10-20% lower yields, while the yield of sugar beet decreases by 35%;
- At the same time, variable production costs for the staple crops would increase by up to 10% per hectare;
- Yield loss for specialty crops would range from 60-100% and variable production costs increase by up to 50%.
- In value, vine would be most affected with €2b of value loss, while sugar beet would show the largest decrease in profitability (-60%) of the staple crops;
- French crop agriculture employs 500,000 direct jobs of which 364,000 jobs relate to the crops covered by the study.

## 4.2 Agriculture in France

Indicating the relative importance of the agricultural sector in France, agriculture makes up 1.7% of the French GDP and some 3% of the total employment is with the sector. France is among the largest agricultural exporters in the world and a major agricultural power in the EU, accounting for 16% of all its agricultural land. Fifty per cent of the French territory is agricultural land, while 30% is covered with forests. More than half of French farms are mostly devoted to animal production. France accounts for 17% of the total cow milk collected in the EU and 12% of the total meat produced (20% for cattle, 12% for sheep & goats and 9% for pigs).[56]

[54] Wheat, barley, potato, maize, rapeseed, sugar beet and vine
[55] Beans, apples and carrots
[56] INRA science and Impact, Agriculture in France

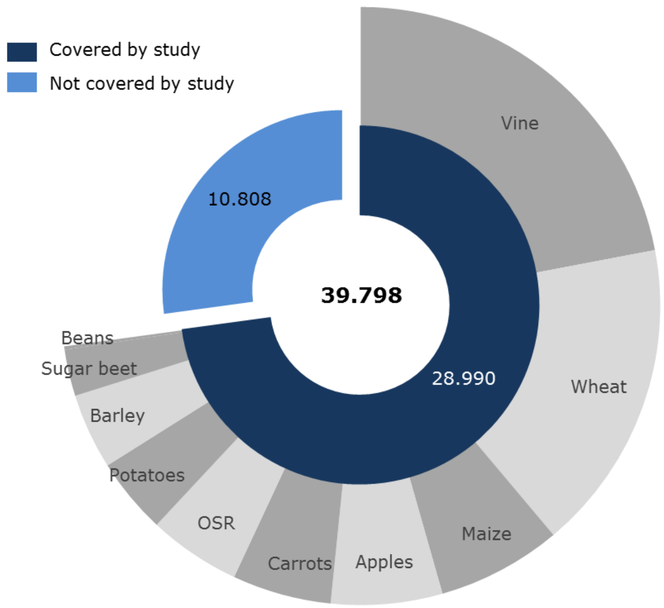



*Exhibit 21: French agricultural production value (in € million)*

The total average annual French agricultural production value[57] of the last five years was some €40 billion. The study focusses on the staple crops wheat, barley, grain maize, oilseed rape, potatoes, sugar beet and vine. In addition, the minor crops apples, carrots and beans are included for France. The selection is based on data availability and relevance of the crops. As Exhibit 21 shows, the crops covered by the study represent some 73% (28.990/39.798) of the total French agricultural production value.

*Table 4: Overview French crops[58]*

| 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 |
| **Oilseed rape** | 1.507 | 3,4 | 5,1 | 388 |
| **Potatoes** | 159 | 43,4 | 6,9 | 237 |
| **Sugar beet** | 387 | 89,2 | 34,5 | 29 |
| **Vine** | 768 | 5,9 | 4,5 | 1.935 |
| **Apples** | 44 | 28,0 | 1,8 | 822 |
| **Carrots** | 13 | 56,4 | 0,6 | 636 |
| **Beans** | 28 | 11,8 | 0,3 | 224 |

## 4.3 Effect of 75 substances on yield and variable costs

Exhibit 22 provides an overview of the consequences related to possibly losing the 75 substances for the staple and specialty crops in France.

[57] Eurostat; Economic accounts for agriculture - values at current prices
[58] Eurostat; Farm statistics, average 2009-2013

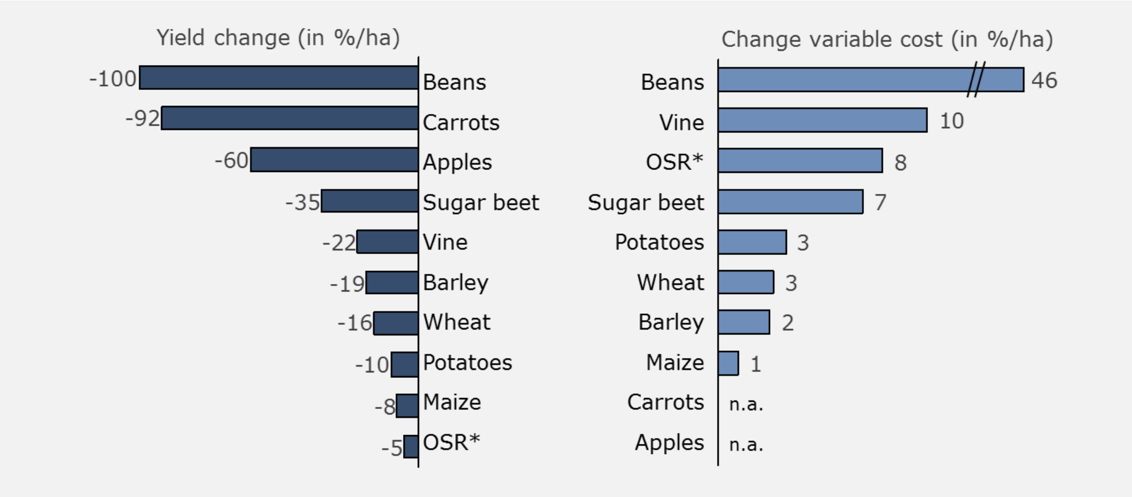



***Exhibit 22: Short-term yield and variable costs changes (in %/ha)***

For the staple crops, the 75 substances allow farmers to harvest some 10-35% more tons per hectare than without the substances. With the 75 substances weed, disease and pest pressure on the crops is lower, allowing the crops to grow larger. Effects for durum wheat, oats and silage maize are expected to be in the same order of magnitude: some 17%, 15% and 8% respectively additional yield related to using the 75 substances per hectare. For oilseed rape, as a consequence of data availability, only the added value of NNIs has been taken into account (5% yield benefit).

For the longer term, the 75 substances have an additional value as they support the avoidance of resistance effects. The risk of emerging resistance effects varies per threat: resistance around fungal diseases mainly affects cereals and potatoes while weed resistance mainly affects cereals and sorghum. For cereals the additional long-term yield effect sums to some 3%, for potatoes to 5%, for sugar beet to 10%. For vine the total short and long-term value of the 75 substances is up to 50%.

The other change is regarding to variable costs. The 75 substances reduce the variable production costs by amongst others improved effectiveness. For most staple crops the effect adds less than 10% additional variable costs, however for specialty crops these costs can increase by up to 50%. Fewer pesticides are applied less frequently. Put differently, the treatment frequency will increase (+ 0.15 treatment/ha on maize, to + 0.85 treatment/ha on barley in average) in the case of the farming tool box being less well equipped.

For potatoes, experts also expect a large quality effect. This might affect the ex-farm price for which farmers can sell their output. In some cases, this can cause extensive damage preventing the sale of potatoes to a large extent.

The size of the farming toolbox is not only important for crop cultivation but also for seed production. For the toolbox of seed producers the EU legislations might cause a reduction of active substances from 77 to 51 which relates to a reduction from 717 to 263 products used[59]. This influences the quality of seeds produced, likely to cause ripple effects to industries using the seeds. That is as seed quality plays a role in crop protection at the beginning of the cultivation cycle. Showing this, a 2011 study by the FNAMS estimates that 90% of diseases present at an early stage can be directly controlled through the intrinsic quality of seeds in terms of health or indirectly with seed treatments (13 crops studied).

[59] FNAMS

## 4.4 Effects on incomes

The lower yields (see Exhibit 22), given a fixed arable area, imply that the overall crop production in France will decrease without the 75 substances. As Exhibit 23 shows, in total French farm output is currently 23 Mt higher for staple crops and 2 Mt for specialty crops.

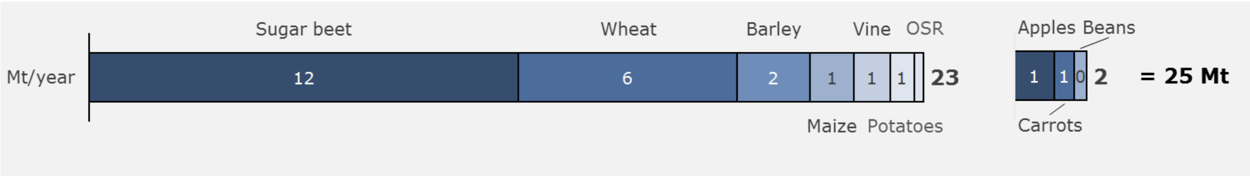



*Exhibit 23: Output changes (in Mt/year)*

Compared to other crops, the 75 substances have relatively the largest influence on the amount of sugar beets produced in France (12 Mt/year). This is driven by the relatively large value the 75 substances add to sugar beet cultivation (35% extra yield) as well as the relatively large area where sugar beet is cultivated in France (387.000 ha).

Depending on ex-farm prices and the changes in variable costs, the gross margins earned on cultivating these crops is affected as well.

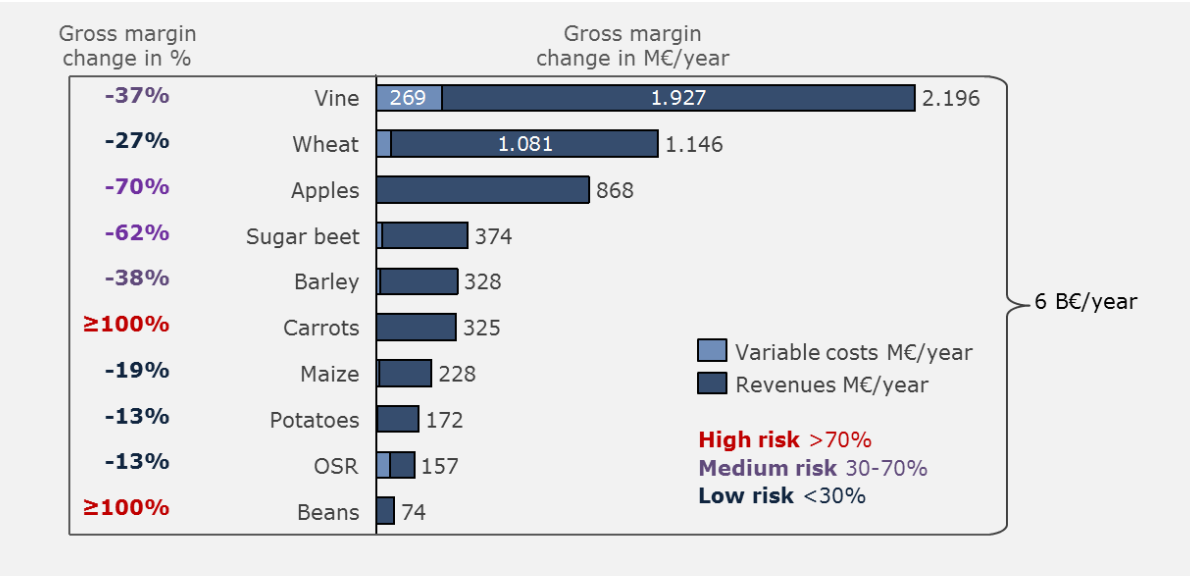



*Exhibit 24: Gross margin effects (in € million/year)*

As shown, in total French farmers gain €6 billion gross margins per year from having the 75 substances. The total change between the two scenarios is mainly driven by revenue losses (€5.4 billion) and to a lesser extent influenced by variable costs (€0.5 billion). Gross margin gains in vine and wheat make up the majority of the overall effect. In value, vine would be most affected by a decrease of the farming tool box with €2 billion in value loss, while sugar beet would show the largest decrease in profitability (-62%) of the staple crops. Overall the largest profitability of carrots and beans is most affected. As the production of beans is assumed to decrease by 100%, there are no additional variable costs. Producer prices for sugar beet per ton are relatively low compared to prices of other crops, therefore the total revenue effect for sugar beet is not among the largest. As explained earlier, the results do not take any crop rotation effects into consideration.

As the gross margins earned on cultivating specialty crops like beans, carrots and apples decrease significantly, there is the chance that cultivation of these crops will no longer take place in France. This is because these crops are at a high risk of losing their economic viability.

For effects on jobs, land use and the carbon footprint please refer to the overall EU chapter.

# 5 Germany

## 5.1 German key effects

With the current farming tool box available, the German production of **5 key staple crops**[60] is **23 Mt higher** and generates **€2.4 billion more value** per year if the 75 substances at risk are not included.

In addition, the **economic viability** of the production of **specialty crops**[61], **34.000t** of output and **€63 million** would be challenged without the 75 substances.

Further results include:

- The economic viability of the staple as well as specialty crops would, without the 75 substances, be put under pressure;
- Wheat, barley, maize, potato would face 20-30% lower yields, while the yield of sugar beet decreases almost 50%;
- At the same time, variable production costs for the staple crops would increase by about 5% per hectare, for sugar beet and onions by some 30%;
- The 75 substances add significantly much value to specialty crops;
- In value, wheat would be most affected with €0.7b of value loss;
- German crop agriculture employs 268,000 direct jobs of which 114,000 jobs relate to the crops covered by the study.

## 5.2 Agriculture in Germany

Indicating the relative importance of the agricultural sector in Germany, agriculture makes up 0.8% of the German GDP and some 2% of the total employment is with the sector. With around 17 and 11 million hectares respectively, agriculture and forestry take up more than half of the area of Germany. With 59 percent of the total crop growing area, grain cultivation takes up most of the arable land, which makes it the most important crop. German agriculture has achieved a massive increase in productivity over the last decades, a fact which is reflected in increased cereal yields per hectare and the increasing milk output of cows. In 1950, a farmer produced enough food to feed 10 people. Today, this figure has risen to around 140 people (without animal feed from abroad).

[60] Wheat, barley, maize, OSR, potatoes and sugar beet
[61] Onions, hops

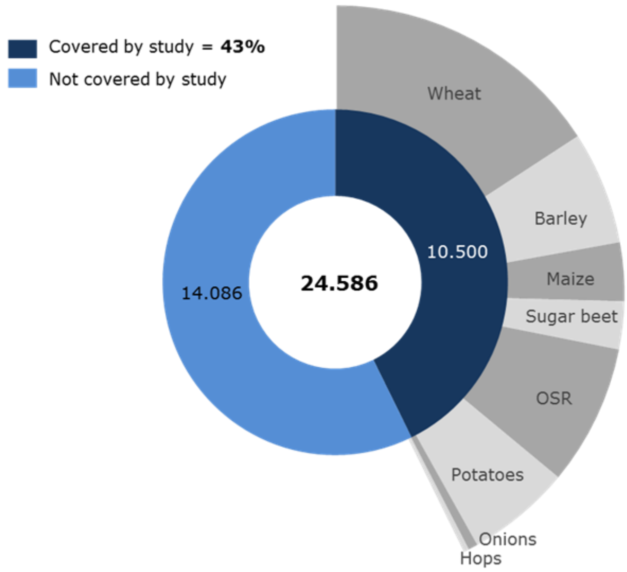



***Exhibit 25: German agricultural production value (in € million)***

The total average annual German agricultural production value[62] of the last five years was some €25 billion. The study focusses on the staple crops wheat, barley, maize, oilseed rape, potatoes, and sugar beet. In addition, the minor crops hops and onions are included. The selection is based on data availability and relevance of the crops. As Exhibit 25 shows, the crops covered by the study represent some 43% (10.500/24.586) of the total German agricultural production value.

***Table 5: Overview German crops[63]***

| 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 |
| **Potatoes** | 252 | 42,9 | 10,8 | 134 |
| **Sugar beet** | 381,1 | 67,9 | 25,9 | 26 |
| **Onions** | 10,0 | 40,0 | 0,5 | 151 |
| **Hops** | 18,0 | 1,9 | 0,03 | 4.500 |

## 5.3 Effect of 75 substances on yield and variable costs

Exhibit 26 provides an overview of the consequences to the staple and specialty crops in Germany due to possibly losing the 75 substances.

[62] Eurostat; Economic accounts for agriculture - values at current prices
[63] Eurostat; Farm statistics, average 2009-2013

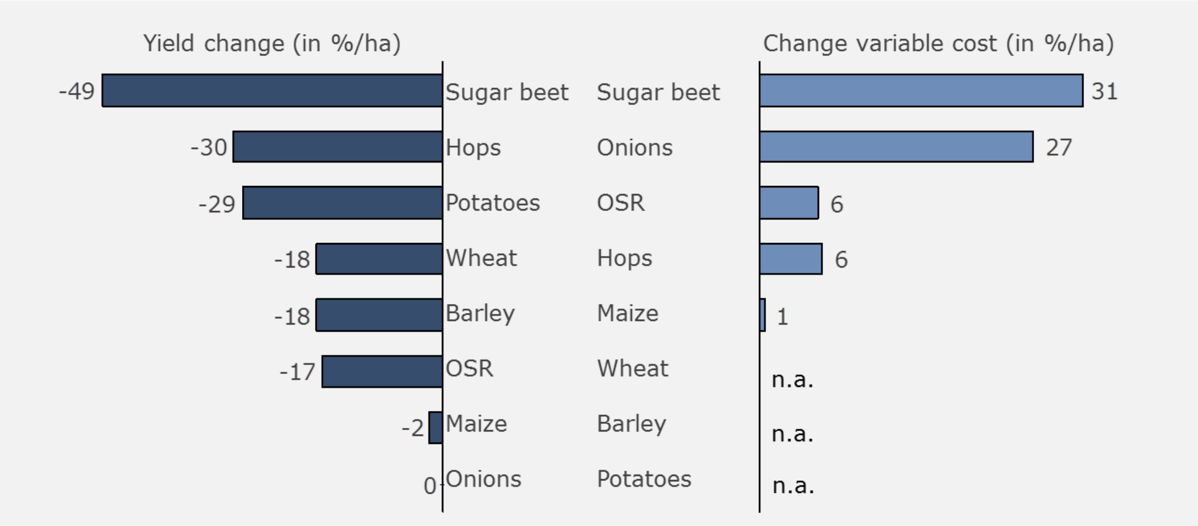



***Exhibit 26: Short-term yield and variable costs changes (in %/ha)***

For the staple crops, the 75 substances add relatively the most value to the sugar beet production, allowing farmers to harvest some 49% more tons per hectare than without the substances. The other staple crops benefit from the substances with 15-30% higher yield[64]. With the 75 substances weed, disease and pest pressure on the crops is lower, allowing the crops to grow larger. The value the 75 substances add is especially high in case that there are no chemical alternatives. For example, the criteria for "endocrine harmful substances" in the framework of approval could lead to loss of three of four cereal fungicides[65].

For the longer term, the 75 substances have an additional value as they support the avoidance of resistance effects. Consequently, the additional long-term yield effect sums to some 25% for sugar beet and to 20% for hops.

The other implication is related to changes of variable production costs. The 75 substances reduce the variable production costs by amongst others improved effectiveness. This is mainly relevant for the cultivation of sugar beet (costs difference of 31%). For onions, banning the 75 substances results in higher variable costs of +27% to keep the yield per hectare at its current level. It is due to fewer pesticides being applied less frequently in case of the 75 substances being available. Put differently, the treatment frequency will increase in case the farming tool box is less well equipped.

### 5.4 Effects on incomes

The lower yields (see Exhibit 26), given the fixed arable area, imply that the overall crop production in Germany will decrease without the 75 substances. As Exhibit 27 shows, in total, German farm output is currently 23Mt higher. In addition, 10.000t more tons of hops out of the current 34.000t can be produced with the substances.

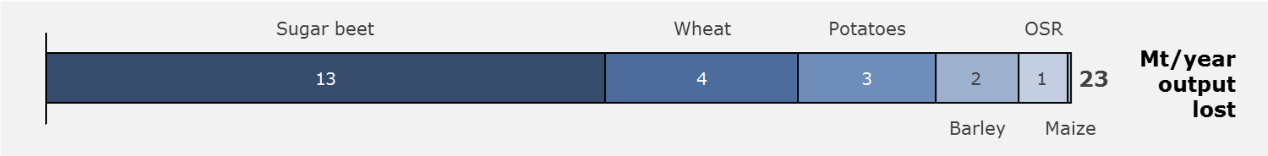



***Exhibit 27: Output changes (in Mt/year)***

[64] for maize, as a consequence of data availability, only the added value of neonicotinoids has been taken into account (2% yield benefit)
[65] Industrieverband Agrar (IVA), ‘Pflanzen ohne Schutz- Droht der Wirkstoffkahlschlag aus Brüssel?‘, 2015

Compared to other crops, the 75 substances have relatively the largest influence on the amount of sugar beets produced in German (13 Mt/year). This is mainly driven by the relatively large value the 75 substances add to sugar beet cultivation (49% extra yield). Put differently, farmers harvest almost twice as much with the 75 substances than they do when applying alternative substances.

Depending on ex-farm prices and the changes in variable costs, the gross margins earned on cultivating these crops is affected as well.

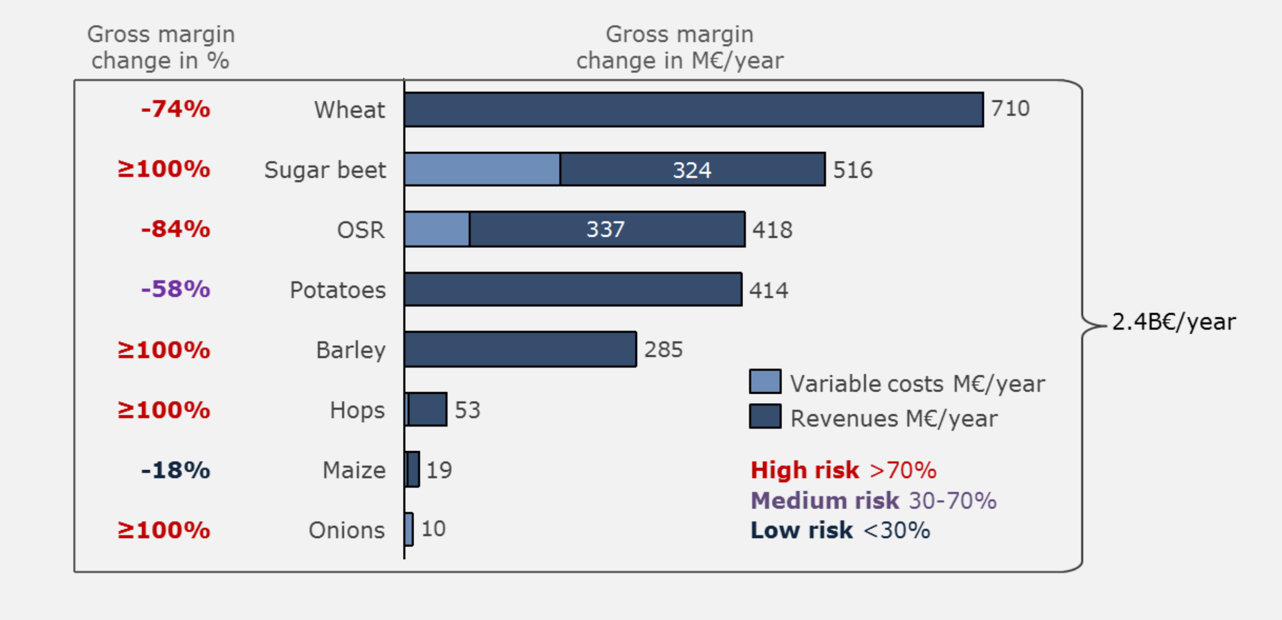



***Exhibit 28: Gross margin effects (in €M/year)***

As shown, in total German farmers gain €2.4 billion gross margins per year from having the 75 substances. The total change between the two scenarios is mainly driven by revenue losses (€2.1 billion) and to a lesser extent influenced by variable costs (€0.3 billion). Gross margin gains in wheat and sugar beet make up the majority of the overall effect. In value, wheat would be most affected from a decrease of the farming tool box with €0.7 billion in value loss. This is as wheat is on average cultivated on by far the largest area. For sugar beet the yield change is larger, however sugar beet is a somewhat smaller crop in Germany.

To shed some light on the situation for specialty crops: as the gross margins earned on cultivating onions decreases, the economic viability of their cultivation is affected significantly. The two most effective products to prevent fungal diseases like downy mildew could not be used anymore. This bears the risk of the emergence of resistance effects and depending on weather conditions might lead to total failure of the harvest. Production costs are affected too: for pre-emergence weed treatment in onions there is currently only one herbicide available. As it is based on pendimethalin it might not be possible anymore to apply this product. An alternative mechanical treatment in an extensive crop like onion is a significant cost factor. Consequently, there is the chance their cultivation will no longer take place in Germany.

For effects on jobs, land use and the carbon footprint please refer to the overall EU chapter.

# 6 UK

## 6.1 British key effects

With the current farming tool box available, the British production of **5 key staple crops**[66] is **4Mt higher** and generates **€1.1 billion more value** per year if the 40 substances at high risk are not included. For the UK only the 40 substances at high risk have been evaluated.

In addition, the **economic viability** of the production of **specialty crops**[67] like peas would be challenged.

Further results include:

- Wheat, barley, sugar beet, potato and oilseed rape would face 10-20% lower yields;
- At the same time, variable production costs for the staple crops would increase by about 15% per hectare;
- Specialty crop peas would be affected to a similar extend;
- In value, wheat would be most affected with €0.4b of value loss;
- British crop agriculture employs 500,000 direct jobs of which 283,000 jobs relate to the crops covered by the study.

## 6.2 Agriculture in the UK

Indicating the relative importance of the agricultural sector in the United Kingdom, agriculture makes up 0.6% of the UK's GDP and 1% of the total employment is with the sector. At June 2014 the Utilised Agricultural Area (UAA) was 17.2 million hectares, making up 71% of the total UK land area. UAA is made up of arable and horticultural crops, uncropped arable land, common rough grazing, temporary and permanent grassland and land used for outdoor pigs. 51% of arable area is planted as cereal crops. Wheat and barley are the predominant cereal crops standing at 1.9 and 1.0 million hectares respectively. Since 1973 total factor productivity has risen by 52% due to a 34% increase in the volume of all outputs and a 12% decrease in the volume of all inputs.[68]

[66] Wheat, barley, OSR, potatoes and sugar beet
[67] For the UK peas are included as specialty crop
[68] Department for Environment, food and rural affairs, Agriculture in the United Kingdom 2014

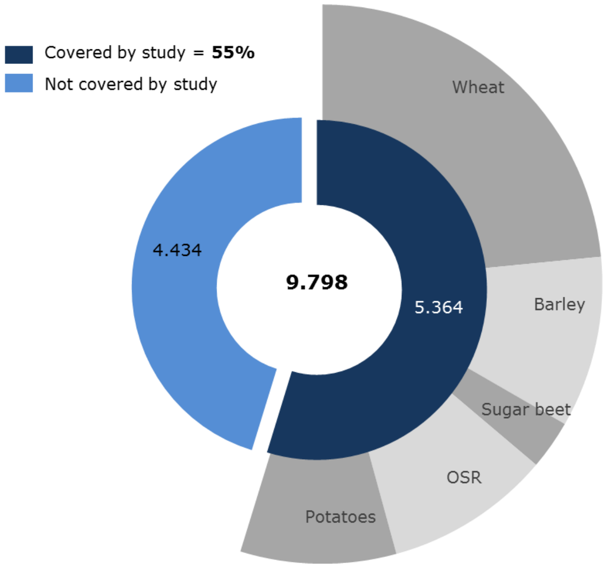



***Exhibit 29: UK agricultural production value (in € million)***

The total average annual UK agricultural production value[69] of the last five years was some €9.8 billion. The study focusses on the staple crops wheat, barley, oilseed rape, potatoes and sugar beet. In addition, the specialty crop peas are included for the UK. The selection is based on data availability and relevance of the crops. As Exhibit 29 shows, the crops covered by the study represent some 55% (5.364/9.798) of the total UK agricultural production value.

***Table 6: Overview UK crops[70]***

| Crop | Area (1000 ha) | Yield (t/ha) | Output (million ton) | Price (€/ton) |
|---|---|---|---|---|
| **Wheat** | 1.858 | 7,5 | 13,9 | 165 |
| **Barley** | 1.050 | 5,7 | 6,0 | 162 |
| **Oilseed rape** | 648 | 3,6 | 2,4 | 398 |
| **Potatoes** | 143 | 40,1 | 5,7 | 154 |
| **Sugar beet** | 116 | 67,4 | 7,8 | 36 |
| **Peas** | 32 | 3,6 | 0,1 | 5 |

## 6.3 Effect of 75 substances on yield and variable costs

Exhibit 30 provides an overview of the added value of the 40 substances at high risk to be lost to the cultivation of staple and specialty crops in the UK. While for the other countries in scope this analysis estimates the current value of substances at high as well as at medium risk to be lost, for the UK only substances with high risk are taken into account. This is as data from the Andersons Centre, who focused on this group of substances, is the basis for the UK's estimations. On the other hand, some UK specific substances[71] have been included as well.

[69] Eurostat; Economic accounts for agriculture - values at current prices
[70] Eurostat; Farm statistics; average 2009-2013
[71] chlorpyrifos, cypermethrin, permethrin, chlorothalonil, 2,4-D, bentazone, bifenox, MCPA, mecoprop, metazachlor, propyzamide and metaldehyde

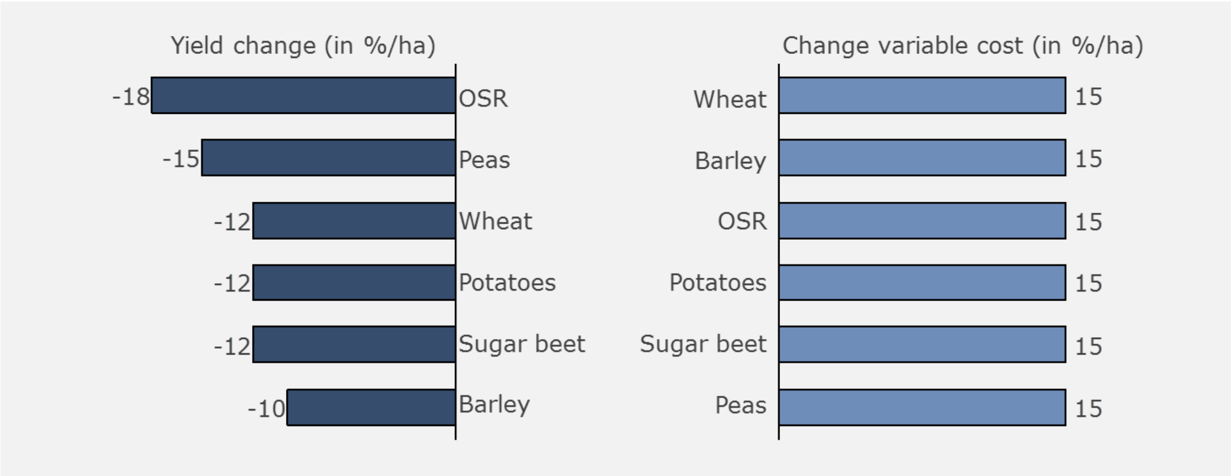



***Exhibit 30: Short-term yield and variable costs changes (in %/ha)***

For the staple crops, the 40 substances add relatively the most value to the oilseed rape production, allowing farmers to harvest some 18% more tons per hectare than without the substances. The other staple crops benefit from the substances with 10-15% higher yield. These yield changes represent the average yield loss for the entire area of the crop taking into account multiple pest pressure. With the 40 substances weed, disease and pest pressure on the crops is lower, allowing the crops to grow larger.

The other implication is related to changes of variable production costs. The 40 substances reduce the variable production costs by amongst others improved effectiveness. This is equally relevant for the cultivation of all staple crops and peas, where costs rise by some 15%[72]. The costs difference is mainly driven by changes in pesticides and application costs. This is due to fewer pesticides being applied less frequently in case of the 40 substances being available. Put differently, the treatment frequency will increase in case the farming tool box is less well equipped.

## 6.4 Effects on incomes

The lower yields (see Exhibit 30), given fixed arable area, imply that the overall crop production in the UK will decrease without the 40 substances. As Exhibit 31 shows, in total, British farm output is currently 4Mt higher.

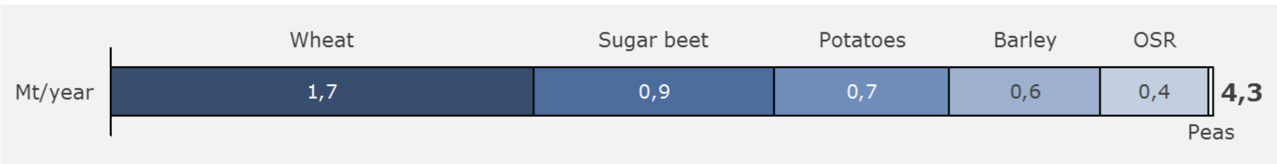



***Exhibit 31: Output changes (in Mt/year)***

Compared to other crops, the 40 substances have relatively the largest influence on the amount of wheat produced in in UK 2 Mt/year). This is mainly driven by the relatively large area on which wheat is cultivated in the UK in combination with yield effect.

Depending on ex-farm prices and the changes in variable costs, the gross margins earned on cultivating these crops is affected as well.

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72 Anderson; 'The effect of the loss of plant protection products on UK agriculture and horticulture and the wider economy'

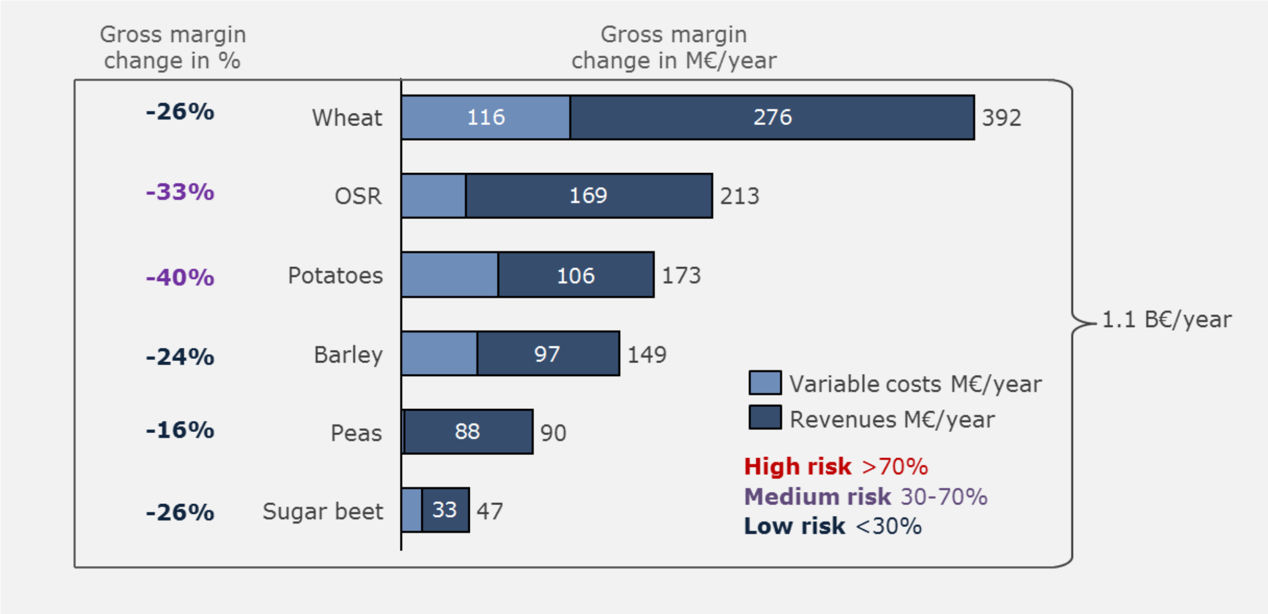


***Exhibit 32: Gross margin effects (in €M/year)***

As shown, in total UK farmers gain €1.1 billion gross margins per year from having the 40 substances. The total change between the two scenarios is mainly driven by revenue losses (€770 million) and to a lesser extent influenced by variable costs (€295 million). In value, wheat would be most affected from a decrease of the farming tool box with €392 million of income loss to the farmer. This is because wheat is on average cultivated on by far the largest area.

For effects on jobs, land use and the carbon footprint please refer to the overall EU chapter.

# 7 Poland

## 7.1 Polish key effects

With the current farming tool box available, the Polish production of **5 key staple crops**[73] is **6m MT higher** and generates **€0.5 billion more value** per year if the 75 substances at risk are not included.

In addition, **0.5 MT** of output and **€0.1 billion** is supported through the production of the **specialty crops** apples and black currants, and its **economic viability** would be challenged without the 75 substances.

Further results include:

- Wheat, maize and potato would face 5-20% lower yields, while the yield of sugar beet decreases by 30%;
- At the same time, variable production costs for the staple crops would increase from 3% for maize by up to 26% for Oilseed rape per hectare;
- Yield loss for specialty crop apples and black currants would decrease by 20%;
- In value, OSR would be most affected with €307m of value loss, while sugar beet and potatoes would show the largest decrease in profitability (>100%) of the staple crops;
- Polish crop agriculture employs 958,000 direct jobs of which 422,000 jobs relate to the crops covered by the study.

## 7.2 Agriculture in Poland

Indicating the relative importance of the agricultural sector in Poland, agriculture makes up 4% of Poland's GDP and 12% of total employment is within this sector. Agriculture and forestry constitute more than half of the total area of Poland; with agriculture using 14 million hectares and forestry 9 million hectares of a total 31 million hectares. More than half of the 1.5 million farms in Poland are smaller than 5 hectares, thus productivity of the agricultural sector remains relatively low. Of the total annual agricultural output 47% is from crops.

Cereals represent almost 40% of crop value. Fruits and vegetables another 30% and are of growing importance. For example, Apple production have grown with more than 50% in the last decade, and made Poland the largest producer in the EU.[74]

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[73] Wheat, potato, maize, rapeseed and sugar beet
[74] EUROSTAT agricultural production data, 2009-2013

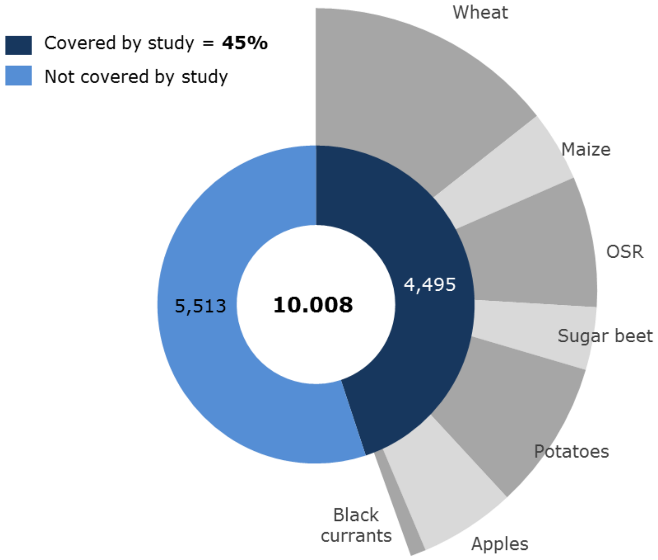


*Exhibit 33: Polish agricultural production value (in € million)*

The total average annual Polish agricultural production value[75] of the last five years was some €10 billion. The study focusses on the staple crops wheat, maize, potatoes, OSR and sugar beet. In addition, the specialty crops apples and black currants are included for Poland. The selection is based on data availability and relevance of the crops. As shown above, the crops covered by the study represent some 45% (4,495/10,008) of the total Polish agricultural production value.

*Table 7: Overview Polish crops[76]*

| 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 |
| **Black Currants** | 34 | 4.3 | 147 | 615 |

## 7.3 Effect of 75 substances on yield and variable costs

Exhibit 34 provides an overview of the consequences of possibly losing the 75 substances for the staple and specialty crops in Poland.

[75] Eurostat; Economic accounts for agriculture - values at current prices
[76] Eurostat; Farm statistics, average 2009-2013

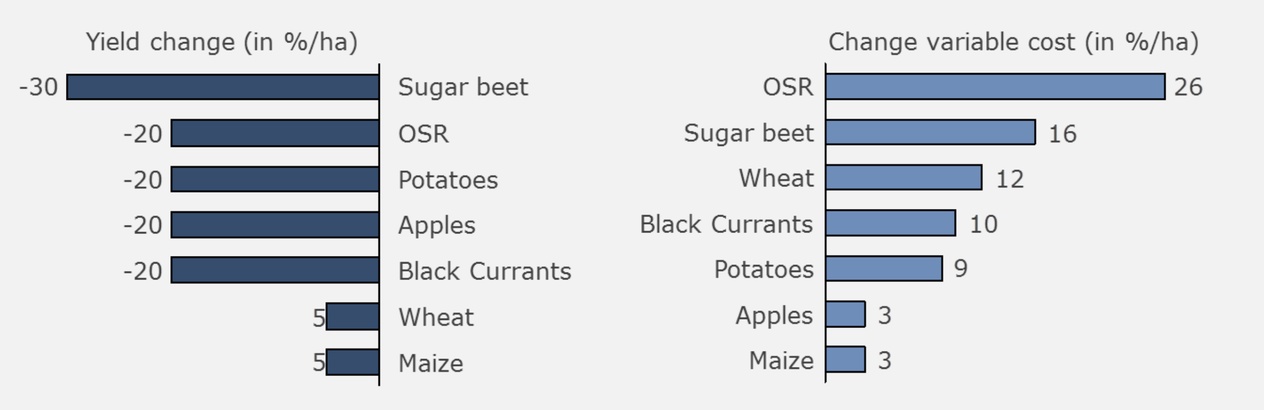


***Exhibit 34: Short-term yield and variable costs changes (in %/ha)***

For the staple crops, the 75 substances add relatively the most value to the sugar beet production, allowing farmers to harvest some 30% more tons per hectare than without the substances[77]. The other staple crops benefit from the substances with 5-20% higher yield. With the 75 substances weed, disease and pest pressure on the crops is lower, allowing the crops to grow larger. The yield effects for Polish staple crops seem lower (see Table 3), but the crop experts provide wider ranges. The ranges itself are well in line with the other countries.

The Polish experts also indicated yield estimates including higher pest pressure and potential resistance effects. Yield effects could sum up to -30% for cereals, -50% for sugar beet and apples and affect almost all produce for sugar beet and potatoes (see Appendix for the ranges). The experts expect an increased resistance of pathogens due to reduced rotation of active substances. This implies a higher risk from mycotoxins.

The other change is regarding variable costs. The 75 substances reduce the variable production costs by amongst others improved effectiveness. For the staple crops the effect varies from 3% for maize up to 26% for oilseed rape in additional variable costs. This is due to fewer pesticides being applied less frequently in case of the 75 substances being available. Put differently the treatment frequency will increase in case the farming tool box is less well equipped.

## 7.4 Effects on incomes

The lower yields (see Exhibit 34), given a fixed arable area, imply that the overall crop production in Poland will decrease without the 75 substances. As Exhibit 35 shows, in total Polish farm output is currently 6 Mt higher for staple crops and 0.5Mt for the specialty crops apples and black currants.

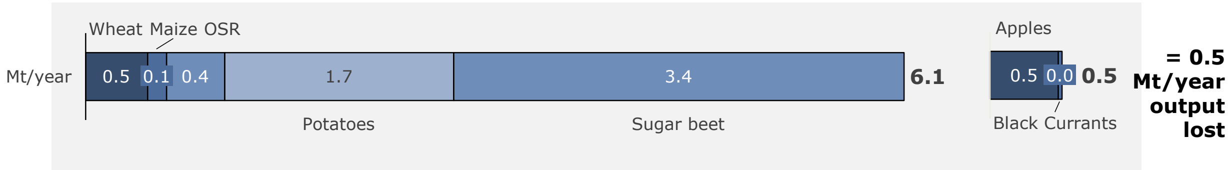


***Exhibit 35: Output changes (in Mt/year)***

Compared to other crops, the 75 substances have relatively the largest influence on the amount of sugar beets produced in Poland (change of 3.4 Mt/year). This is driven by the

[77] Best alternatives available will be included in the final report in Appendix I.D

relatively large value the 75 substances add to sugar beet cultivation (30% extra yield) as well as the relatively large area where sugar beet is cultivated in Poland (203,000 ha).

Depending on ex-farm prices and the changes in costs, the net margins earned on cultivating these crops is affected as well.

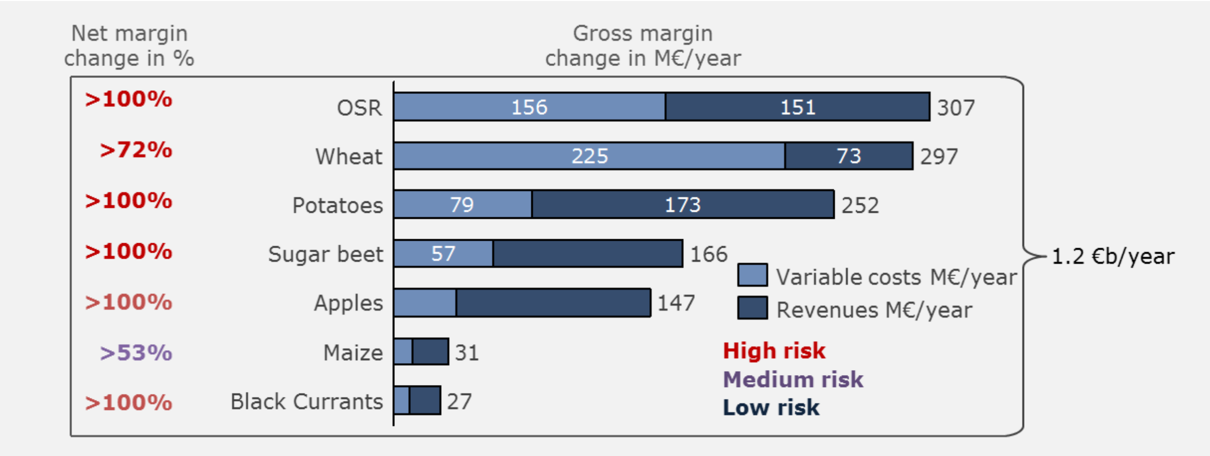


***Exhibit 36: Net margin effects (in €m/year)[78]***

As shown, in total Polish farmers gain €1.2 billion income per year from having the 75 substances. The largest share of the total change is driven by revenue losses (€638 million), but also the increase in cost contributes substantially (€527 million). In value, OSR and wheat would be most affected by a decrease of the farming tool box with €307 and €297 million of value loss, while potatoes and sugar beet would show the largest decrease in profitability (>100%) of the staple crops. Producer prices for sugar beet per ton are relatively low compared to prices of other crops, therefore the total revenue effect for sugar beet is not among the largest.

As the net margins earned on cultivating staple crops OSR, potatoes and sugar beet decrease significantly, there is the chance that cultivation of these crops will no longer take place in Poland. This is because these crops are at a high risk of losing their economic viability.

The Polish experts also expect an increase in number of treatments, as the alternative products are less effective. Consequently, they expect that this will translate in a higher burden on the environment.

For effects on jobs, land use and the carbon footprint we refer to the overall EU chapter.

[78] The Kleffmann report describes the effects on net margins instead of gross margins building on Polish crop experts. Therefore, the relative margin change in Poland is higher than the other countries as these represent gross margins.

# 8 Spain

## 8.1 Spanish key effects

With the current farming tool box available, the Spanish production of the 8 crops analysed[79] is **11 Mt** higher and generates **€2.7 billion** more value per year if the 75 substances at risk are not included.

Further results show that:

- The 75 substances allow harvesting 85% more open field tomatoes per hectare
- For sugar beet, olives and glass tomatoes the yield with the substances is ca 35-45% higher than without and ranges for the other crops between 15-30%;
- At the same time, variable production costs for the staple crops would increase by up to 50% per hectare;
- In value, citrus fruits would be most affected with €1.5b of value loss;
- Spanish crop agriculture employs 560,000 direct jobs of which 135,000 jobs relate to the crops covered by the study.

## 8.2 Agriculture in Spain

Indicating the relative importance of the agricultural sector in Spain, agriculture makes up 2.5% of the Spanish GDP and some 4% of the total employment is in the sector. 25 million hectares of land in Spain are dedicated to agriculture equalling about 15% of the total EU agricultural area. The agricultural sector continues to be of great importance to Spain with around 95% of Spanish agricultural and livestock produce exported, accounting for 5% of all Spanish exports.[80] In total, the EU-28 produced an estimated 17 million tonnes of tomatoes in 2014, of which approximately two thirds came from Italy and Spain[81].

Spain is the second largest producer of sweet cherries in Europe and is the seventh largest producer in the world[82]. Within Spain, there are 4 primary production areas: Extremadura (32%), Aragón-Catalonia (34%), Andalusia (10%) and Valencia (9%).

[79] Tomatoes (open and glass) olives, citrus fruits, vine, sunflower, cherry and rice
[80] Mintec, Agricultural importance in Spain
[81] Eurostat, Agricultural production
[82] Cherry Cultivation in Spain http://www.chilecerezas.cl/contenidos/20101101210734.pdf

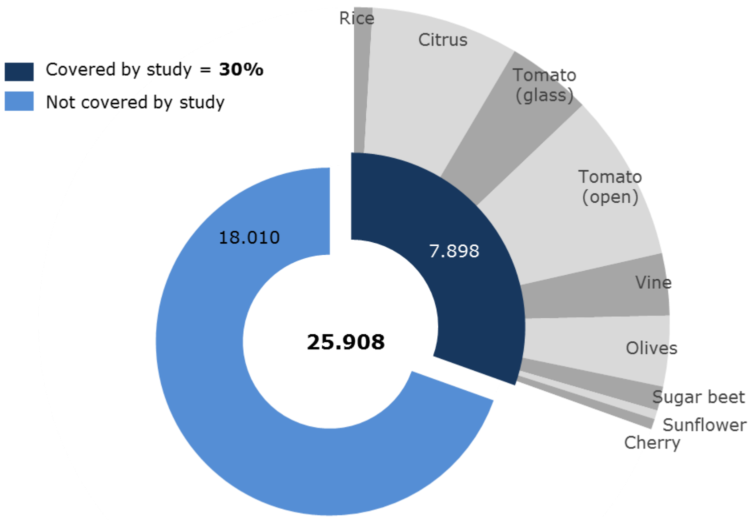


***Exhibit 37: Spanish agricultural production value (in € million)***

The total average annual Spanish crop production value[83] of the last five years was some €26 billion. The study focusses on some of the most relevant crops in Spain, citrus fruits, tomatoes (both open air and glass production), vine, olives and smaller crops like rice, sunflower, sugar beet and cherry. The selection is based on data availability and relevance of the crops. As Exhibit 37 shows, the crops covered by the study represent some 30% (7.898/35.900) of the total average annual Spanish agricultural production value. This means that the implications indicated hereafter represent 30% of the Spanish agriculture and can be assumed to be larger for the Spanish agriculture as a whole.

***Table 8: Overview Spanish crops[84]***

| Crop | Area (1000 ha) | Yield (t/ha) | Output (million ton) | Price (€/ton) |
|---|---|---|---|---|
| **Tomato (glass)** | 18 | 100,0 | 1.8 | 620 |
| **Tomato (open)** | 33 | 86,0 | 2.8 | 78 |
| **Sugar beet** | 42 | 85,7 | 3.6 | 33 |
| **Citrus** | 313 | 18,9 | 5.9 | 330 |
| **Cherry** | 25 | 6,0 | 0,1 | 1.132 |
| **Sunflower** | 803 | 1,1 | 0.9 | 356 |
| **Rice** | 118 | 7,7 | 0.9 | 269 |
| **Vine** | 963 | 6,3 | 6.0 | 136 |
| **Olives** | 2.504 | 3,1 | 7.8 | 121 |

## 8.3 Effect of 75 substances on yield and variable costs

Exhibit 38 provides an overview of the consequences related to possibly losing the 75 substances for crops in Spain.

[83] Eurostat; Economic accounts for agriculture - values at current prices
[84] Eurostat; Farm statistics, average 2009-2013 & others (for full sources see Appendix)

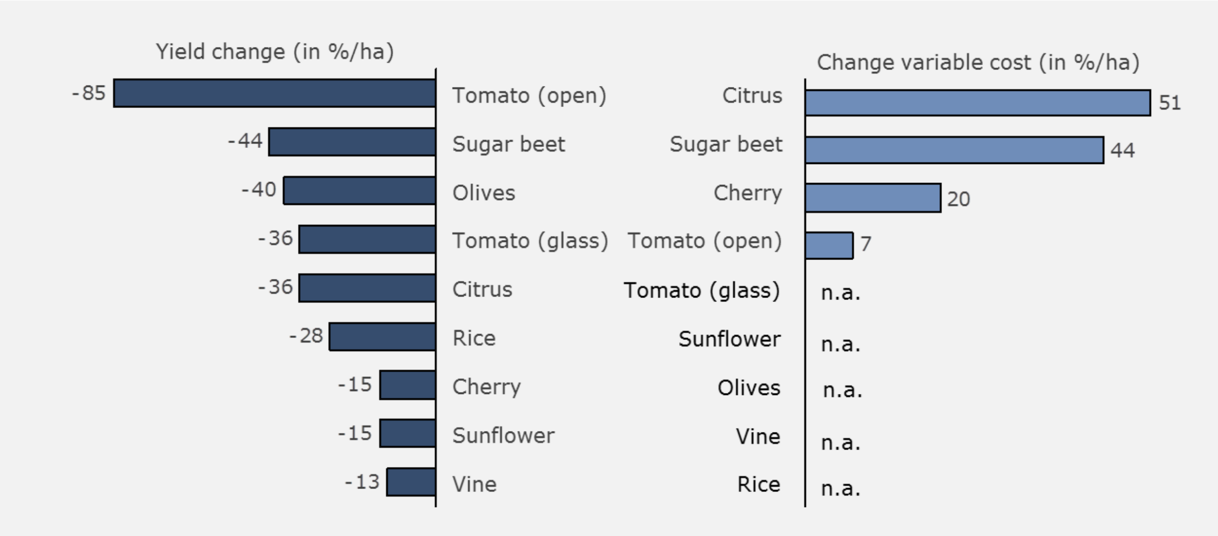


***Exhibit 38: Short-term yield and variable costs changes (in %/ha)***

The 75 substances add the relative most value to open field tomatoes (85% yield effect). Sugar beet and olives harvest almost twice as much with the 75 substances in their tool box. These effects focus on the immediate implications only, a long-term resistance effect of pests (e.g. for glass tomatoes of an additional 15% yield difference) against the remaining substances would affect the yield even further. With the 75 substances weed, disease and pest pressure on the crops is lower, allowing the crops to grow larger. To give an example, azoles form a key component to control for foliar diseases in the Spanish sugar beet cultivation. A possible removal could cause immediate yield losses of 15-30% as experts indicate that without azoles there might be insufficient control for cercospora blight and rust. Today these diseases are present on some 70% of the area. In the long-run attacks might become more virulent as without treatment farmers are afraid the diseases might spread. An alternative could be to delay the planting data as later in the year the disease cause less damage. However every day sugar beets gain 0.5 t/ha of root weight and with delaying plantation by 30 days being recommended to lower disease pressure significantly hence implies a loss of 15 t/ha or €600/ha farm income. This would reduce the economic viability of sugar beet cultivation in Spain.

For the longer term, the 75 substances have an additional value as they support the avoidance of resistance effects. Consequently, the additional long-term yield effect sums to some 16% for glass tomatoes and to 3% for sunflowers.

The other major implication affects variable production costs. The 75 substances reduce the variable production costs by amongst others improved efficiency. For citrus fruits this can amount to some 50% more variable costs without the 75 substances. This is because in case of the current tool box, fewer pesticides (in kilo) are applied less frequently which saves purchase, labour and energy cost. Put differently, the treatment frequency will increase in case the farming tool box is less well equipped.

## 8.4 Effects on incomes

The lower yields (see Exhibit 38), given a fixed arable area, imply that the overall crop production in Spain will decrease without the 75 substances. As Exhibit 39 shows, in total, Spanish farm output is currently 11 Mt/year higher than with a reduced tool box. For the crops analysed, this represents an overall reduction of a third (see Table 8).

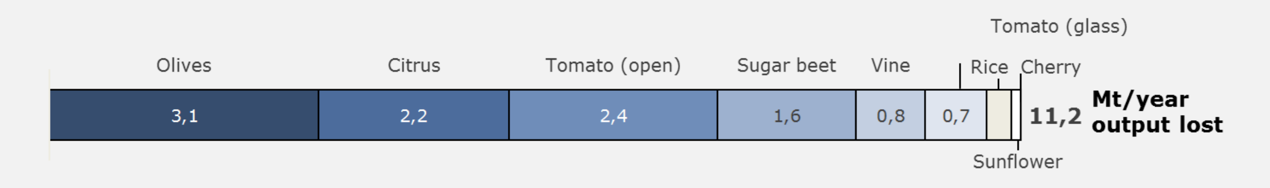


**Exhibit 39: Output changes (in Mt/year)**

Compared to other crops, the 75 substances have relatively the largest influence on the amount of olives produced in Spain (3 Mt/year), citrus fruits (2 Mt/year) and open field tomatoes (2 Mt/year). This is driven by the relatively large value the 75 substances add to open field tomato cultivation (85% extra yield) as well as the relatively large area where olives and citrus fruits is cultivated in Spain (see Table 8).

Especially the large change in output of open field tomatoes, which are used for industrial purposes, puts pressure on the Spanish tomato processing industry. This is because most of the Spanish tomatoes are also processed in the country and local processors' business results depend amongst others on the throughput volume. In total, there are currently 28 tomatoes processors operating in Spain. Together these companies processed in the 2015 harvest some 3Mt tomatoes generating revenues of €290 million and employing 1.500 seasonal and 400 fixed employees[85].

Depending on ex-farm prices and the changes in variable costs, the gross margins earned on cultivating these crops is affected as well.

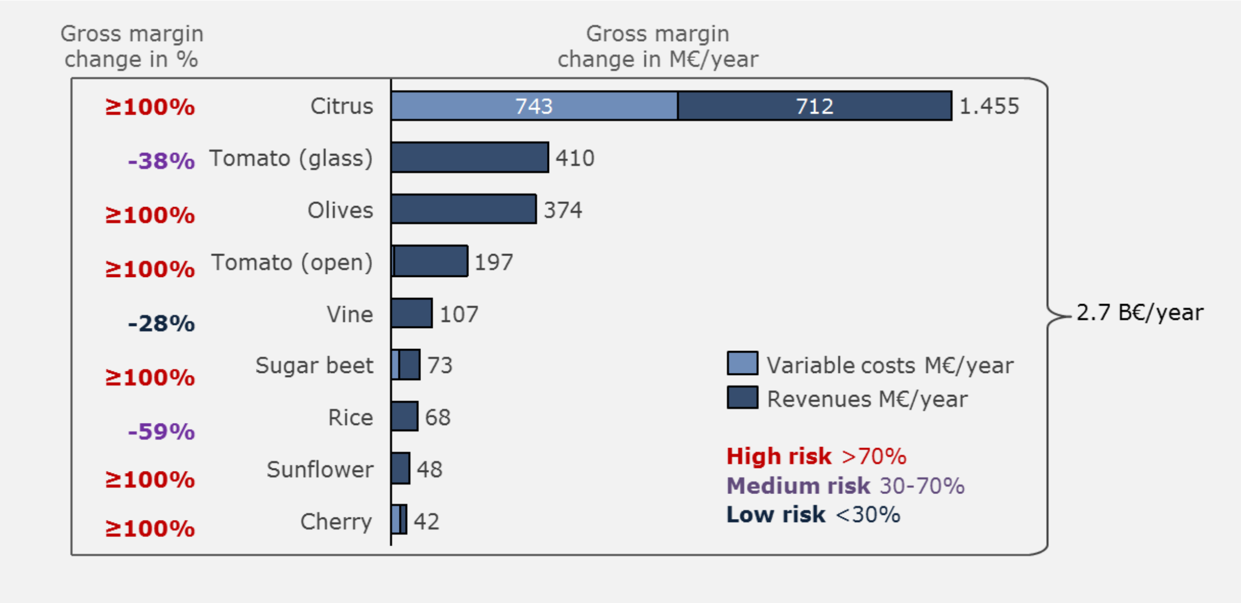


**Exhibit 40: Gross margin effects (in €M/year)**

As shown, in total Spanish farmers gain some €2.7 billion gross margins per year from applying the 75 substances. The total change in the scenario where these substances are no longer applied is mainly driven by revenue losses (€1.9 billion) and to a lesser extent influenced by variable costs (€0.7 billion). Gross margin gains in citrus fruits make up the majority of the overall effect. In value, citrus fruits would almost equally be affected from a decrease in revenues (€712 million) as higher variable production costs (€743 million).

[85] Source: Cooperativas agro-alimentarias

The relatively gross margin change gives insights into the overall economic viability of cultivating the crops. Given the revenue losses and the additional variable costs change, the profitability for citrus fruits, olives, open air tomatoes, sugar beet, sunflower and cherry is at the very least questionable, and might endanger the long-term sustainability of cultivating these crops in Spain. In other words, these crops can be argued to be at a high risk of losing their economic viability.

For effects on jobs, land use and the carbon footprint please refer to the overall EU chapter.

# 9 Italy

## 9.1 Italian key effects

With the current farming tool box available, the Italian production of the 14 crops analysed[86] is **10 Mt** higher and generates **€2.7 billion** more value per year if the 75 substances at risk are not included.

Further results show that:
- The economic viability of the staple as well as specialty crops would, without the 75 substances, be put under pressure;
- Most grains would face lower yields with 14-25% t/ha, while the yields of olives, hazelnuts, pears and apples are expected to decrease by 60-65%;
- Also costs are likely to increase with 5% for grains and 18-34% for olives and vines.
- The 75 substances contribute to extra farm income of €2.7 billion, of which €1.9 extra revenues and €0.8 lower costs;
- The largest single contribution is to vine with €0.6 billion;
- Italian crop agriculture employs 488,000 direct jobs of which 145,000 jobs relate to the crops covered by the study.

## 9.2 Agriculture in Italy

Indicating the relative importance of the agricultural sector in Italy, agriculture makes up 2.2% of the Italian GDP and some 4% of the total employment is in the sector. 14 million hectares of land in Italy are dedicated to agriculture equalling about 8% of the total EU agricultural area.[87] It is characterized by its wide variety of crops and large difference between the north and the south. The northern part produces primarily maize, rice, sugar beets, soybeans, meat, fruits and dairy products, while the South specializes in (durum) wheat and citrus fruits. Overall, grains (31%), olive trees (8.2%), vineyards (5.4%) represent the largest part of the agricultural area. Among others, Italy is the largest producer of vine, rice and soy in Europe.

Many of its typical fruits and vegetables are exported of which 65% to other EU member states.[88] Furthermore, several food processing activities in Italy are closely linked to crop production such as the production of wine (second largest in the world), olive oil and (hazel) nuts processing in Tuscany. Also many of these processed foods are widely exported.

[86] Maize, wheat (durum, soft), rice, potatoes, tomatoes (sauce), vine, apples, pears, peaches, nectarines, barley, soy, hazelnut, olives
[87] Average over 2009-2013 (ISTAT). According to INEA, total farm surface has decreased by 3.3% over the last year.
[88] ISTAT 2009-2013, EUROSTAT 2009-2013

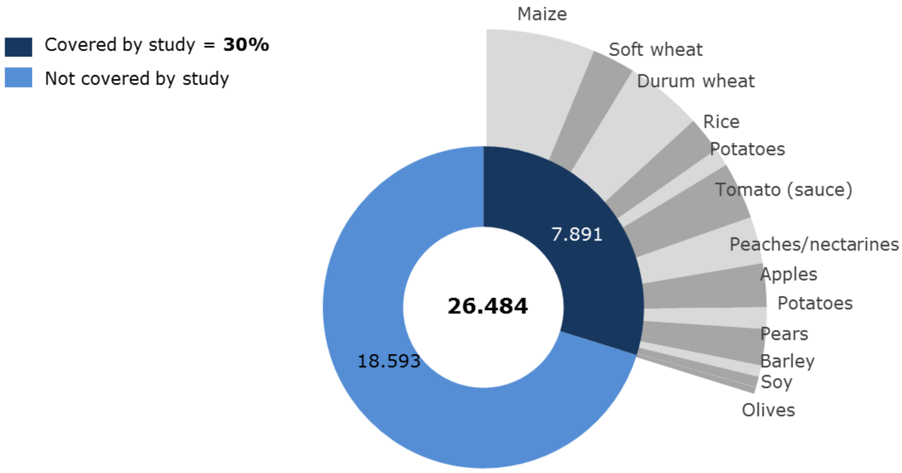


*Exhibit 41: Italian agricultural production value (in € million)*

The total average annual Italian crop production value[89] of the last five years was some €26 billion. The study focusses on some of the most relevant crops in Italy, maize, wheat, rice, potatoes, tomatoes, peaches, nectarines, apples, pears, potatoes, barley and olives. The selection is based on data availability and relevance of the crops. As

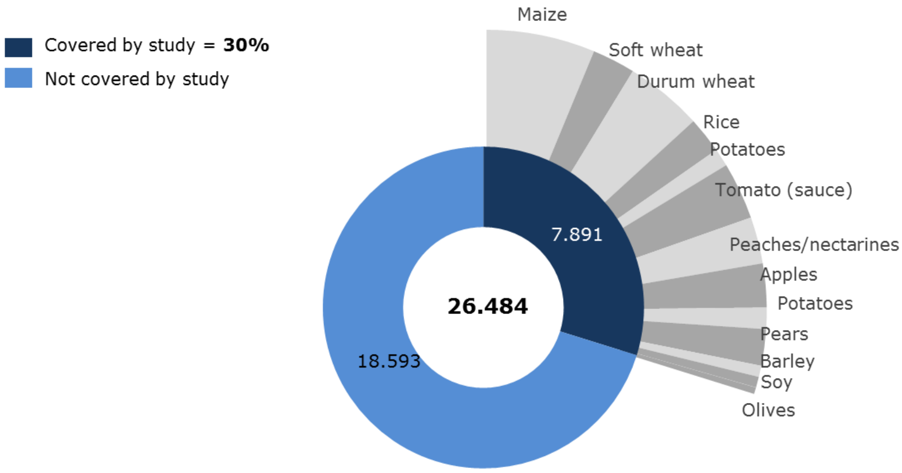


Exhibit *41* shows, the crops covered by the study represent some 30% (7,891/26,484) of the total average annual Italia agricultural production value. This means that the implications indicated hereafter represent 30% of the Italian agriculture and can be assumed to be larger for the Italian agriculture as a whole.

*Table 9: Overview Italian crops[90]*

| Crop | Area (1000 ha) | Yield (t/ha) | Output (million ton) | Price (€/ton) |
|---|---|---|---|---|
| Maize | 952 | 8.9 | 8,505 | 195 |
| Soft wheat | 580 | 5.3 | 3,101 | 212 |
| Durum wheat | 1,262 | 3.1 | 3,942 | 301 |
| Rice | 237 | 6.6 | 1,567 | 352 |
| Potatoes | 43 | 28.1 | 1,206 | 228 |
| Tomato (sauce) | 84 | 61.3 | 5,153 | 169 |

[89] ISTAT – agricultural statistics, Eurostat; Economic accounts for agriculture - values at current prices
[90] ISTAT – agricultural statistics 2009-2013, INEA 2009-2013 average prices

| | | | | |
|---|---|---|---|---|
| Vine | 698 | 9.2 | 6,400 | 111 |
| Apples | 57 | 39.8 | 2,253 | 296 |
| Pears | 38 | 20.9 | 790 | 412 |
| Peaches/nectarines | 81 | 19.0 | 1,534 | 362 |
| Barley | 267 | 3.6 | 963 | 178 |
| Soy | 159 | 3.3 | 532 | 306 |
| Hazelnut | 68 | 1.6 | 109 | 21 |
| Olives | 1,154 | 2.8 | 3,262 | 31 |

Italian farmers have about 250 active substances available in their toolbox. Overall, the quantity of pesticides have decreased from 2003-2013 by more efficient and effective uses by farmers.[91] Over the last years, new parasites have emerged in Italy driven largely by changes in its climate. These demand changes in crop management especially for fruits and vegetables. Currently, farmers seem to have limited options to face these new challenges.[92]

### 9.3 Effect of 75 substances on yield and variable costs

Exhibit 42 provides an overview of the consequences related to possibly losing the 75 substances for crops in Italy.

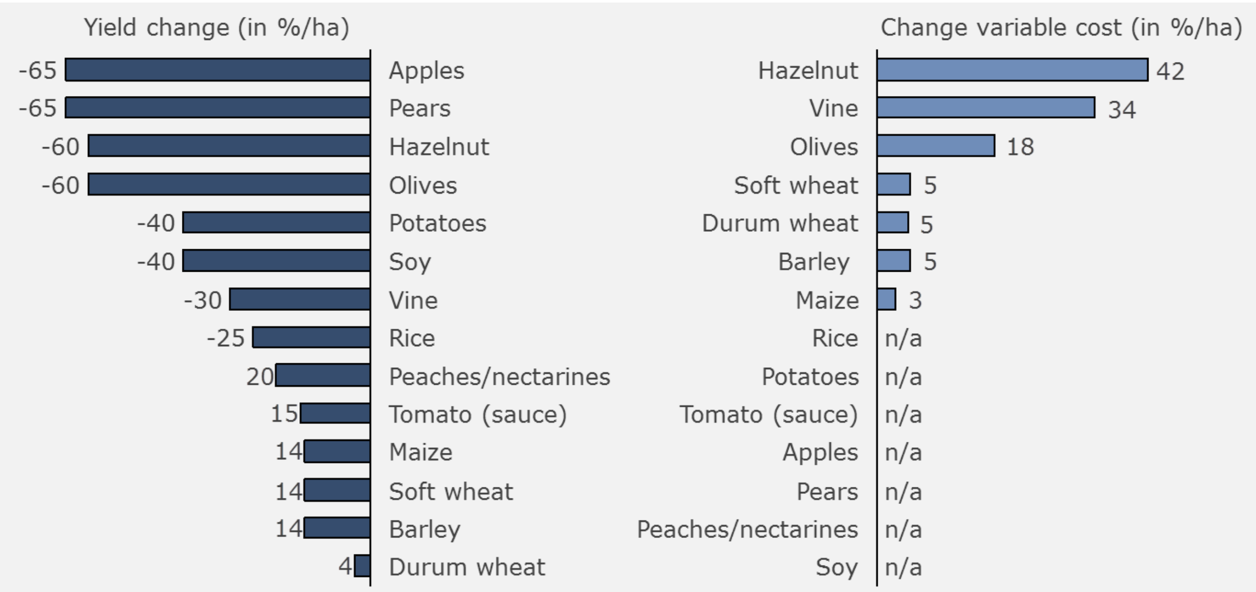


***Exhibit 42: Short-term yield and variable costs changes (in %/ha)***

The 75 substances add the relative most value to apples, pears, hazelnuts and olives (60-65% yield effect). Most cereals will lose 14-25% of their yields with a smaller toolbox. Vine, one of Italians key crops, benefit with 30% higher yields in the current situation. The production costs are also likely to increase: the extent to which this is the case ranges from 5% for grains and is largest for hazelnuts (+42%).

These yield values represent the effects that at least occur in the short run. As Italian crop experts indicated, yield effects could be larger in years of high pest pressure and also in the long run when including potential resistance effects. Effects for cereals can vary from -14% up to -35%. For tomatoes these can be as large as -35% while for several typical Italian

[91] ISTAT 2003-2013, pesticide use in Italy
[92] Environchange, L'impatto del cambiamento climatico sulle malattie delle piante, June 2012

fruits and vegetables like vine grapes and olives, these could affect large shares of these crops (see also the yield ranges in the Appendix).

## 9.4 Effects on incomes

The lower yields (see Exhibit 42), given a fixed arable area, imply that the overall crop production in Italy will decrease without the 75 substances. As Exhibit 43 shows, in total, Italian farm output is currently 10 Mt/year higher than with a reduced tool box. For the crops analysed, this represents an overall reduction of 25% (see Table 9).

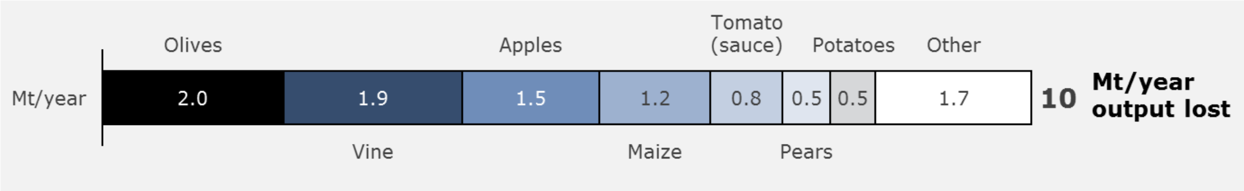


***Exhibit 43: Output changes (in Mt/year)***

Compared to other crops, the 75 substances have relatively the largest influence on the amount of olives and vines (2.0 and 1.9 Mt/year), but also apples (1.5) and maize (1.2) will decrease significantly in production size. This is driven by the relatively large value the 75 substances add to these crops as well as the relatively size in Italian agriculture (see Table 8).

Depending on ex-farm prices and the changes in variable costs, the gross margins earned on cultivating these crops is affected as well.

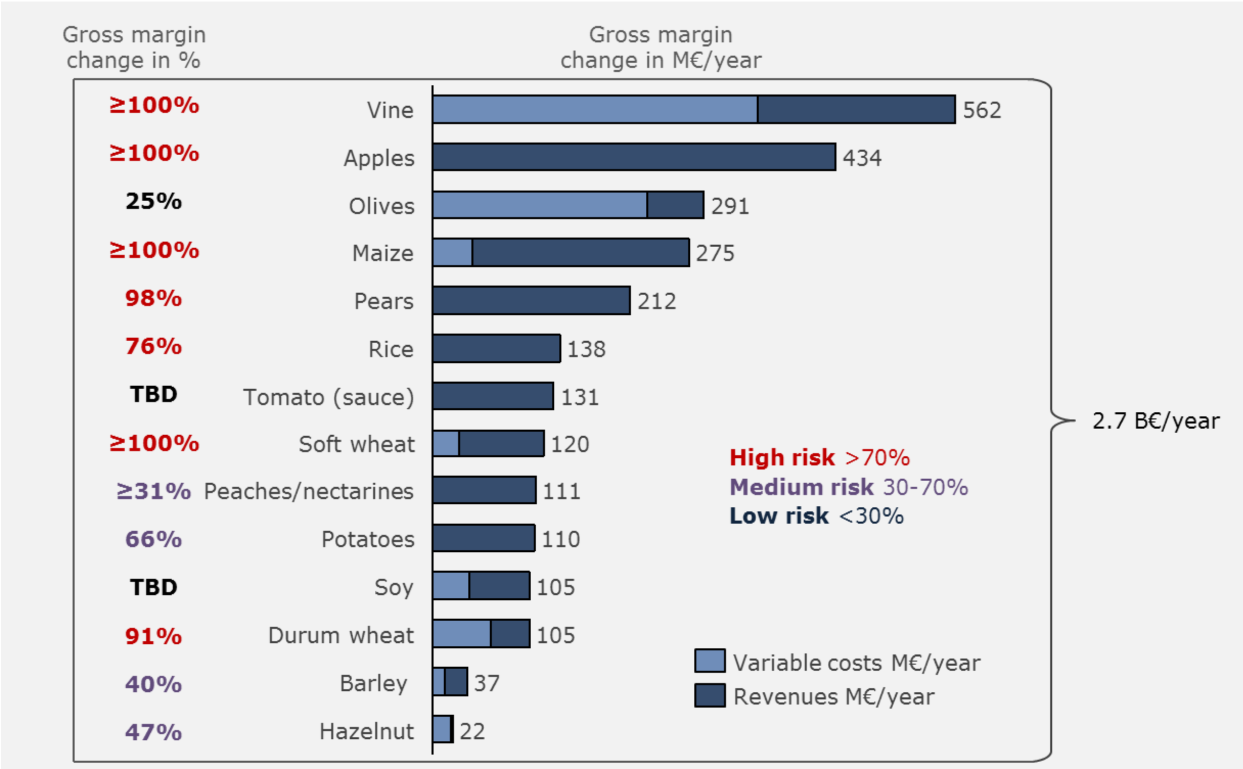


***Exhibit 44: Gross margin effects (in €M/year)***

As shown, in total Italian farmers gain some €2.7 billion gross margins per year from applying the 75 substances. The total change in the scenario where these substances are no longer applied relate mostly to revenue losses (€1.9 billion). However, extra production costs would add another €0.8 billion. Gross margin gains in vine make up the majority of the overall effect (€0.6 billion), but also apples, maize, olives and pears would lose also over €200-400m in value.

The relatively gross margin change gives insights into the overall economic viability of cultivating the crops. Given the revenue losses, the profitability for vine, apples, maize and soft wheat is largely affected (≥100% gross margin loss), but also pears, rice and durum wheat profitability losses are substantial. This might endanger the long-term sustainability of cultivating these crops in Italy. In other words, these crops can be argued to be at a high risk of losing their economic viability.

For effects on jobs, land use and the carbon footprint please refer to the overall EU chapter.

# 10 The Netherlands

## 10.1 Dutch key effects

With the current farming tool box available, the Dutch production of **4 key staple crops**[93] is **3m Mt higher** and generates **€0.3 billion more value** per year as if the 75 substances at risk are not included.

In addition, **€0.9 billion** value of the **specialty crops**[94] tulip bulbs, bell-pepper and apple trees and their **economic viability** would be challenged without the 75 substances.

Further results include:

- Wheat, barley and potatoes would face 15-18% lower yields, while the yield of sugar beet decreases by at least 36%;
- At the same time, variable production costs for the staple crops would increase up to 6% up to 36% per hectare;
- Yield loss for the specialty crops tulip bulbs, bell pepper and apple trees would range from 70-100%
- In value, tulip bulbs would be most affected with €515m of value loss, while sugar beet would show the largest decrease in profitability (-45%) of the staple crops;
- Dutch crop agriculture employs 92,000 direct jobs of which 23,000 jobs relate to the crops covered by the study.

## 10.2 Agriculture in the Netherlands

Indicating the relative importance of the agricultural sector in the Netherlands, agriculture makes up 2% of the Netherland's GDP and 2.6% of the labour force is employed in the sector. The land area of the Netherlands that is used for agriculture is 1.8 million hectares, approximately 55% of total land area. Forestry only constitutes 11% of total land area. 53% of agricultural output is from crops, of which 70% are vegetables and horticultural products. The Netherlands is the world's second largest exporter of agricultural products, and one of the top 3 producers of vegetables and fruit, which given the availability of arable land indicates the high levels of productivity. For several specialty crops, it is the largest producer among other tulip bulbs and apple trees included in the scope. Naturally, supported effects on apple trees relate strongly to apple production in and outside the country produced with Dutch apple trees.

[93] Wheat, barley, potato, maize, rapeseed, sugar beet and vine
[94] Beans, apples and carrots

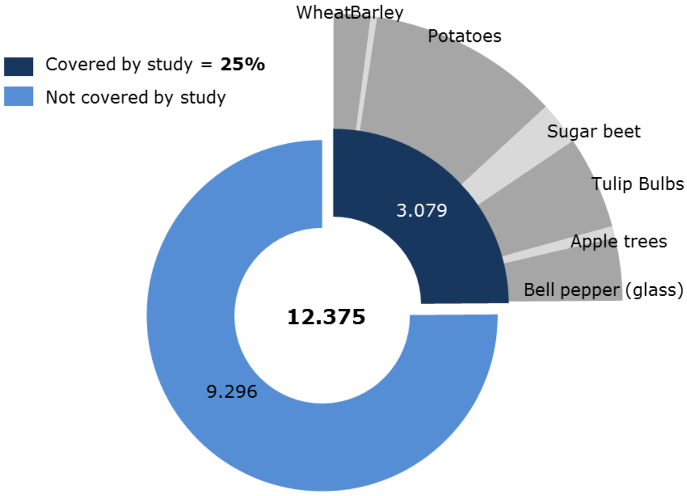


***Exhibit 45: Dutch agricultural production value (in € million)***

The total average annual Dutch agricultural production value[95] of the last five years was some €12 billion. The study focusses on the staple crops wheat, barley, potatoes (ware and seed) and sugar beet. In addition, the specialty crops bell-pepper (glass), tulip bulbs and apple trees are included for the Netherlands. The selection is based on data availability and relevance of the crops. As

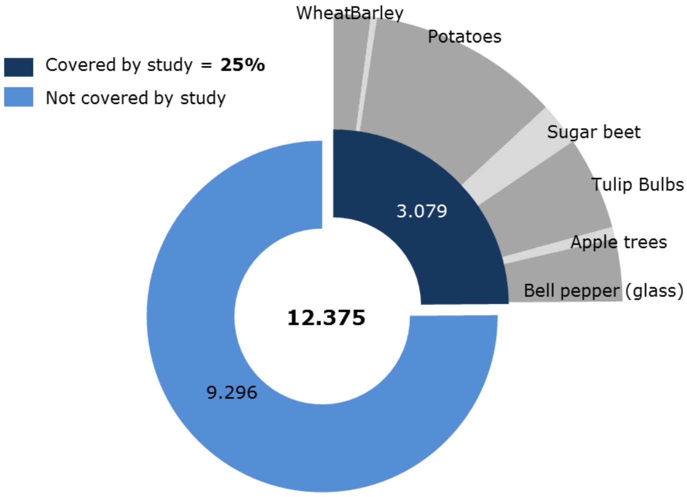


Exhibit ***45*** shows, the crops covered by the study represent some 25% (3,079/12,375) of the total Dutch agricultural production value. Table 10 summarizes the production data for the crops in scope.

***Table 10: Overview Dutch crops[96]***

| Crop | Area (1000 ha) | Yield (t/ha) | Output ('000 ton) | Price (€/ton) |
|---|---|---|---|---|
| **Wheat** | 152 | 8.7 | 1,323 | 193 |
| **Barley** | 34 | 6.7 | 228 | 187 |
| **Seed potatoes** | 39 | 38.0 | 1,474 | 266 |
| **Ware potatoes** | 71 | 50.7 | 3,601 | 134 |

95 Eurostat; Economic accounts for agriculture - values at current prices
96 Agricultural economic institute (LEI) of Wageningen University, average 2009-2013. For the specialty crops tulip bulbs and apple trees, the number of bulbs and trees is a more common measure of quantity. Bell pepper prices refer to 2014 averages from GFActueel based on three different auctions.

| | | | | |
|---|---|---|---|---|
| **Potatoes** | 110 | 46 | 5,075 | 181 |
| **Sugar beet** | 73 | 78.1 | 5,660 | 52 |
| **Tulip Bulbs** | 12 | n/a | n/a | n/a |
| **Apple trees** | 0.8 | n/a | n/a | n/a |
| **Bell pepper (glass)** | 1,330 | 267 | 361 | 1,200 |

## 10.3 Effect of 75 substances on yield and variable costs

Exhibit 46 provides an overview of the consequences related to possibly losing the 75 substances for the staple and specialty crops in the Netherlands.

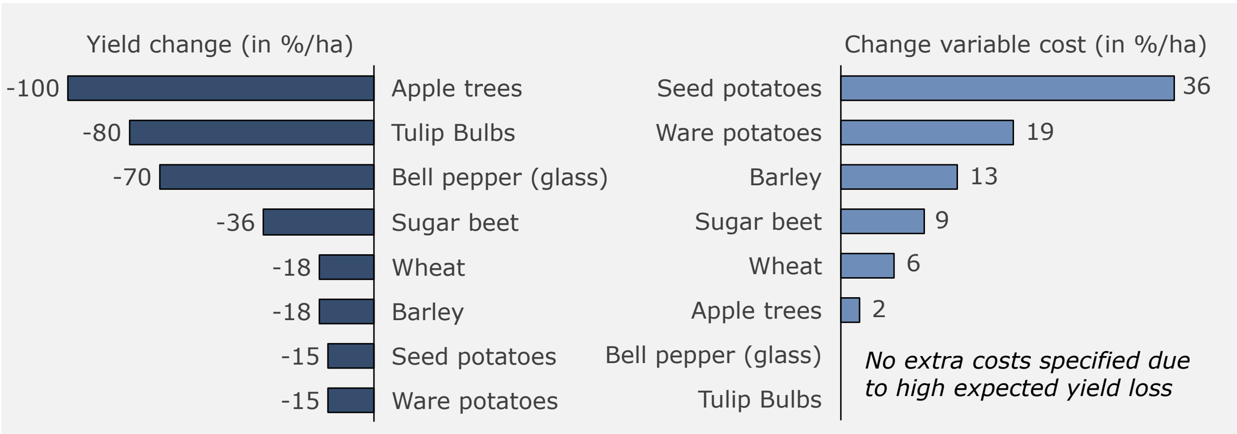


***Exhibit 46: Short-term yield and variable costs changes (in %/ha)***

For the staple crops, the 75 substances add relatively the most value to the sugar beet production, allowing farmers to harvest some 36% more tons per hectare than without the substances. The other staple crops benefit from the substances with at least 15-18% higher yield. With the 75 substances weed, disease and pest pressure on the crops is lower, allowing the crop to grow larger.

The value represents the effects that will at least occur in the short run. Under unfavourable pest conditions, yield effects could be higher. Furthermore, a smaller crop protection toolbox will increase the chance on resistance development. For potatoes, yield effects could sum up 20-30%, while for yields for cereals and sugar beet could increase to 46-60% (see Appendix).

The other change is with regards to variable costs. The 75 substances reduce the variable production costs by amongst others improved effectiveness. For most staple crops the effect adds less than 13% additional variable costs, however for potatoes these costs can increase from 19% up to 36%. This is due to fewer pesticides being applied less frequently in case of the 75 substances being available.

## 10.4 Effects on incomes

The lower yields (see Exhibit 46), given a fixed arable area, imply that the overall crop production in the Netherlands will decrease without the use of the 75 substances. As Exhibit 47 shows, in total, Dutch farm output is currently 3.1 Mt higher for staple crops and 0.3 Mt for bell pepper.

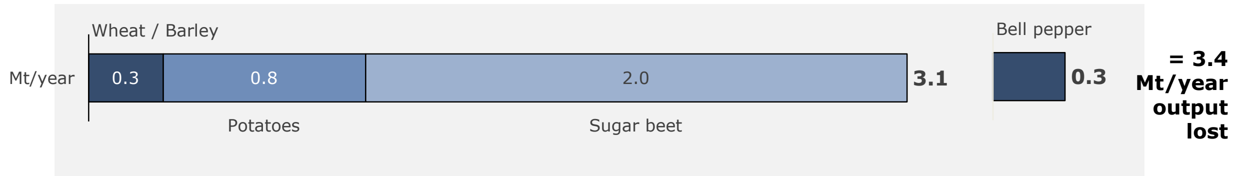


*Exhibit 47: Output changes (in Mt/year)*

Compared to other crops, the 75 substances have relatively the largest influence on the amount of sugar beets produced in the Netherlands (2 Mt/year). This is driven by the relatively large value the 75 substances add to sugar beet cultivation (at least 36% extra yield) as well as the relatively large area upon which sugar beet is cultivated in the Netherlands (73,000 ha).

Depending on ex-farm prices and the changes in variable costs, the gross margins earned on cultivating these crops is affected as well.

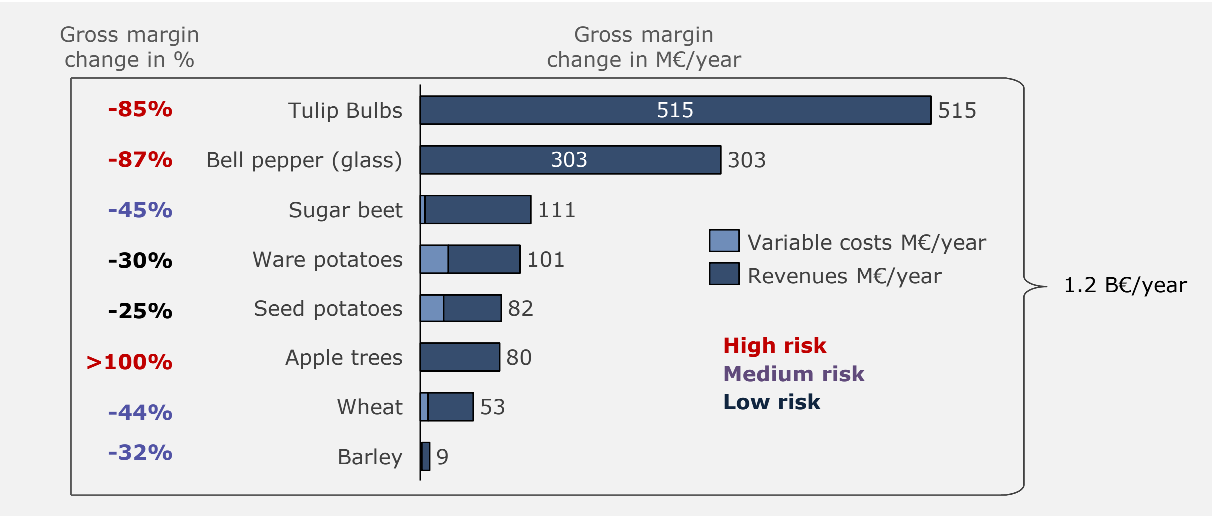


*Exhibit 48: Gross margin effects (in €m/year)*

As shown, in total Dutch farmers gain €1.2 billion gross margins per year from having the 75 substances. The total change between the two scenarios is mainly driven by revenue losses (€1.1 billion) and to a lesser extent influenced by variable costs (€0.1 billion). In value, tulip bulbs would be most affected from a decrease of the farming tool box with 515 million of value loss, while sugar beet would show the largest decrease in profitability (-37%) of the staple crops. Overall the profitability of apple trees, tulip bulbs and bell pepper is most affected. As the production of tulip bulbs and bell pepper is assumed to decrease by 70-80%, there are no additional variable costs specified.

As the gross margins earned on cultivating specialty crops like apple trees, tulip bulbs and bell-pepper (glass) decrease significantly, there is the chance that cultivation of these crops will no longer take place in the Netherlands. This is because these crops are at a high risk of losing their economic viability.

For effects on jobs, land use and the carbon footprint please refer to the overall EU chapter.

# 11 Austria

## 11.1 Austrian key effects

With the current farming tool box available, the Austrian production of **7 key staple crops**[97] is **2 Mt higher** and generates **€420 million more value** per year as if the 75 substances at risk are not included.

Further results include:

- sugar beet would face 35% lower yields, while the yield of wheat, barley, maize, potato and vine decreases by 10-25%;
- At the same time, variable production costs for most of the crops would increase by up to 10% per hectare, for sugar beet variable production costs would double;
- In value, vine would be most affected with €118 million of value loss, while sugar beet would show the largest decrease in profitability of the staple crops;
- Austrian crop agriculture employs 61,000 direct jobs of which 30,000 jobs relate to the crops covered by the study.

## 11.2 Agriculture in Austria

Indicating the relative importance of the agricultural sector in Austria, agriculture makes up 1.3% of the Austrian GDP and some 5% of the total employment is with the sector. The prevailing annual crops include durum wheat, grain maize, soybean and sunflowers in the warmest parts of Austria. Grasslands are dominant in the highlands and mountainous regions. The agricultural area including alpine pastures makes up about 40% of the Austrian total territory. The main Austrian crop production is located in the eastern and north-eastern low-lands of the country. As in these regions the yearly potential evapotranspiration has the same magnitude as the precipitation, Austrian crop production is quite sensitive to shifts in soil water availability. For Austria, the change of crop yield in 2008 referred to 1990 has been estimated based on several combinations of models and scenarios; the outcomes show an increase ranging from 16.7% - 20.5%.[98]

[97] Wheat, barley, potato, maize, oilseed rape, sugar beet and vine
[98] Climate adoption EU, Agriculture and horticulture in numbers

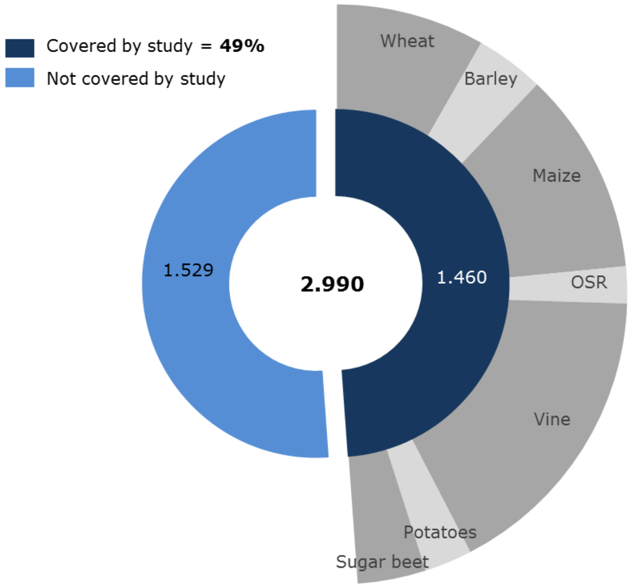


*Exhibit 49: Austrian agricultural production value (in € million)*

The total average annual Austrian agricultural production value[99] of the last five years was some €3 billion. The study focusses on the staple crops soft wheat, winter barley, oilseed rape, grain maize, seed and ware potatoes as well as sugar beet and vine. The selection is based on data availability and relevance of the crops. As Exhibit 49 shows, the crops covered by the study represent some 49% (1.460/2.990) of the total Austrian agricultural production value.

*Table 11: Overview Austrian crops[100]*

| Crop | Area (1000 ha) | Yield (t/ha) | Output (1000 ton) | Price (€/ton) |
|---|---|---|---|---|
| **Wheat** | 285 | 5,9 | 1.547 | 160 |
| **Barley** | 82 | 6 | 721 | 159 |
| **Maize** | 211 | 10 | 2.095 | 162 |
| **Sugar beet** | 47 | 72 | 3.192 | 36 |
| **Seed Potatoes** | 1,5 | 20 | 30 | 256 |
| **Ware Potatoes** | 20 | 31 | 635 | 176 |
| **Potatoes** | 22 | 30 | 665 | 179 |
| **OSR** | 56 | 3,3 | 173 | 415 |
| **Vine** | 44 | 7 | 305 | 1.690 |

## 11.3 Effect of 75 substances on yield and variable costs

Exhibit 50 provides an overview of the consequences related to possibly losing the 75 substances for the crops covered in Austria.

[99] Federal Institute of Agricultural Economics Austria- values at current prices, average 2009-2013
[100] Statistics Austria; Farm statistics, average 2009-2013

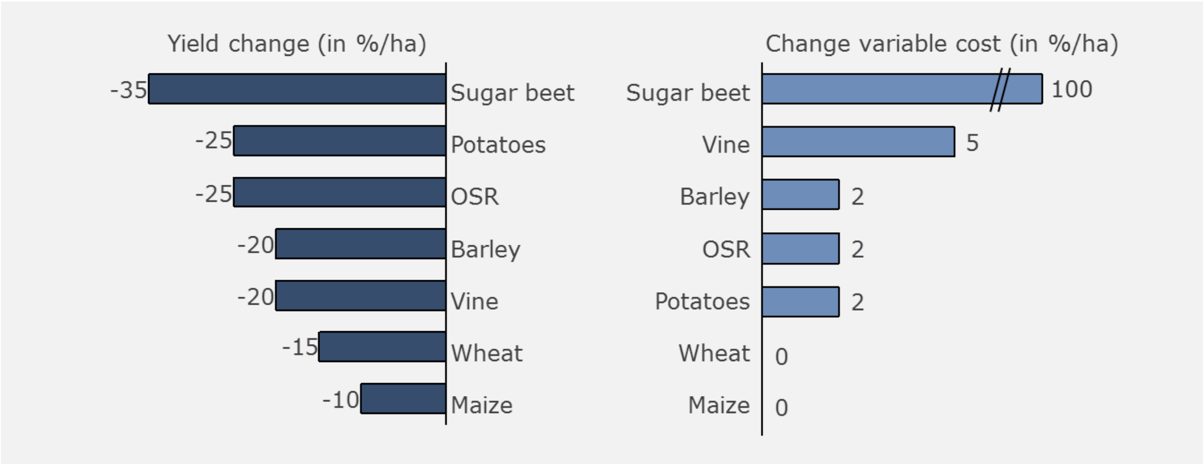


***Exhibit 50: Short-term yield and variable costs changes (in %/ha)***

The 75 substances add relatively the most value to the sugar beet production, allowing farmers to harvest some 35% more tons per hectare than without the substances. For potatoes and oilseed rape the 75 substances add 25% more yield and the other crops benefit from the substances with 10-20% higher yield. With the 75 substances weed, disease and pest pressure on the crops is lower, allowing the crops to grow larger.

For the longer term (not shown in the exhibit above), the 75 substances have an additional value as they support the avoidance of resistance effects. For cereals the additional long-term yield effect ranges from 2% for wheat to 7% for barley, for maize it is 2%, for oilseed rape 8%, for seed and ware potatoes 10%, for sugar beet 15% and for vine 5%.

In addition, variable production costs are affected. The 75 substances reduce the variable production costs by amongst others improved effectiveness compared to other substances in the tool box. For sugar beet, the ban of the 75 substances would lead to twice as many variable production costs. For the other staple crops the effect is up to 5% additional variable costs. This is caused by fewer amounts of pesticides currently being applied less frequently. Put differently, the treatment frequency is likely to increase in case the farming tool box is less well equipped.

The results for potatoes presented in Exhibit 50 combine the effects of ware and seed potatoes that differ in the change of variable costs. Barley refers to winter barley and maize to grain maize.

### 11.4 Effects on incomes

The lower yields (see Exhibit 50), given a fixed arable area, imply that the overall crop production in Austria will decrease without the 75 substances. As Exhibit 51 shows, in total, Austrian farm output is currently 2 Mt higher than without the 75 substances.


***Exhibit 51: Output changes (in Mt/year)***

Compared to other crops, the 75 substances have the relatively largest influence on the amount of sugar beets produced in Austria (1 Mt/year). This is driven by the relatively large value the 75 substances add to sugar beet cultivation (35% extra yield) as well as the relatively high yield per hectare (72t/ha).

Depending on ex-farm prices and the changes in variable costs, the gross margins earned on cultivating these crops is affected as well.

Exhibit 52 summarizes these effects. As shown, in total Austrian farmers gain €420 million gross margins per year from having the 75 substances. The total change is mainly driven by revenue losses (€330 million) and to a lesser extent influenced by variable costs (€87 million). Gross margin gains in sugar beet and vine make up the majority of the overall effect. In value, sugar beet would be most affected from a decrease of the farming tool box with €118 million of value loss. Given the relatively high ex-farm price per ton of output of vine, the 20% yield change for vine also results in a significant total gross margin loss.

The relative gross margin change gives insights into the overall economic viability of cultivating the crops. Given the revenue losses and the additional variable costs change, the profitability for sugar beet is at least questionable and might endanger the long-term sustainability of cultivating sugar beet in Austria. In other words, sugar beet can be argued to be at a high risk of losing its economic viability.

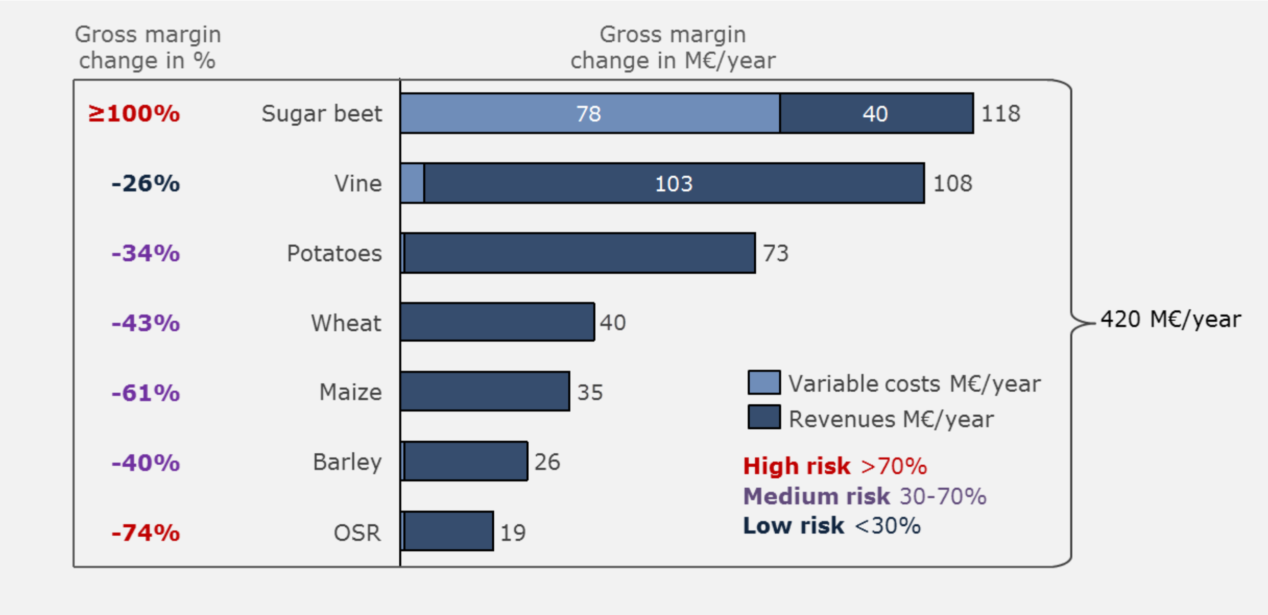


***Exhibit 52: Gross margin effects (in €M/year)***

For effects on jobs, land use and the carbon footprint please refer to the overall EU chapter.

# 12 Ireland

## 12.1 Irish key effects

With the current farming tool box available, the Irish production of **4 key staple crops**[101] is **1.4m MT higher** and generates **€0.1 billion more value** per year as if the 75 substances at risk are not included.

In addition, the **economic viability** of the production of **specialty crops**[102], **0.1m MT** of output and **€0.1 billion** is would be challenged without the 75 substances.

Further results include:

- Wheat, barley and potatoes would face 20-30% lower yields, while the yield of silage maize decreases by 50%;
- Yield loss for the specialty crops mushrooms, brassica and carrots would range from 40-55% and variable production costs increase by 38-61%.
- In value, mushrooms would be most affected with €108m of value loss, while carrots would show the largest decrease in profitability (-55%);
- Irish crop agriculture employs 26,000 direct jobs of which 9,000 jobs relate to the crops covered by the study.

## 12.2 Agriculture in Ireland

Indicating the relative importance of the agricultural sector in Ireland, agriculture makes up 1.6% of the Irish GDP and 5.7% of the labour force is employed within the sector. More than three quarters of the land in Ireland is used for agriculture and forestry; with agriculture at 45 million hectares, constituting 64% of land area. Irish agriculture is primarily a grass-based industry, only 9% of the agricultural area is allocated to crop production.  Of the agricultural output 26% is from crops, of which the bulk is vegetables and horticultural products.

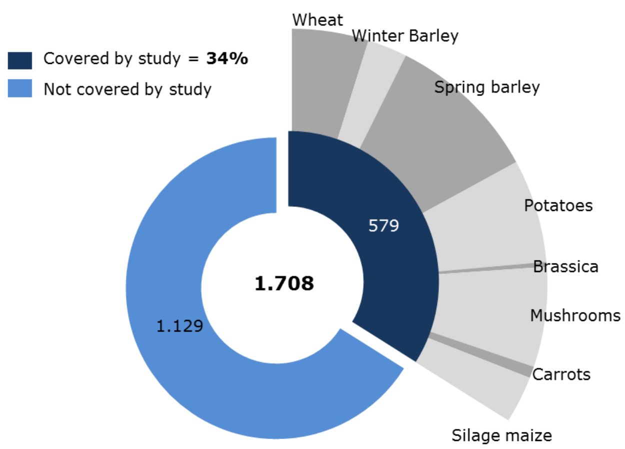


***Exhibit 53: Irish agricultural production value (in € million)***

[101] Wheat, barley, potato, silage maize
[102] Mushrooms, brassica, carrots

The total average annual Irish agricultural production value[103] of the last five years was some €1.7 billion. The study focusses on the staple crops wheat, barley, potatoes and (silage) maize. In addition, the specialty crops brassica, carrots and mushrooms are included for Ireland. The selection is based on data availability and relevance of the crops. As Exhibit 53 shows, the crops covered by the study represent some 34% (579/1,708) of the total Irish crop production value.

Mushrooms is one of Irish most valuable crops and is acknowledged to be one of the best in the world, and has positive growth prospects in the near future. It employs about 3,200 people directly and 400 people downstream. 75% of its production is exported to the UK, while the British demand is expected to grow steadily.[104]

***Table 12: Overview Irish crops[105]***

| Crop | Area (1000 ha) | Yield (t/ha) | Output (million ton) | Price (€/ton) |
|---|---|---|---|---|
| **Wheat** | 66 | 8.9 | 585 | 141 |
| **Winter barley** | 32 | 8.7 | 279 | 746 |
| **Spring barley** | 160 | 6.7 | 1,078 | 0 |
| **Potatoes** | 11 | 32.1 | 351 | 318 |
| **Brassica** | 1 | 25.8 | 19 | 271 |
| **Mushrooms** | n/a | n/a | 63 | 1715 |
| **Carrots** | 1 | 56.0 | 36 | 353 |
| **(Silage) Maize** | 12 | 145.7 | 1,788 | 28 |

Typically, Irish farmers have less active substances available to manage their crops in comparison to other EU member states such as its neighbour UK (including Northern Ireland). Similar to other small crop markets, the cost of registration outweighs the upside market opportunity, especially in times of low crop prices. Ireland has a favourable climate for cereal production, but is heavily reliant upon intensive application of artificial inputs due to high fungi pressure.[106]

## 12.3 Effect of 75 substances on yield and variable costs

Exhibit 54 provides an overview of the consequences related to possibly losing the 75 substances for the staple and specialty crops in Ireland.

[103] Eurostat; Economic accounts for agriculture - values at current prices
[104] Teagasc, Mushroom Sector Development Plan to 2020, October 2013
[105] Eurostat; Farm statistics, average 2009-2013, CSO/Teagasc farm statistics 2009-2013
[106] Jess et al, European Union (EU) policy on pesticides: Implications for agriculture in Ireland, 2014

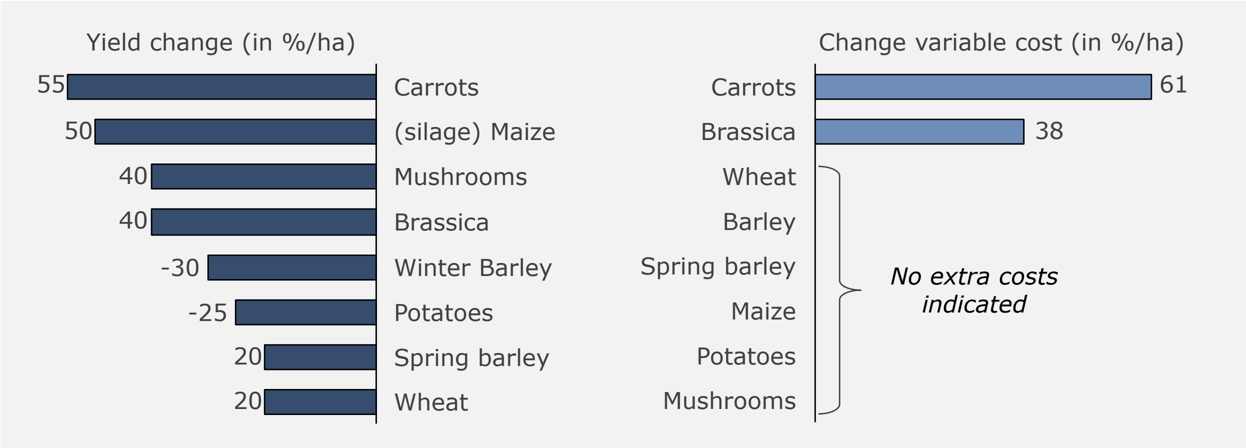


*Exhibit 54: Short-term yield and variable costs changes (in %/ha)*

For the staple crops, the 75 substances add relatively the most value to (silage) maize production, allowing farmers to harvest some 50% more tons per hectare than without the substances. The other staple crops benefit from the substances with 20-30% higher yield. With the 75 substances weed, farms are better protected against disease and pest pressure, allowing the crops to grow larger.

These yield values indicate the lowest expected yield values, while crop experts from Teagasc provided yield ranges including effects when facing high pest pressure and including resistance effects. Under these circumstances, yield effects of wheat and barley could increase up to 50-70% and similarly for the vegetables carrots and brassica crops (see yield and cost ranges in the Appendix).

The other change is with regards to variable costs. The 75 substances reduce the variable production costs by amongst others improved effectiveness. For the staple crops, we do not have effects on additional variable costs available. For the specialty crops carrots and brassica (e.g. cabbage), the cost changes range from 38-61%.

## 12.4 Effects on incomes

The lower yields (see Exhibit 54), given a fixed arable area, imply that the overall crop production in Ireland will decrease without the 75 substances. As Exhibit 55 shows, in total, Irish farm output is currently 1.4 Mt higher for the staple crops in scope and 0.1 Mt for the mushrooms, brassica and carrots.

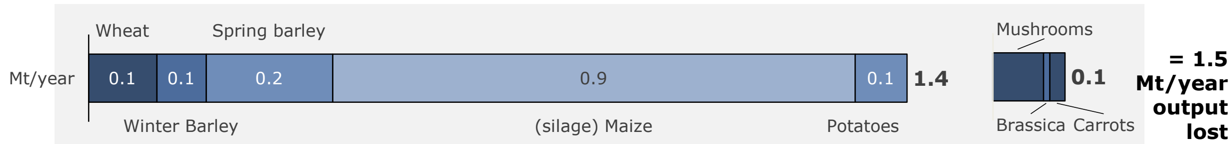


*Exhibit 55: Output changes (in m MT/year)*

Compared to other crops, the 75 substances have relatively the largest influence on the amount of (silage) maize produced in Ireland (0.9 Mt/year). This is driven by the relatively large value the 75 substances add to silage maize cultivation (50% extra yield).

Depending on ex-farm prices and the changes in variable costs, the gross margins earned on cultivating these crops is affected as well.

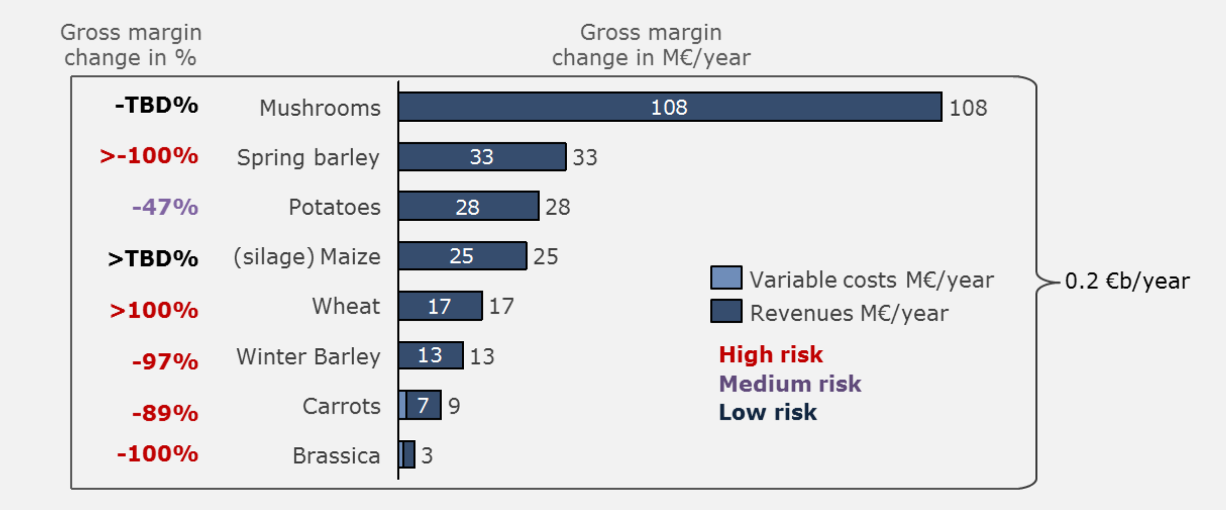


***Exhibit 56: Gross margin effects (in €m/year)***

As shown, in total Irish farmers gain €0.2 billion gross margins per year from having the 75 substances. The total change is a representation of revenue losses (€233 million), as the cost change estimates for most crops is not available. For carrots and brassica, changes in production would increase variable costs by €3 million. In value, mushrooms would be most affected from a decrease of the farming tool box with 108 million of value loss, while all crops show large decreases in profitability from -47% for potatoes and>-90% for all other crops.

As the gross margins earned on cultivating specialty crops like carrots and brassica decrease significantly, there is the chance that cultivation of these crops will no longer take place in Ireland. This is because these crops are at a medium or high risk of losing their economic viability.

For effects on jobs, land use and the carbon footprint please refer to the overall EU chapter.

## APPENDIX I – Detailed changes

### A. FRANCE

| Crop | Pests | Substance name[107] | Substance type | Alternative compared against | Area affected | Immediate yield (change in %) | Add. resistance effect | Change Production costs (€/ha) |
|---|---|---|---|---|---|---|---|---|
| **Wheat** | **Total** | | | | | **-16%** | **3%** | **12** |
| | Septoria | triazoles | Fungicide | SDHI, strobilurins | 95% | -5% | | |
| | Aphids and cicadel | imidacloprid<br>lambda-cyhalothrin | Insecticide | Cypermethrin, cyfluthrin, alphamethrin, thau fluvalinate, g cyhalothrin | 15% | -1% | | |
| | All weeds | pendimethalin<br>ioxynil<br>chlorotolurun | Herbicide | | 95% | -10% | | |
| **Barley** | **Total** | | | | | **-19%** | **3%** | **11** |
| | Septoria | triazoles | Fungicide | SDHI, strobilurins | 95% | -5% | | |
| | Aphids and cicadel | Imidacloprid<br>lambda-cyhalothrin | Insecticide | Cypermethrin, cyfluthrin, alphamethrin, thau fluvalinate, g cyhalothrin | 60% | -10% | | |
| | All weeds | pendimethalin<br>ioxynil<br>chlorotolurun | Herbicide | | 95% | -4% | | |
| **Grain Maize** | **Total** | | | | | **-8%** | **n.a.** | **8** |
| | Diseases | triazoles | Fungicide | | 95% | -/+0% | | |
| | Aphids and cicadellae | imidacloprid<br>thiamethoxam<br>clothianidin | Insecticide | Chlorpyriphos<br>Cypermethrin<br>Tefluthrin | 95% | -3% | | |
| | All weeds | pendimethalin<br>s-metolachlor | Herbicide | | 95% | -5% | | |

[107] For beans, OSR, vine and apples also one or several of the following substances have been taken into account: acetamiprid, strobilurins, pyrethrinoïds, penconazole, dimethoat, cyprodinil, fludioxonil, benfluraline, bentazone, ethoflumesate, imazamox, pirimicarb, pyrimicarge and chlorpyrifos

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| OSR | **Total** | | | | | **-5%** | **n.a.** | **38** |
| | Insects | imidacloprid | | | | | | |
| | | clothianidin | Insecticide | All other technologies | 95% | -5% | | |
| | | thiacloprid | | | | | | |
| | | thiamethoxam | | | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Sugar beet | **Total** | | | | | **-35%** | **n.a.** | **70** |
| | Diseases | cyproconazole | Fungicide | | 95% | -25% | | |
| | | difenoconazole | | | | | | |
| | | epoxiconazole | | | | | | |
| | | propiconazole | | | | | | |
| | | tetraconazole | | | | | | |
| | | quinoxyfen | | | | | | |
| | | hymexazol | | | | | | |
| | | iprodione | | | | | | |
| | | mancozeb | | | | | | |
| | | maneb | | | | | | |
| | | thiram | | | | | | |
| | Insects | clopyralid | Herbicide | | 95% | -7% | | |
| | | dimethenamid-P | | | | | | |
| | | ethofumesate | | | | | | |
| | | fluazifop-p-butyl | | | | | | |
| | | lenacil | | | | | | |
| | | s-metolachlor | | | | | | |
| | | triflusulfuron | | | | | | |
| | Weeds | clothianidin | Insecticide | | 95% | -3% | | |
| | | imidacloprid | | | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | thiamethoxam | | | | | | |
| **Potato** | **Total** | | | | | **-10%** | **n.a.** | **55** |
| | Diseases | multisite fungicides<br>contact fungicides | Fungicide | | 95% | -10% | | |
| | Wire worms | imidacloprid | Insecticide | Fosthiazate<br>Chlorpyriphos-ethyl | 95% | +/-0% | | |
| | Weeds | metribuzin | Herbicide | | 95% | +/-0% | | |
| **Vine** | **Total** | | | | | **-22%** | **n.a.** | **350** |
| | Guignardia bidwellii | triazoles | Fungicide | dithianon | 0,05 | -10% | | |
| | Downy mildew | folpet | | metiram | 0,95 | -5% | | |
| | | mancozeb | | | | | | |
| | Scaphoïdeus titanus | neonicotinoïds | Insecticide | pyrethrinoids | 60% | -10% | | |
| | Weeds | amitrole | Herbicide | mechanical solution | 0,9 | +/-0 | | |
| | | flumioxazine | | glyphosate | | | | |
| | | | | flazasulfuron, isoxaben, oryzalin, penoxulam | | | | |
| **Apples** | **Total** | | | | | **-60%** | **n.a.** | **n.a.** |
| | Mildew | bupirimate | Fungicide | | 95% | no figures available | | |
| | | myclobutanil | | | | | | |
| | | tetraconazole | | | | | | |
| | Scap | captan | Fungicide | dithianon | 95% | up to -100% | | |
| | | difenoconazole | | | | | | |
| | | fenbuconazole | | | | | | |
| | | fluquinconazole | | | | | | |
| | | mancozeb | | | | | | |
| | | maneb | | | | | | |
| | | tebuconazole | | | | | | |
| | Fruit storage disease | thiophanate-meythl | Fungicide | | 95% | no longer used | | |
| | Apple scrap | thiram | Fungicide | | 59% | no figures available | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Fly speck | | | | | | | |
| | Sooty blotch | | | | | | | |
| | Leaf miners | abamectin | Fungicide | | 95% | no figures available | | |
| | Moth | beta-cyfluthrin | Insecticide | fenoxycarb | 95% | -50% to -100% | | |
| | Aphid | deltamethrin<br>esfenvalerate<br>lambda-cyhalothrin<br>spinosad<br>thiacloprid | Insecticide | spinosad | 59% | -20% to -100% | | |
| | Aphid | deltamethrin<br>lambda-cyhalothrin<br>spirotetramat<br>thiacloprid | Insecticide | | 95% | -20% to -80% | | |
| | Woolly pucernon | thiamethoxam<br>clothianidin | Insecticide | | 95% | -20% to -50% | | |
| | all weeds | amitrole<br>carbetamide<br>clopyralid<br>fluazifop-p-butyl<br>flumioxazine<br>fluroxypyr<br>glufosinate<br>glyphosate<br>pendimethalin | Herbicide | | 95% | up to 100% | | |
| | Disinfection | metam sodium | Other | basamid | 95% | no figures available | | |
| **Carrots** | **Total** | | | | | **-92%** | **n.a.** | **n.a.** |
| | Pythiacées | mancozeb | Fungicide | | 40% | -20% | | |
| | CH. Autre que pythiacée | difenoconazole | Fungicide | | 95% | -20% | | |
| | Oïdium | myclobutanil | Fungicide | | 20% | -20% | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Désherbage | metribuzin | Herbicide | | 20% | -20% | | |
| | | pendimethalin | Herbicide | | 95% | -20% | | |
| | | linuron | Herbicide | no alternative | 95% | -30% | | |
| | Ch. Sol | metam sodium | Other | | 30% | -20% | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Beans** | **Total** | | | | | **-100%** | **n.a.** | **646** |
| | White mold (Sclerotinia sclerotiorum) | iprodione | Fungicide | boscalid | 75% | -100% | | |
| | | thiophanate-meythl | | | | | | |
| | Black nightshade, thorn apple, annual mercury | s-metolachlor | Herbicide | clomazon | 100% | -100% | | |
| | Insects | lambda-cyhalothrin | Insecticide | | 95% | -30% | | |
| | | deltamethrin | | | | | | |
| | Aphids | deltamethrin | Insecticide | no alternative | 67% | | | |
| | | lambda-cyhalothrin | | | | | | |
| | Seed maggots & wireworms | chlorpyrifos | Insecticide | no alternative | 30% | | | |
| | Caterpillars | not affected | Insecticide | | 95% | 0% | | |

## B.

## B. GERMANY

| Crop | Pests | Substance name[108] | Substance type | Alternative compared against | Area affected | Immediate yield (change in %) | Add. resistance effect | Change Production costs (€/ha) |
|---|---|---|---|---|---|---|---|---|
| Wheat/Barley | **Total** | | | | | **-18%** | **n.a.** | **n.a.** |
| | Septoria, rust | azoles | Fungicides | Strobilurins, Carboxamides | | -17% | | |
| | Broadleaved weeds | ioxynil<br>linuron | Herbicides | | 2% | 0% | | |
| | Windhalm, Rispe, Kamille, Vogelniere, Hundskerbel und Kornblume | chlorotolurun | Herbicides | Isoproturon | 30% | 0% | | |
| | Disteln, Kornblume und Kamille | clopyralid | Herbicides | U 46 M-Fluid<br>Tribenuron | 15% | -1% | | |
| | Klette, Vogelmiere und Winden | fluroxypyr | Herbicides | Florasulam, Amidosulfuron | 15% | -1% | | |
| | Couch grass after harvest | glyphosate | Herbicides | no alternatives | 1% | -10% | | |
| | Black grass | glyphosate | Herbicides | no alternatives | 5% | -10% | | |
| | Voraussetzung für die konservierende Bodenbearbeitung | glyphosate | Herbicides | no alternatives | 30% | | | |
| | Poppy seed, silky went grass | pendimethalin | Herbicides | no alternatives | 5% | -5% | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Maize | **Total** | | | | | **-2%** | **n.a.** | **9** |
| | | imidacloprid<br>clothianidin<br>thiacloprid<br>thiamethoxam | Insecticides | All other technologies | | -1% | | |
| | Hirsen und Bingelkraut | dimethenamid-P | Herbicides | Metolachlor und Pethoxamid | 10% | 0% | | |
| | Couch grass after harvest | glyphosate | Herbicides | no alternatives | 1% | -10% | | |
| | Blackgrass | glyphosate | Herbicides | no alternatives | 5% | -10% | | |

[108] For wheat/barley, maize, OSR and onions also one or several of the following substances have been taken into account: 2,4-D, acetamiprid, propyzamide, prosulfocarb, aclonifen

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Prerequisite for the conservation tillage | glyphosate | Herbicides | no alternatives | 30% | | | |
| | Hirsen und Storchenschnabel-Arten | s-metolachlor | Herbicides | Dimethenamid, Petoxamid, Flufenacet | 30% | 0% | | |
| | Weeds | terbuthylazine | Herbicides | no alternatives | 50% | 0% | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **OSR** | **Total** | | | | | **-17%** | **n.a.** | **55** |
| | Cabbage flea beetle & Cabbage root fly | imidacloprid | Insecticides | All other technologies | 60% | -5% | | |
| | | clothianidin | | | | | | |
| | | thiacloprid | | | | | | |
| | | thiamethoxam | | | | | | |
| | Septotia, rust | azoles | Fungicides | Strobilurins, Carboxamides | | -7% | | |
| | Grass- and broadleved weeds | S-metolachlor | Herbicides | | 80% | -5% | | |
| | Disteln, Kornblume, Kamille | clopyralid | Herbicides | no alternatives | 2% | -1% | | |
| | Couch grass | glyphosate | Herbicides | no alternatives | 1% | -10% | | |
| | Blight leaf | glyphosate | Herbicides | no alternatives | 5% | -10% | | |
| | Prerequisite for the conservation tillage | glyphosate | Herbicides | no alternatives | 30% | | | |
| | Speedwell species, poppy and panicle | pendimethalin | Herbicides | no alternatives | 25% | 0% | | |
| | Chamomile fighting | picloram | Herbicides | Diflufenican und Beflubetamid | 5% | -2% | | |
| | Volunteer rape and other weeds | triflusulfuron | Herbicides | no alternatives | 20% | -2% | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Sugar beet** | **Total** | | | | | **-49%** | **-25%** | **505** |
| | Creeping thistle, Chamomile, Nightshade, Buckwheat, Fool's Parsley | beta-cyfluthrin | Insecticide | Tefluthrin | 60% | 0% | n.a. | |
| | | clothianidin | Insecticide | Alpha-cypermetrin, Pirimicarb | 100% | -10% | | |
| | | imidacloprid | Insecticide | Alpha-cypermetrin, Pirimicarb | | | | |
| | | thiamethoxam | Insecticide | Alpha-cypermetrin, Pirimicarb | | | | |
| | | deltamethrin | Insecticide | Alpha-cypermetrin, Pirimicarb | 0 bis 25% | -10% | | |
| | | dimethoate | Insecticide | Alpha-cypermetrin, Pirimicarb | 0 bis 15% | | | |
| | | lambda-cyhalothrin | Insecticide | Alpha-cypermetrin, Pirimicarb | 0 bis 25% | | | |
| | | cyproconazole | Fungicide | Quinoxyfen, Strobilurine | bis 100 % | -15% | n.a. | |
| | | difenoconazole | Fungicide | Sulfur | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | thiophanate-meythl | Fungicide | | 10% | -10% | | |
| | | prochloraz | Fungicide | | 60% | -10% | | |
| | | thiram | Fungicide | No alternative | 100% | -15% | | |
| | | hymexazol | Fungicide | No alternative | 100% | | | |
| | | clopyralid | Herbicide | No alternatives | 10% | -10% | 5-10% | 115 |
| | Amaranth, Speedwell, Chamomile, Geranium, Fool's Parsley Nightshade | dimethenamid-P | Herbicide | No alternatives | 15% | -5% | | |
| | Amaranth, Cleavers, Goosefoot, Knotweed | ethofumesate | Herbicide | Quinmerac | 100% | -10% | | |
| | Graminizid | fluazifop-p-butyl | Herbicide | Other Fop products like Targa Super, Agil-S, Galant Super | 5% | -5% | | 35 |
| | Amaranth, Cleavers, Smartweed, Oil radish, Volunteer rape, Camomile, Fool's Parsley, | triflusulfuron | Herbicide | No alternatives | 50% | -10% | | 95 |
| | | lenacil | Herbicide | | 80% | 0% | | 60 |
| | Old weeds in spring. Important in the no-till sowing of sugar beet in mulch sowing. | glyphosate | Herbicide | No alternatives | 40% | 0% | 5-10% | |
| **Potato** | **Total** | | | | | **-29%** | **n.a.** | **n.a.** |
| | Leaf blight | glyphosate<br>glyphosate | Fungicides | Compared to<br>untreated situation | | -26% | | |
| | Couch grass | glyphosate | Herbicides | No alternatives | 1% | -10% | | |
| | Blackgrass before sowing | glyphosate | Herbicides | No alternatives | 5% | -10% | | |
| | Prerequisite for the conservation tillage | glyphosate | Herbicides | No alternatives | 30% | | | |
| | General weeds | metribuzin | Herbicides | No alternatives | 70% | -3% | | |
| **Onions** | **Total** | | | | | **0%** | **n.a.** | **1000** |
| | | pendimethalin | Herbicides | No alternatives available | | up to 100% | | |
| | | ioxynil | | | | | | |
| | | mancozeb | Fungicides | No alternatives available | | 50% | | |
| | | Imidacloprid | Insecticides | No alternatives available | | | | |
| **Hops** | **Total** | | | | | **-30%** | **-19%** | **400** |
| | Spider mites | abamectin | Insecticides | spirodiclofen, acequinocyl, milbemectin, hexythiazox | 100% | -5% | 0% | + 150 €/ha |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Aphids | imidacloprid | Insecticides | flonicamid | 10% | -1% | 90% | |
| | hop flee beetle | lambda-cyhalothrin | Insecticides | none | 30% - 50% | -0,15 | 0% | |
| | alfalfa snout weevil, hop flea beetle | thiamethoxam | Insecticides | none | 30% - 50% | -0,15 | 0% | |
| | Downy mildew | mandipropamid | Fungicides | azoxystrobin, dimethomorph, copperhydroxide, dithianon + cymoxynil, pyraclostrobin + boscalid, fosetyl-al | 25% | -1% | 0% | |
| | Powdery mildew | myclobutanil | Fungicides | pyraclostrobin+boscalid, potassium hydrogene carbonate, sulfur | 100% | -20% | 10% plus up to 10% quality loss | + 100 €/ha |
| | | quinoxyfen | | | | | | |
| | | triademenol | | | | | | |
| | Monocotylidones | fluazifop-p-butyl | Herbicides | none | 60% | -3% | 0% | + 50 €/ha |
| | | tepraloxydim | | | | | | |
| | Basal defoliation | flumioxazine | Herbicides | early defoliation: none | 35% | 0% | 0% | +100 €/ha |

## B.

## C. UK

| Crop | Pests | Substance name | Substance type | Alternative compared against | Area affected | Yield (change %) | Additonal resistance effect | Change variable production costs (%/ha) |
|---|---|---|---|---|---|---|---|---|
| **Wheat** | **Total** | | | | | **-12%** | **n/a** | **EUR 62/ha** |
| | Insects | Bifenthrin<br>esfenvalerate<br>thiacloprid | Insecticide | Metaldehyde and ferric phosphate, lambda-cyhalothrin | 34% | -2% | | |
| | Septoria and other fungal diseases | carbendazim<br>Azoles | Fungicide | Chlorothalonil, mancozeb, folpet, biaxfen, boscalid, fluxapyroxad and isopyrazam | 68-100% | -3% | | |
| | Blackgrass and other weeds (including broadleaved) | Pendimethalin<br>ioxynil<br>linuron | Herbicide | Chlorotoluron, clopyralid and glyphosate | 52-75% | -20% | | |
| **Barley** | **Total** | | | | | **-10%** | **n/a** | **EUR 50/ha** |
| | Fungal diseases (mildew, fusarium) | carbendazim<br>quinoxyfen<br>Azoles | Fungicide | | 58% | -1% | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Insects | Bifenthrin<br>esfenvalerate<br>thiacloprid | Insecticide | Cypermethrin, cyfluthrin, alphametrhin, thau fluvalinate, ferric phosphate | 21% | -1% | | |
| | Blackgrass and other weeds (including broadleaved) | Pendimethalin<br>ioxynil<br>linuron | Herbicide | Chlorotoluron, clopyralid and glyphosate | 52-75% | -20% | | |
| **Oilseed Rape** | **Total** | | | | | **-18%** | **n/a** | **EUR 67/ha** |
| | Phoma leaf spot | Metconazole<br>flusilazole | Fungicide | Foliar sprays, prothioconazole | 90% | -3% | | |
| | Aphids, turnip yellow virus, cabbage stem flea beetle | Clothianidin<br>imidacloprid<br>thiamethoxam<br>cypermethrin | Insecticide | Ferric phosphate, deltamethrin | 67% | 17% | | |
| | Volunteer cereals, grass weed and other weed | Carbetamide<br>metazachlor<br>propyzamide | Herbicide | | 4% | 24% | | |
| **Sugar beet** | **Total** | | | | | **-12%** | **n/a** | **EUR 123/ha** |
| | Fungal disease | Cyproconazole | Fungicide | Difenoconazole, benfuracarb, fosthiazate and oxamyl | 80% | -15% | | |
| | Other pests (cutworms, aphids, moths etc) | Cypermethrin<br>methiocarb | Insecticide | Lambda-cyhalothrin | 10% | -15% | | |
| **Potatoes** | **Total** | | | | | **-12%** | **n/a** | **EUR 467/ha** |
| | Blight | Chlorothalonil<br>fluazinam<br>mancozeb<br>maneb | Fungicide | Benfuracarb, fosthiazate and oxamyl | 100% | -10% | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Slugs and other pests (aphids, nematodes etc) | Cypermethrin<br>Methiocarb | Insecticide | Metaldehyde and ferric phosphate, lambda-cyhalothrin | 80% | -2% | | |
| | Volunteer cereals, grass weed and other weed | Pendimethalin<br>linuron | Herbicide | | 95% | -1% | | |
| **Peas** | **Total** | | | | | **-15%** | **n/a** | **EUR 57/ha** |
| | Fungal diseases | Chlorothalonil<br>Metconazole | Fungicide | | 10% | -20% | | |
| | Potatoe berries, broadleaved weeds and grass weeds | Pendimethalin | Herbicide | | 30% | -3% | | |

## D. POLAND

| Crop | Pests | Substance name | Substance type | Alternative compared against[109] | Area affected | Yield (% change) Minimum | Yield (% change) Maximum (incl resistance) | Change variable production costs (%/ha) |
|---|---|---|---|---|---|---|---|---|
| Wheat | Total | | | | | -5% | -30% | EUR 100-250 |
| | Aphid | Dimethoate | Insecticide | | | | | |
| | | Lambda-Cyhalothrin | | | | | | |
| | | Imidacloprid | | | | | | |
| | | Deltamethrin | | | | | | |
| | | Beta-Cyfluthrin | | | | | | |
| | | Esfenvalerate | | | | | | |
| | | Thiamethoxam | | | | | | |
| | Leaf diseases (rust, septoriosis), fusarium root rot, powdery mildew | tebuconazole | fungicide | | | | | |
| | | Epoxiconazole | | | | | | |
| | | Propiconazole | | | | | | |
| | | Prothioconazole | | | | | | |
| | | Prochloraz | | | | | | |
| | | Cyproconazole | | | | | | |
| | | Metconazole | | | | | | |
| | | Tetraconazole | | | | | | |
| | | Difenoconazole | | | | | | |
| | | Fluquinconazole | | | | | | |
| | | Carbendazim | | | | | | |
| | | Thiophanate-methyl | | | | | | |
| | | triadimenol | | | | | | |
| | | Mancozeb | | | | | | |
| | | Folpet | | | | | | |

[109] Best alternatives in Poland will be included in the final report.

| | | | | | | |
|---|---|---|---|---|---|---|
| | | Thiram | | | | |
| | Monocot and dicot weeds | Glyphosate | Herbicide | | | |
| | | Tralkoxydim | | | | |
| | | Metribuzin | | | | |
| | | chlorotolurun | | | | |
| | | Pendimethalin | | | | |
| | | Fluroxypyr | | | | |
| | | Clopyralid | | | | |
| | | Pinoxaden | | | | |
| **Maize** | **Total** | | | **-5%** | **-30%** | **EUR 25-200** |
| | Wireworms, european corn borer, frit fly, western corn rootworm | Lambda-Cyhalothrin | Insecticide | | | |
| | | Thiacloprid | | | | |
| | | Imidacloprid | | | | |
| | | Deltamethrin | | | | |
| | ear fusariosis, minor leaf blight, corn smut, maize head smut, seedling blight | Epoxiconazole | fungicide | | | |
| | | Triticonazole | | | | |
| | | Thiram | | | | |
| | Monocot and dicot weeds | terbuthylazine | Herbicide | | | |
| | | Fluroxypyr | | | | |
| | | Pendimethalin | | | | |
| | | S-Metolachlor | | | | |
| | | Linuron | | | | |
| | | Dimethenamid-P | | | | |
| | | Glyphosate | | | | |
| **Potatoes** | **Total** | | | **-20%** | **-70%** | **EUR 200-300** |
| | Colorado potato beetle, soil pests | Lambda-Cyhalothrin | Insecticide | | | |
| | | Thiacloprid | | | | |
| | | Esfenvalerate | | | | |
| | | Clothianidin | | | | |
| | | Thiamethoxam | | | | |
| | | Deltamethrin | | | | |
| | | Beta-Cyfluthrin | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | Imidacloprid | | | | |
| | Potato late blight, alterneria leaf spot | mandipropamid | fungicide | | | |
| | | Fluazinam | | | | |
| | | Mancozeb | | | | |
| | | Captan | | | | |
| | | Metiram | | | | |
| | | Folpet | | | | |
| | Monocot and dicot weeds | Lambda-Cyhalothrin | Herbicide | | | |
| | | Thiacloprid | | | | |
| | | Esfenvalerate | | | | |
| | | Clothianidin | | | | |
| | | Thiamethoxam | | | | |
| | | Deltamethrin | | | | |
| | | Beta-Cyfluthrin | | | | |
| | | Imidacloprid | | | | |
| | Growth control | Chlorpropham | Other | | | |
| | **Total** | | | **-20%** | **-70%** | **EUR 280-300** |
| **Sugar beet** | Soil pests, foliar pests | Esfenvalerate | Insecticide | | | |
| | | Dimethoate | | | | |
| | | beta-cyfluthrin | | | | |
| | | Thiamethoxam | | | | |
| | | Clothianidin | | | | |
| | | Imidacloprid | | | | |
| | | Deltamethrin | | | | |
| | | Thiacloprid | | | | |
| | | Lambda-Cyhalothrin | | | | |
| | Taro leaf blight, powdery mildew | Epoxiconazole | fungicide | | | |
| | | Mancozeb | | | | |
| | | Tetraconazole | | | | |
| | | Tebuconazole | | | | |
| | | Cyproconazole | | | | |
| | | thiophanate-methyl | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | Thiram | | | | |
| | | Hymexazol | | | | |
| | Monocot weeds | Glyphosate | Herbicide | | | |
| | | Ienacil | | | | |
| | | Tepraloxydim | | | | |
| | | Triflusulfuron | | | | |
| | | Clopyralid | | | | |
| | | Ethofumesate | | | | |
| | | Fluazifop-P-Butyl | | | | |
| | | S-Metolachlor | | | | |
| OSR | **Total** | | | **-20%** | **-50%** | **EUR 200-300** |
| | Soil pests, foliar pests | Esfenvalerate | Insecticide | | | |
| | | Dimethoate | | | | |
| | | Thiamethoxam | | | | |
| | | Clothianidin | | | | |
| | | Imidacloprid | | | | |
| | | Deltamethrin | | | | |
| | | Thiacloprid | | | | |
| | | Lambda-Cyhalothrin | | | | |
| | Taro leaf blight, powdery mildew | Epoxiconazole | fungicide | | | |
| | | Mancozeb | | | | |
| | | Tetraconazole | | | | |
| | | Tebuconazole | | | | |
| | | Cyproconazole | | | | |
| | | thiophanate-methyl | | | | |
| | | Thiram | | | | |
| | | Hymexazol | | | | |
| | Monocot weeds | Ienacil | Herbicide | | | |
| | | Tepraloxydim | | | | |
| | | Triflusulfuron | | | | |
| | | Clopyralid | | | | |
| | | Ethofumesate | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | Fluazifop-P-Butyl | | | | |
| | | S-Metolachlor | | | | |
| **Apples** | **Total** | | | **-20%** | **-50%** | **EUR 200-300** |
| | Autumn rapeseed pests, weevil, pollen beetle | Lambda-Cyhalothrin<br>Beta-Cyfluthrin<br>Clothianidin<br>Deltamethrin<br>Esfenvalerate<br>Imidacloprid<br>Thiacloprid | Insecticide | | | |
| | Growth control, dry rot, cylindrosporiosis, white mold | Metconazole<br>Difenoconazole<br>Prothioconazole<br>Tetraconazole<br>Tebuconazole<br>Carbendazim<br>thiophanate-methyl<br>Prochloraz<br>Thiram | fungicide | | | |
| | Monocot and dicot weeds | Glyphosate<br>glufosinate<br>Fluazifop-P-Butyl<br>Clopyralid<br>Picloram<br>Dimethenamid-P | Herbicide | | | |
| **Black currants** | **Total** | | | **-20%** | **-100%** | **EUR 250-500** |
| | Aphid | Lambda-Cyhalothrin<br>Thiacloprid<br>Thiamethoxam | Insecticide | | | |

| | | | |
|---|---|---|---|
| | | Deltamethrin | |
| | Anthracnose, powdery mildew | Metiram<br>Mancozeb<br>thiophanate-methyl<br>Bupirimate | fungicide |
| | monocot & other weeds | Fluazifop-P-Butyl<br>Glyphosate<br>glufosinate | Herbicide |

## E. SPAIN

| Crop | Pests | Substance name[110] | Substance type | Alternative compared against | Area affected | Immediate yield (change %) | Add. resistance effect | Change production costs (€/ha) |
|---|---|---|---|---|---|---|---|---|
| Citrus | **Total** | | | | | **-36%** | **n.a.** | **2.371** |
| | Aguado, alternaria, antracnosis | mancozeb | Fungicide | Azoxistrobin, Copper, Fosetil-al | 20% | -12% | | |
| | Louses,<br>Whiteflies<br>Aphids | spirotetramat | Insecticide | Metil, Clorpirifos, Aceites, Parafinicos, Feromonas, Piriproxifen | 50% | -10% | | 10% of variable costs |
| | Aphids, thrips, minelayer | dimethoate<br>thiamethoxam | Insecticide | Flonicamida, Tau-FLuvalinato | | -5% | | 5% of variable costs |
| | Red mite,<br>red spider mite,<br>leaf miner | abamectina | Insecticide & acaricide | Piridaben, Etoxazol,<br>Fenpiroximato<br>Spiridiclofen, Hexitiazon | 60% | -12% | | |
| | Fruit flies | deltamethrin<br>lambda-cyhalothrin | Insecticide | Etofenprox, Lambda, Chialotrin | 30% | -5% | | 20%of variable costs |

[110] For citrus fruits and cherries also one or several of the following substances have been taken into account: abamectina and fludioxonil

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | spinosad | | | | | | |
| | Minelayers | imidacloprid | Insecticide | Azadirectina | 10% | -9% | | |
| | Snails | methiocarb | Helicide | No alternative available | 20% | -30% | | |
| | All weeds | glyphosate | Herbicide | 2,4-D, Acido, Triclopir, Amitrol, MCPA, Diflufenican, Pendimetalin, Diflufenican, Oxifluorfen | -10% | 35% | | |
| **Tomato (open)** | **Total** | | | | | **-85%** | | **250** |
| | | metribuzin | Herbicides | Rimsulfuron | 70% | -100% | | |
| | | metam sodium | Other | Oxamilo, Dicloropropeno | 50% | -50% | | |
| | | | | Organic substances | | | | |
| **Tomato (glass)** | **Total** | | | | | **-36%** | **-15%** | **n.a.** |
| | Desinfection soil fungi | metam sodium | Fungicide | No alternative available | 50% | -50% | -25% | |
| | Aphids, | spiromesifen | Insecticide | | 15% | -4% | -0.6% | |
| | Mealy bugs | spirotetramat | | | | | | |
| | White spider | | | | | | | |
| | Trips | spinosad | Insecticide | No alternative available | 15% | -30% | -4.5% | |
| | Mildew | mandipropami d | Fungicide | | 40% | -15% | -6% | |
| | | mancozeb | | | | | | |
| | Botritis | iprodione | Fungicide | | 30% | unknown | unknown | |
| **Vine** | **Total** | | | | | **-13%** | **n.a.** | **n.a.** |
| | Botritis o Pobredumbre gris (Botrytis cinerea) | | Fungicide | | 13% | | | |
| | Mildiu (Plasmopora viticola) | | Fungicide | | 57% | | | |
| | Oidio (Erysiphe necator) | | Fungicide | | 32% | | | |
| | Piral (Sparganothis pilleriana) | | Insecticide | | 5% | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Pollilla del racimo (Lobesia botrana/Eupoecilla ambiguella) | | Insecticide | | 2% | | | |
| **Olives** | **Total** | | | | | **-40%** | **n.a.** | **n.a.** |
| | Monocots | glyphosate | Herbicide | Quizalafop-etil | 100% | -20% | | |
| | Prays | dimethoate | Insecticide | No alternatives | 50% | -40% | | |
| | | | Fungicide | | | | | |
| **Sugar beet** | **Total** | | | | | **-44%** | **n.a.** | **521** |
| | Cercospora blight, | carbendazim | Fungicide | | 70% | -15% to | | |
| | Powdery mildew, | cyproconazole | | | | -30% | | |
| | Rust | difenoconazole | | No alternative | | | | |
| | | epoxiconazole | | available | | | | |
| | | hymexazol | | | | | | |
| | | mancozeb | | | | | | |
| | | maneb | | | | | | |
| | | prochloraz | | | | | | |
| | | propiconazole | | | | | | |
| | | tetraconazole | | | | | | |
| | | thiophanate-meythl | | | | | | |
| | | carbendazim | | | | | | |
| | Flea beetles, | beta-cyfluthrin | Insecticide | | | | | |
| | Aphids, | clothianidin | | | | | | |
| | Weevils, | deltamethrin | | | | | | |
| | Casida, | dimethoate | | | | -10% to | | |
| | Noctuids | esfenvalerate | | | 40% | -30% | | |
| | | imidacloprid | | | | | | |
| | | lambda-cyhalothrin | | | | | | |
| | | thiacloprid | | | | | | |
| | Composed, | clopyralid | Herbicide | | 100% | -30% | | |
| | Xanthium, | ethofumesate | | | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Abutillon, | fluazifop-p-butyl | | | | | | |
| | Torilis, | glyphosate | | | | | | |
| | Mauve, | lenacil | | | | | | |
| | Crop sprouts | S-metolachlor | | | | | | |
| | like sunflower | triflusulfuron | | | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Rice** | **Total** | | | | | **-28%** | **n.a.** | **n.a.** |
| | Pyricularia | tebuconazole | Fungicide | Triciclazol | 80% | -25% | | |
| | | prochloraz | | Azoxistrobin | | | | |
| | | propiconazole | | | | | | |
| | Aphids | imidacloprid | Insecticide | Etofenprox | 10% | -10% | | |
| | All weeds | MCPB | Herbicide | Penoxulan | 100% | -7% | | |
| | | | | Bednesulfuron | | | | |
| | | | | Bentazone, Halosulfuron | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Sunflower** | **Total** | | | | | **-15%** | **n.a.** | **n.a.** |
| | | imidacloprid | All other technologies available | Other | | -15% | | |
| | | | | technologies | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Cherry** | **Total** | | | | | **-15%** | **n.a.** | **1.040** |
| | Weed | glyphosate | Herbicide | | | -10% | | |
| | Aphids | dimethoate | Insecticide | | | -25% | | |
| | Aphids | spinosad | Insecticide | | | -25% | | |
| | Cochinillas, Orugas | chlorpropham | Insecticide | | | -10% | | |
| | | thiamethoxam | | | | | | |
| | Maelybugs, caterpillars | Imidacloprid | Insecticide | | | -10% | | |
| | Miner, aphids | mancozeb | Fungicide | | | -12% | | |
| | Brown rot, anthracnose | tebuconazole | Fungicide | | | -25% | | |

## F. ITALY

| Crop | Pests | Substance name | Substance type | Alternative compared against | Area affected | Yield (% change) Minimum | Yield (% change) Maximum (incl resistance) | Change variable production costs (%/ha) |
|---|---|---|---|---|---|---|---|---|
| Maize (example input: Veneto) | Total (Veneto, Friuli, Emilia) | | | | | -14% | -25% | EUR 45-480 |
| | | Deltamethrin | Insecticide | etofenprox | 30% | -5% | | |
| | | Dimethenamid-P | herbicide | nicosolfuron | 40% | 0 to -5% | | |
| | | fluroxypyr | herbicide | bentazone | 30% | 0 | | |
| | | Glyphosate | herbicide | diquat | 80% | -7% | | |
| | | lambda-cyhalothrin | Insecticide | indoxacarb | 5% | 0 to -15% | | |
| | | Linuron | herbicide | prosulfuron | 10% | -4% | | |
| | | methiocarb | Insecticide | tefluthrin | 40% | 0 to -10% | | |
| | | pendimethalin | herbicide | nicosolfuron | 10% | 0 to -5% | | |
| | | prothioconazole | fungicide | none | 1% | -15% | | |
| | | S-metolachlor | herbicide | Thiencarbazone-methyl, Isoxaflutole, Cyprosulfamide | 40% | 0 to -5% | | |
| | | tebuconazole | fungicide | none | 15% | -15% | | |
| | | terbuthylazine | herbicide | Thiencarbazone-methyl, Isoxaflutole, Cyprosulfamide | 40% | 0 to -5% | | |
| Soft wheat (example input: Veneto) | Total (Veneto, Friuli, Emilia) | | | | | -14% | -30% | EUR 50-482 |
| | | beta-cyfluthrin | insecticide | Alfacipermetrina | 15% | 0 | | |
| | | cyproconazole | fungicide | procloraz | 15% | 0 | | |
| | | Clopyralid | herbicide | mcpa | 35% | 0 to -5% | | |
| | | Deltamethrin | insecticide | Alfacipermetrina | 10% | 0 | | |
| | | Difenoconazole | fungicide | procloraz | 15% | 0 | | |
| | | dimethoate | insecticide | imidaclopid | 25% | 0 | | |
| | | Epoxiconazole | fungicide | metconazolo | 30% | 0 to -5% | | |
| | | Esfenvalerate | insecticide | Alfacipermetrina | 10% | 0 to -5% | | |
| | | Fluroxypyr | herbicide | tribenuron, tifensulfuron | 20% | 0 to -10% | | |
| | | Glyphosate | herbicide | none | 80% | -15% | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | lambda-cyhalothrin | insecticide | imidacloprid | 80% | 0 | | |
| | Mancozeb | fungicide | none | 80% | -15% | | |
| | Pinoxaden | herbicide | tribenuron, tifensulfuron | 60% | 0 | | |
| | prochloraz | fungicide | ciproconazolo | 10% | 0 | | |
| | propiconazole | fungicide | ciproconazolo | 30% | 0 | | |
| | prothioconazole | fungicide | procloraz | 10% | 0 | | |
| | tebuconazole | fungicide | procloraz | 10% | 0 | | |
| | tetraconazole | fungicide | ciproconazolo | 30% | 0 | | |
| **Durum wheat (example input: Puglia)** | **Total (Puglia, Friuli, Emilia)** | | | | **-3.5%** | **-30%** | **EUR 50-482** |
| | Cyproconazole | fungicide | procloraz | 20% | 0 | | |
| | Clopyralid | herbicide | fluroxipir | 4% | 0 | | |
| | Difenoconazole | fungicide | procloraz | 10% | 0 | | |
| | Fluroxypyr | herbicide | clopiralid | 3% | 0 | | |
| | Glyphosate | herbicide | fluroxipir, clopiralid | 3% | 0 | | |
| | Pinoxaden | herbicide | fluroxipir, clopiralid | 5% | 0 | | |
| | prochloraz | fungicide | Propiconazolo | 10% | 0 | | |
| | Propiconazole | fungicide | Procloraz | 20% | 0 | | |
| | Tebuconazole | fungicide | Procloraz | 15% | 0 | | |
| | Tetraconazole | fungicide | Procloraz | 15% | 0 | | |
| | Thiram | fungicide | none | 20% | -10% | | |
| | tralkoxydim | herbicide | none | 10% | -15% | | |
| | Triticonazole | fungicide | Procloraz | 5% | 0 | | |
| **Tomatoes, sauce (example input: Puglia)** | **Total (Puglia, Emilia)** | | | | **-15%** | **-35%** | **n/a** |
| | Beta-cyfluthrin | insecticide | Imidacloprid | 5% | 0% | | |
| | Cyproconazole | fungicide | none | 15% | -15% | | |
| | Deltamethrin | insecticide | Lambda-cialotrina | 10% | 0% | | |
| | Difenoconazole | fungicide | Tebuconazolo | 10% | 0% | | |
| | Esfenvalerate | insecticide | none | 3% | -15% | | |
| | Glyphosate | herbicide | none | 5% | -15% | | |
| | Imidacloprid | insecticide | Beta-ciflutrin | 10% | 0% | | |
| | lambda-cyhalothrin | insecticide | Deltametrina | 10% | 0% | | |
| | Metribuzin | herbicide | none | 90% | -15% | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | pendimethalin | herbicide | none | 10% | -15% | | |
| | | Tebuconazole | fungicide | Difenoconazolo | 20% | 0% | | |
| | | Tetraconazole | fungicide | Difenoconazolo | 10% | 0% | | |
| Peaches, Nectarines (example input: Emilia) | **Total (Emilia)** | | | | | **-20%** | **-70%** | **n/a** |
| | | Abamectin | insecticide | tebufenpirad, piridaben | 100% | 0% | | |
| | | beta-cyfluthrin | insecticide | spinosad, clorpirifos methyl | 100% | 0% | | |
| | | Bupirimate | fungicide | various EBI fungicides | 100% | 0% | | |
| | | Captan | fungicide | ziram | 100% | -15% | | |
| | | Cyproconazole | fungicide | various other azoles | 100% | 0% | | |
| | | clothianidin | insecticide | imidacloprid | 100% | 0% | | |
| | | Deltamethrin | insecticide | other pirethroids | 100% | 0% | | |
| | | Difenoconazole | fungicide | piraclostrobin + boscalid | 100% | 0% | | |
| | | Fenbuconazole | fungicide | piraclostrobin + boscalid | 100% | 0% | | |
| | | Imidacloprid | insecticide | thiametoxan, acetamiprid | 100% | 0% | | |
| | | lambda-cyhalothrin | insecticide | alfacipermetrina | 100% | 0% | | |
| | | myclobutanil | fungicide | propiconazolo, penconazolo | 100% | 0% | | |
| | | Penconazole | fungicide | propiconazolo | 100% | 0% | | |
| | | pendimethalin | herbicide | oxiforfen | 25% | 0% | | |
| | | Propiconazole | fungicide | penconazolo | 100% | 0% | | |
| | | quinoxyfen | fungicide | none | 100% | -20% | | |
| | | Spinosad | insecticide | etofenprox | 100% | -20% | | |
| | | Spirotetramat | insecticide | flonicamid | 100% | 0% | | |
| | | Tebuconazole | fungicide | piraclostrobin + boscalid | 100% | 0% | | |
| | | Tetraconazole | fungicide | propiconazolo, penconazolo | 100% | 0% | | |
| | | Thiacloprid | insecticide | emamectina, etofenprox | 100% | 0% | | |
| | | Thiamethoxam | insecticide | imidacloprid | 100% | -10% | | |
| | | thiophanate-methyl | fungicide | none | 100% | -15% | | |
| Rice (example input: Lombardia) | **Total (Lombardia, Piemonte)** | | | | | **-25%** | **-35%** | **n/a** |
| | | Glyphosate | herbicide | none | 60% | -10% | | |
| | | lambda-cyhalothrin | insecticide | Alfacipermetrina | 20% | 0% | | |
| | | Metam sodium | herbicide/insecticide | Flufenacet | 5% | -5% | | |
| | | pendimethalin | herbicide | none | 60% | -15% | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | triticonazole | Fungicide | strobilurina, azoxistrobina | 100% | -10% | | |
| Potatoes (example input: Emilia) | **Total (Emilia)** | | | | | **-40%** | | **n/a** |
| | Leptinotarsia decemlineata | imidacloprid<br>thiamethoxam<br>deltamethrin<br>lambda-cyhalothrin | insecticides | metaflumizone, clorantranilprole, bacillus | 70% | | | |
| | Phytophthora infestans | fluazinam<br>mancozeb<br>metiram<br>mandipropamid | funghicides | zoxamide, propineb, dimetomorf, cyazofamide, ametoctradin | 70% | | | |
| | Chenopodium spp. Amaranthus spp. Solanum spp. Cuscuta spp. | linuron<br>pendimethalin<br>metribuzin | herbicides | clomazone, aclonifen, metazaclor, metabromunron | 80% | | | |
| Vine grapes (example input: Emilia) | **Total (Emilia, Friuli, Bolzano)** | | | | | **-30%** | **-80%** | **EUR 500-2000** |
| | Panonychus ulmi, Tetranychus urticae | abamectin | Insecticides | pyridaben | 30-70% | | | |
| | Scale (Planococcus ficus, Heliococcus boemicus) | thiamethoxam | | acetamiprid, clorpirifos metile, buprofezin | | | | |
| | Scaphoideus titanus, Empoasca vitis | spirotetramat | | acetamiprid, buprofezin, acrinatrina | | | | |
| | Lobesia botrana | Spinosad | | clorantranilprole, emamectina, bacillus | | | | |
| | Erysiphae necator, Plasmopara viticola | dinocap<br>quinoxyfen<br>Bupirimate<br>Difenoconazole<br>myclobutanil<br>Penconazole<br>propiconazole<br>tebuconazole<br>fluazinam<br>Mancozeb<br>folpet<br>mandipropamid | fungicide | sulfur, spiroxamina, kresoxym-metyl, boscalid, metrafenone, potassium bicarbonate<br>propineb, ditianon, dimetomorf | 90% | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | metiram | | | | | | |
| Apples (example input: Emilia) | **Total (Emilia)** | | | | | **-65%** | | **n/a** |
| | Dysaphis plantaginea, Aphis pomi, Eriosoma lanigerume | clothianidin | insecticide | flonicamid, fluvalinate, pirimicarb | 90% | | | |
| | | Imidacloprid | | | | | | |
| | | Thiamethoxam | | | | | | |
| | | Spirotetramat | | | | | | |
| | Venturia inaequalis | fluazinam | fungicide | ditianon, dodina, copper, sulfur | 90% | | | |
| | | Mancozeb | | | | | | |
| | | metiram | | | | | | |
| | | Captan | | | | | | |
| | | Difenoconazole | | | | | | |
| Pears (example input: Emilia) | **Total (Emilia)** | | | | | **-70%** | | **n/a** |
| | Cacopsylla pyri | Abamectin | insecticide | none | 90% | | | |
| | | Spirotetramat | | | | | | |
| | Stemphylium vesicarium | fluazinam | fungicide | pyraclostrobin + boscalid, fludioxonyl, copper | 90% | | | |
| | Venturia inaequalis | iprodione | | ditianon, dodina, copper, sulfur | | | | |
| | | Captan | | | | | | |
| | | Tebuconazole | | | | | | |
| | | Thiram | | | | | | |
| | | metiram | | | | | | |
| | | mancozeb | | | | | | |
| | | Difenoconazole | | | | | | |
| Soy (example input: Piemonte) | **Total (Piemonte, Friuli, Emilia)** | | | | | **-40%** | **-80%** | **EUR 250-300** |
| | weeds | pendimethalin | Herbicides | imazamox, metribuzim,linuron | 90% | | | |
| | ragnetto rosso | Abamectin | Insecticide | not available | 100% | | | |
| | weeds | fluazifop-p-butyl | Herbicides | quizalofop p etile | 60% | | | |
| | weeds | Glyphosate | Herbicides | altri diserbi | 50% | | | |
| | weeds | glufosinate | Herbicides | altri diserbi | 50% | | | |
| | cimici | lambda-cyhalothrin | Insecticide | not available | 100% | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | weeds | Linuron | Herbicides | metribuzim-oxadiazon | 50% | | | |
| | weeds | Metribuzin | Herbicides | linuron | 50% | | | |
| | weeds | S-metolachlor | Herbicides | not available | 100% | | | |
| | weeds | tepraloxydim | Herbicides | ciclossidim | 50% | | | |
| | **Total (Fruili, Veneto)** | | | | | **-14%** | **-25%** | **EUR 40-450** |
| **Barley (example input: Friuli)** | Mal del Piede | Cyproconazole | fungicide | Altro fungicida | | | | |
| | Dicotilendoni, Infestanti | clopyralid | Herbicides | Aumento densità semina | | | | |
| | Afidi | Deltamethrin | Insecticide | Altro insetticida | | | | |
| | Fusarium | Epoxiconazole | fungicide | Altro fungicida | | | | |
| | Afidi | Esfenvalerate | Insecticide | Altro insetticida | | | | |
| | Dicotilendoni, Infestanti | Fluroxypyr | Herbicides | Aumento densità semina | | | | |
| | Malerbe infestanti | Glyphosate | Herbicides | Erpicatura con erpice rotante | | | | |
| | Non reg | glufosinate | Herbicides | | | | | |
| | Afidi | Imidacloprid | Insecticide | Altro insetticida | | | | |
| | Dicotilendoni, Infestanti | ioxynil | Herbicides | Aumento densità semina | | | | |
| | Afidi | lambda-cyhalothrin | Insecticide | Altro insetticida | | | | |
| | Non reg | Linuron | Herbicides | | | | | |
| | Septoria | Mancozeb | fungicide | Altro fungicida | | | | |
| | Fusarium | metconazole | fungicide | Altro fungicida | | | | |
| | Malerbe infestanti | Metribuzin | Herbicides | Aumento densità semina | | | | |
| | Malerbe infestanti | Pendimethalin | Herbicides | Aumento densità semina | | | | |
| | Graminacee, Infestanti | Pinoxaden | Herbicides | Aumento densità semina | | | | |
| | Mal del Piede | prochloraz | fungicide | Altro fungicida | | | | |
| | Ruggine | propiconazole | fungicide | Altro fungicida | | | | |
| | Fusarium | prothioconazole | fungicide | Altro fungicida | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Fusarium | Tebuconazole | fungicide | Altro fungicida | | | | |
| | Ruggine | Tetraconazole | fungicide | Altro fungicida | | | | |
| | Mal del Piede | thiophanate-methyl | fungicide | Altro fungicida | | | | |
| **Olives (example input: Tuscany)** | **Total (Tuscany, Piemonte)** | | | | | **-60%** | **-100%** | **EUR 200-400** |
| | mosca | spinosad | insetticida | trappole cromotropicheed alimentari | 90% | | | |
| | mosca/tignola | deltamethrin | insetticida | nessuna con la stessa | 90% | | | |
| | mosca/tignola | dimethoate | insetticida | efficacia | 90% | | | |
| | mosca | Imidacloprid | insetticida | dimetoato | 90% | | | |
| | erbe infestanti | Glyphosate | erbicida | maggiori lavorazioni | 20% | | | |
| | erbe infestanti | glufosinate | erbicida | al terreno e sfalci erba | 20% | | | |
| | erbe infestanti | Amitrole | erbicida | | | | | |
| | x | fluazifop-p-butyl | erbicida | | | | | |
| | x | tebuconazole | fungicida | | | | | |
| | occhio pavone | mancozeb | fungicida | Sali rame | 20% | | | |
| **Hazelnut (example input: Tuscany)** | **Total (Tuscany, Piemonte)** | | | | | **-60%** | **-100%** | **EUR 300-500** |
| | erbe infestanti | Glyphosate | erbicida | | 30% | | | |
| | erbe infestanti | glufosinate | erbicida | | 30% | | | |
| | cloesporium marciumi | thiophanate-methyl | Fungicida | Sali rame | 90% | | | |
| | frutti cytospora | myclobutanil | Fungicida | Sali rame | 90% | | | |
| | cimici afidi balanino | lambda-cyhalothrin | insetticida | Piretro /etofenprox | 90% | | | |

## G. THE NETHERLANDS

| Crop | Pests | Substance name | Substance type | Alternative compared against | Area affected | Yield (% change) Minimum | Yield (% change) Maximum (incl resistance) | Change variable production costs (%/ha) |
|---|---|---|---|---|---|---|---|---|
| Seed potatoes | Total | | | | | -15% | -30% | EUR 600 |
| | Green fly, colorado beetle | deltamethrin<br>esfenvalerate<br>dimethoate<br>lambda-cyhalothrin<br>imidacloprid<br>esfenvalerate<br>thiacloprid | Insecticide | pirimicarb, fosthiazate, ethroprofos | | | | |
| | Nematodes | Metam sodium | Nematicide, Fungicide | oxamyl, fosthiazate, ethroprofos | | | | |
| | Rhizoctonia, Phytophthora and Alternaria | iprodione<br>mancozeb<br>maneb<br>metiram<br>chlorotolurun<br>fluazinam<br>mandipropamid<br>difenoconazole | Fungicide | azoxystrobine, cyazofamid, fluopicolide+propamocarb, thiabendazool (+imazalil) | | | | |
| | Weed and desiccation | linuron<br>glufosinate<br>metribuzin<br>tepraloxydim | Herbicide | aclinofen, prosulfocarb, cycloxydim, haloxyfo-P-methyl | | | | |
| Ware Potato | Total | | | | | -15% | -20% | EUR 400 |
| | Green fly, colorado | esfenvalerate | Insecticide | pirimicarb, pymetrozine, | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | beetle | dimethoate | | flonicamid | | | |
| | | lambda-cyhalothrin | | | | | |
| | | clothianidin | | | | | |
| | | lambda-cyhalothrin | | | | | |
| | | thiacloprid | | | | | |
| | Nematodes, dry rot | Metam sodium | Nematicide, Fungicide | fosthiazaat, oxamyl, ethoprofos, cyazofamid, fluopicolide+propamocarb, azoxystrobine, thiabendazool (+imazalil) | | | |
| | | mancozeb | | | | | |
| | | maneb | | | | | |
| | | metiram | | | | | |
| | | fluazinam | | | | | |
| | | mandipropamid | | | | | |
| | | difenoconazole | | | | | |
| | Weed and desiccation | linuron | Herbicide | bentazon, rimsulfuron, diquat, carfentrazone-ethyl | | | |
| | | glufosinate | | | | | |
| | | metribuzin | | | | | |
| | | pendimethalin | | | | | |
| | | tepraloxydim | | | | | |
| | **Total** | | | | **-18%** | **-60%** | **EUR 50** |
| **Winter wheat, barley** | Greenfly | deltamethrin | Insecticide | fluoxastrobin, fludioxonil, fenpropidin, azoxystrobine | | | |
| | | dimethoate | | | | | |
| | | esfenvalerate | | | | | |
| | | lambda-cyhalothrin | | | | | |
| | Nematodes | Metam sodium | Nematicide, Fungicide | | | | |
| | Fungal diseases | mancozeb | Fungicide | | | | |
| | | maneb | | | | | |
| | | thiram | | | | | |
| | | tebuconazole | | | | | |
| | | metconazole | | | | | |
| | | triadimenol | | | | | |
| | | prothioconazole | | | | | |
| | | prochloraz | | | | | |
| | | propiconazole | | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | cyproconazole | | | | | |
| | | epoxiconazole | | | | | |
| | | prothioconazole | | | | | |
| | Weed | ioxynil | Herbicide | | | | |
| | | glufosinate | | | | | |
| | | pendimethalin | | | | | |
| | | ioxynil | | | | | |
| **Sugar beet** | **Total** | | | | **-36%** | **-46%** | **EUR 60** |
| | Crane fly larvae, other soil insects, greenfly, yellowing disease, caterpillars, other leaf insects | bifenthrin | Insecticide | pirimicarb, thiacloprid | | | |
| | | beta-cyfluthrin | | | | | |
| | | clothianidin | | | | | |
| | | imidacloprid | | | | | |
| | | thiamethoxam | | | | | |
| | | deltamethrin | | | | | |
| | | lambda-cyhalothrin | | | | | |
| | | esfenvalerate | | | | | |
| | Nematodes | Metam sodium | Nematicide, Fungicide | oxamyl | | | |
| | Leaf mold, seed and soil fungi | clothianidin | Fungicide | Hymexazool, Chloridazon, Metamitron | | | |
| | | cyproconazole | | | | | |
| | | epoxiconazole | | | | | |
| | | quinoxyfen | | | | | |
| | | thiamethoxam | | | | | |
| | | thiram | | | | | |
| | Weed | clopyralid | Herbicide | | | | |
| | | tepraloxydim | | | | | |
| | | glufosinate | | | | | |
| | | glyphosate | | | | | |
| **Bell pepper (glass)** | **Total** | | | | **-70%** | **-100%** | **n/a** |
| | Greenfly, leaf miner, caterpillar, mite, thrips, white fly | imidacloprid | Insecticide | pymetrozine, acetamiprid en pirimicarb, hexythiazox, bifenazate, pyridaben*, cyromazin, beauveria bassiana stam GHA, Lecanicillium | | | |
| | | thiacloprid | | | | | |
| | | deltamethrin | | | | | |
| | | abamectin | | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | spinosad<br>spiromesifen | | muscarium, pyriproxyfen, pymetrozine | | | |
| | Botrytis, scerotinia, powdery mildew | iprodione<br>thiram<br>penconazole | Fungicide | boscalid+ pyraclostrobin, fludioxonil+cyprodinil, fenpyrazamine, fenhaxamid, azoxystrobine, metrafenon pyraclostrobin, trifloxystrobin, zwavel | | | |
| | pythium, phytophthora | No Change | Fungicide | | | | |
| **Apple trees** | **Total** | | | | **-100%** | **-100%** | **EUR 600** |
| | Caterpillars, thrips, wants, aphids, mites, greenfly, | abamectin<br>deltamethrin<br>imidacloprid<br>spirotetramat<br>thiacloprid<br>thiamethoxam | Insecticide | spirodiclofen, acetamiprid, Lambda cyhalotrin | | | |
| | Scab, powdery mildew, rust, grey mold, septoria | bupirimate<br>captan<br>folpet<br>tebuconazole<br>iprodione<br>mancozeb<br>penconazole<br>propiconazole<br>tebuconazole | Fungicide | dodine, a.o., clethodim, diquat, metobromuron | | | |
| | Weeds | fluazifop-p-butyl<br>glyphosate<br>linuron | | | | | |
| **Tulip Bulbs** | **Total** | | | | **-80%** | **-90%** | **n/a** |
| | aphids | deltamethrin<br>esfenvalerate<br>imidacloprid<br>lambda-cyhalothrin | Insecticide | Pirimicarb<br>Pyrethrinen<br>Aluminum fosfide | | | |

| | | | | |
|---|---|---|---|---|
| | | thiacloprid | | |
| | | captan<br>carbendazim<br>fluazinam<br>folpet<br>iprodione<br>maneb<br>mancozeb<br>prochloraz<br>tebuconazole<br>prothioconazole<br>thiophanate-methyl | Fungicide | Chloorthalonil, Flutolanil, Methyl cyclopropeen |
| | Nematodes | Metam sodium | | |
| | Weeds | glufosinate<br>pendimethalin<br>tepraloxydim<br>Metam sodium<br>asulam<br>chlorpropham<br>dimethenamid-P<br>fluazifop-p-butyl<br>glyphosate<br>s-metolachlor | Herbicide | 2,4-D, Aluminum fosfide, Diquat, Chloridazon |

## H. AUSTRIA

| Crop | Pests | Substance name[111] | Substance type | Alternative compared against | Area affected | Immediate yield (change in %) | Add. resistance effect | Change variable production costs (%/ha) |
|---|---|---|---|---|---|---|---|---|
| Wheat | **Total** | | | | | **-15%** | **-2%** | **+/-0%** |
| | Fungal diseases | carbendazim<br>cyproconazole<br>difenoconazole<br>epoxiconazole<br>fluquinconazole<br>mancozeb<br>metconazole<br>prochloraz<br>propiconazole<br>prothioconazole<br>quinoxyfen<br>tebuconazole<br>tetraconazole<br>thiophanate-meythl<br>triticonazole | Fungicide | Azoxystrobin, bixafen, cyflufenamid, cyprodinil, fluoxastrobin, fluxapyroxad, fludioxonil, fenpropidin, fenpropimorph, isopyrazam, pyraclostrobin, spiroxamine, trifloxystrobin | | | | |
| | Green fly, cereal leaf beetle, biting insects, sucking insects, diptera, frit fly | beta-cyfluthrin<br>deltamethrin<br>esfenvalerate<br>imidacloprid<br>lambda-cyhalothrin<br>pirimicarb | Insecticide | Flonicamid, pirimicarb; zeta-cypermethrin, tau-fluvalinate | | | | |

[111] For wheat, barley and OSR also one or several of the following substances have been taken into account: chlorthalonil, cyprodinil, isopyrazam, chlorpyrifos, pirimicarb, amidosulfuron, diflufenican, MCPA, mecoprop, 2,4-D, chlortholuron, flyroxypur, metaldehyd and propyzamide

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | thiacloprid | | | | | |
| | Weed | amidosulfuron | Herbicide | Great number of substances | | | |
| | | chlorotolurun | | | | | |
| | | clopyralid | | | | | |
| | | diflufenican | | | | | |
| | | fluroxypyr | | | | | |
| | | glyphosate | | | | | |
| | | ioxynil | | | | | |
| | | MCPA | | | | | |
| | | mecoprop | | | | | |
| | | metribuzin | | | | | |
| | | pendimethalin | | | | | |
| | | pinoxaden | | | | | |
| | | 2,4-D | | | | | |
| **Winter barley** | **Total** | | | | **-20%** | **-7%** | **2%** |
| | Fungal diseases | | Fungicide | Azoxystrobine, bixafen, cyprodinil, fluoxastrobin, fluxapyroxad, fludioxonil, fenpropidin, isopyrazam, spiroxamine | | | |
| | | carbendazim | | | | | |
| | | cyproconazole | | | | | |
| | | difenoconazole | | | | | |
| | | epoxiconazole | | | | | |
| | | fluquinconazole | | | | | |
| | | mancozeb | | | | | |
| | | metconazole | | | | | |
| | | prochloraz | | | | | |
| | | propiconazole | | | | | |
| | | prothioconazole | | | | | |
| | | tebuconazole | | | | | |
| | | triticonazole | | | | | |
| | Green fly, cereal leaf beetle, biting insects, sucking insects, diptera, fruit fly | beta-cyfluthrin | Insecticide | Flonicamid, pirimicarb; zeta-cypermethrin, tau-fluvalinate | | | |
| | | deltamethrin | | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | esfenvalerate<br>imidacloprid<br>lambda-cyhalothrin<br>thiacloprid | | | | | |
| | Weed | chlortholuron<br>clopyralid<br>flyroxypur<br>glyphosate<br>ioxynil<br>metribuzin<br>pendimethalin<br>pinoxaden | Herbicide | Great number of substances | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| OSR | **Total** | | | | -25% | -8% | 2% |
| | Fungal diseases | difenoconazole<br>metconazole<br>prochloraz<br>prothioconazole<br>tebuconazole | Fungicide | Azoxystrobine, boscalid, dimoxystrobin, fluopyram, paclobutrazole | | | |
| | Rape flee beetle, soil insects, rape stem weevils, blossom beetles, rape flee beetle, leaf insects, snails | clothianidin<br>imidacloprid<br>thiamethoxam<br>beta-cyfluthrin<br>deltamethrin<br>esfenvalerate<br>lambda-cyhalothrin<br>thiacloprid<br>metaldehyd | Insecticide | Cypermethrin, tau-fluvalinate, zeta-cypermethrin, acetamiprid, etofenprox, malathion, pymetrozine | | | |
| | Weed | Clopyralid<br>dimethenamid-p<br>fluazifop-p-butyl<br>glyphosate | Herbicide | Bifenox, clethodim, clomazone, cycloxidim, dimetachlor, haloxyfop, napropamide, | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | S-metolachlor | | propaquizafop-p, quinmerac, quizalafop-p, quizalafop-p tefuryl | | | |
| | | pendimethalin | | | | | |
| | | picloram | | | | | |
| | | propyzamide | | | | | |
| | **Total** | | | | **-35%** | **-15%** | **100%** |
| **Sugar beet** | | cyproconazole | Fungicide | Quinoxyfen, netzschwefel, kupferoxiclorid. S, trobi-resistenzen | | | |
| | | difenoconazole | | | | | |
| | | epoxiconazole | | | | | |
| | | propiconazole | | | | | |
| | | tetraconazole | | | | | |
| | | thiophanate-meythl | | | | | |
| | | prochloraz | | | | | |
| | | thiram | | | | | |
| | | hymexazol | | | | | |
| | | beta-cyfluthrin | Insecticide | Tefluthrin, primicarb, spritzung met Wirkstoffen | | | |
| | | clothianidin | | | | | |
| | | imidacloprid | | | | | |
| | | thiamethoxam | | | | | |
| | | deltamethrin | | | | | |
| | | dimethoate | | | | | |
| | | lambda-cyhalothrin | | | | | |
| | | clopyralid | Herbicide | | | | |
| | | dimethenamid-P | | | | | |
| | | ethofumesate | | | | | |
| | | fluazifop-p-butyl | | | | | |
| | | triflusulfuron | | | | | |
| | | lenacil | | | | | |
| | | glyphosate | | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Seed Potato** | **Total** | | | | **-25%** | **-10%** | **4%** |
| | Phytophthora, alternaria, silver scurf | difenoconazole | Fungicide | metalaxyl-M, benalaxyl-M, propamocarb, fluopicolide, cymoxanil, dimethomorph, benthiavalicarb, valfenalate, famoxadon, copper, zoxamide, ametoctradin, cyzofamid, azoxystrobin, pyraclostrobin, boscalid, imazalil | | | |
| | | fluazinam | | | | | |
| | | mancozeb | | | | | |
| | | maneb | | | | | |
| | | metiram | | | | | |
| | | mandipropamid | | | | | |
| | | prothioconazole | | | | | |
| | Greenfly, Colorado beetle | clothianidin | Insecticide | pirimicarb, pymetrozine, flonicamid | | | |
| | | esfenvalerate | | | | | |
| | | lambda-cyhalothrin | | metaflumizone, chlorantraniliprole, phosmet, azadirachtin, acetamiprid, Bacillus thuringiensis, pyrethrine | | | |
| | | thiacloprid | | | | | |
| | | beta-cyfluthrin | | | | | |
| | | deltamethrin | | | | | |
| | | imidacloprid | | | | | |
| | | spinosad | | | | | |
| | | thiacloprid | | | | | |
| | | thiamethoxam | | | | | |
| | Weeds | fluazifop-p-butyl | Herbicide | flufenacet, aclonifen, prosulfocarb, flurochloridone, rimsulfuron, propaqizafop, cycloxydim, quizalofop-p-tefuryl, clethodim | | | |
| | | linuron | | | | | |
| | | metribuzin | | | | | |
| | | pendimethalin | | | | | |
| **Ware Potato** | **Total** | | | | **-25%** | **-10%** | **2%** |
| | Phytophthora, alternaria, silver scurf | difenoconazole | Fungicide | metalaxyl-M, benalaxyl-M, propamocarb, | | | |
| | | fluazinam | | | | | |

| | | | | |
|---|---|---|---|---|
| | | mancozeb | | fluopicolide, cymoxanil, dimethomorph, benthiavalicarb, valfenalate, famoxadon, copper, zoxamide, ametoctradin, cyzofamid, azoxystrobin, pyraclostrobin, boscalid |
| | | maneb | | imazalil |
| | | metiram | | |
| | | mandipropamid | | |
| | | prothioconazole | | |
| | Greenfly, Colorado beetle | clothianidin | Insecticide | pirimicarb, pymetrozine, flonicamid |
| | | esfenvalerate | | metaflumizone, chlorantraniliprole, phosmet, azadirachtin, acetamiprid, Bacillus thuringiensis, pyrethrine |
| | | lambda-cyhalothrin | | |
| | | thiacloprid | | |
| | | beta-cyfluthrin | | |
| | | deltamethrin | | |
| | | imidacloprid | | |
| | | spinosad | | |
| | | thiacloprid | | |
| | | thiamethoxam | | |
| | Weeds | fluazifop-p-butyl | Herbicide | flufenacet, aclonifen, prosulfocarb, clomazone, flurochloridone, rimsulfuron, propaqizafop, cycloxydim, quizalofop-p-tefuryl, clethodim |
| | | linuron | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | metribuzin | | | | | | |
| | | pendimethalin | | | | | | |
| | Sprouting | chlorpropham | Growth regulator | maleinsäurehydrazid | | | | |
| Grain Maize | **Total** | | | | | **-10%** | **-2%** | **+/-0%** |
| | | triazole | Fungicide | | | | | |
| | Corn rootworm | neonicotinoids | Insecticide | | | | | |

## I. IRELAND

| Crop | Pests | Substance name | Substance type | Alternative compared against | Area affected | Yield (% change) Minimum | Yield (% change) Maximum (incl resistance) | Change variable production costs (%/ha) |
|---|---|---|---|---|---|---|---|---|
| **Winter wheat** | **Total** | | | | | **-20%** | **-70%** | **n/a** |
| | Grain Aphids (feeding) | Dimethoate | insecticide | pirimicarb | 75% | | | |
| | Foliar diseases (e.g. septoria tritici blotch, STB), Stem / root diseases (e.g. eyespot / take-all), Ear diseases (e.g. fusarium head blight, FHB) | epoxiconazole<br>prothioconazole<br>metconazole<br>tebuconazole<br>folpet<br>silthiofam | fungicide | SDHIs (bosclaid, bixafen, fluxapyroxad isopyrazm and penthiopyrad), chlorothalonil | 100% | | | |
| | Used as desicant, grass weeds, BLWs | glyphosate<br>Pinoxaden<br>Pendimethalin | herbicide | mesosulfuron, iodosulfuron, pyroxulam, fenoxaprop p ethyl, IPU, Prosulfcarb (Defy) | 25-75% | | | |
| **Winter barley** | **Total** | | | | | **-30%** | **-70%** | **n/a** |
| | Grain Aphids (kdr with BYDV) | clothianidin | insecticide | Cypermethrin | 90% | | | |
| | Foliar diseases (e.g. Rhynhcosporium, net blotch, brown rust and Ramularia), Stem / root diseases (e.g. eyespot / take-all), Ear diseases (e.g. FHB) | epoxiconazole<br>prothioconazole<br>metconazole<br>tebuconazole<br>folpet<br>silthiofam | fungicide | SDHIs (bosclaid, bixafen, fluxapyroxad isopyrazm and penthiopyrad), chlorothalonil, QoIs (azoxystrobin, fluxostrobin, pyraclostrobin), specific mildewicides | 100% | | | |
| | Used as desicant, wild oats, canary grass, Grass weeds (pre-drilling), Grass and BLW's | glyphosate<br>Pinoxaden<br>Pendimethalin | | diquat, fenoxaprop p ethyl, IPU, Prosulfcarb (Defy) | 10-75% | | | |
| **Spring barley** | **Total** | | | | | **-20%** | **-50%** | **n/a** |
| | Foliar diseases (e.g. Rhynhcosporium, net blotch, brown rust and | epoxiconazole<br>prothioconazole | fungicide | SDHIs (bosclaid, bixafen, fluxapyroxad isopyrazm and | 98% | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Ramularia), Stem / root diseases (e.g. eyespot / take-all), Ear diseases (e.g. FHB) | metconazole<br>tebuconazole<br>folpet<br>silthiofam | | penthiopyrad), chlorothalonil, QoIs (azoxystrobin, fluxostrobin, pyraclostrobin), specific mildewicides | | | | |
| | Used as desicant, wild oats, canary grass, Grass weeds (pre-drilling), Grass and BLW's | glyphosate<br>Pinoxaden<br>Pendimethalin | | diquat, fenoxaprop p ethyl, IPU, Prosulfcarb (Defy) | 5-75% | | | |
| **Potatoes** | **Total** | | | | | **-25%** | **-50-100%** | **n/a** |
| | aphids | lambda-cyhalothrin<br>thiacloprid<br>Dimethoate | insecticide | Flonicamid, Pymetrozin, Cypermethrin, Rimisulfuron | | | | |
| | Potato late blight, early blight | fluazinam<br>mancozeb<br>mandipropamid | fungicide | Cymoxanil, benthiavalicarb-isopropyl (Valbon), fluopicolide and cyazofamid | | | | |
| | Broad and narrow leaved weeds | metribuzin<br>linuron | herbicide | Prosulfucarb,, Diquat, Clomazon, cycloxydim, propaquizafop, Carfentrazone-ethyl | | | | |
| **Silage maize** | **Total** | | | | | **-50%** | **-50%** | **n/a** |
| | Weeds | terbuthylazine<br>pendimethalin | herbicide | mesotrione | 100% | | | |
| **Brassica (cabbage)** | **Total** | | | | | **-40%** | **-60%** | **EUR 1,300/ha** |
| | Caterpillars, Flea Beetle, Aphids | Spinosad<br>Thiacloprid<br>deltamethrin<br>esfenvalerate<br>lambda-cyhalothrin<br>Spirotetramat | insecticide | indoxacarb (Caterpillar) Pyrethrins (Flea Beetle), Aphids (Pymetrozine, Pyrethrins) | 50% | | | |
| | Fungal diseases | Azoles | fungicide | Signum, Amistar | 70% | | | |
| | Weeds | Pendimethalin<br>pendimethalin<br>dimethenamid-P | herbicide | metolachlor, clopyralid | 90% | | | |
| **Carrots** | **Total** | | | | | **-55%** | **-75%** | **EUR 2,700/ha** |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Aphids, Root Fly | Thiacloprid<br>lambda-cyhalothrin | Insecticides | | | |
| | Fungal diseases | Azoles<br>Mancozeb | fungicide | | | |
| | Broad leaf and grasses | Pendimethalin<br>linuron<br>metribuzin | herbicide | | | |
| **Mushrooms** | **Total** | | | **-40%** | **-40%** | **n/a** |
| | Cobweb, Verticillium, etc | prochloraz | fungicide | | | |

## APPENDIX II – Production data

### A. FRANCE

| Crop | Area (in 1000 ha) | Total output (1000 tons) | Avg yield (t/ha) | Ex-farm price (€/t) | Revenues (€/ha) | Avg seed cost (€/ha) | Avg fertilizer (€/ha) | Avg crop protection costs (€/ha) | Avg other variable costs (€/ha) | Total variable costs (€/ha) |
|---|---|---|---|---|---|---|---|---|---|---|
| **Wheat** | 5.404 | 37.818 | 7,0 | 178 | 1.242 | 62 | 129 | 124 | 156 | 471 |
| **Barley** | 1.666 | 10.683 | 6,4 | 153 | 978 | 74 | 122 | 107 | 151 | 454 |
| **Sugar beet** | 387 | 34.476 | 89,2 | 29 | 2.595 | 217 | 240 | 216 | 359 | 1.032 |
| **Grain Maize** | 1.687 | 15.199 | 9,0 | 176 | 1.586 | 170 | 160 | 84 | 473 | 887 |
| **Potatoes** | 159 | 6.895 | 43,4 | 237 | 10.306 | 780 | 305 | 475 | 174 | 1.734 |
| **OSR** | 1.507 | 5.118 | 3,4 | 388 | 1.316 | 40 | 161 | 123 | 179 | 503 |
| **Vine** | 768 | 4.527 | 5,9 | 1.935 | 11.400 | 65 | 190 | 415 | 2.907 | 3.577 |
| **Beans** | 28 | 330 | 11,8 | 224 | 2.590 | 470 | 233 | 323 | 371 | 1.397 |
| **Apples** | 44 | 1.759 | 28,0 | 822 | 22.996 | - | 254 | 1.288 | 3.155 | 4.697 |
| **Carrots** | 13 | 555 | 56,4 | 636 | 35.883 | 1.053 | 426 | 493 | 5.598 | 7.570 |

## B. GERMANY

| Crop | Area (in 1000 ha) | Total output (1000 tons) | Avg yield (t/ha) | Ex-farm price (€/t) | Revenues (€/ha) | Avg seed cost (€/ha) | Avg fertilizer (€/ha) | Avg crop protection costs (€/ha) | Avg other variable costs (€/ha) | Total variable costs (€/ha) |
|---|---|---|---|---|---|---|---|---|---|---|
| **Wheat** | 3.197 | 23.888 | 7,5 | 163 | 1.215 | 82 | 221 | 131 | 38 | 916 |
| **Barley** | 1.673 | 10.417 | 6,2 | 150 | 933 | 80 | 76 | 62 | 30 | 801 |
| **Sugar beet** | 381 | 25.889 | 67,9 | 26 | 1.737 | 268 | 270 | 245 | 25 | 1.607 |
| **Maize** | 488 | 4.765 | 9,8 | 169 | 1.652 | 187 | 245 | 67 | 285 | 1.432 |
| **Potatoes** | 252 | 10.800 | 42,9 | 134 | 5.741 | 1.710 | 194 | 280 | 285 | 2.910 |
| **OSR** | 1.471 | 6.307 | 4,3 | 308 | 1.319 | 56 | 260 | 140 | 65 | 982 |
| **Onions** | 10 | 481 | 40,0 | 151 | 6.040 | 573 | 224 | 313 | 2.658 | 3.768 |
| **Hops** | 18 | 34 | 1,9 | 4.500 | 9.465 | 200 | 350 | 1.000 | 5.000 | 6.550 |

## C. UK

| Crop | Area (in 1000 ha) | Total output (1000 tons) | Avg yield (t/ha) | Ex-farm price (€/t) | Revenues (€/ha) | Avg seed cost (€/ha) | Avg fertilizer (€/ha) | Avg crop protection costs (€/ha) | Avg other variable costs (€/ha) | Total variable costs (€/ha) |
|---|---|---|---|---|---|---|---|---|---|---|
| **Wheat** | 1.858 | 13.879 | 7,5 | 165 | 1.236 | 79 | 140 | 107 | 90 | 416 |
| **Barley** | 1.050 | 6.006 | 5,7 | 162 | 924 | 63 | 92 | 97 | 80 | 332 |
| **Sugar beet** | 116 | 7.842 | 67,4 | 36 | 2.393 | 184 | 208 | 201 | 230 | 823 |
| **Maize** | 164 | 5.537 | 33,8 | 33 | 1.103 | 81 | 174 | 141 | 91 | 487 |
| **Potatoes** | 143 | 5.740 | 40,1 | 154 | 6.156 | 793 | 360 | 617 | 1344 | 3.114 |
| **OSR** | 648 | 2.353 | 3,6 | 398 | 1.447 | 44 | 169 | 145 | 90 | 448 |
| **Peas** | 32 | 117 | 3,6 | 5.025 | 18.211 | 111 | 44 | 149 | 75 | 379 |

## D. POLAND

| Crop | Area (in 1000 ha) | Total output (1000 tons) | Avg yield (t/ha) | Ex-farm price (€/t) | Revenues (€/ha) | Avg seed cost (€/ha) | Avg fertilizer (€/ha) | Avg crop protection costs (€/ha) | Avg other variable costs (€/ha) | Total variable costs (€/ha) |
|---|---|---|---|---|---|---|---|---|---|---|
| **Wheat** | 2,245 | 9,342 | 4.2 | 156 | 647 | | | | | 836 |
| **Maize** | 420 | 2,826 | 6.7 | 145 | 977 | | | | | 840 |
| **OSR** | 779 | 2,134 | 2.7 | 355 | 972 | | | | | 1,758 |
| **Sugar beet** | 203 | 11,216 | 55.2 | 32 | 1.786 | | | | | 2,232 |
| **Potatoes** | 396 | 8,566 | 21.6 | 101 | 2.183 | | | | | 773 |
| **Apples** | 176 | 2,589 | 14.7 | 215 | 3.156 | | | | | 6,696 |
| **Black Currants** | 34 | 147 | 4.3 | 615 | 90 | | | | | 2,510 |

## E. SPAIN

| Crop | Area (in 1000 ha) | Total output (1000 tons) | Avg yield (t/ha) | Ex-farm price (€/t) | Revenues (€/ha) | Avg seed cost (€/ha) | Avg fertilizer (€/ha) | Avg crop protection costs (€/ha) | Avg other variable costs (€/ha) | Total variable costs (€/ha) |
|---|---|---|---|---|---|---|---|---|---|---|
| **Tomato (glass)** | 18 | 1.835 | 100,0 | 620 | 62.000 | 510 | 450 | 240 | 1.320 | 2.520 |
| **Tomato (open)** | 33 | 2.844 | 86,0 | 78 | 6.708 | 470 | 621 | 797 | 1.815 | 3.703 |
| **Sugar beet** | 42 | 3.586 | 85,7 | 33 | 2.833 | 172 | 385 | 290 | 325 | 1.172 |
| **Citrus** | 313 | 5.929 | 18,9 | 330 | 6.244 | - | 623 | 522 | 3.504 | 4.650 |
| **Cherry** | 25 | 94 | 6,0 | 1.132 | 6.792 | 410 | 430 | 184 | 4.177 | 5.201 |
| **Sunflower** | 803 | 897 | 1,1 | 356 | 398 | 70 | 177 | 12 | 150 | 409 |
| **Rice** | 118 | 909 | 7,7 | 269 | 2.077 | 168 | 170 | 250 | 500 | 1.088 |
| **Vine** | 963 | 6.050 | 6,3 | 136 | 856 | 9 | 83 | 76 | 291 | 459 |
| **Olives** | 2.504 | 7.758 | 3,1 | 121 | 374 | 61 | 89 | 33 | 48 | 231 |

## F. ITALY

| Crop | Area (in 1000 ha) | Total output (1000 tons) | Avg yield (t/ha) | Ex-farm price (€/t) | Revenues (€/ha) | Avg seed cost (€/ha) | Avg fertilizer (€/ha) | Avg crop protection costs (€/ha) | Avg other variable costs (€/ha) | Total variable costs (€/ha) |
|---|---|---|---|---|---|---|---|---|---|---|
| **Maize** | 952 | 8,505 | 8.9 | 195 | 1,659 | 130 | 340 | 230 | 830 | 1530 |
| **Soft wheat** | 580 | 3,101 | 5.3 | 212 | 656 | 130 | 280 | 115 | 470 | 995 |
| **Durum wheat** | 1,262 | 3,942 | 3.1 | 301 | 1,185 | 130 | 300 | 130 | 470 | 1030 |
| **Rice** | 237 | 1,567 | 6.6 | 352 | 551 | 170 | 600 | 320 | 475 | 1565 |
| **Potatoes** | 43 | 1,206 | 28.1 | 228 | 275 | | | | | 2544 |
| **Tomato (sauce)** | 84 | 5,153 | 61.3 | 169 | 871 | | | | | |
| **Vine** | 698 | 6,400 | 9.2 | 111 | 710 | | | | | 1477 |
| **Apples** | 57 | 2,253 | 39.8 | 296 | 668 | | | | | 4620 |
| **Pears** | 38 | 790 | 20.9 | 412 | 326 | | | | | 2904 |
| **Peaches/nectarines** | 81 | 1,534 | 19.0 | 362 | 555 | | | | | 2417 |
| **Barley** | 267 | 963 | 3.6 | 178 | 171 | | | | | 995 |
| **Soy** | 159 | 532 | 3.3 | 306 | 163 | | | | | |
| **Hazelnut** | 68 | 109 | 1.6 | 21 | 2 | | | | | 712 |
| **Olives** | 1,154 | 3,262 | 2.8 | 31 | 100 | | | | | 1096 |

## G. THE NETHERLANDS

| Crop | Area (in 1000 ha) | Total output (1000 tons) | Avg yield (t/ha) | Ex-farm price (€/t) | Revenues (€/ha) | Avg seed cost (€/ha) | Avg fertilizer (€/ha) | Avg crop protection costs (€/ha) | Avg other variable costs (€/ha) | Total variable costs (€/ha) |
|---|---|---|---|---|---|---|---|---|---|---|
| **Wheat** | 152 | 1.323 | 8,7 | 193 | 1.674 | 516 | 110 | 202 | 47 | 875 |
| **Barley** | 34 | 228 | 6,7 | 187 | 1.243 | 91 | 119 | 111 | 75 | 396 |
| **Seed potatoes** | 39 | 1.474 | 38,0 | 266 | 10.112 | 2 | 826 | 340 | 497 | 1.665 |
| **Ware potatoes** | 71 | 3.601 | 50,7 | 134 | 6.794 | 936 | 635 | 399 | 167 | 2.138 |
| **Potatoes** | 110 | 5.075 | 46 | 181 | 8.349 | 606 | 703 | 378 | 284 | 1.971 |
| **Sugar beet** | 73 | 5.660 | 78,1 | 52 | 4.095 | 228 | 286 | 149 | 7 | 670 |
| **Tulip Bulbs** | 12 | | | | 644 | | | | | 2.990 |
| **Apple trees** | 0,8 | | | | 80 | | | | | 23.992 |
| **Bell pepper (glass)** | 1 | 361 | 267 | 1200 | 320.400 | | | | | 64.553 |

## H. AUSTRIA

| Crop | Area (in 1000 ha) | Total output (1000 tons) | Avg yield (t/ha) | Ex-farm price (€/t) | Revenues (€/ha) | Avg seed cost (€/ha) | Avg fertilizer cost (€/ha) | Avg crop protection costs (€/ha) | Avg other variable costs (€/ha) | Total variable costs (€/ha) |
|---|---|---|---|---|---|---|---|---|---|---|
| **Wheat** | 285 | 1.682 | 5,9 | 160 | 944 | 73 | 136 | 34 | 369 | 612 |
| **Barley** | 82 | 774 | 6 | 159 | 932 | 72 | 222 | 51 | 375 | 720 |
| **Maize** | 211 | 2.147 | 10 | 162 | 1.638 | 171 | 334 | 81 | 788 | 1.374 |
| **Sugar beet** | 47 | 3.250 | 72 | 36 | 2.565 | 199 | 397 | 285 | 776 | 1.657 |
| **Seed Potatoes** | 1,5 | 30 | 20 | 256 | 5.120 | 585 | 458 | 434 | 991 | 2.468 |
| **Ware Potatoes** | 20 | 635 | 31 | 176 | 5.447 | 1.102 | 358 | 483 | 1.302 | 3.246 |
| **Potatoes** | 22 | 665 | 30 | 179 | 5.424 | 1.102 | 358 | 483 | 1.302 | 3.246 |
| **OSR** | 56 | 173 | 3,3 | 415 | 1.351 | 49 | 231 | 158 | 392 | 830 |
| **Vine** | 44 | 305 | 7 | 1.690 | 11.705 | - | 60 | 592 | 1.673 | 2.325 |

## I. IRELAND

| Crop | Area ('000 ha) | Total output (1000 tons) | Av. yield (t/ha) | Ex-farm price (€/t) | Revenues €/ha | Avg seed cost (€/ha) | Avg fertilizer (€/ha) | Avg crop protection costs (€/ha) | Avg other variable costs (€/ha) | Avg total variable cost (€/ha) |
|---|---|---|---|---|---|---|---|---|---|---|
| **Wheat** | 66 | 585 | 8,9 | 141 | 1.255 | 80 | 247 | 278 | 440 | 1.045 |
| **Barley** | 32 | 279 | 8,7 | 154 | 1.334 | 86 | 150 | 125 | 560 | 921 |
| **Spring barley** | 160 | 1.078 | 6,7 | 154 | 1.036 | 86 | 150 | 125 | 560 | 921 |
| **Potatoes** | 11 | 351 | 32,1 | 318 | 10.204 | 990 | 498 | 794 | 2500 | 4.782 |
| **Brassica** | 1 | 19 | 25,8 | 271 | 7.011 | 384 | 625 | 431 | 2001 | 3.441 |
| **Mushrooms** | | 63 | | 1715 | - | | | | | |
| **Carrots** | 1 | 36 | 56,0 | 353 | 19.745 | 952 | 445 | 660 | 2367 | 4.424 |
| **Maize** | 12 | 1.788 | 145,7 | 28 | 4.134 | | | | | |

## APPENDIX III - Methodology

### Yield effects

**Immediate yield change (%)**

To estimate the changes in yields per crop and country requires various analytical steps:

1. Elaboration of pests/diseases that occur
2. Identifying which substances are used to treat the crop
3. Estimation of the area on which the substances are applied
4. Description of alternatives that remain available
5. Assessment of the immediate yield changes
6. Evaluation of future resistance effects

The starting point for the analysis is the pests/diseases that occur per crop in a particular land. Subsequently, based on the list of the 75 substances, experts filtered the substances with risk to be banned that are applied to treat these pests/diseases. This is done for each crop and for each sort of pesticide (insecticide, herbicide, fungicide, disinfection).

In order to complete the estimation, the overall effect is balanced by the area on which the substance is applied. This is influence by the share of the total agricultural area of a specific crop on which the pest/disease occurs as well as the market share of the substance and the organic share of production.

$$\left[\frac{\text{Technical loss}}{\text{Average yield}}\right] \text{ x } [\text{Area affected}]$$

Given this basis, for each pest the crop experts estimated the yield losses due to the withdrawal of the substance. Were possible the estimation was based on agronomic references. Generally it consists of comparing the yield per hectare obtained with the substance to the yield obtained with the remaining alternatives. These alternatives can be other substances but also different farming techniques etc.

To give an example, if neonicotinoids were to be removed, the remaining alternative to treat barley against insects would be pyrethrin. The yield loss, according to the Arvalis Institute, would be 1.25 t/ha. In this case, the Institute assessed that 40% of cultivated area in barley is concerned. The change in yield expressed in % is:

$$\left[\frac{\text{Technical loss=1.25t/ha}}{\text{Average yield=6.4 t/ha}}\right] \text{ x } [\text{Area affected} = 40\%] \ = -9.4\%$$

If the molecule concerns several pests on the same crop, losses due to different pests may be added. But it may be determine case by case. Particular caution was paid to avoid double counting, if a crop didn’t develop optimally due to insects, using fungicides has a smaller added value etc.

For some specialty crops, especially when the number of pesticide solutions is low to begin with, the withdrawal of one or more substances may affect the crop heavily. In this case it the yield effect related to losing the 75 substances might be equal to the total average yield of that crop.

### Resistance effects & crop protection costs (%)

In the long-term effects of the withdrawal of the 75 substances may increase the resistance risk. To estimate this, the following steps were taken:

1. Identification of the number of active substance for each pesticide type:
    - Insecticides: number of substances families
    - Fungicides: number of substances families (C, M, SDHI, triazols, morpholins, strobs, Aza-napht, benzimid)
    - Herbicides: number of substances by HRAC mode of action (A, C1, C2, C3, K1, K2, O)
2. Analysis of the number of remaining substances
3. Classification of the level of risk based on the amount of alternatives remaining.
    - Remaining 0-1 mode of action: high risk
    - Remaining 2-3 mode of action: medium risk
    - Remaining 4-5 mode of action: low risk
4. Assessment of the new situation
   Based on agronomic expertise, depending on the amount of alternatives remaining counting the more frequent risk for the whole modes of action. For example:

| | Resistance risk | | | | | | | | Risk level | Additional crop protection costs | Alternatives |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | M | C | SDHI | strobilurin | triazol | morpholin | Aza-Napht | Benzimid | | | |
| cereals | -50% | | | | -100% | | -50% | -100% | | | azole disappearance would increase the risk of resistance on SDHI and strobilurins, last substances to be effective on septoria |
| before | 4 | | | | 11 | | 2 | 1 | medium | 10% | |
| after | 2 | | | | 0 | | 1 | 0 | | | |

5. Transformation of the new situation in increasing cost based on the following correspondence table:
    - No risk: no change
    - Low risk: increase costs crop protection of 5%
    - Medium risk: increase costs crop protection of 10 %
    - High risk: increase costs crop protection of 15 %

6. Determination of the global impact for the crop based on the average result for insecticides, herbicides and fungicides. For example: +10% for wheat in France.

| | % add. costs insecticides | % add. cost herbicides | % add. cost in fungicides | Total average % add. cost |
|---|---|---|---|---|
| Wheat | 5% | 15% | 10% | 10% |
| Durum wheat | 5% | 15% | 10% | 10% |
| Barley | 5% | 15% | 10% | 10% |

7. The related long-term yield effect is estimated based on agro-economic expertise.

## Extrapolation

The extrapolation is done based on several steps:

1. First, the model calculates the weighted average of the yield change per crop. This is based on the individual country's share of total EU production of a particular crop.
2. This EU average yield change is applied to the total uncovered EU production, EU production outside of the 9 countries in scope.
3. The average ex-farm price and variable crop production costs, relevant to calculate the total gross margin change, are total EU averages as well. The ex-farm price is based on Eurostat information for EU-28 while the variable crop production costs are the weighted average of the 9 countries studied in detail.

Crops/countries combinations for which only NNI info is available to estimate the yield effect are excluded from the extrapolation.

## Environmental impact

### Change in GHG (% of CO2 eq t/ha)

This indicator is often linked to the change in treatment frequency. We consider that the number of applications may increase in the same ratio that the GHG.

Sometime the alternative solution is a cultivation pass. The energy used by the tractor is higher than needed by a sprayer application. The change in GHG must be indicated. There is no specific methodology except having the accurate references.

### Change in treatment frequency

This indicator may be relevant for some countries. For example when you replace a seed treatment (neoni) by a conventional spray (pyrethrin), you often use two treatments to obtain the same effect, in the best case. The treatment frequency has been increased by 100% (1→2). We suggest adding this information close to the "change in protection cost". In many cases the change in protection cost is corresponding to the change in treatment frequency.

Analysis of carbon footprint is based on the following:

| Indicator | Statistics | Source |
|---|---|---|
| **Farm level input** | | |
| Farm Input Emissions | | State of the Art on Energy Efficiency in Agriculture; Agree & Wageningen UR |
| Litre diesel use per application | 7 | |
| Amount of additional applications | 2 | |
| **Transport** | | |
| kg CO2 emissions per litre Diesel | 3,14 | Harvesting energy with fertilizers, Fertilizer Europe |
| Distance USA to EU (in km) | 7.895 | |
| g CO2 eq emissions per km | 14 | Guidelines for Measuring and Managing CO2 Emission from Freight Transport |

| | | |
|---|---|---|
| | | Operations |
| **Land use changes** | | |
| t CO2 eq. emissions for biomass on one hectare | 57 | IPCC Guidelines Volume 4: Agriculture, Forestry and Other Land Use (AFOLU) |
| Year amortization time to convert one time deforestation to annual impact | 20 | IPCC Guidelines Volume 4: Agriculture, Forestry and Other Land Use (AFOLU) |

## APPENDIX IV - Substances

*Table 13: Sources for substances in* Table 3

| Source | Title | Year | Description/Scope of document |
|---|---|---|---|
| **WRc** **(for DEFRA)** | Extended impact assessment study of the human health and environmental criteria for endocrine disrupting substances proposed by HSE, CRD | 2013 | To determine which active substances from the PPP Approved List can be regarded as EDs of very high regulatory concern, which substances require further information, which substances are considered EDs of low concern and which substances are not EDs |
| **DEFRA** **(Department for Environment, Food and Rural Affairs)** | Water Framework Directive implementation in England and Wales: new and updated standards to protect the water environment | 2014 | List of pollutants causing greatest risk of harm |
| **CRD** **(Chemicals regulation directorate)** | PROPOSAL FOR A REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL CONCERNING THE PLACING OF PLANT PROTECTION PRODUCTS ON THE MARKET: Summary impact assessment | 2009 | List of substances with high and medium risk of |
| **EU Restriction** | | 2014 | The European Union has voted to ban the use of methiocarb slug pellets due to their hazardous effect on grain-eating farm birds such as finches and sparrows. The approval for these poison-bait pellets is being stopped through the EU, and in the UK it is likely to have the biggest impact on potato growers. Bayer CropScience is the only global manufacturer of methiocarb and it has confirmed that this year will be the last one that it can be sold in the UK. The other major slug pellet product used in the UK is metaldehyde, which accounts for about 80% of the market, but it has come under pressure after the product has been found in watercourses. |

## APPENDIX V - References

*Table 14: Data sources wheat*

| Wheat | Source | Type | Total estimate[112] |
|---|---|---|---|
| **France** | | | SRQ |
| **Fungicide** | Nomisma; 'The Assessment of the Economic Importance of Azoles in European Agriculture: Wheat case study'; 2012 | Study | |
| **Insecticide** | Humboldt Forum for Food and Agriculture 'The value of neonicotinoid seed treatment in the European Union'; 2013 Arvalis Institute | Study Experts | |
| **Herbicide** | Avarlis Institute | Experts | |
| **UK** | | | Study |
| **Fungicide** | Anderson; 'The effect of the loss of plant protection products on UK agriculture and horticulture and the wider economy'; 2014 | Study | |
| **Insecticide** | Anderson; 'The effect of the loss of plant protection products on UK agriculture and horticulture and the wider economy'; 2014 | Study | |
| **Herbicide** | Anderson; 'The effect of the loss of plant protection products on UK agriculture and horticulture and the wider economy'; 2014 | Study | |
| **Germany** | | | SRQ |
| **Fungicide** | Trinity College Dublin; 'Restricted availability of azole-based fungicides'; 2011 | Study | |
| **Insecticide** | No information available | | |
| **Herbicide** | Landwirtschaftskammer NRW | Experts | |
| **Poland** | | | Study |
| **Fungicide** | | | |
| **Insecticide** | Fed of agri producers | | |
| **Herbicide** | | | |
| **Italy** | | | |
| **Fungicide** | Nomisma; 'The Assessment of the Economic Importance of Azoles in European Agriculture: Wheat case study'; 2012 Confagricoltura, Coldiretti | Study Experts | |
| **Insecticide** | Confagricoltura, Coldiretti | Experts | |
| **Herbicide** | Confagricoltura, Coldiretti | Experts | |
| **Netherlands** | | | Study |
| **Fungicide** | Wageningen University, Agrifirm | Experts | |
| **Insecticide** | WUR Study | Study | |
| **Herbicide** | | Experts | |
| **Ireland** | | | |

[112] This refers to whether the experts/studies provided one total yield change effect per crop or whether SRQ estimated a total figure based on separate figures per pesticide type provided

| | | | |
|---|---|---|---|
| **Fungicide** | | | |
| **Insecticide** | Teagasc | Experts | |
| **Herbicide** | | | |
| **Austria** | | | |
| **Fungicide** | | | |
| **Insecticide** | Landwirtschaftskammer Niederösterreich<br>Landwirtschaftskammer Oberösterreich | Experts | |
| **Herbicide** | | | |

***Table 15: Data sources barley***

| **Barley** | **Source** | **Type** | **Total estimate** |
|---|---|---|---|
| **France** | | | SRQ |
| **Fungicides** | Arvalis Institute | Experts | |
| **Insecticides** | Humboldt Forum for Food and Agriculture Working Paper 01/2013; 'The value of neonicotinoid seed treatment in the European Union'<br>Arvalis Institute | Study<br>Experts | |
| **Herbicides** | Arvalis Institute | Experts | |
| **UK** | | | Study |
| **Fungicides** | Anderson; 'The effect of the loss of plant protection products on UK agriculture and horticulutre and the wider economy'; 2013 | Study | |
| **Insecticides** | Anderson; 'The effect of the loss of plant protection products on UK agriculture and horticulutre and the wider economy'; 2014 | Study | |
| **Herbicides** | Anderson; 'The effect of the loss of plant protection products on UK agriculture and horticulutre and the wider economy'; 2015 | Study | |
| **Germany** | | | SRQ |
| **Fungicides** | Trinity College Dublin, Institut für Agribusiness ; 'Restricted availability of azole-based fungicides'; 2011 | Study | |
| **Insecticides** | No information available | | |
| **Herbicides** | Landwirtschaftskammer NRW | Experts | |
| **Netherlands** | | | Study |
| **Fungicides** | | | |
| **Insecticides** | Study Wageningen University<br>Piet Spoorenberg, WUR<br>Aaldrik Venhuizen, Agrifirm | Experts<br>Study<br>Experts | |
| **Herbicides** | | | |
| **Ireland** | | | |
| **Fungicides** | | | |
| **Insecticides** | Teagasc | Experts | |
| **Herbicides** | | | |
| **Austria** | | | Expert |
| **Fungicides** | | | |
| **Insecticides** | LK NÖ bzw. LK OÖ | | |
| **Herbicides** | | | |

*Table 16: Data sources oilseed rape*

| OSR | Source | Type | Total estimate |
|---|---|---|---|
| **France** | | | SRQ |
| **Fungicides** | Arvalis Institute | Experts | |
| **Insecticides** | Humboldt Forum for Food and Agriculture; 'The value of neonicotinoid seed treatment in the European Union'; 2013<br>Arvalis Institute | Study<br>Experts | |
| **Herbicides** | Arvalis Institute | Experts | |
| **UK** | | | Study |
| **Fungicides** | Anderson; 'The effect of the loss of plant protection products on UK agriculture and horticulutre and the wider economy'; 2013 | Study | |
| **Insecticides** | Anderson; 'The effect of the loss of plant protection products on UK agriculture and horticulutre and the wider economy'; 2014 | Study | |
| **Herbicides** | Anderson; 'The effect of the loss of plant protection products on UK agriculture and horticulutre and the wider economy'; 2015 | Study | |
| **Germany** | | | SRQ |
| **Fungicides** | Trinity College Dublin, Institut für Agribusiness; 'Restricted availability of azole-based fungicides'; 2011 | Study | |
| **Insecticides** | Humboldt Forum for Food and Agriculture; 'The value of neonicotinoid seed treatment in the European Union'; 2013 | Study | |
| **Herbicides** | Landwirtschaftkammer NRW | Experts | |
| **Poland** | | | |
| **Fungicides** | | Study<br>Expert | |
| **Insecticides** | Humboldt Forum for Food and Agriculture; 'The value of neonicotinoid seed treatment in the European Union'; 2013 | Study<br>Expert | |
| **Herbicides** | | Study<br>Expert | |
| **Ireland** | | | |
| **Fungicides** | | | |
| **Insecticides** | Teagasc | Experts | |
| **Herbicides** | | | |
| **Austria** | | | |
| **Fungicides** | | | |
| **Insecticides** | Austrian Chamber of Agriculture | Expert | |
| **Herbicides** | | | |

*Table 17: Data sources potatoes*

| Potatoes | Source | Type | Total estimate |
|---|---|---|---|
| **France** | | | Expert |
| **Fungicides** | Arvalis Institute | Expert | |
| **Insecticides** | Arvalis Institute | Expert | |
| **Herbicides** | Arvalis Institute | Expert | |
| **UK** | | | Study |
| **Fungicides** | Anderson | Study | |
| **Insecticides** | Anderson | Study | |
| **Herbicides** | Anderson | Study | |
| **Germany** | | | SRQ |
| **Fungicides** | Bavarian State Research Center for Agriculture; Nechwatal, J, Wagber, S. and Zellner, M.: Pflanzenschutzrückblick 2014 | Study | |
| **Insecticides** | no information available | | |
| **Herbicides** | Landwirtschaftskammer NRW | Experts | |
| **Poland** | | | |
| **Fungicides** | Fed of agri producers | | |
| **Insecticides** | | | |
| **Herbicides** | | | |
| **Netherlands** | | | Study |
| **Fungicides** | WUR and Agrifirm<br>Study Wageningen University | | |
| **Insecticides** | | Study + Expert | |
| **Herbicides** | | | |
| **Ireland** | | | |
| **Fungicides** | | | |
| **Insecticides** | Teagasc | Experts | |
| **Herbicides** | | | |
| **Austria** | | | |
| **Fungicides** | Landwirtschaftskammer Niederösterreich | Experts | |
| **Insecticides** | | Experts | |
| **Herbicides** | | Experts | |

*Table 18: Data sources sugar beet*

| Sugarbeet | Source | Type | Total estimate |
|---|---|---|---|
| **France** | | | SRQ |
| **Fungicides** | Institut Technique de la Betterave<br>Arvalis Institute | Experts<br>Experts | |
| **Insecticides** | Institut Technique de la Betterave<br>Arvalis Institute<br>Humboldt Forum for Food and Agriculture; 'The value of neonicotinoid seed treatment in the European Union'; 2013 | Experts<br>Experts<br>Study | |
| **Herbicides** | Institut Technique de la Betterave<br>Arvalis Institute | Experts<br>Experts | |
| **UK** | | | Study |
| **Fungicides** | Anderson; 'The effect of the loss of plant protection products on UK agriculture and horticulture and the wider economy'; 2014 | Study | |
| **Insecticides** | Anderson; 'The effect of the loss of plant protection products on UK agriculture and horticulture and the wider economy'; 2014 | Study | |
| **Herbicides** | Anderson; 'The effect of the loss of plant protection products on UK agriculture and horticulture and the wider economy'; 2014 | Study | |
| **Germany** | | | SRQ |
| **Fungicides** | Landwirtschaftskammer NRW<br>Trinity College Dublin, Institut für Agribusiness; 'Restricted availability of azole-based fungicides'; 2011 | Expert<br>Study | |
| **Insecticides** | Landwirtschaftskammer NRW<br>Humboldt Forum for Food and Agriculture; 'The value of neonicotinoid seed treatment in the European Union'; 2013 | Expert<br>Study | |
| **Herbicides** | Landwirtschaftskammer NRW | Expert | |
| **Spain** | | | SRQ |
| **Fungicides** | Aimcra | Experts | |
| **Insecticides** | Aimcra | Experts | |
| **Herbicides** | Aimcra | Experts | |
| **Netherlands** | | | Study |
| **Fungicides** | WUR, IRS<br>Study Wageningen University | Experts<br>Study | |
| **Insecticides** | | | |
| **Herbicides** | | | |

*Table 19: Data sources maize*

| Maize | Source | Type | Total estimate |
|---|---|---|---|
| **Germany** | | | |
| **Fungicides** | Humboldt Forum | | |
| **Insecticides** | | Study<br>Expert | Yes |
| **Herbicides** | Landwirtschaftkammer NRW | | |
| **Austria** | | | |
| **Fungicides** | | | |
| **Insecticides** | Austrian Chamber of Agriculture / LK Steiermark | Expert | |
| **Herbicides** | | | |
| **France** | | | |
| **Fungicides** | | | |
| **Insecticides** | Arvalis Institute<br>Humboldt Study | Study<br>Expert | |
| **Herbicides** | | | |
| **Poland** | | | |
| **Fungicides** | | | |
| **Insecticides** | Fed of agri producers | | |
| **Herbicides** | | | |
| **Italy** | | | |
| **Fungicides** | Confagricoltura, Coldiretti | Expert | No |
| **Insecticides** | Confagricoltura, Coldiretti, Humboldt | Study<br>Expert | No |
| **Herbicides** | Confagricoltura, Coldiretti | Expert | No |
| **Ireland** | | | |
| **Fungicides** | Teagasc | Experts | |
| **Insecticides** | Teagasc | Experts | |
| **Herbicides** | Teagasc | Experts | |

## References production costs

| Country | Crop | Year | Source base data | Year | Source variable costs data |
|---|---|---|---|---|---|
| **Austria** | Wheat | 2009-2013 | Landwirtschaftskammer Oberösterreich | 2010-2014 | Bundesanstalt für Agrarwirtschaft Österreich; Landwirtschaftskammer Oberösterreich |
| **Austria** | Barley | 2009-2013 | Eurostat | 2010-2014 | Bundesanstalt für Agrarwirtschaft Österreich |
| **Austria** | Maize | 2010-2014 | Bundesanstalt für Agrarwirtschaft Österreich | 2010-2014 | Bundesanstalt für Agrarwirtschaft Österreich |
| **Austria** | Sugar beet | 2009-2013 | Eurostat | 2010-2014 | Bundesanstalt für Agrarwirtschaft Österreich |
| **Austria** | Seed Potatoes | 2010-2014 | Landwirtschaftskammer Niederösterreich | 2010-2014 | Bundesanstalt für Agrarwirtschaft Österreich |
| **Austria** | Ware Potatoes | 2010-2014 | Landwirtschaftskammer Niederösterreich | 2010-2014 | Bundesanstalt für Agrarwirtschaft Österreich |
| **Austria** | Potatoes | 2010-2014 | Landwirtschaftskammer Niederösterreich | 2010-2014 | Bundesanstalt für Agrarwirtschaft Österreich |
| **Austria** | OSR | 2009-2013 | Eurostat | 2010-2014 | Bundesanstalt für Agrarwirtschaft Österreich |
| **Austria** | Vine | 2009-2013 | Eurostat | 2008 | Bundesministerium für Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft (BMLFUW) |
| **France** | Carrots | 2009-2013 | Eurostat | | CTIFL |
| **France** | Apples | 2009-2013 | Eurostat | | CTIFL |
| **France** | Soft Wheat | 2009-2013 | Eurostat | 2010 | Brookes |
| **France** | Wheat | 2009-2013 | Eurostat | 2010 | Brookes |
| **France** | Winter barley | 2009-2013 | Eurostat | 2010 | Brookes |
| **France** | Barley | 2009-2013 | Eurostat | 2010 | Brookes |
| **France** | Spring barley | 2009-2013 | Eurostat | 2010 | Brookes |
| **France** | Durum wheat | 2009-2013 | Eurostat | 2010 | Brookes |
| **France** | Maize | 2009-2013 | Eurostat | 2010 | Brookes |
| **France** | OSR | 2009-2013 | Eurostat | 2010 | Brookes |
| **France** | Sugar beet | 2009-2013 | Eurostat | 2010 | Brookes |
| **France** | Potatoes | 2009-2013 | Eurostat | 2010 | Brookes |
| **France** | Beans | 2009-2013 | Eurostat/Cenaldi | 2009-2013 | ANPLC/Cénaldi |
| **France** | Vine | 2009-2013 | Eurostat | | FADN |
| **Germany** | Wheat | 2009-2013 | Eurostat | | Bayerische Landesanstalt für Landwirtschaft |
| **Germany** | Barley | 2009-2013 | Eurostat | | Bayerische Landesanstalt für Landwirtschaft |
| **Germany** | Maize | 2009-2013 | Eurostat | | Bayerische Landesanstalt für Landwirtschaft |
| **Germany** | Sugar beet | 2009-2013 | Eurostat | | Bayerische Landesanstalt für Landwirtschaft |
| **Germany** | Potatoes | 2009-2013 | Eurostat | | Bayerische Landesanstalt für Landwirtschaft |
| **Germany** | OSR | 2009-2013 | Eurostat | | Bayerische Landesanstalt für Landwirtschaft |
| **Germany** | Hops | 2009-2013 | Eurostat | | Arbeitsgruppe Hopfenanbau |

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| | | | | | und Produktionstechnik |
| **Germany** | Onions | 2009-2013 | Eurostat | | Koordination Pflanzenschutz Gemüsebau Dienstleistungszentrum Ländlicher Raum - Rheinpfalz - (DLR) |
| **Ireland** | Wheat | 2009-2013 | CSO | 2010 | Brookes |
| **Ireland** | Barley | 2009-2013 | CSO | 2010 | Brookes |
| **Ireland** | Spring barley | 2009-2013 | CSO | 2010 | Brookes |
| **Ireland** | Potatoes | 2009-2013 | CSO | 2010 | Brookes |
| **Ireland** | Brassica | 2010-2013 | Teagasc | | Teagasc |
| **Ireland** | Mushrooms | 2010-2013 | Teagasc | | |
| **Ireland** | Carrots | 2010-2013 | Teagasc | 2008 | Teagasc |
| **Ireland** | Maize | 2009-2013 | Eurostat | | |
| **Italy** | Soft wheat | 2009-2013 | Eurostat | 2010 | Brookes |
| **Italy** | Durum wheat | 2009-2013 | Eurostat | 2010 | Brookes |
| **Italy** | Wheat | 2009-2013 | Eurostat | 2010 | Brookes |
| **Italy** | Maize | 2009-2013 | Eurostat | 2010 | Brookes |
| **Italy** | Tomato (open) | 2009-2013 | Eurostat | | |
| **Italy** | Peaches/nectarines | 2009-2013 | Eurostat | | |
| **Italy** | Rice | 2009-2013 | Eurostat | | |
| **NL** | Wheat | 2009-2013 | Agrimatie / WUR LEI | 2009-2013 | Agrimatie / WUR LEI |
| **NL** | Barley | 2009-2013 | Agrimatie / WUR LEI | 2009-2013 | Agrimatie / WUR LEI |
| **NL** | Seed potatoes | 2009-2013 | Agrimatie / WUR LEI | 2009-2013 | Agrimatie / WUR LEI |
| **NL** | Ware potatoes | 2009-2013 | Agrimatie / WUR LEI | 2009-2013 | Agrimatie / WUR LEI |
| **NL** | Potatoes | | | | |
| **NL** | Sugar beet | 2009-2013 | Agrimatie / WUR LEI | 2009-2013 | Agrimatie / WUR LEI |
| **NL** | Tulip Bulbs | 2009-2013 | Agrimatie / WUR LEI | 2009-2013 | Agrimatie / WUR LEI |
| **NL** | Apple trees | 2009-2013 | ZLTO | 2009-2013 | Agrimatie / WUR LEI |
| **NL** | Bell pepper (glass) | 2009-2013 | Agrimatie / WUR LEI, CBS, GFActueel.nl | 2009-2013 | Agrimatie / WUR LEI |
| **Poland** | Winter wheat | 2009-2013 | Eurostat | 2010 | Brookes |
| **Poland** | Wheat | 2009-2013 | Eurostat | 2010 | Brookes |
| **Poland** | Barley | 2009-2013 | Eurostat | 2010 | Brookes |
| **Poland** | Maize | 2009-2013 | Eurostat | 2010 | Brookes |
| **Poland** | OSR | 2009-2013 | Eurostat | 2010 | Brookes |
| **Poland** | Sugar beet | 2009-2013 | Eurostat | 2010 | Brookes |
| **Poland** | Potatoes | 2009-2013 | Eurostat | 2010 | Brookes |
| **Poland** | Apples | 2009-2013 | Eurostat | | |
| **Poland** | Black Currants | 2009-2013 | Eurostat | 2010 | Brookes |
| **Spain** | Tomato (glass) | | AEPLA | | AEPLA |
| **Spain** | Tomato (open) | | AEPLA | | Cooperativas Agro-Alimentarias |
| **Spain** | Sugar beet | 2009-2013 | Eurostat | 2010 | Brookes |
| **Spain** | Citrus | 2009-2013 | Eurostat | | Cooperativas Agro-Alimentarias |
| **Spain** | Cherry | 2009-2013 | Eurostat | | Cooperativas Agro-Alimentarias |

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|---|---|---|---|---|---|
| **Spain** | Sunflower | 2009-2013 | Eurostat | 2010 | Brookes |
| **Spain** | Rice | 2009-2013 | Eurostat | | AVA-ASAJA |
| **Spain** | Vine | 2009-2013 | Eurostat | 2012 | FADN (Spain - Vine) |
| **Spain** | Olives | 2009-2013 | Eurostat | 2009-2012 | FADN (Spain - Horticulture) |
| **UK** | Wheat | 2009-2013 | Eurostat | 2010 | Brookes |
| **UK** | Barley | 2009-2013 | Eurostat | 2010 | Brookes |
| **UK** | Sugar beet | 2009-2013 | Eurostat | 2010 | Brookes |
| **UK** | Maize | 2009-2013 | Eurostat | 2010 | Brookes |
| **UK** | Potatoes | 2009-2013 | Eurostat | 2010 | Brookes |
| **UK** | OSR | 2009-2013 | Eurostat | 2010 | Brookes |
| **UK** | Peas | 2009-2013 | Eurostat | 2010 | Brookes |