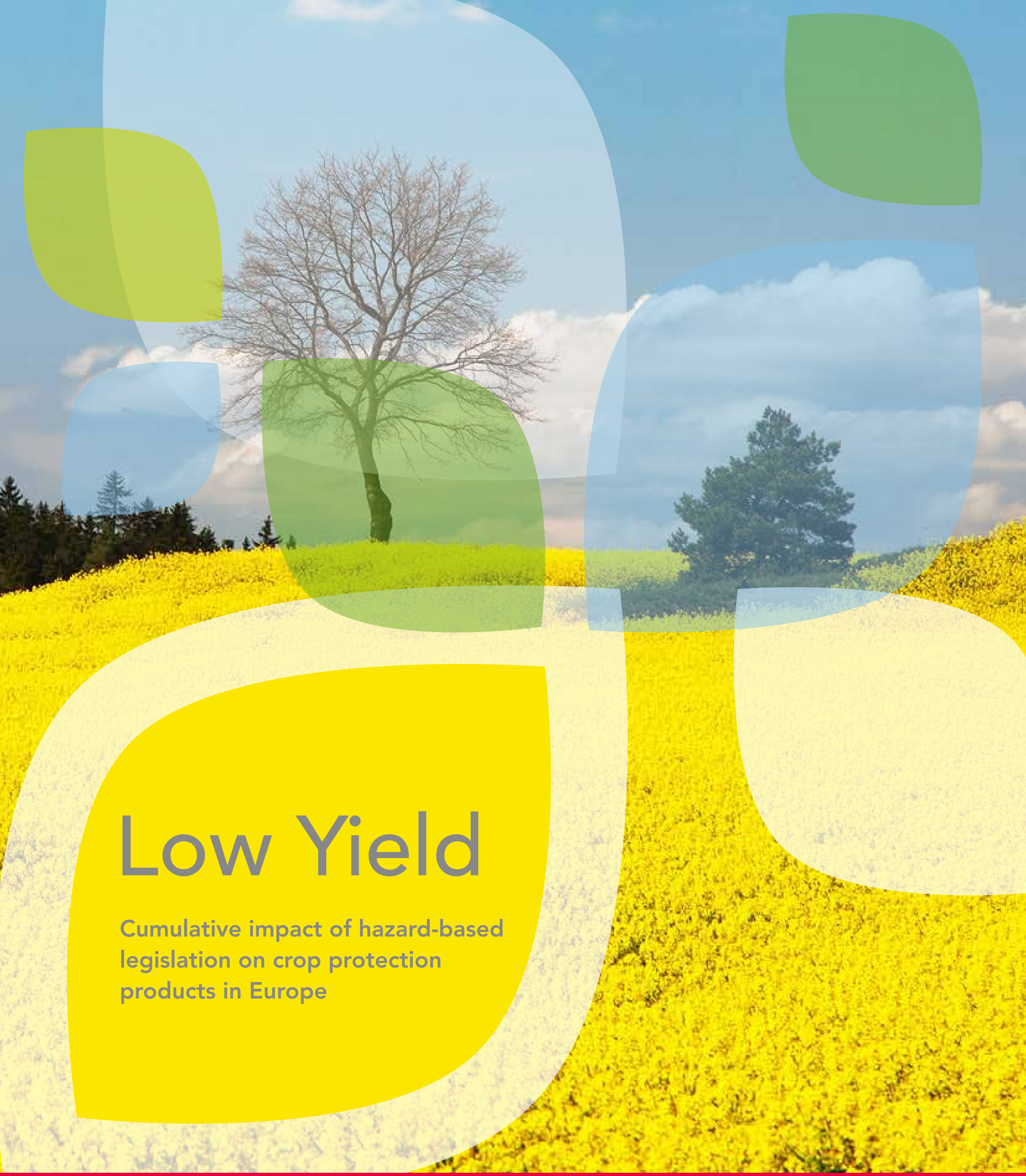

Low Yield

Cumulative impact of hazard-based legislation on crop protection products in Europe

Final report July 2016

European Crop Protection

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European
Crop Protection

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About the authors

COMPANY PROFILE

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

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 basic foods and at the same time supporting agricultural incomes. Detractors assert environmental implications and are concerned about human health. Our socio-economic impact assessments go beyond assertions in an effort to quantify the direct and indirect impacts of pesticide use, adding a quantitative dimension to the discussions.

THE AUTHORS

René Kim is founder and partner of Steward Redqueen. He has worked with many multinational companies and private equity funds in both developed and emerging markets. He has previously worked for the Boston Consulting Group in Amsterdam and has a Ph.D. cum laude in hydrology and meteorology.

Willem Ruster has a strong track record in socio-economic impact assessments and has executed more than 40 projects in various sectors around the globe. Over the last few years, Willem has specialised in innovation and developments in the agro-food chain.

Hedda Eggeling holds a cum laude master's degree in economics and has over six years of experience performing socio-economic impact assessments, supply chain analyses and economic modelling. Within Steward Redqueen, Hedda's special interest is in the link between trade and development.

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 and beverage firms, agriculture, banks and recreational organisations, in Asia, Africa, Latin America and Europe.

For more information visit:
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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 strives towards greener agriculture, however, 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, as well as many regions outside the EU. EU legislation therefore not only affects Europeans but also other nations.

In this light, the development of next generation substances gains importance. But the pipeline of new crop protection products is drying up; every year time to market for new products increases and the number of available products has consequently halved over the last 15 years.

In this report, we address the socio-economic effects of hazard-based legislation on farmers and the European food chain. Compared to the 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 of such changes 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 insight into the Europe-wide effects of all at-risk substances on farmers and the food chain, analyzing the effects for 49% of EU's crop value. These insights are complementary to other societal assessments on health and environmental aspects. Future research could further contribute to gaining 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 a sustainable supply of affordable and safe food for Europe. At the end of the day, we support decision-making on what is the best use of European (agricultural) land.

1. Summary

The viability of European agriculture has been 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 definitive decision on which active substances are facing withdrawal has yet been made, earlier research identified some 75 out of the total 400 substances currently available to be phased out.

However, for the cultivation of various staples, as well as specialty crops, it is possible that no alternative method would remain on the market to treat specific common diseases, pests or weeds. As part of Integrated Pest Management (IPM), diversity in available substances is crucial for facing immediate pest pressure and preventing long-term resistance effects. Looking ahead, withdrawn substances are not likely to be easily replaced. There are two reasons for this: first, the development of new active ingredients up to market introduction takes about 11 years and costs over $280 million.[1] Second, 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 the 2000, down to 28 in 2012).[2]

Against this background, this study aims to shed light on the current value of the 75 substances for European agriculture. It focuses on seven staple crops at the EU level and 24 specialty crops across nine EU member states, representing 49% (in crop value).[3] The various crops are studied individually; 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 five 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 the Andersons Centre[4] with UK's Department for Environment, Food and Rural Affairs (DEFRA) as primary source. Twelve substances have been omitted from the study as these are based on UK-specific regulations or are considered low risk;
- 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 countries studied, 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;
- We use the best available national and EU databases on crop production and cost structures (e.g. EUROSTAT, FAOSTAT, FADN, WUR, Teagasc, DEFRA).

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

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 €204bn, FAOSTAT*

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 *Staple crops include: wheat, barley, maize, oilseed rape, potatoes, sugar beet and grapes. Specialty crops include: durum wheat, carrots, apples, beans, hops, onions, brassica, mushrooms, rice, tomatoes (open-air and greenhouse produces), pears, peaches/nectarines, soy, hazelnut, olives, tulip bulbs, apple trees, bell peppers, black currants, citrus fruits, cherries, sunflowers and peas for selected countries*

KEY FINDINGS

1. Use of the 75 substances identified for the production of seven key staple crops in the EU (potatoes, barley, wheat, sugar beet, rapeseed, maize and grapes) contributes to 96 million tons or €15bn in crop value:

   - Barley, wheat, rapeseed and maize could face 10-20% lower yields, while potatoes and sugar beets might decrease by up to 30-40%; grape yields with 20%;
   - At the current speed of technological progress, it would take 15-20 years to make up for this loss[1];
   - Higher yields and lower production costs for these crops support farmer income by €17bn (i.e. €15bn additional revenue, €2bn lower costs);
   - With the 75 substances, overall farm profitability is 40% higher (€17bn of a total of €44bn)[2];
   - In value, wheat benefits the most with €4bn of value, while sugar beet shows the largest profitability surplus (+100%);
   - The seven staple crops correspond to 1.2m direct jobs. Of these, 30% face a medium or high risk of job loss due to relatively 'thin' margins for these crops.

2. The 75 substances are crucial for the economic viability of the 24 specialty crops covered in the scope of this study:

   - The supported yields range from 40-100%, a total of 12 million tons[3];
   - The size of the crop protection toolbox of many specialty crops is already limited and is the key driver of the high potential for 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 EU's self-sufficiency for wheat, barley, potatoes and sugar beets, while limiting the import levels of rapeseed and maize:

   - In contrast to the current situation with a positive trade balance, without these 75 substances, the EU is likely to depend on imports for more than 20% of its staple crop demand;
   - Meeting the demand for staples with imported crops entails risk of selling crops on the European market produced with non-EU standards;
   - Meeting the demand for specialty crops seems even more challenging as sufficient import amounts are not always readily available;
   - 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[4];

1 *"The technology challenge", FAO, High Level Expert Forum, 2009*

2 *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*

3 *Includes durum wheat, carrots, apples, beans, hops, onions, brassica, mushrooms, rice, tomatoes (open-air and greenhouse), pears, peaches/nectarines, soy, hazelnuts, olives, tulip bulbs, apple trees, bell peppers, black currants, citrus fruits, cherries, sunflowers and peas for selected countries*

4 *Total used agricultural area in the UK was 17,326,990 ha in 2013, Eurostat*

- This would increase the carbon emissions by up to 49 million t CO_2-eq (i.e. 10% EU agriculture, 1% of EU, similar to the total emissions of Denmark[1] or twice the international aviation emissions of Germany[2]), putting the CO_2 aims of European legislation at risk;[3]

- In monetary terms, these increases could mean additional emissions to the value of €500 million.[4]

4. Mediterranean crops analysed benefit from using the 75 active substances for protecting against a wide range of pest diseases. Most of these are specialty crops that currently benefit of a limited number of registered active substances:

   - The supported grape yields would decrease by 20% (22% in France, 13% Spain, 20% Austria and Italy even 30%) and overall farm profitability would be 11% lower;

   - The EU is currently self-sufficient for grapes. Losing the active substances will require the EU to import some 4m tons of grapes from third countries;

   - Yields are expected to decrease by 92% in carrots, 60% in apples, 65% in pears, 40% in olives, 36% in tomatoes, 36% in citrus fruits and 15% in cherries.

5. Smaller local crop supply will also affect EU value chains with higher costs and less jobs:

   - Primary crop processors in the EU could run into difficulties with their supplies, e.g. if tomatoes 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 to the consumer but also to affect EU trading partners.

1 Total Danish greenhouse gas emissions (including international aviation and excluding LULUCF) in 2013 were 57.1 million ton CO2eq., EUROSTAT

2 German greenhouse gas emissions related to international aviation in 2013 were 25.7 million tons CO2eq., EUROSTAT

3 Agriculture made up 10% of total European emissions in 2012 out of a total 4,683 million tons, EUROSTAT

4 €10 per ton, average 2009-2013 ETS prices


02

2. Introduction

ECPA along with their respective national organisations commissioned Steward Redqueen to examine the socio-economic effects of current hazard-based 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 and profitability, jobs, carbon footprint and land use;
- These insights should complement other socio-economic work and research undertaken 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.

EU LEGISLATION

Before the 1990s, prior to Directive 91/414/EEC, individual member states were responsible for pesticide approval. From the Directive's implementation onwards, substances were required to meet specific safety and efficacy criteria before being approved for the EU market as a whole. The harmonisation following this regulation led to a first round of reducing active substances available to EU farmers. In the following years, several additional legislations were implemented. Among them are:

- The Water Framework Directive 2000/60/EC[1]
- Regulation 1107/2009[2]
- Regulation 485/2013[3]

The Water Framework Directive 2000/60/EC's goal is for all rivers, lakes, ground, coastal and drinking water in the EU to reach healthy ecological and chemical standards. Setting limits on amounts of permitted pesticides and introducing quality requirements for groundwater have therefore been introduced.

Regulation 1107/2009 came 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 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 cases they where bear the following characteristics (i) are mutagenic, (ii) are carcinogenic or present reproductive toxicity, (iii) act as an endocrine disruptor, (iv) are persistent organic pollutants, (v) are persistently bio-accumulative and toxic and (vi) are very persistent/very bio-accumulative. For substances identified as 'candidates of substitution', initial approval can be achieved 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 the research literature they refer to different degrees of pre-caution. Hazard becomes a risk depending on exposure: watching a shark from the beach is a hazard but becomes a risk if swimming.

1 *Directive 2000/60/EC establishing a framework for Community action in the field of water policy*

2 *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*

3 *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*

This shift towards risk evaluation of crop protection substances from a hazard based perspective has implications for the farming toolbox, i.e. the amount of solutions available for pest control. This hazard-based stance is believed to have contributed to the list of permitted substances dropping down from over 800 in the 1990s to fewer than 400 active substances available for European farmers today[1]. Regulation 485/2013 imposes restrictions on three neonicotinoid substances. While it remains possible to use these substances on crops such as sugar beets, the restriction remains for flowering and spring planted crops until a full review of all new scientific data.

INTEGRATED PEST MANAGEMENT AND 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 employed by farmers.

Moreover, 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 the 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.

1 *Development of approved active substances, Source: European Commission, Healthy Harvest, NFU*

With evidence of high risk, at least four 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, 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)[2].

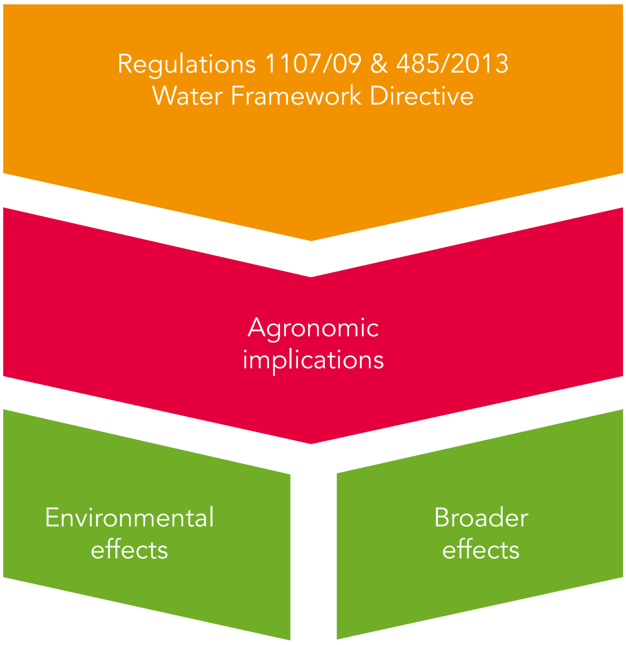
SCOPE OF THIS STUDY

This study aims to shed light on the current value of 75 substances used in pesticides for European agriculture.

2 *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;*

This analysis is peformed by investigating the implications of losing those particular 75 substances currently at risk of being removed all at once. Put differently, the study establishes a hypothetical 'new normal' situation of the crop protection toolbox available for farmers for the coming five years.

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



In scope

28 Herbicides	**Other**
31 Fungicides	Metam sodium
14 Insecticides	Methiocarb

Yield	Crop output
Production costs	Farm income
Land/Energy use	Farm profitability

CO2 Footprint	Rural emplyment
Land use changes	Self-sufficieny

Currently out of scope

Residue Levels	Jobs / income wider economiy
Biodiversity	Food waste
Health effects	Quality wast

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

In terms of crops considered, the study focuses on seven staple crops[1] and 24[2] specialty crops across nine EU member states.[3] For the staple crops, implications for the national level are extrapolated to EU totals. Altogether, the study covers 49% of the total EU crop value.

1 *Winter wheat, winter barley, grain maize, oilseed rape, sugar beet, potatoes and grapes*

2 *Depending on country, based on data availability and relevance: includes durum wheat, carrots, apples, beans, hops, onions, brassica, mushrooms, rice, tomatoes (open-air & greenhouse), pears, peaches/nectarines, soy, hazelnut, olives, tulip bulbs, apple trees, bell pepper, black currants, citrus fruits, cherries, sunflowers and peas*

3 *France, Germany, UK, Poland, Spain, Italy, the Netherlands, Austria and Ireland*

METHOD, DATA AND PROCESS

METHOD

Regulations 1107/09 and 485/2013 in combination with the Water Framework Directive (WFD) as outlined above will likely lead to reduced availability of active substances for EU agriculture. Because the issue is still the subject of ongoing dialogue, it is not yet possible to produce a definite list; this study therefore makes use of existing academic literature to establish a working list of at-risk active substances. In particular, it uses a list of 87[1] overall and 75 non-UK specific or low-risk active substances drafted by the Andersons Centre. Andersons Centre bases theirs on ADAS research with DEFRA, and as primary sources, the UK's HSE-CRD and the European Commission.[2] The 75 substances identified below 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	Source21
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

1 *There have been 12 substances (chlorpyrifos, cypermethrin, permethrin, chlorothalonil, 2,4-D, bentazone, bifenox, MCPA, mecoprop, metazachlor, propyzamide and metaldehyde) omitted from the list as these are based on UK-specific regulation.*

2 *WRc plc; Extended impact assessment study of the human health and environmental criteria for endocrine disrupting substances proposed by HSE, CRD; January 2013 (commissioned by DEFRA). DEFRA; Water Framework Directive implementation in England and Wales: new and updated standards to protect the water environment; May 2014. 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*

Category	Substance name	Likelihood to be lost	Legislation/cut-off criteria	Source21
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-term, for some substances (e.g. neonicotinoids), this could apply to 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 in the distant future.

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

- The 75 active substances are compared to their best currently available alternative solutions in the farmers' toolbox and the Good Agricultural Practices (including chemical, biological, mechanical and cultural practices);

- All substances to be removed from the market at the same time and no other substances will be introduced over the next five years. Given lengthy R&D and approval processes this might not be an unrealistic scenario;

- The various crops are studied in isolation; crop rotation (or any significant change in the rotations[1]) or other changes in the production area have not been taken into consideration;

- The analysis is based on five year average productivity and costs (2009-2013) thereby averaging yearly variations in weather conditions and related pest pressure. Furthermore, we look at the average effects for all farmers per crop in each country to obtain a conservative insight at the national and EU levels. However, we recognize volatility in yields and prices are important aspects of agriculture, and the results might therefore be rather conservative;

- Yield and variable costs per hectare are subject to change ceteris paribus, i.e. means the utilised area and farm-gate prices are presumed fixed.

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

The first step is to investigate which weeds, pests and diseases are the main threats to the cultivation of a particular crop. Consequently, the study establishes which substances farmers currently apply to fight these threats. An analysis of the alternatives which remain available after withdrawing the 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 estimations are based on expert's judgement as well as field tests. In the third step, the study corrects for the share of the total arable hectare to which an active substance is currently applied. This depends on the share of organic production and areas where pest pressures are low.

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

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

1 *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*

Agronomists fear that the risk of resistance could spark a chain reaction: reduced availability of control solutions implies more resistance risk, which implies less efficiency of remaining alternatives. A lack of strong pest control measures could therefore result in losses greater than predicted.

Next to yields, the availability of substances also influences the variable costs of production. Variances in efficiency of the remaining substances might lead to farmers changing the treatment frequency and applying pesticides that are more or less expensive. Consequently, farm input costs may vary.
In summation, the study focuses on and differentiates between:

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

In addition, for some crops the quality of the output might be affected, meaning the crop output can no longer be sold as premium quality. However, as the farm-gate price is assumed to be fixed (see above) this is not explicitly taken into account[1].

Building on Exhibit 2: Overview of approach, the section below illustrates the approach, using the example of wheat in France. The study does this by applying the yield and cost changes as identified by farm experts[2] to the actual base figures[3].

Farmers in France currently harvest 7.0 tons of wheat per hectare. Without the 75 substances (see appendix for full list) the yield would be 16% lower: 5.9 tons per hectare. At the same time, production costs will rise by 3% from the current €471/ha to €483/ha. This inflation is mainly due to additional treatment to protect the crops against pests.

Taking these two effects together, the costs per ton increase by 22%.

We subsequently apply the effects per hectare to the total agricultural production area of wheat in France[4].

The average annual production of wheat in France from the last five years was 38 million tons. Without 75 substances, a yield change of -16% (see appendix for details) is expected to lead to a decrease of output, lowering the annual production to 32 million tons. This affects farmers' revenues as well as costs.

1 *Although a conservative approach, non-compliance with marketing standards will vary for farm-gate prices.*

2 *Yield and production cost changes as identified by Arvalis, France*
3 *Average production and cost data for French wheat 2009-2013, EUROSTAT and Farm Accounting Data Network.*
4 *This is possible as changes of yield effects incorporate national average levels of pest threats based on the experience of 2009-2013.*

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

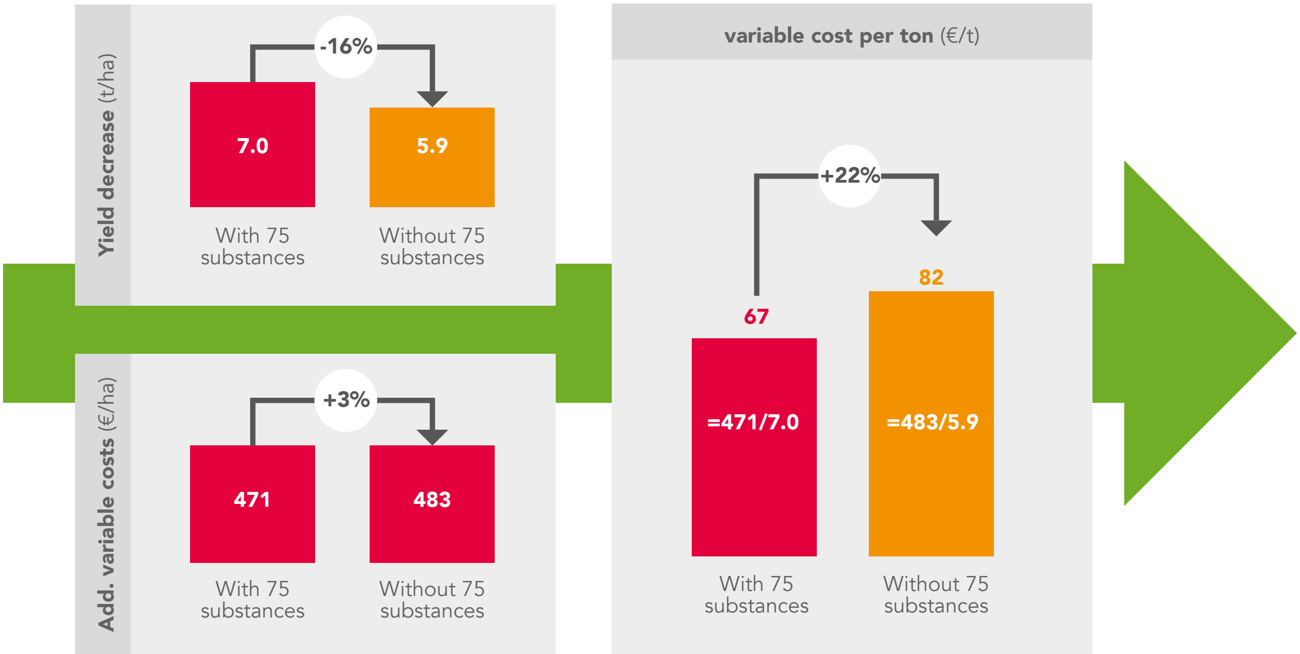
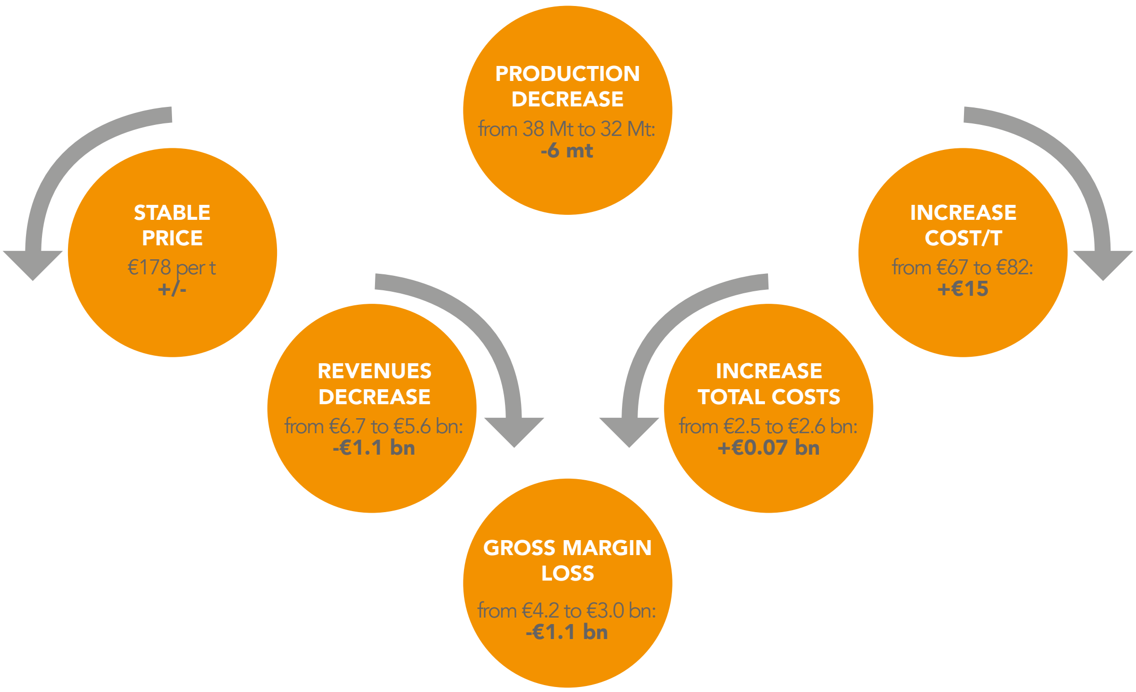


Exhibit 4: *Changes in farm income, costs and gross margins for French wheat*



Assuming that the price farmers receive for a ton of wheat is €178,[1] the total revenues for 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 will 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[2] 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 AND 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.

The execution of this study included intensive contact with the various parties[3] mentioned above. These experts followed the steps outlined in Exhibit 2 and also provided information regarding the yield, the farm-gate 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 at the EU level and subsequently has separate country chapters for all countries included in the scope of the study. At the EU level the study also elaborates on the value of the 75 substances with regard to employment, trade and 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.

***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 and unions[4]	COEXPHAL		LTO-glaskracht, Agrodis	AWI-BMLFUW	
UNILET/ANPLC	Center for Hop research Hüll			ACOPAEX		ZLTO		
Cénaldi				DCOOP		IRS		
Terres Inovia								

1 *The price could be negatively affected by an additional loss in quality and could be positively affected by decrease in supply; for simplicity, we presume a stable price*

2 *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*

3 *With the exception of the UK, where we used the insights from the Andersons Centre "The effect of the loss of plant protection products on UK agriculture and horticulture in the wider economy"*

4 *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*


3

3. EU-level impact

This section analyses the effects of removing the 75 crop protection substances for the staple crops covered in the study on EU level.

EU FARM-LEVEL INCOME EFFECTS

EU-level results are based on weighted averages of the national figures. Exhibit 5 on page 22-23 depicts the countries for which national information on staple crops was available.

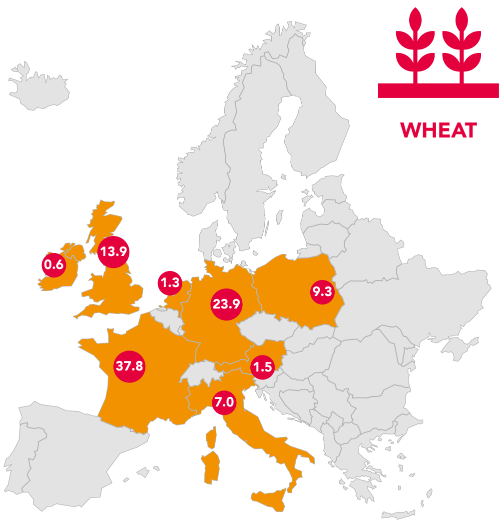
The farm-level data for wheat, barley, oilseed rape (also OSR hereafter), potatoes, sugar beets and maize cover between 50% and 80% of the total EU production of each particular crop. The higher the percentage of output covered on a country-by-country level, the more likely it is that the extrapolation will be representative of the EU as a whole. (For details on extrapolation, please refer to the appendix.) Table 2 below summarizes total crop production as well as how much land is cultivated in EU28 for an average year.[1] This official information forms the basis for our comparison.

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

Crop	Area (million ha)	Yield (t/ha)	Output (million tons =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
GRAPES	3.2	7.1	23.1	721

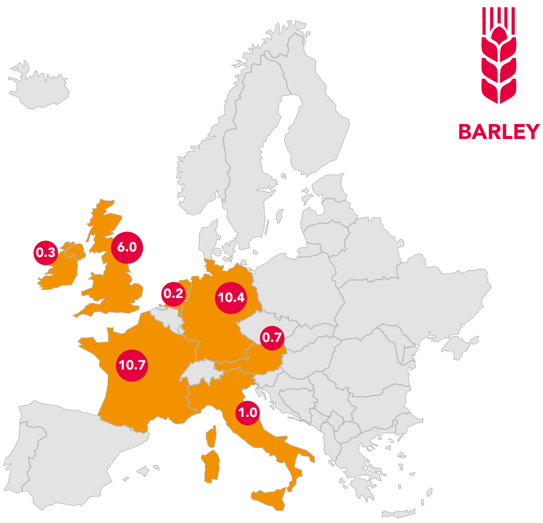
1 *Based on EUROSTAT farm statistics 2009-2013*
2 *Average prices for EU in a five year period*

__Exhibit 5__: EU crop production basis for extrapolation (in million ton)



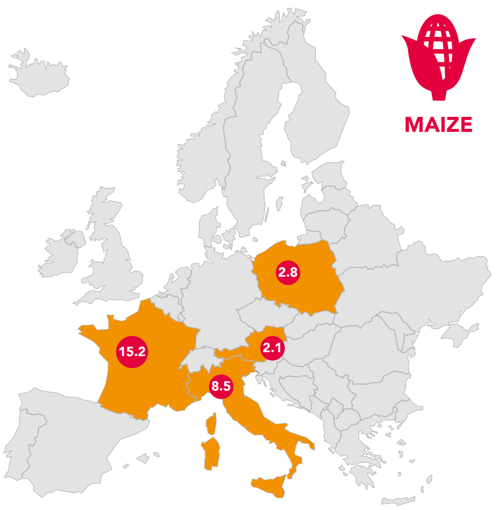
Total EU production = 137mt

Basis for extrapolation = 70%



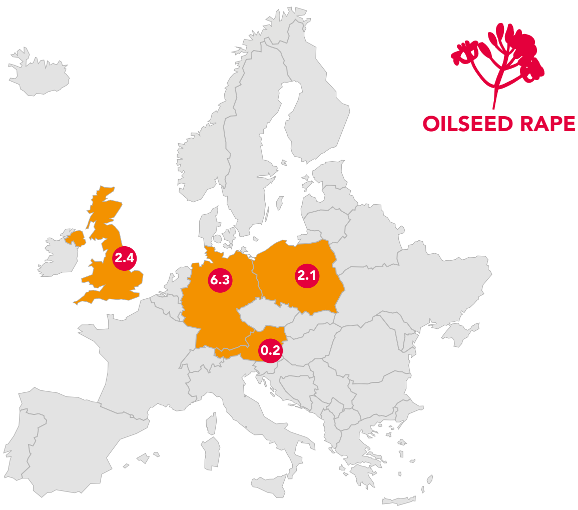
Total EU production = 55mt

Basis for extrapolation = 53%



Total EU production = 62mt

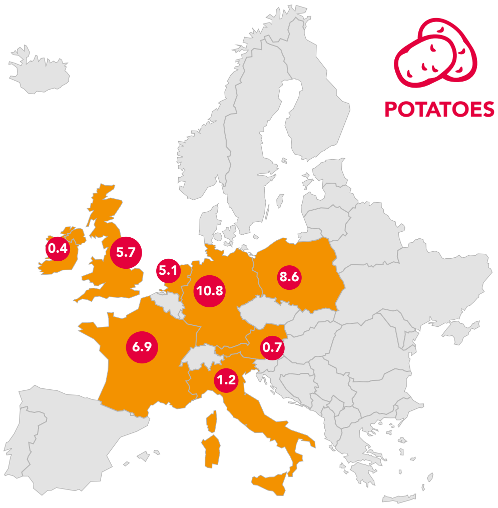
Basis for extrapolation = 47%



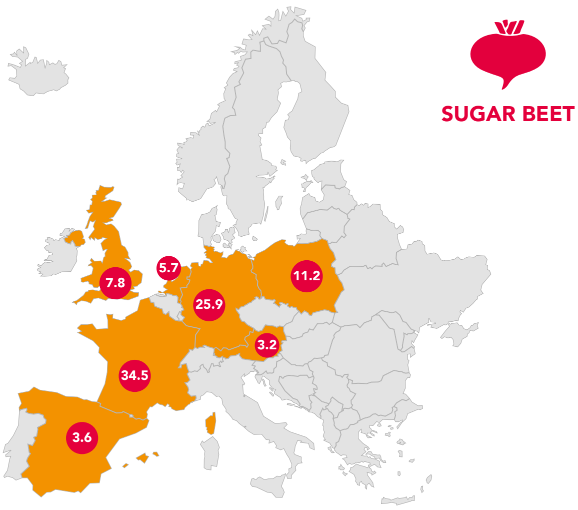
Total EU production = 21mt

Basis for extrapolation = 52%

Table 3: Overview short-term yield effect per country/staple crop provides an overview of the immediate variations in tons harvested per hectare. The potential yield effects in this table represent the lowest value in the ranges we received from the experts (see also Section 2). These changes are then compared to results achieved with the best remaining alternative substances and/or methods for the main European staple crops. You may notice that, for some crops, the UK yield effects are lower than in other countries. The lower figures are because we drew on The Andersons Centre's study for the UK data. While we used the same substance list as found in that study, the Andersons Centre focused solely on substances with high risk of becoming unavailable (i.e. 40 instead of 75). Furthermore, in some individual cases, the estimates represent only a selection of at-risk substances (due to limited data availability), explaining the lower values in for example OSR in France and maize in Germany. Regarding the Polish figures, the estimates of wheat and maize are lower compared to the other countries. This is, because we received large ranges of potential yield effects; whereas, the ranges for these crops are well in line with the other countries.



Total EU production = 59mt   Basis for extrapolation = 67%



Total EU production = 114mt   Basis for extrapolation = 81%

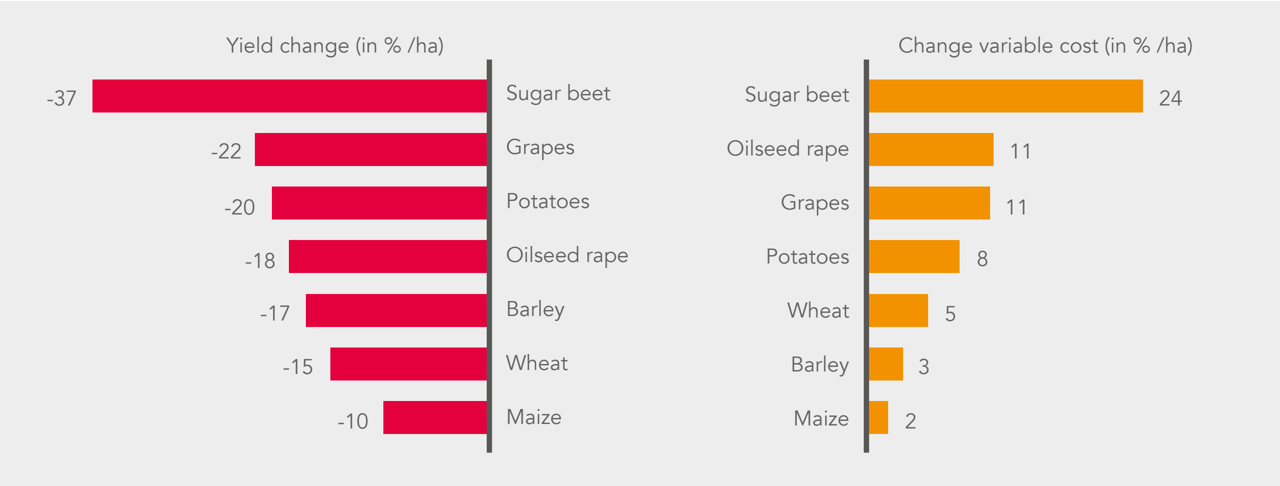
We analysed the added value of the 75 substances for all crops and countries within the scope of this study following the approach discussed above. Exhibit 6: Yield and variable cost changes (in %/ha) presents the results for farmers in the EU. All details for crops/countries can be found in the appendix.

***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%	X	-5%	X	-14%	X	-10%	X
OSR	-18%	-5%[1]	-17%	-18%	-20%	X	X	X	-25%	X
POTATOES	-20%	-10%	-29%[2]	-12%	-20%	X	-40%	-15%	-25%	-25%
SUGAR BEET	-37%	-35%	-49%	-12%	-30%	-44%	X	-36%	-35%	X
GRAPES	-22%	-22%	X	X	X	-13%	-30%	X	-20%	X

1 *Note that the yield effect refers to banning NNIs only*
2 *Given data availability, as compared to an untreated situation.*

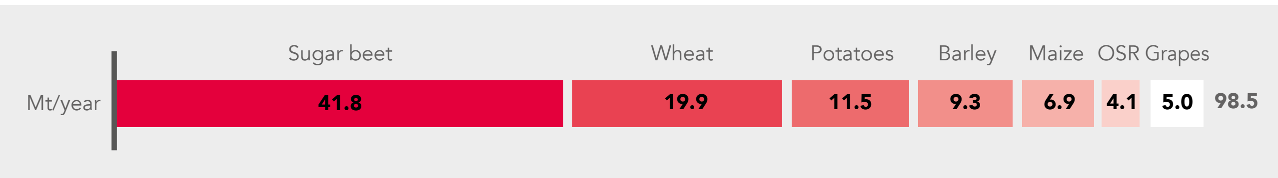
***Exhibit 6**: Yield and variable cost changes (in %/ha)*



Depending on the crop, the utilisation of the 75 substances allows EU farmers to harvest 10% to 40% more tons per hectare than without them. With these 75 debated substances, weed, disease and pest pressure on the crops is lower, allowing the crops to grow larger. At the same time, variable costs are 25% lower with the utilisation of the 75 substances. When also factoring in gthe long-term resistance effects (not shown in Exhibit 6), the contribution of the 75 substances is even higher. Depending on the number of alternative treatments still available as well as their level of effectiveness, pests could potentially become immune to treatment with alternatives.

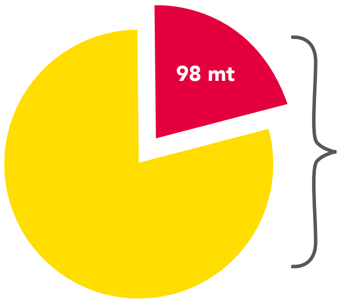
According to national farm experts for cereals, this long-term effect is estimated to add an additional 5% of yield change. For sugar beets, potatoes and grapes, the 75 substances positively affect the size of the yield by about 20% (for full reference of farm experts refer to the appendix). The other consequence of changes in the farming toolbox concerns variable production costs. The 75 substances reduce variable production costs through their superior effectiveness. For most staple crops, the influence is lower, adding less than 10% additional variable costs; however, for sugar beet production, costs can increase by approximately 25% per hectare.

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



In total, EU crop output is currently 98 million tons (=Mt) more than would be possible without the use of the 75 substances. In other words, having the 75 substances in the farming toolbox equates to 98 million tons additional crop output, 42 million tons of which are sugar beets. 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 seven key crops out of a total 471 million tons.

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



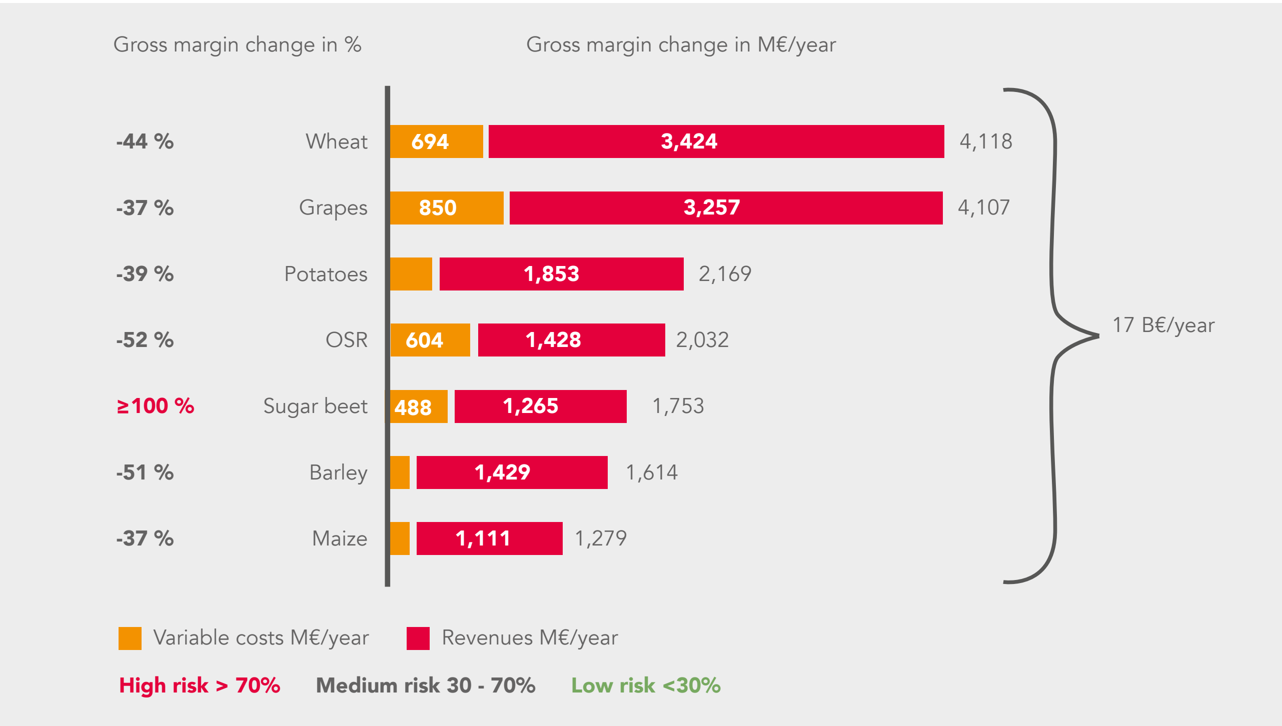
Applying the short-term yield and cost changes discussed above to the current situation provides insights into the changes in terms of the gross margin of EU farmers.

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

To elaborate on the farm income results above, farmers put a great deal of effort into stabilising their yields and anticipating price changes.

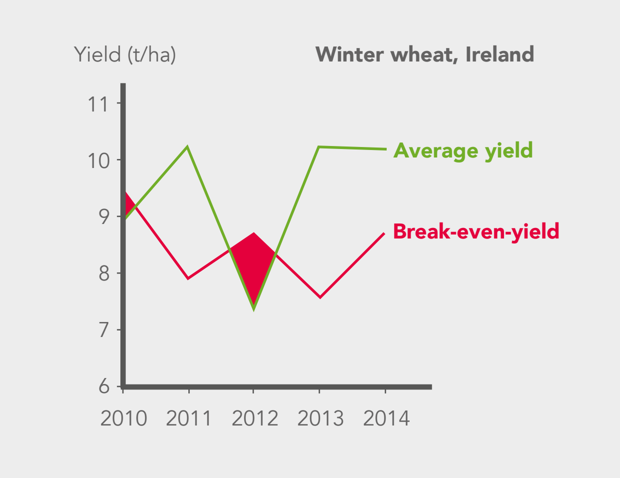
However, incomes are subject to fluctuation. Pest pressure, for instance, has a significant impact on annual yields. Its degree and variation is largely influenced by weather conditions and can therefore vary widely per year. Changing climate conditions also add to the extent and variation of effects.

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



The current crop protection toolbox helps farmers react quickly and effectively to upcoming pests and keep yield volatility under 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, an Irish public agricultural research authority, illustrates that not only does the average yield vary each year, but also the break-even yield. This fluctuation is in addition to farm input costs, for which its use depend 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*[1]



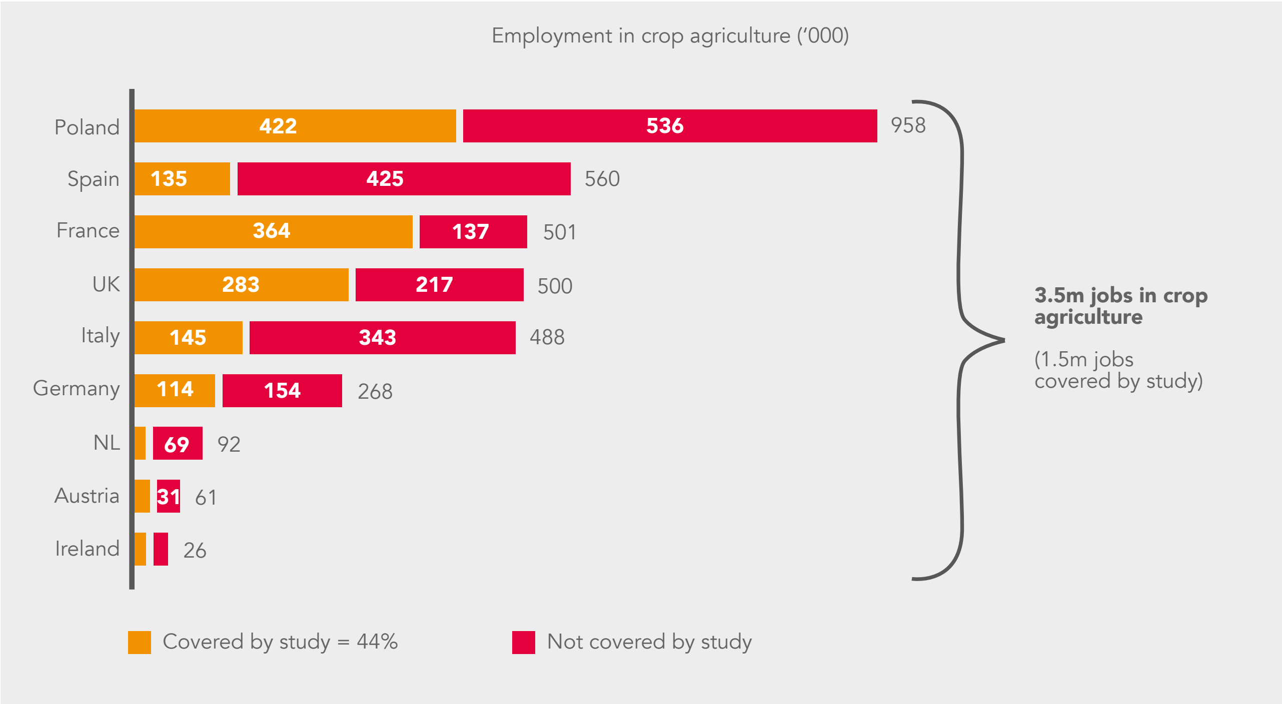
EU FARM-LEVEL EMPLOYMENT EFFECTS

According to official statistics for the nine countries selected, 3.5 million jobs rely on crop agriculture.[2] Allocating these 3.5 million jobs to the various crops based on the value of the crops reveals that 1.5m jobs are contingent upon the seven staple and 24 specialty crops in the scope of this study (see Exhibit 11).

1 *Crop Production in Ireland and impacts of Regulation 1107/2009, Teagasc 2015*

2 *Source: EUROSTAT, Agrimatie Wagenging University*

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 job security 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 in the nine countries covered by the study, the exhibit consequently provides an overview of the contribution of the 75 substances of job security. There are three distinct risk categories: low, medium, and high1 depending on the crop's gross margin variation. The results show that 45% of crop agriculture employment - around 670,000 jobs - are at high or medium risk of being lost. Of the 1.5m jobs referred to in this study, 313,000 (17%) have a high risk of job loss. Most high-risk jobs are at German and Spanish farms. In Spain, this is driven by the high yield losses in tomatoes, citrus, olives and cherries, while the 'thin' margins in Germany for wheat, barley and sugar beets act as proof of the contribution of the 75 active 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 vastly reduced, cultivating barley instead could be profitable.

In this case, jobs related to wheat cultivation may not be affected. However, this would be different for specialty crops where, firstly, switching crop type involves higher costs and, secondly, the alternative crops may be greatly affected by changes in the farming toolbox. To illustrate this point, the alternatives for producing fruit trees, bell peppers and tulip bulbs in the Netherlands require use of similar crop protection toolboxes. Therefore, we expect that producers of these crops have limited ability to move to other crops, further underlining the high risk of job loss.

1 *high=above 70%, medium=30-70%, low=up to 30% gross margin loss*

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

EU SELF-SUFFICIENCY AND TRADE EFFECTS

Given these farm-level changes, the changes to yields and costs described above also affect the competitiveness of EU agriculture and thus 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, *ca.* 13 Mt of wheat, 3 Mt of barley and 1 Mt of potatoes are exported to countries outside of the EU. Banning the 75 substances would lead to a situation in which, instead of exporting, the EU will need to import these crops to satisfy its consumption needs. Because the average yield for wheat would decrease by 14%, the total wheat production would decrease from 137 Mt to 117 Mt. This implies that the EU will have to import 5 Mt to cover the local demand of 123 Mt. For barley and potatoes the trade deficits would be 6 Mt and 10 Mt respectively.

With the 75 active substances still 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 depends on world market availability and transportation which is not straightforward for this crop.

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

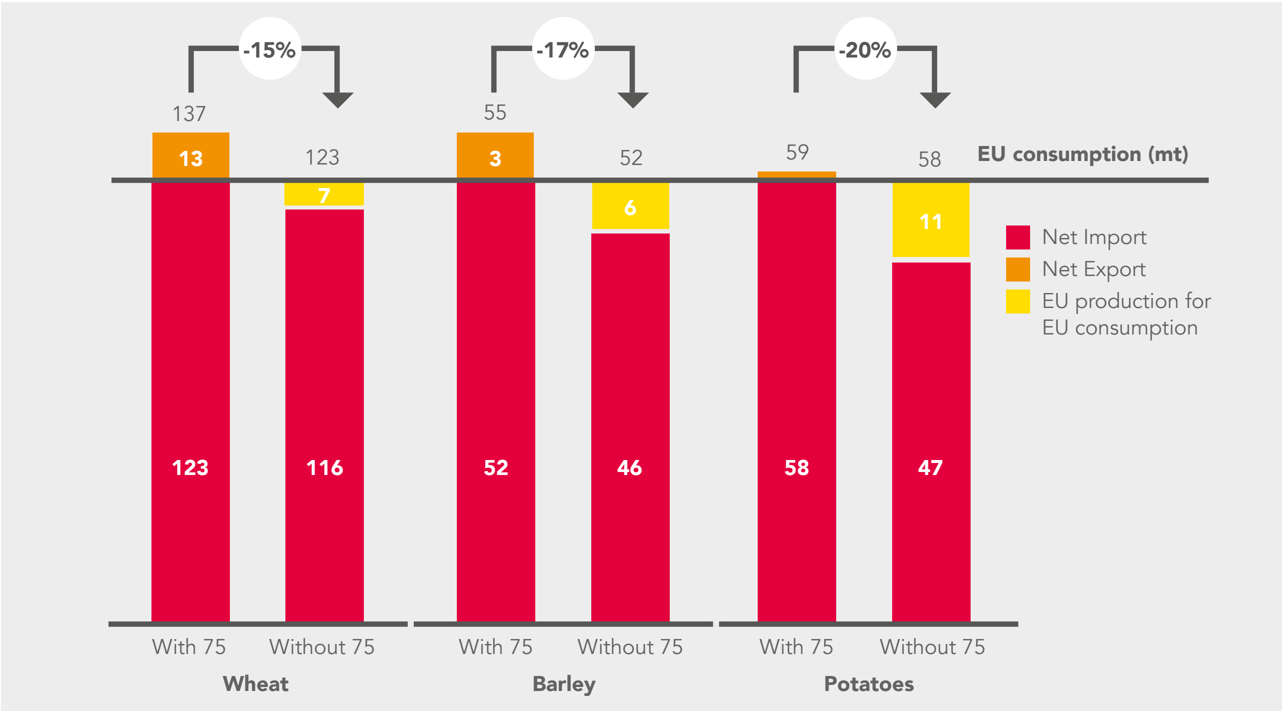
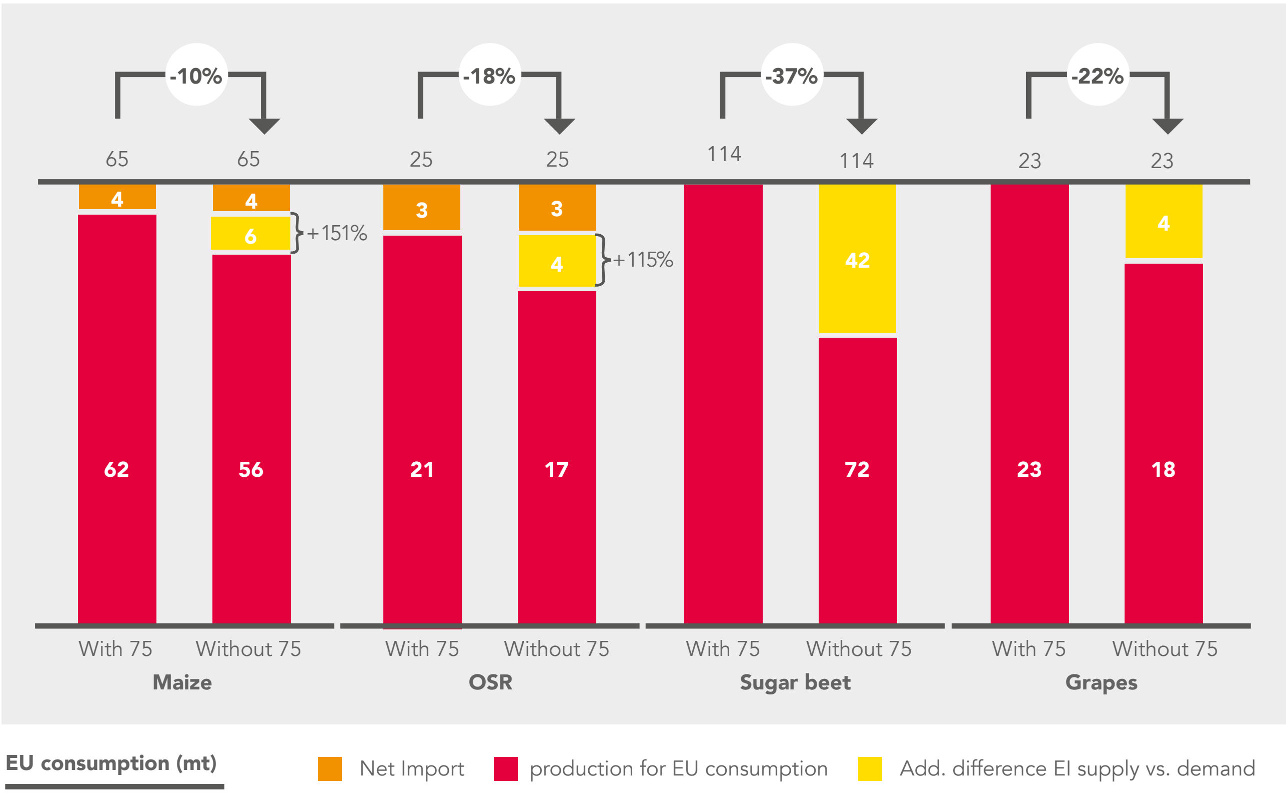


***Exhibit 14**: Trade balance shift for net imported crops (in million tons)*



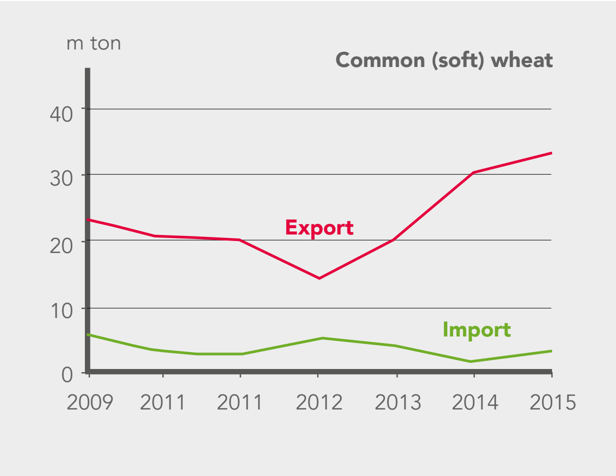
The EU's demand for maize and oilseed rape, even with the 75 substances, is partially fulfilled by imports. Out of the 65 Mt of maize consumed in the EU annually, around 4 Mt are currently imported from outside the EU. Based on the analysis of yield changes, we estimate that this will increase by 6 Mt to a total of 10 Mt to be imported if the 75 substances are banned. This implies that imports will more than double. For oilseed rape, removing the 75 substances from the farming toolbox would lead to an additional consumption gap of 4 Mt, necessitating the difference of 7 Mt to be filled by imports (+115%). The EU is currently self-sufficient for sugar beets and grapes. This will likely change if the 75 substances are no longer permitted, thus requiring the EU to import 42 Mt of sugar beets and 4 Mt grapes from abroad.

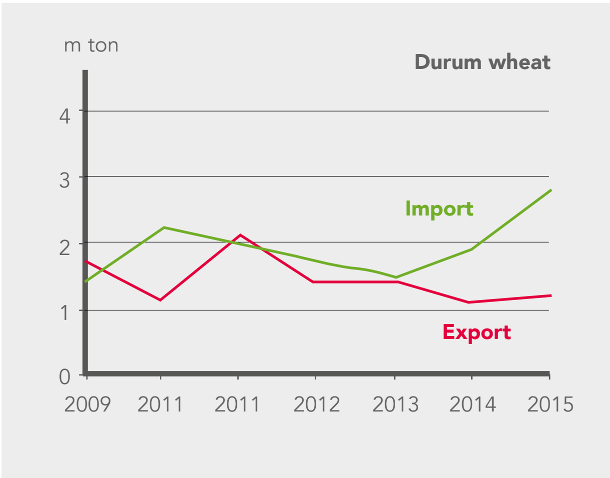
BROADER RIPPLE EFFECTS

Lower production and the trade balance shifts of EU's largest crops presented in Exhibit 13: Trade balance shift for currently net exported crops (Mt) and Exhibit 14: Trade balance shift for net imported crops (in million tons) will affect both EU and worldwide trade of agro-commodities. In turn, these consequences will trickle down the agri-food chain to the consumers. Cereals provide an excellent example for explaining some of the potential broader impacts on Europe.

The crops wheat, barley and maize represent two-thirds of all cereal crops produced and consumed in the EU.[1] Of these, wheat is also EU's largest crop; the EU is also the wheat's largest global producer (20% of total). Therefore, 21 Mt less EU wheat (-15% EU yield) plays a significant role in decreasing global production by 3%. This has implications inside as well as outside the EU.

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





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

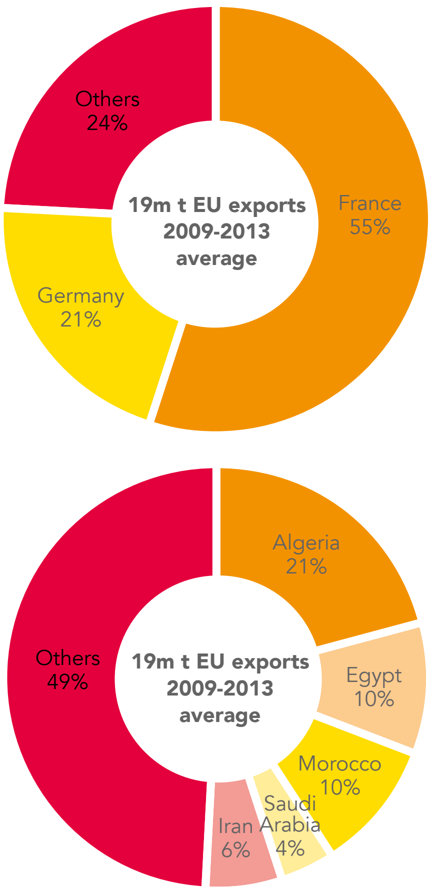
In reality, the export and import situation varies widely per EU country. The two main soft wheat 'surplus countries', Germany and France, represent 76% of all EU wheat exports and supply many other EU countries.[2]

1 *European Commission, EUROSTAT*

2 *DG AGRI, HGCA 2013*

The 75 substances support more than half of France's exports and all exports in Germany.[1] Without these crop protection substances, France will become 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 for the Middle East and Northern Africa (see the exhibit below). These regions could confront higher import prices in case they have to import wheat from other sources.

***Exhibit 16**: Common wheat exports by EU exporting countries (top) and destinations (bottom)*



1 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).

Lower durum wheat production will mostly affect Italy, the EU's main producer and consumer. Currently, the country imports 30% of its durum for producing pasta and other food products, and represent almost all imports of the EU's total durum wheat imports (1.5 Mt, 80% of EU imports).

In the EU, 44% of wheat is used for food products, 41% for feed and the other 15% mostly for industrial purposes.[2] 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[3]. IFPRI, a leading food policy research body, expects that all cereal prices and other major agro-commodities will steadily increase over the next few decades. Any price increase implies an extra increase in addition to those predicted by current trends.

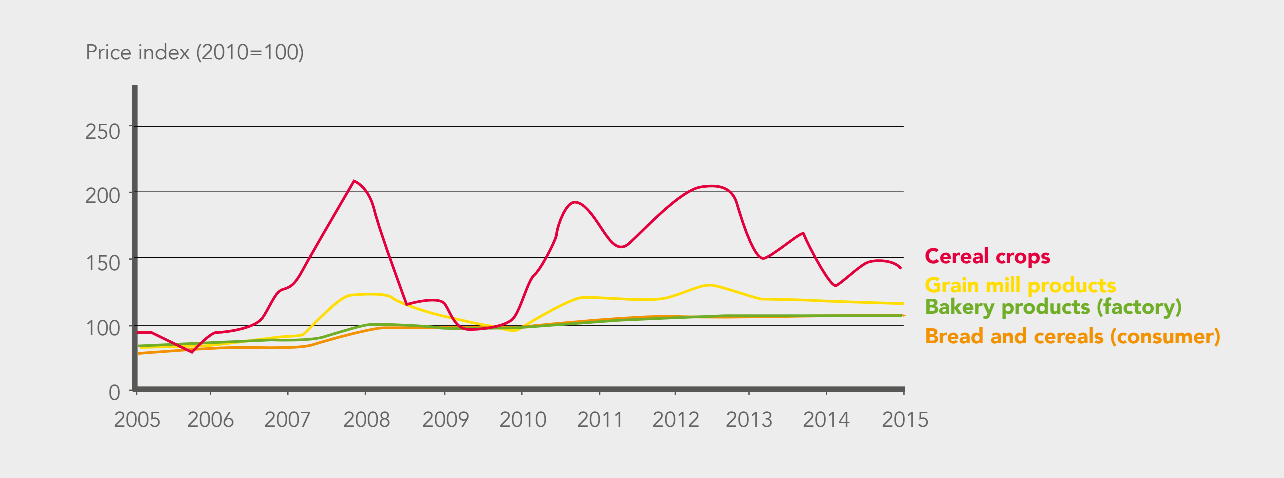
According to EC food price monitoring, prices typically trickle down to consumers. However, the relative share of wheat in cereal-based products is relatively small. For example, wheat price represents about 10-15% of the average bread price for the consumer. In total, every wheat price increase of €10 could potentially increase EU consumer costs for bread by €700 m and leaking out of the European economy.[4]

2 DG AGRI, cereals balance

3 HFFA 2013

4 €10/t wheat price change is ±5% of the wheat price. The wheat price represents 10-15% of the average bread price of €1.50/bread. Therefore, a wheat price increase could add 1cents per 500 grams bread. In total, this sums up to €700m for 38m t bread in Europe (AIBI Bread Market Report 2013, Jan 2015).

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



LAND USE

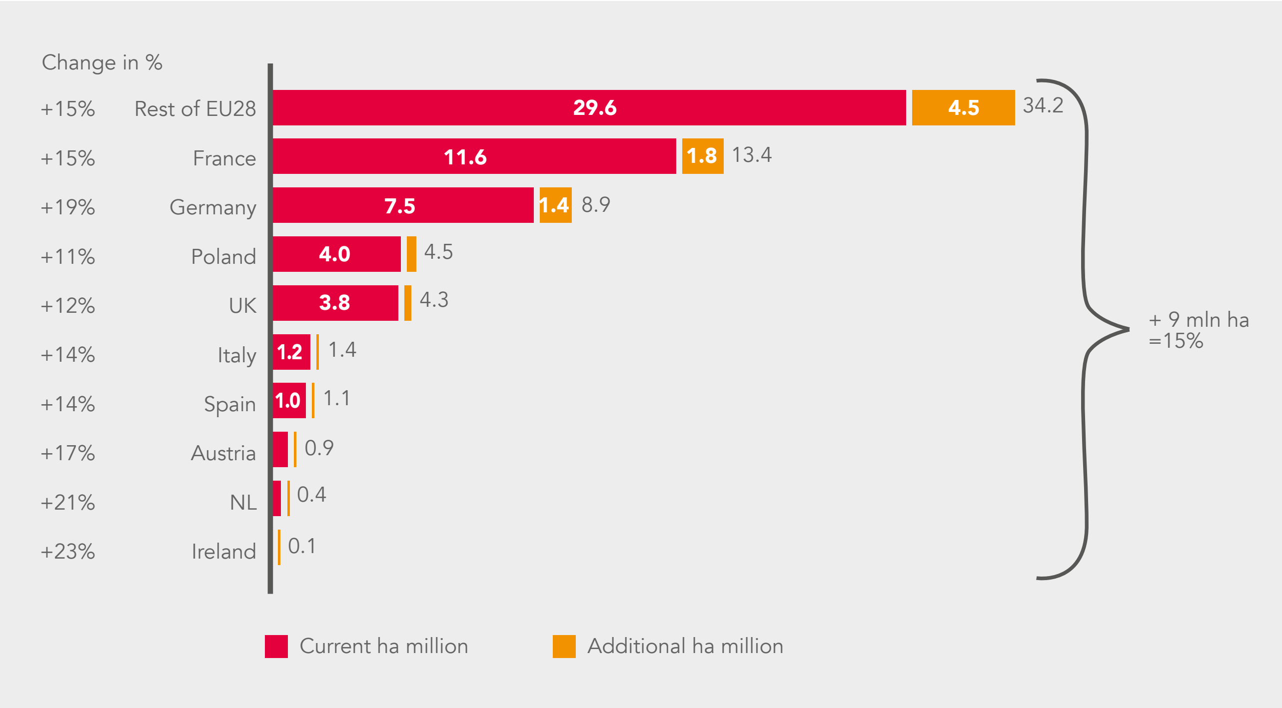
The previous section discussed the implications of keeping the 75 substances available to promote farm income and EU self-sufficiency. This section elaborates on the land use effects.

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.[1] The key staple crops wheat, barley, maize, sugar beets, oil seed rape, potatoes and grapes make up 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 a 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.

1 *EUROSTAT, Agricultural Census 2010*

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



The relative change per country depends amongst others on the staple crops' share of the total agricultural area of a country.

Given the limited availability of farmland in the EU, it is uncertain whether this additional farmland would be on EU territory. In other areas of the world, for instance, farmland is competing against the construction of roads, houses and other urban needs as well as being threatened by erosion.[1] Decreases in productivity per hectare thus add fuel to the competition for land.

It is also important to note that EU's most productive arable land is currently already been exploited. It is thus likely that any additional land will not be as productive without the appropriate technology being available.

CARBON FOOTPRINT

From recent discussions about climate change, the concept of an 'carbon footprint' has been increasingly gaining public attention. In light of this study, the carbon footprint goals of the European Union are supported by the use of pesticides for two reasons: the effect of the 75 substances on land use, and treatment frequencies.

Looking forward, with the 75 substances phased out, there are two possible scenarios to fill any gap between local production and local demand. Firstly, more land within the EU28 could be made available to produce the crop outputs and, secondly, additional amounts 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.

1 *Problems of agriculture – loss of land and decreased varieties*

__Exhibit 19__: Carbon footprint effects related to changes in farming toolbox

If procured from within the EU

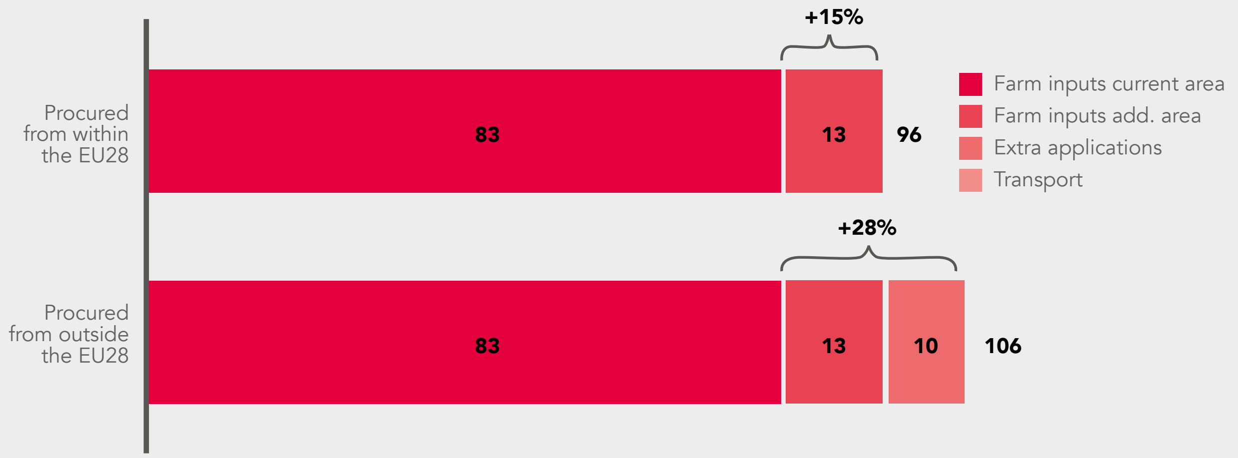
1. Carbon footprint related to **farm inputs**
2. Carbon footprint related to **extra applications**
3. Carbon footprint related to **land use changes**

If procured from outside the EU

1. Carbon footprint related to **farm inputs**
2. Carbon footprint related to **transport**

At present, the cultivation of wheat, barley, maize, oilseed rape, potatoes, sugar beets and grapes in the EU causes the emission of 83 million tons CO_2 equivalent. The two main drivers for this are the use of fertilizers and diesel. 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 substances and is depicted on the left hand side of Exhibit 20 marked as 'current area'.

Exhibit 20: Carbon footprint of EU's seven major staple crops related to changes in toolbox (in million ton CO_2 eq.)



This excludes emissions related to land use changes of 26 million ton CO_2 emissions per year

In the upper scenario in which additional land within the EU is used to compensate for lower yields per hectare the footprint of these seven staple crops could rise by 15% from using a larger area, adding farm inputs, and increasing treatment frequency. These are annual effects. In addition, if extra land has to be converted into an agricultural area, there would be annual emissions of an additional 26 million tons for the next 20 years[1]. The total change in the overall footprint of the seven staple crops would consequently rise by almost half (47%).[2]
The other option to fulfil European crop demand is to import. In the case of import, the emissions of crop output would rise by 28% (*ca.* 23 million tons). We assumed that all crops are to be imported from the US.[3] In terms of yield per hectare and farm inputs used, production for several crops in the US is similar to the EU. The main difference between the footprints of crops produced in the US and EU lies in the emissions related to transport. This might be different for crop imports from other parts of the world (e.g. different fertilizer use and intensity in Brazil). If additional land has to be converted to agricultural areas to fulfil the EU's new demand, total annual emissions of imported crops including emission from land use changes could increase by 59%[4] 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 adds up to around 4,600 million tons CO_2 eq.[5] Agriculture constitutes around 10% or 443 million tons of these emissions, whereas non-livestock agriculture relates to 295 million tons. This study focuses on the key staple crops, accountable for about 30% of all non-livestock agricultural emissions. This corresponds with the share of 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 add up to €500 million[6] 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 major influences at the country level.

1 *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))*
2 *47% = (83+13+26)/83*
3 *Distance of 7.895km with 14g of emissions per km/ton*
4 *47% = (83+13+10+26)/83*
5 *Eurostat Greenhouse gas emission statistics*

6 *€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*

France

FRENCH KEY EFFECTS

With the currently available farming toolbox, French production of the **seven staple crops**[1] is **23Mt higher** and generates **€5 billion more value** per year than if the 75 at-risk substances were not included.
In addition, without the 75 substances, **economic viability** of **specialty crops**,[2] would be challenged: **2Mt** of output and **€1 billion** would be at stake.
Further results include:

- In the short run, wheat, barley, maize, potatoes and grapes would face 10-20% lower yields, while the yield of sugar beets would decrease 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 would increase by up to 50%.
- In value, grapes would be most affected with €2b of value loss, while sugar beets would show the largest decrease in profitability (-60%) of the staple crops;
- French crop agriculture provides 500,000 direct jobs, of which 364,000 depend on the crops covered by the study.

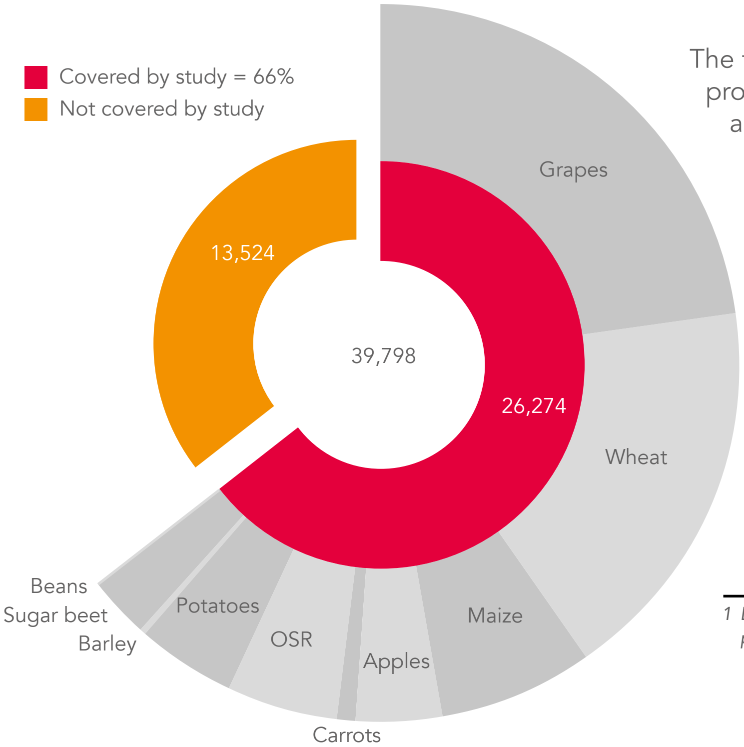
1 *Wheat, barley, potatoes, maize, rapeseed, sugar beets and grapes*
2 *Beans, apples and carrots*

AGRICULTURE IN FRANCE

Indicating the relative importance of the agricultural sector in France, agriculture makes up 1.7% of the French GDP, and approximately 3% of the total employment is in this 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. A total of 50% of 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 total cow milk collected in the EU, and 12% of total meat produced (20% for cattle, 12% for sheep and goats and 9% for pigs).[3]

3 *INRA Science and Impact, Agriculture in France*

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



The total average annual French agricultural production value[1] of the last five years was amounted to around €40 billion. The study focusses on the staple crops wheat, barley, grain maize, oilseed rape, potatoes, sugar beets and grapes. 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 73% (28.990/39.798) of the total French agricultural production value.

1 *Eurostat; Economic accounts for agriculture - values at current prices*

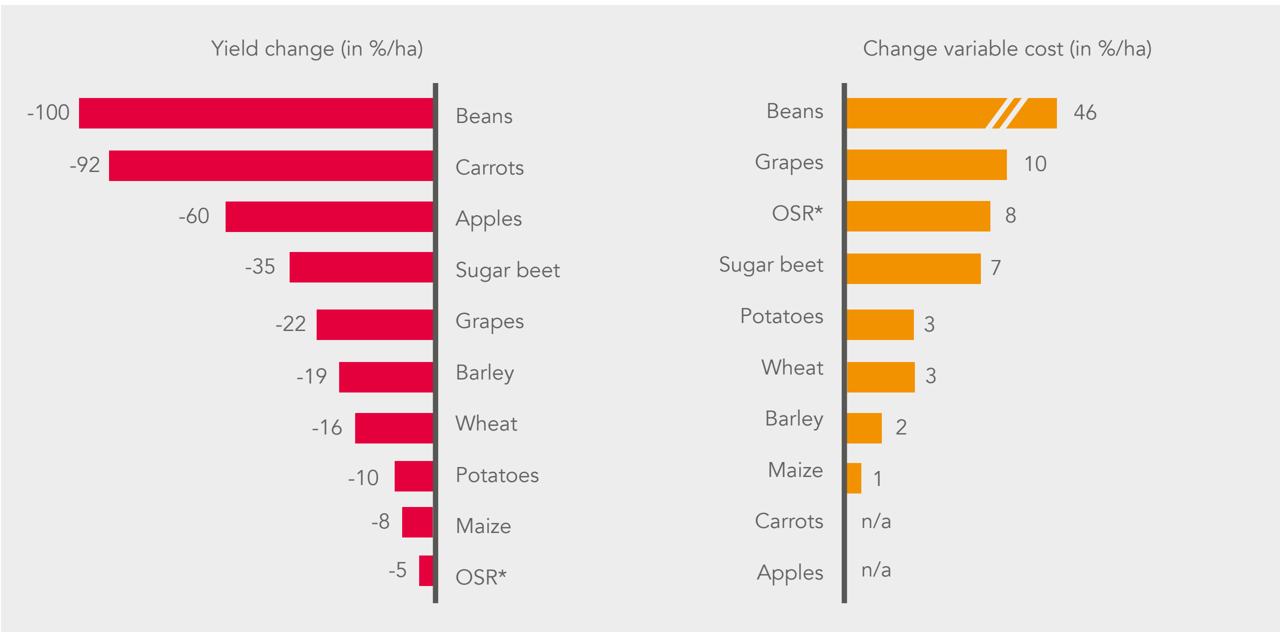
***Table 4**: Overview French crops*[1]

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
GRAPES	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

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.

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



1 *Eurostat; Farm statistics, average 2009-2013*

Of the staple crops, the 75 substances allow farmers to harvest 10-35% more tons per hectare than without the substances. With the 75 active substances, the 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: about 17%, 15%, and 8% per hectare, respectively, of additional yield related to using the 75 substances. For oilseed rape, as a consequence of data availability, only the added value of neonicotinoids has been taken into account (5% yield benefit).

Over the longer term, the 75 substances would have an additional value as they help deflect resistance effects. The risk of emerging resistance effects varies per threat: resistance around fungal diseases mainly affects cereals and potatoes, whereas weed resistance mainly affects cereals and sorghum. For cereals the additional long-term yield effect adds up to 3%, for potatoes 5%, for sugar beets 10%. For grapes the total short and long-term value of the 75 substances is up to 50%. The other potential change is the impact on variable costs. The 75 substances reduce the variable production costs with their improved effectiveness. For most staple crops, the effectiveness adds less than 10% additional variable costs; however, for specialty crops, these costs can increase up to 50%. Fewer pesticides are applied less frequently. In other words, when the farming toolbox is less well equipped, treatment frequency will increase (+ 0.15 treatment/ha on maize, to + 0.85 treatment/ha on barley on average).

For potatoes, experts also expect a strong impact on crop quality, possibly affecting the farm-gate price and what farmers earn. In some cases, lack of active substances can cause extensive damage, thereby preventing the sale of potatoes to a large extent.

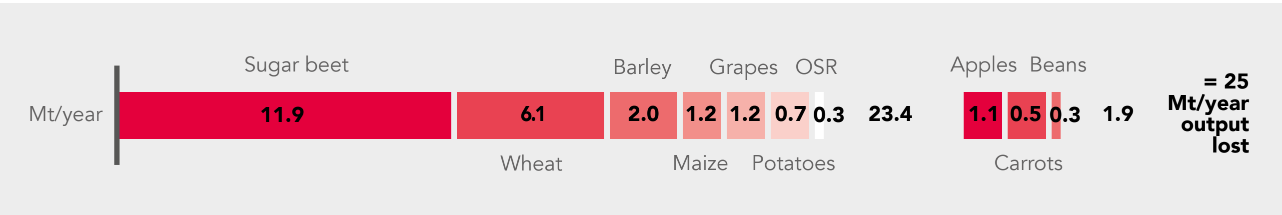
The size of the farming toolbox is not only important for crop cultivation but also for seed production. For the toolbox of seed producers, the new EU legislations could potentially cause a reduction from 77 to 51 active substances, corresponding to a reduction of 717 to 263 products available for use.[1] These changes will likely influence the quality of the seeds produced, causing ripple effects over to industries since seed quality plays a role in crop protection from the beginning of the cultivation cycle. To illustrate, a 2011 study by the Fédération Nationale des Agriculteurs Multiplicateurs de Semences (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).

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 higher for specialty crops.

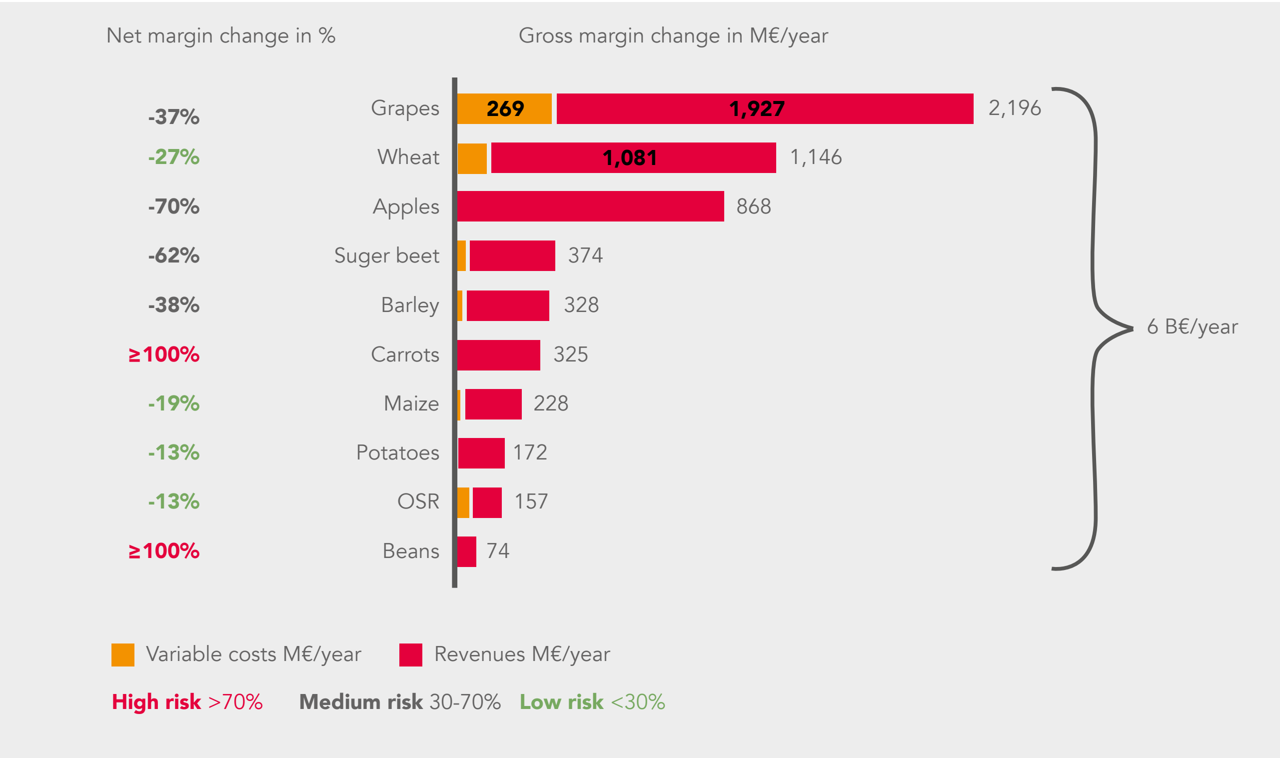
1 *FNAMS*

***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 that the 75 substances add to sugar beet cultivation (35% extra yield) as well as the comparatively large area where sugar beets are cultivated in France (387.000 ha).
Depending on farm-gate prices and the changes in variable costs, the gross margins earned on cultivating these crops would also greatly be affected.

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



As shown, French farmers earn a total of €6 billion gross margins per year as a result of the benefits of the 75 substances. The total change between the two scenarios is mainly driven by revenue losses (€5.4 billion) and, to a lesser extent, variable costs (€0.5 billion). Gross margin gains in grapes and wheat make up the majority of the overall effect. In value, grapes would be most affected by a decrease of the farming toolbox 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 estimated 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 previously noted, however, this is because crop rotation effects are not taken into consideration.
As gross margins for cultivating specialty crops like beans, carrots and apples begin to decrease, their economic viability also decreases, thereby creating conditions that encourage farmers to stop producing these crops in France.
Please refer to the chapter on the EU for effects on jobs, land use and carbon footprint.


05

Germany

GERMAN KEY EFFECTS

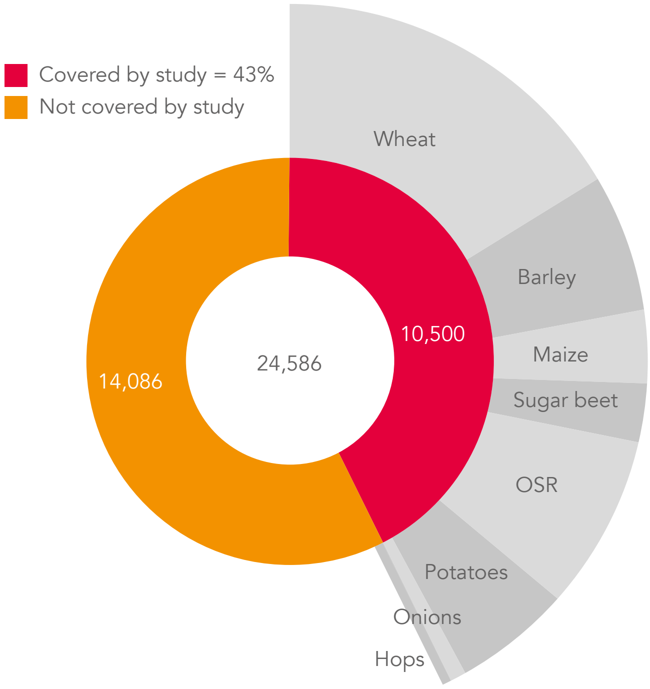
At present, German production of **five key staple crops**[1] is **23 Mt higher** and generates **€2.4 billion more value** per year than if the 75 active substances were removed from the toolbox.
In addition, the **economic viability** of the production of **specialty crops**,[2] equal to **34,000 tons** of output and **€63 million**, would be threatened without the 75 substances.
Further impacts include:

- The economic viability of the staple as well as specialty crops would, without the 75 substances, be put under pressure;
- Wheat, barley, maize and potatoes would face 20-30% lower yields, while the yield of sugar beets would drop by almost 50%;
- Variable production costs for the staple crops would increase by about 5% per hectare; for sugar beets and onions by approximately 30%;
- The 75 substances add significantly more value to specialty crops;
- Wheat would be the crop most affected by removeal of the substances with €0.7bn of value loss;
- German crop agriculture employs 268,000 direct jobs, of which 114,000 rely on the crops covered by the study.

AGRICULTURE IN GERMANY

Indicating the relative importance of the agricultural sector in Germany, agriculture makes up 0.8% of the German GDP and 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. Grain cultivation takes up most of the arable land, with 59% of the total crop growing area making it the most important crop category. German agriculture has achieved a massive increase in productivity over the last couple of decades, a fact 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).

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



The total average annual German agricultural production value[3] of the last five years was *ca.* €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 43% (10,500/24,586) of the total German agricultural production value.

1 *Wheat, barley, maize, OSR, potatoes and sugar beet*
2 *Onions, hops*

3 *Eurostat; Economic accounts for agriculture - values at current prices*

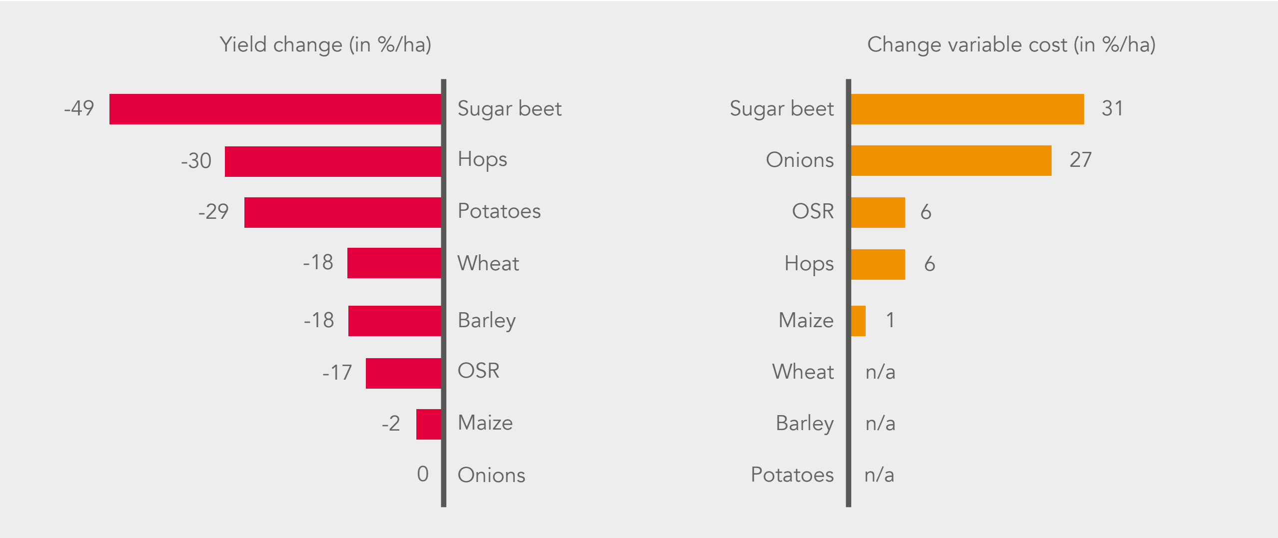
***Table 5**: Overview German crops*[1]

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

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 potentially removing the 75 substances.

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



1 Eurostat; Farm statistics, average 2009-2013

Of the staple crops, sugar beets benefit the most from the 75 substances, allowing farmers to harvest 49% more tons per hectare than without the substances. The other staple crops benefit from the substances with 15-30% higher yield.[1] Weed, disease and pest pressure on the crops is lower with application of active substances, allowing the crops to grow larger. The value the 75 substances add is especially high in cases where 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.[2]

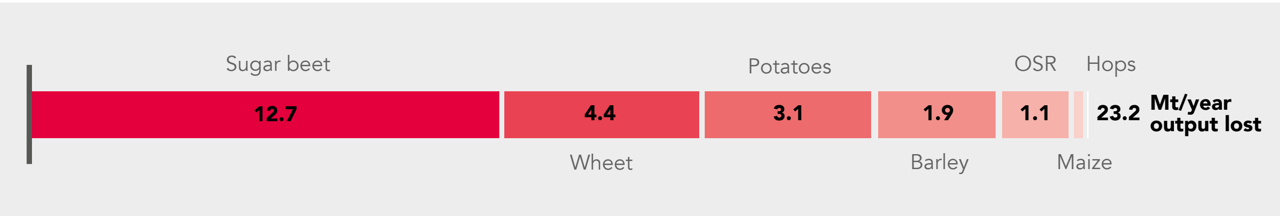
For the longer term, the 75 substances have an additional value as they support the avoidance of resistance effects. Consequently, the additional long-term yield effect sums to totals 25% for sugar beets and 20% for hops.

The other implication is related to changes of variable production costs. The 75 substances reduce the variable production costs by improved effectiveness. This is mainly relevant for the cultivation of sugar beets (cost difference of 31%). For onions, banning the 75 substances would result in higher variable costs of +27% to keep the yield per hectare at its current level, due to fewer pesticides being applied less frequently. Put differently, the treatment frequency will increase should the farming toolbox be reduced.

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 23 Mt higher. In addition, 10,000 tons more tons of hops out of the current 34,000 tons can be produced with the substances.

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



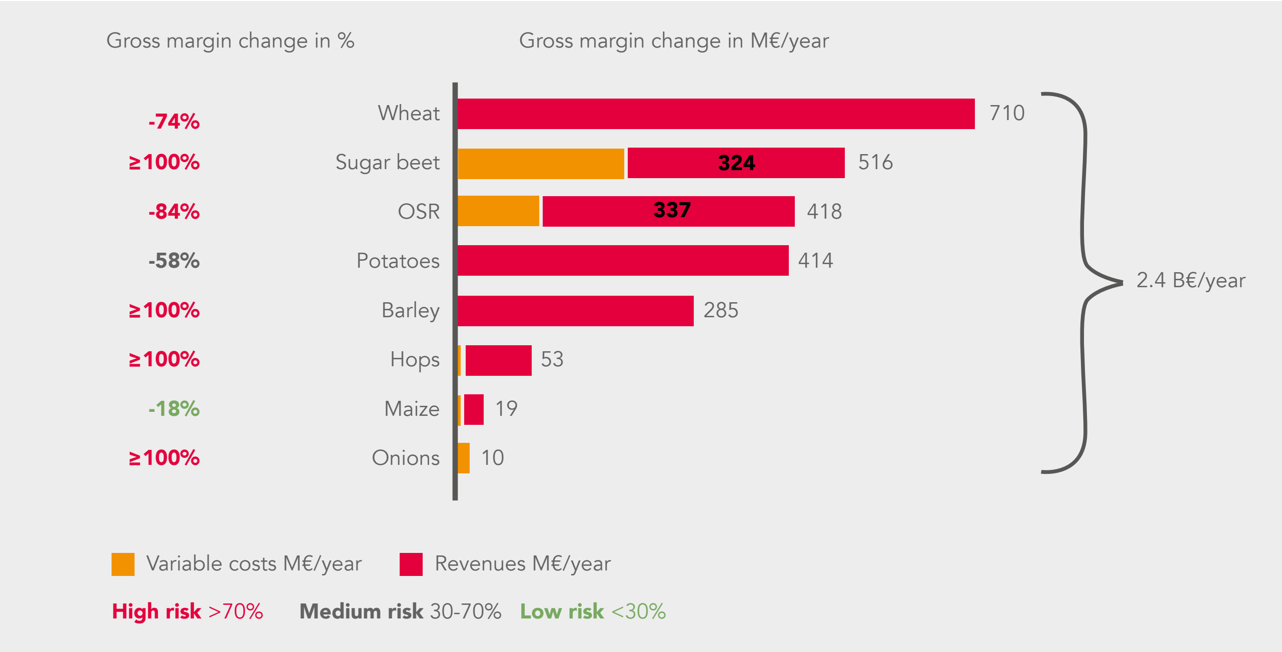
Compared to other crops, the 75 substances have the largest influence on the amount of sugar beets produced in German (13 Mt/year). This is mainly driven by the relatively large value the 75 substances add to sugar beet cultivation (49% extra yield), farmers harvest almost twice as much with the support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

Depending on farm-gate prices and the changes in variable costs, the gross margins earned on cultivating these crops are aslo affected.

1 for maize, as a consequence of data availability, only the added value of neonicotinoids has been taken into account (2% yield benefit)

2 Industrieverband Agrar (IVA), 'Pflanzen ohne Schutz- Droht der Wirkstoffkahlschlag aus Brüssel?', 2015

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



As shown, German farmers earn €2.4 billion gross margins per year due to increased yields enabled by the 75 substances. The total change between the two scenarios is mainly driven by revenue losses (€2.1 billion) and, to a lesser extent, variable costs (€0.3 billion). Gross margin gains in wheat and sugar beets make up the majority of the losses. Wheat would suffer a loss of €0.7 billion since it is, on average, cultivated on the largest area. For sugar beets the yield change would even be larger; however, the sugar beet crop is a somewhat less significant crop in Germany.

For specialty crops, the situation is as follows: as the gross margins earned on cultivating onions decreases, the economic viability of their cultivation is significantly reduced. The two most effective products to prevent fungal diseases like downy mildew would no longer be permitted. This bears the risk of the emergence of resistance effects and, depending on weather conditions, it could lead to total failure of the harvest. Production costs are also affected: for pre-emergence weed treatment in onions there is currently only one herbicide available. However, since it is based on pendimethalin, the product will likely be discontinued. An alternative mechanical treatment in an extensive crop like onion is a significant cost factor. Consequently, there is the chance that onion cultivation in Germany will have to cease.

Please, refer to the EU chapter for effects on jobs, land use and carbon footprint.


06

UK

BRITISH KEY EFFECTS

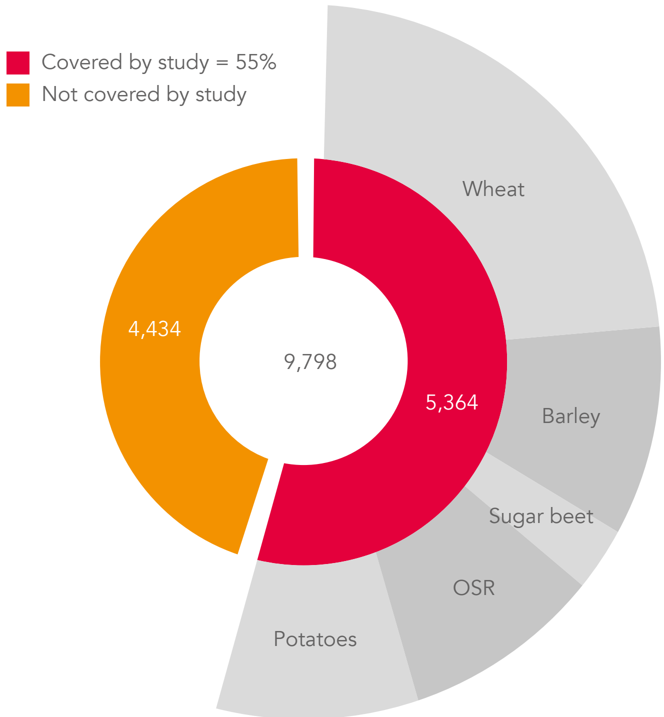
For the UK, the results represent only the loss of the 40 substances at high risk (i.e. excluding medium risk) and are based on the Andersons Centre' study. The British production of **five key staple crops**[1] is currently **4 Mt higher** and generates **€1.1 billion more value** per year than if the 40 substances were removed from the farming toolbox.
In addition, the **economic viability** of the production of **specialty crops**[2] such as peas would be challenged.
Further impacts include:

- Wheat, barley, sugar beets, potatoes and oilseed rape would face 10-20% lower yields;
- Variable production costs for the staple crops would increase by about 15% per hectare;
- Specialty crop peas would be affected to a similar extent;
- Wheat would be most affected with €0.4bn of value loss;
- British crop agriculture provides 500,000 fulltime jobs of which 283,000 rely on the crops discussed in this study.

AGRICULTURE IN THE UK

Agriculture makes up 0.6% of the UK's GDP; 1% of total employment is in the agriculture sector. As of June 2014, the Utilised Agricultural Area (UAA) was 17.2 million hectares, making up 71% of 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. Of the arable area, 51% 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.[3]

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



The total average annual UK agricultural production value[4] of the last five years was approximately €9.8 billion. The study focusses on the staple crops wheat, barley, oilseed rape, potatoes and sugar beets. In addition, peas as a specialty crop 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 55% (5,364/9,798) of the total UK agricultural production value.

1 *Wheat, barley, OSR, potatoes and sugar beet*
2 *For the UK peas are included as specialty crop*
3 *Department for Environment, food and rural affairs, Agriculture in the United Kingdom 2014*

4 *Eurostat; Economic accounts for agriculture - values at current prices*

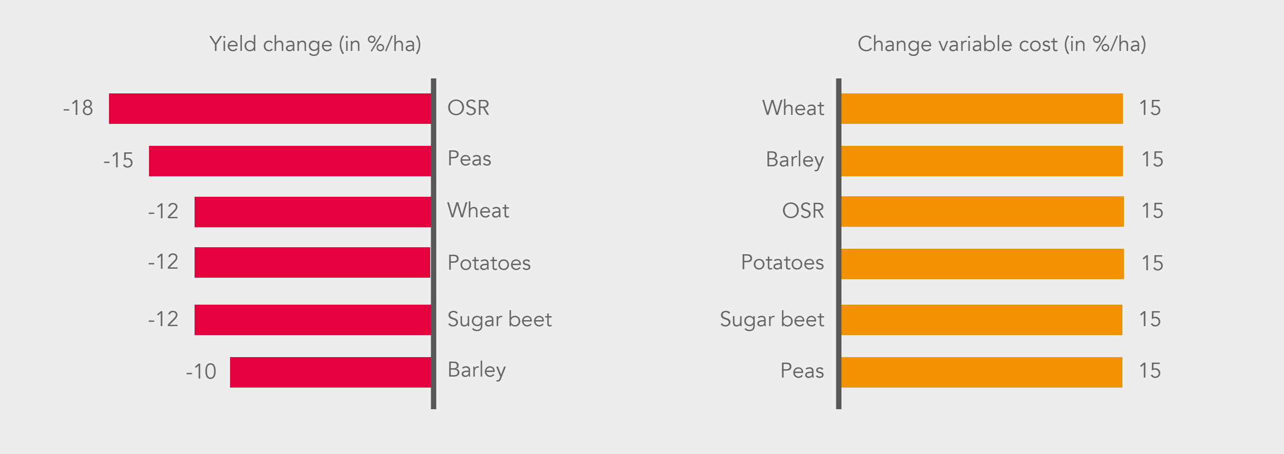
__Table 6__: Overview UK crops[1]

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

EFFECT OF 75 SUBSTANCES ON YIELD AND VARIABLE COSTS

Exhibit 30 provides an overview of the added value to the cultivation of staple and specialty crops in the UK of the 40 substances at high risk of discontinuation. While for the other countries in the scope of this analysis estimates are for substances both at high and medium risk, for the UK, only high-risk are examined, because the data from the Andersons Centre, which focused on this group of substances, is the basis for the UK estimations. On the other hand, some UK specific substances[2] have been included as well.

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



1 *Furostat; Farm statistics; average 2009-2013*

2 *Including chlorpyrifos, cypermethrin, permethrin, chlorothalonil, 2,4-D, bentazone, bifenox, MCPA, mecoprop, metazachlor, propyzamide and metaldehyde*

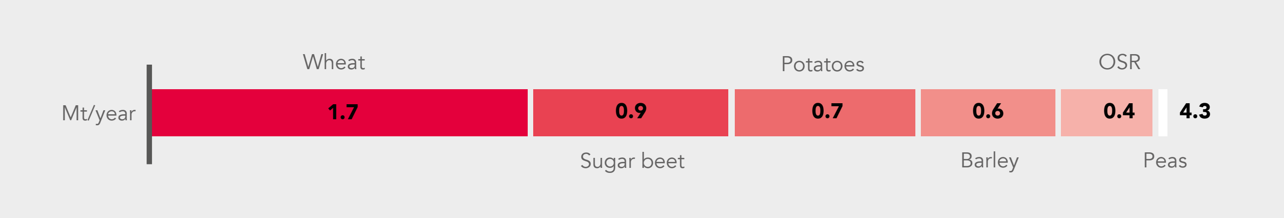
Of the staple crops, the 40 substances add relatively the most value to the oilseed rape production, allowing farmers to harvest about 18% more tons per hectare than without them. The other staple crops benefit from the substances with 10-15% higher yields. These yield changes represent the average yield loss for the entire area of the crop taking into account multiple pest pressure. Weed, disease and pest pressure on the crops are alleviated by crop protection substances and the crops are thus more abundant.

The other implication is related to changes of variable production costs. The 40 substances reduce the variable production costs with improved effectiveness. This is equally relevant for the cultivation of all staple crops and peas, where costs rise by 15%.[1] The cost 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. The treatment frequency will increase in case the farming toolbox is reduced.

EFFECTS ON INCOMES

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

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

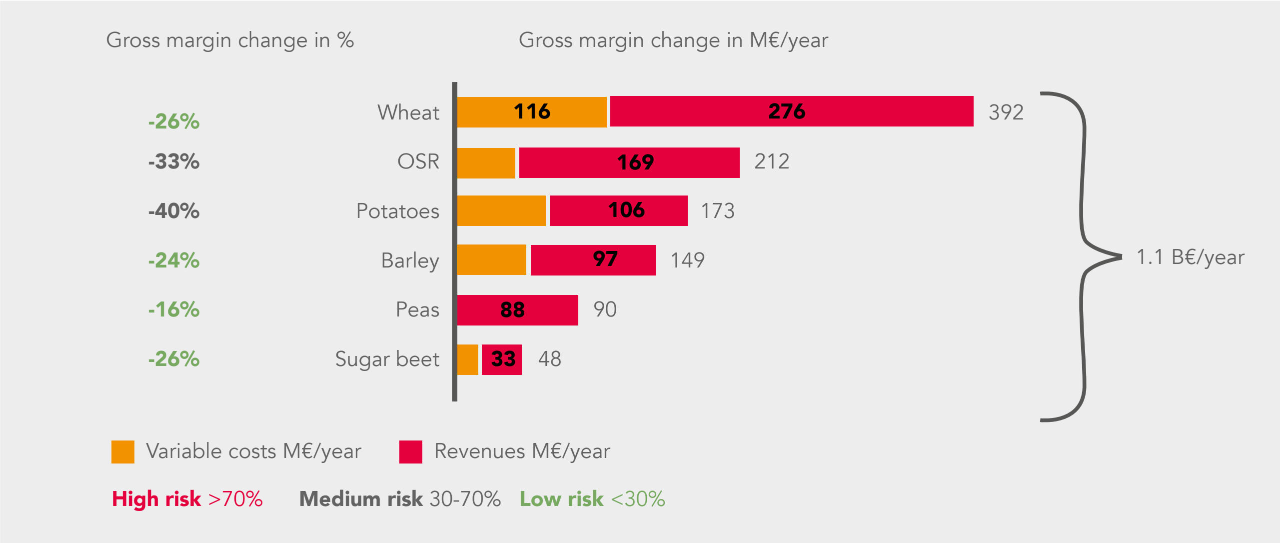


Compared to other crops, the 40 substances have relatively the largest influence on the amount of wheat produced in the UK (2 Mt/year), mainly because of the large area for wheat cultivation in the UK in combination with yield effect.

Depending on farm-gate prices and the changes in variable costs, the gross margins earned through cultivating these crops will also be affected.

1 *The Andersons Centre; '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, UK farmers earn €1.1 billion gross margins per year as a direct result of the 40 at-risk substances. The total change between the two scenarios (with or without the active substances) is mainly driven by revenue losses (€770 million) and, to a lesser extent, variable costs (€295 million). Wheat would be most affected from a decrease of the farming toolbox with €392 million of income loss to the farmer, because wheat is on average cultivated on by far the largest area. Please, refer to the EU chapter for effects on jobs, land use and carbon footprint.

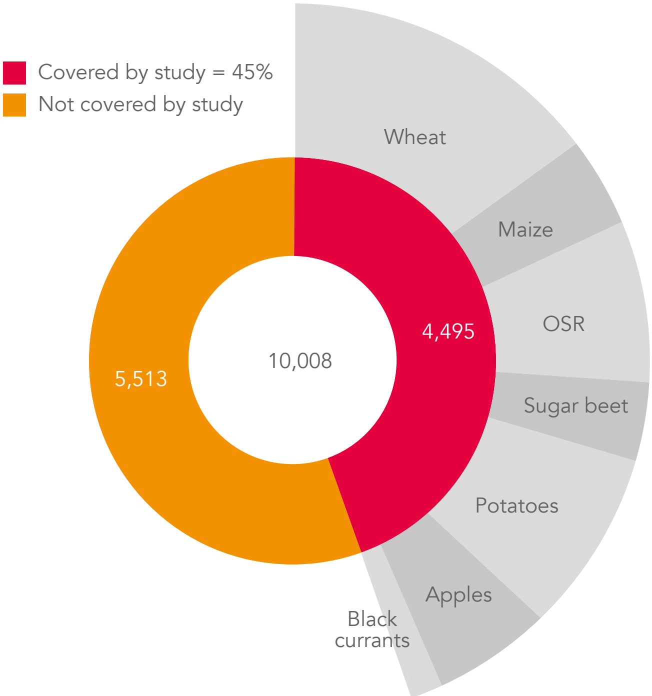
Poland

POLISH KEY EFFECTS

With the current farming toolbox available, Polish production of **five key staple crops**[1] is **6m Mt higher** and generates **€0.5 billion more value** per year than otherwise.
In addition, **0.5 Mt** of output and **€0.1 billion** is supported through the production of the **specialty crops** apples and blackcurrants, and their **economic viability** would be challenged without the support of the 75 at-risk substances.
Further impacts include:

- Wheat, maize and potatoes would face 5-20% lower yields, while the yield of sugar beets would decrease by 30%;
- 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 blackcurrants would decrease by 20%;
- OSR would be most affected with a value loss of €307m; sugar beets and potatoes would see the largest decrease in profitability (>100%) of the staple crops;
- Polish crop agriculture provides 958,000 direct jobs, of which 422,000 rely on the crops examined in this study.

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



AGRICULTURE IN POLAND

The agricultural sector is important to the economy of 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 comprise another 30% and are of increasing importance. For example, apple production has grown more than 50% in the last decade, rendering Poland the largest producer in the EU.[2]

The total average annual Polish agricultural production value[3] of the last five years was *ca.* €10 billion. The study focusses on the staple crops wheat, maize, potatoes, OSR and sugar beet. In addition, the specialty crops apples and blackcurrants 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 45% (4,495/10,008) of the total Polish agricultural production value.

1 *Wheat, potatoes, maize, rapeseed and sugar beet*
2 *EUROSTAT agricultural production data, 2009-2013*

3 *Eurostat; Economic accounts for agriculture - values at current prices*

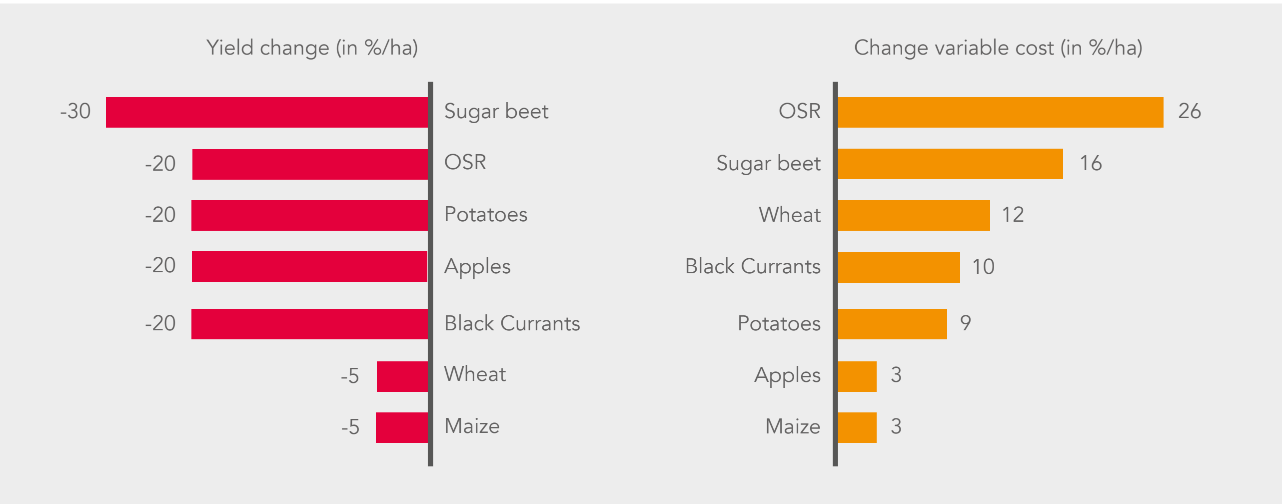
***Table 7**: Overview Polish crops*[1]

Crop	Area (1000 ha)	Yield (t/ha)	Output ('000 ton)	Price (€/ton)
WHEAT	2,245	4.2	9,342	156
MAIZE	420	6.7	2,826	145
OSR	779	2.7	2,134	355
SUGAR BEET	203	55.2	11,216	32
POTATOES	396	21.6	8,566	101
APPLES	176	14.7	2,589	215
BLACKCURRANTS	34	4.3	147	615

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.

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



Of staple crops, the 75 substances add relatively the most value to the sugar beet production, allowing farmers to harvest 30% more tons per hectare than without the substances.

The other staple crops benefit from the substances with 5-20% higher yield. Weed, disease and pest pressure on the crops is lower with crop protection substances, thereby 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.

1 *Eurostat; Farm statistics, average 2009-2013*

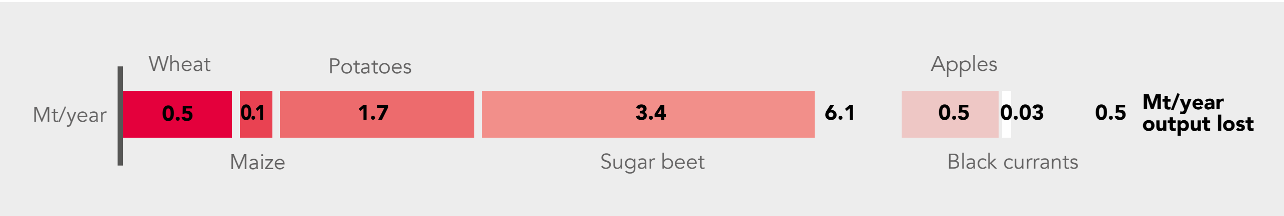
The Polish experts also indicated yield estimates including higher pest pressure and potential resistance effects. Yield effects could sum up to -30% for cereals, -50% for sugar beets and apples and affect almost all produce for sugar beet and potatoes (see appendix for the ranges). The experts expect 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 through improved effectiveness. For the staple crops, the effect varies from 3% for maize up to 26% for oilseed rape in increased variable costs. This is due to fewer pesticides being applied less frequently with the 75 substances being available. The treatment frequency will necessarily increase if the farming toolbox were to be smaller.

EFFECTS ON INCOMES

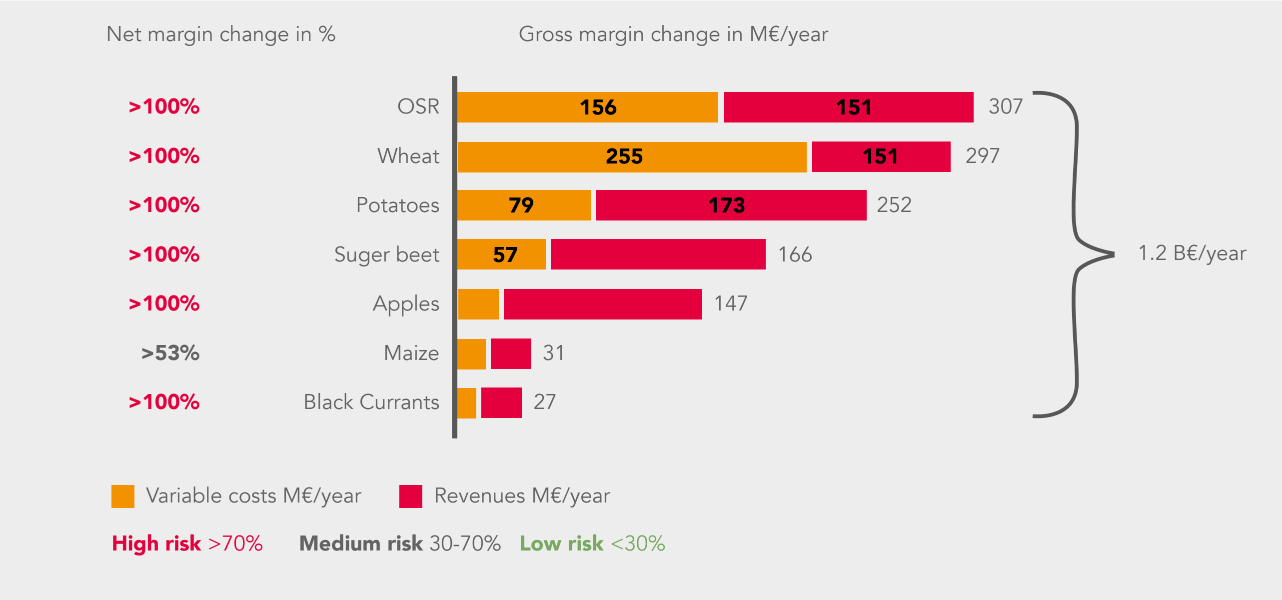
The lower yields (see Exhibit 34), given a fixed arable area, imply that the overall crop production in Poland will decrease without the 75 substances. As Exhibit 35 shows, Polish farm output is currently 6 Mt higher for staple crops and 0.5 Mt for the specialty crops apples and blackcurrants.

***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 relatively large value the 75 substances add to sugar beet cultivation (30% extra yield) as well as the relatively large area where sugar beets are cultivated in Poland (203,000 ha). Depending on farm-gate prices and the changes in costs, the net margins earned on cultivating these crops is affected as well.

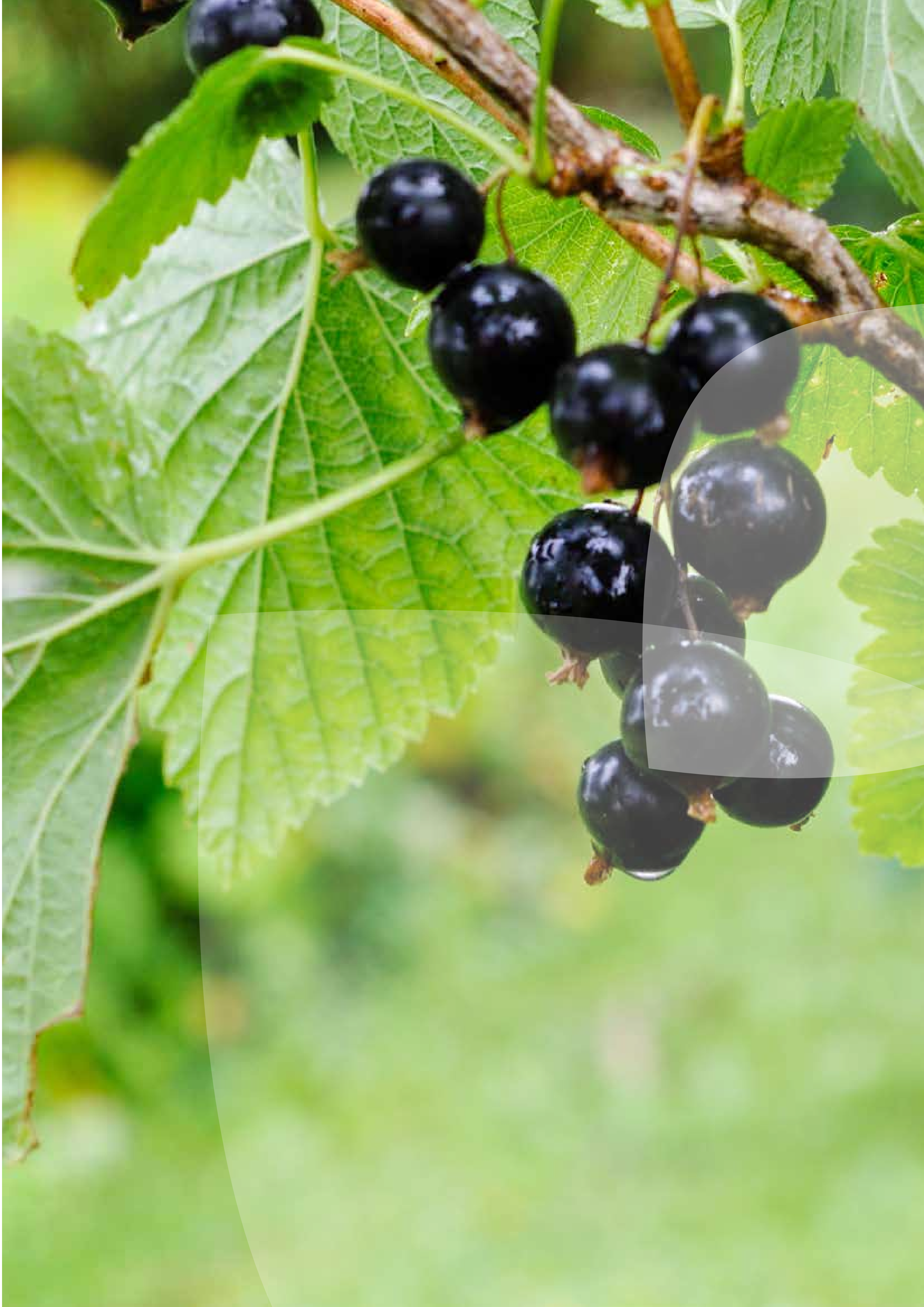
Exhibit 36: Net margin effects (in €m/year)[1]



Polish farmers earn €1.2 billion income per year with the protection of 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). Of the staple crops, OSR and wheat would be most greatly affected by a smaller farming toolbox with value losses of €307 and €297 million, while potatoes and sugar beets would suffer the largest decrease in profitability (>100%). Producer prices for sugar beet per ton are relatively low compared to prices of other crops, so the loss of revenue for sugar beets is not as significant.

Because these staple crops are at a high risk of losing their economic viability with decreasing net margins, there is a chance that their cultivation will no longer take place in Poland.
The Polish experts also expect an increase in the number of treatments necessary, as the alternative products are less effective. Consequently, they expect that this will translate into a higher burden on the environment.
Please, refer the EU chapter for effects on jobs, land use and carbon footprint.

1 *The Kleffmann report describes the effects on net margins instead of gross margins, building on information provided by Polish crop experts. The relative margin change in Poland therefore appears significantly higher than for the other countries as they are represented in gross margins.*




8

Spain

SPANISH KEY EFFECTS

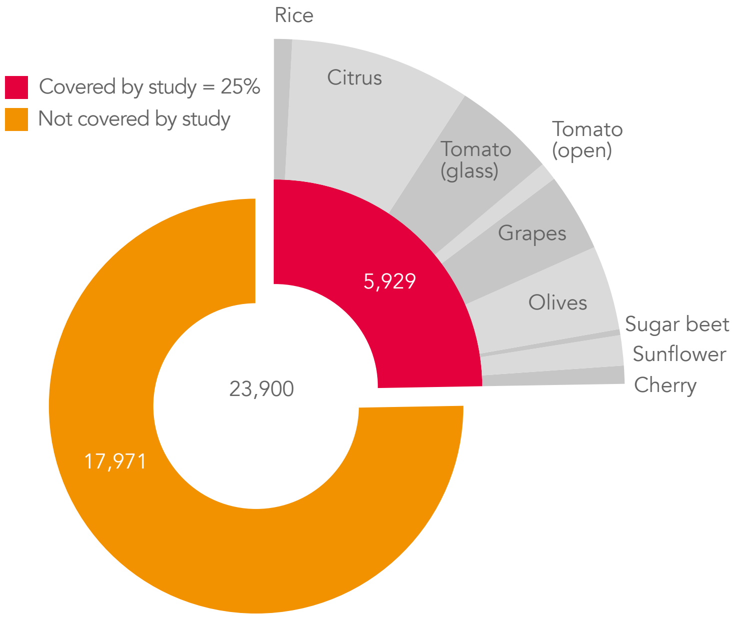
With the current farming toolbox available, the Spanish production of the eight crops analysed[1] is **11 Mt** higher and generates **€2.7 billion** more value per year with the 75 substances at risk than without.
Further results show that:

- The 75 substances allow harvesting 85% more open field tomatoes per hectare
- For sugar beets, olives and greenhouse tomatoes the yield with the substances is *ca.* 35-45% higher than without and ranges for the other crops between 15-30%;
- Variable production costs for the staple crops would increase by up to 50% per hectare;
- Citrus fruits would be most affected with €1.5b of value loss;
- Spanish crop agriculture provides 560,000 direct jobs, of which 135,000 rely on the crops examined in this study.

AGRICULTURE IN SPAIN

To illustrate the importance of the agricultural sector in Spain, it makes up 2.5% of the Spanish GDP, and 4% of total employment belongs to the agricultural sector. There are 25 million hectares of land in Spain dedicated to agriculture, equalling about 15% of EU's total 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.[2] In total, the EU-28 produced an estimated 17 million tons of tomatoes in 2014, of which approximately two thirds came from Italy and Spain.[3]
Spain is the second largest producer of sweet cherries in Europe and is the seventh largest producer in the world.[4] Within Spain, there are four primary production areas: Extremadura (32%), Aragón-Catalonia (34%), Andalusia (10%) and Valencia (9%).

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



The total average annual Spanish crop production value[5] of the last five years was €26 billion. The study focusses on some of the most relevant crops in Spain, citrus fruits, tomatoes (both open-air and greenhouse-grown), grapes, olives and smaller crops like rice, sunflowers, sugar beets and cherries. The selection is based on data availability and relevance of the crops. As Exhibit 37 shows, the crops discussed in the study represent 30% (7,898/35,900) of the total average annual Spanish agricultural production value, meaning that the implications indicated hereafter represent 30% of Spanish agriculture and can be assumed to be larger for Spanish agriculture as a whole.

1 *Tomatoes (open and glass) olives, citrus fruits, grapes, sunflower, cherry and rice*
2 *Mintec, Agricultural importance in Spain*
3 *Eurostat, Agricultural production*
4 *Cherry Cultivation in Spain http://www.chilecerezas.cl/contenidos/20101101210734.pdf*

5 *Eurostat; Economic accounts for agriculture - values at current prices*

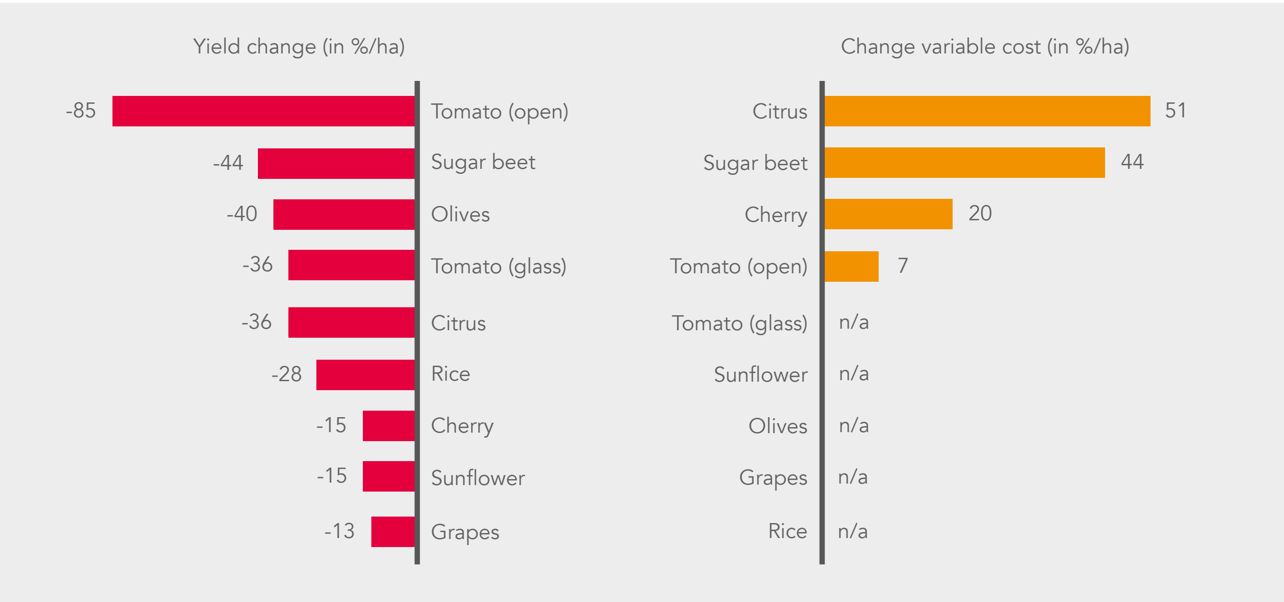
***Table 8**: Overview Spanish crops*[1]

Crop	Area (1000 ha)	Yield (t/ha)	Output (million ton)	Price (€/ton)
TOMATOES (GLASS)	18	100.0	1.8	620
TOMATOES (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
GRAPES	963	6.3	6.0	136
OLIVES	2,504	3.1	7.8	121

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.

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



1 *Eurostat; Farm statistics, average 2009-2013 & others (for full sources see Appendix)*

The 75 substances add most value to open-field tomatoes (85% yield effect). Sugar beets and olives harvest almost twice as much with the 75 substances in their toolbox. These effects focus on the immediate implications only, a long-term resistance effect of pests (e.g. for greenhouse tomatoes of an additional 15% yield difference) against the remaining substances would affect the yield even further. Weed, disease and pest pressure on the crops is reduced with the protection of the active substances, thereby allowing the crops to grow larger. To give an example, azoles form a key component for control of foliar diseases in 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 in 70% of the area. In the long-run, fungal attacks could become more virulent; farmers are afraid the diseases will spread without treatment. An alternative could be to delay the planting later in the year when the disease is less likely to cause damage. However, sugar beets gain 0.5 t/ha of root weight every day. Delaying plantation by the 30 days recommended to lower disease would mean a loss of 15 t/ha or €600/ha farm income, thus reducing the economic viability of sugar beet cultivation in Spain.

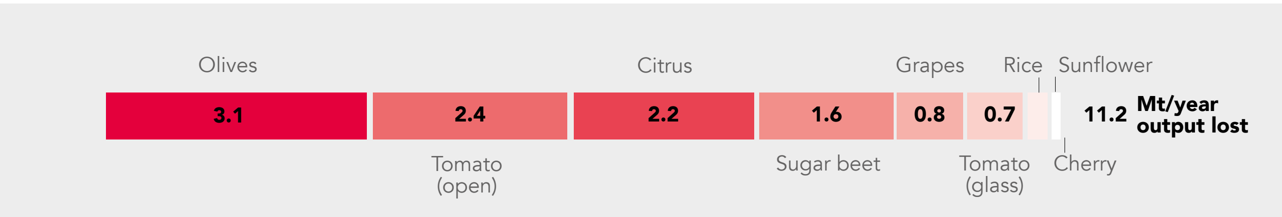
Over the long term, the 75 substances have an additional value as they support the avoidance of resistance effects. Consequently, the additional long-term yield effect adds up to 16% for glass tomatoes and 3% for sunflowers.

The other major implication affects variable production costs. The 75 substances reduce the variable production costs with improved efficiency. For citrus fruits this can amount to 50% in additional variable costs without the 75 substances. This is because, with the current toolbox, fewer pesticides (in kilos) are applied less frequently, ultimately saving purchase, labour and energy costs. The treatment frequency will thus increase should the 75 substances be removed.

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 toolbox. For the crops analysed, this represents an overall reduction of one-third (see Table 8: Overview Spanish crops).

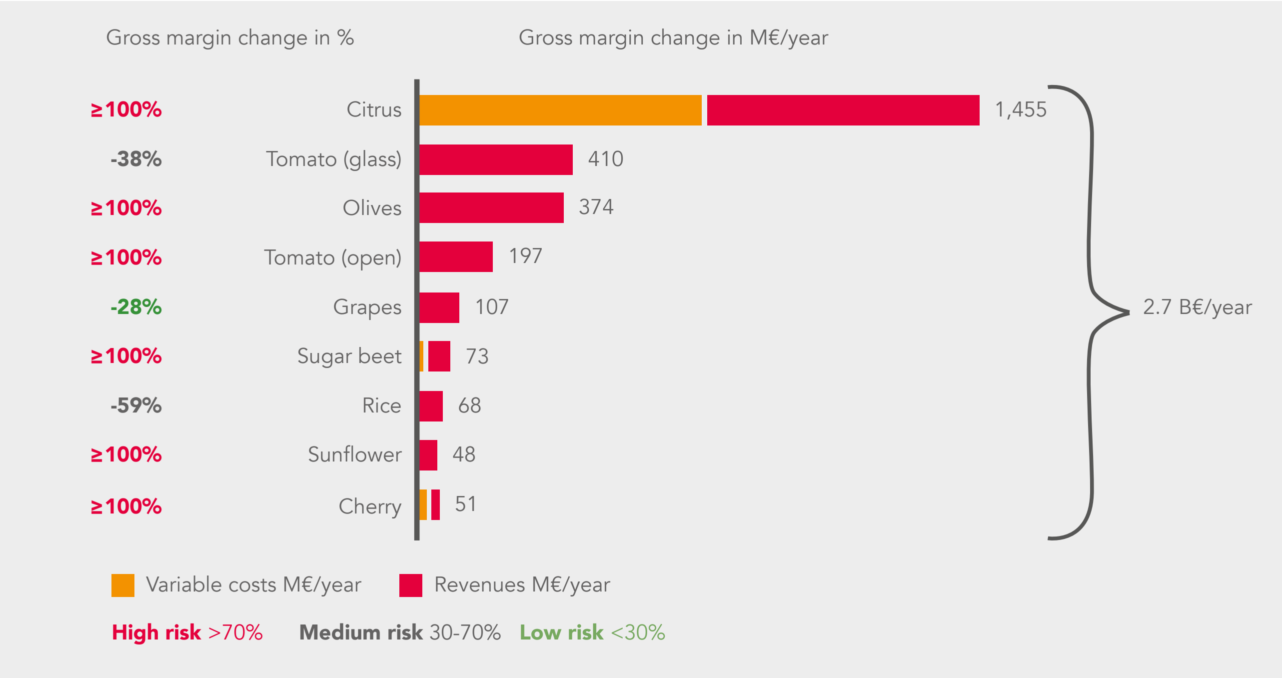
***Exhibit 39**: Output changes (in Mt/year)*



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 that the 75 substances add to open field tomato cultivation (85% extra yield) as well as the relatively large area where olives and citrus fruits are cultivated in Spain (see Table 8: Overview Spanish crops).
Any drastic change in output of open-field tomatoes, which are used for industrial purposes, would put pressure on the Spanish tomato-processing industry, because most of the Spanish tomatoes are also processed in the country and

local processors' businesses depend on the throughput volume. In total, there are currently 28 tomato processors operating in Spain. Together these companies processed in the 2015 harvest around 3Mt tomatoes, generating revenues of €290 million and employing 1,500 seasonal and 400 fixed employees[1].
Depending on farm-gate prices and the changes in variable costs, the gross margins earned cultivating these crops will also be affected.

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



It has been demonstrated that Spanish farmers benefit from about €2.7 billion gross margins per year by applying the 75 substances. If these active substances were removed, there would be revenue losses (€1.9 billion) and, to a lesser extent, higher variable costs (€0.7 billion). Gross margin gains in citrus fruits make up the majority of the overall effect. Citrus fruits would almost equally be affected from a decrease in revenues (€712 million) and higher variable production costs (€743 million).
The impact on gross margins provides insight into the overall economic viability of cultivating crops.

Given the revenue losses and additional variable costs, the profitability for citrus fruits, olives, open-field tomatoes, sugar beets, sunflowers and cherries is at the very least questionable, and could endanger the long-term sustainability of cultivating these crops in Spain due to loss of economic viability.
Please refer to the EU chapter for effects on jobs, land use and carbon footprint.

1 *Source: Cooperativas agro-alimentarias*

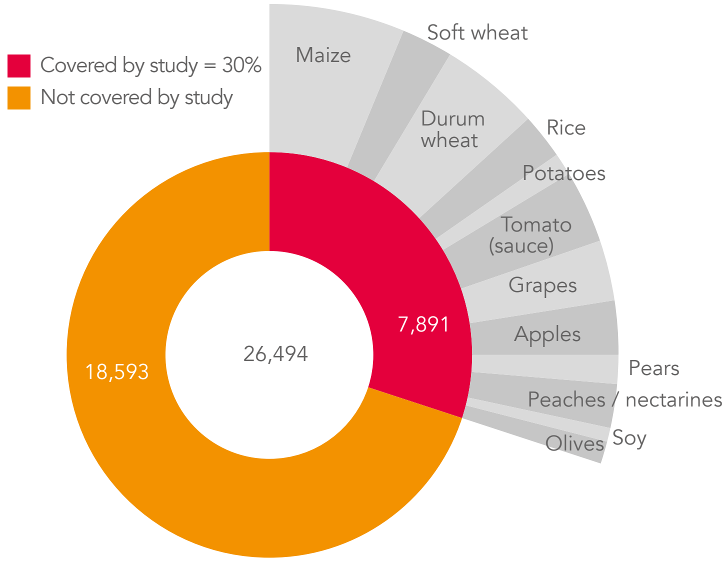
Italy

ITALIAN KEY EFFECTS

With the current farming toolbox available, the Italian production of the 14 crops analysed[1] is **10 Mt** higher and generates **€2.7 billion** more value per year than if the 75 at-risk substances 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 of 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 5% for grains and 18-34% for olives and grapes.
- The 75 substances contribute to extra farm income of €2.7 billion: €1.9bn from extra revenues and €0.8bn from lower costs;
- The largest single contribution is to grapes with €0.6 billion;
- Italian crop agriculture employs 488,000 direct jobs of which 145,000 rely on the selected crops.

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



AGRICULTURE IN ITALY

Italy's agriculture makes up 2.2% of the Italian GDP, and 4% of total employment belongs to that sector. There are 14 million hectares of land in Italy dedicated to agriculture, equalling about 8% EU's total agricultural area.[2] It is characterized by its wide variety of crops and agricultural distinctions between the north and south. The northern regions produce 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. Italy is the largest producer of grapes, rice and soy in Europe. Many of its typical fruits and vegetables are exported; 65% of these exports go to other EU member states.[3] 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)nut processing in Tuscany. Also many of these foods are widely exported.

The total average annual Italian crop production value[4] of the last five years was €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 30% (7,891/26,484) of the total average annual Italian agricultural production value. This means that the implications indicated hereafter represent 30% of the Italian agriculture and can be assumed to be even larger for the Italian agriculture as a whole.

1 *Maize, wheat (durum, soft), rice, potatoes, tomatoes (sauce), grapes, apples, pears, peaches, nectarines, barley, soy, hazelnut, olives*
2 *Average over 2009-2013 (ISTAT). According to INEA, total farm surface has decreased by 3.3% over the last year.*
3 *ISTAT 2009-2013, EUROSTAT 2009-2013*

4 *ISTAT – agricultural statistics, Eurostat; Economic accounts for agriculture - values at current prices*

Table 9: Overview of Italian crops[1]

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
GRAPES	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

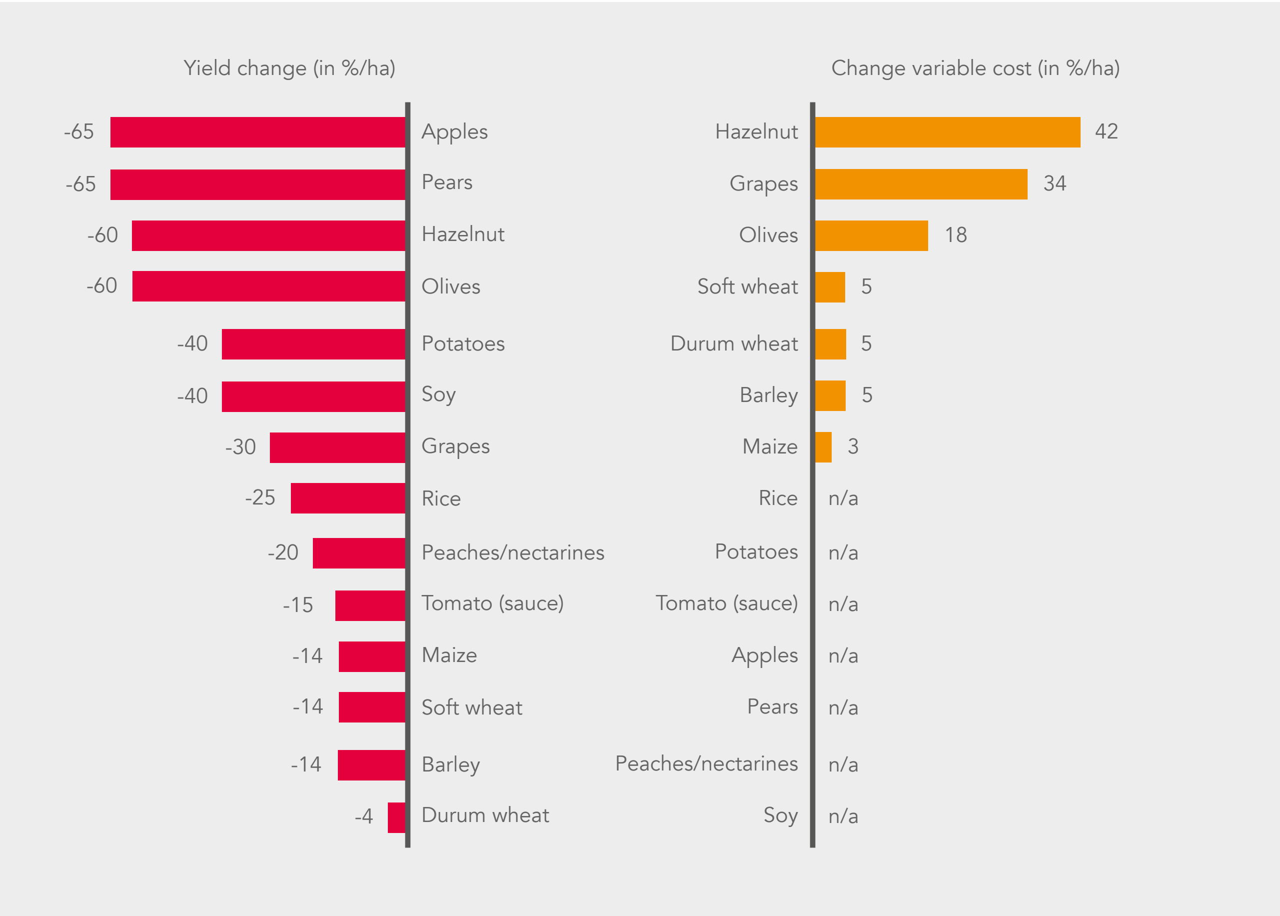
Italian farmers have about 250 active substances available in their toolbox. Overall, the quantity of pesticides has decreased from 2003-2013 by more efficient and effective uses by farmers.[2] Over the last few years, new parasites have emerged in Italy driven largely by changes in its climate. Crop management, especially for fruits and vegetables, will need to adapt. Currently, farmers seem to have limited options for facing these new challenges.[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.

1 *ISTAT – agricultural statistics 2009-2013, INEA 2009-2013 average prices*
2 *ISTAT 2003-2013, pesticide use in Italy*
3 *Environchange, L'impatto del cambiamento climatico sulle malattie delle piante, June 2012*

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

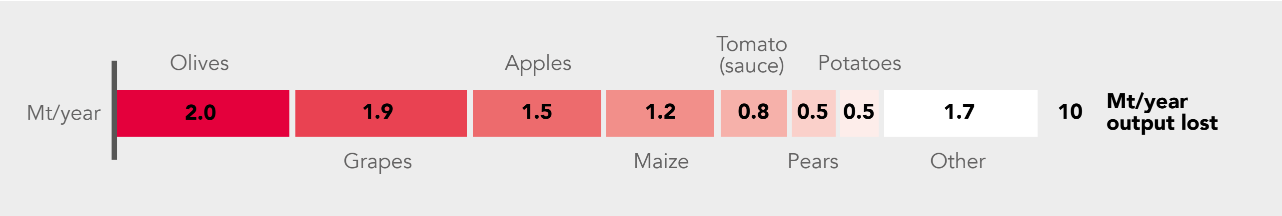


The 75 substances add the relative most value to apples, pears, hazelnuts and olives (60-65% more yield). Most cereals will lose 14-25% of their yields with a smaller toolbox. Grapes, one of Italy's key crops, currently benefits from yields 30% higher. The production costs are also likely to increase: the extent to which this is the case ranges from 5% for grains to 42% for hazelnuts.
These yield values represent the expected short-term effects. Italian crop experts predict even larger negative yield effects in years of high pest pressure and also over time with potential resistance development. The impact on cereals can vary from -14% to -35%. For tomatoes, these numbers can be as large as -35%, while for several typical Italian fruits and vegetables like grapes and olives, large shares of these crops would be affected (see also the yield ranges in the appendix).

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 illustrated in Exhibit 43, Italian farm output is currently 10 Mt/year higher than with a reduced toolbox. For the staple crops analysed here, this represents an overall reduction of 25% (see Table 9).

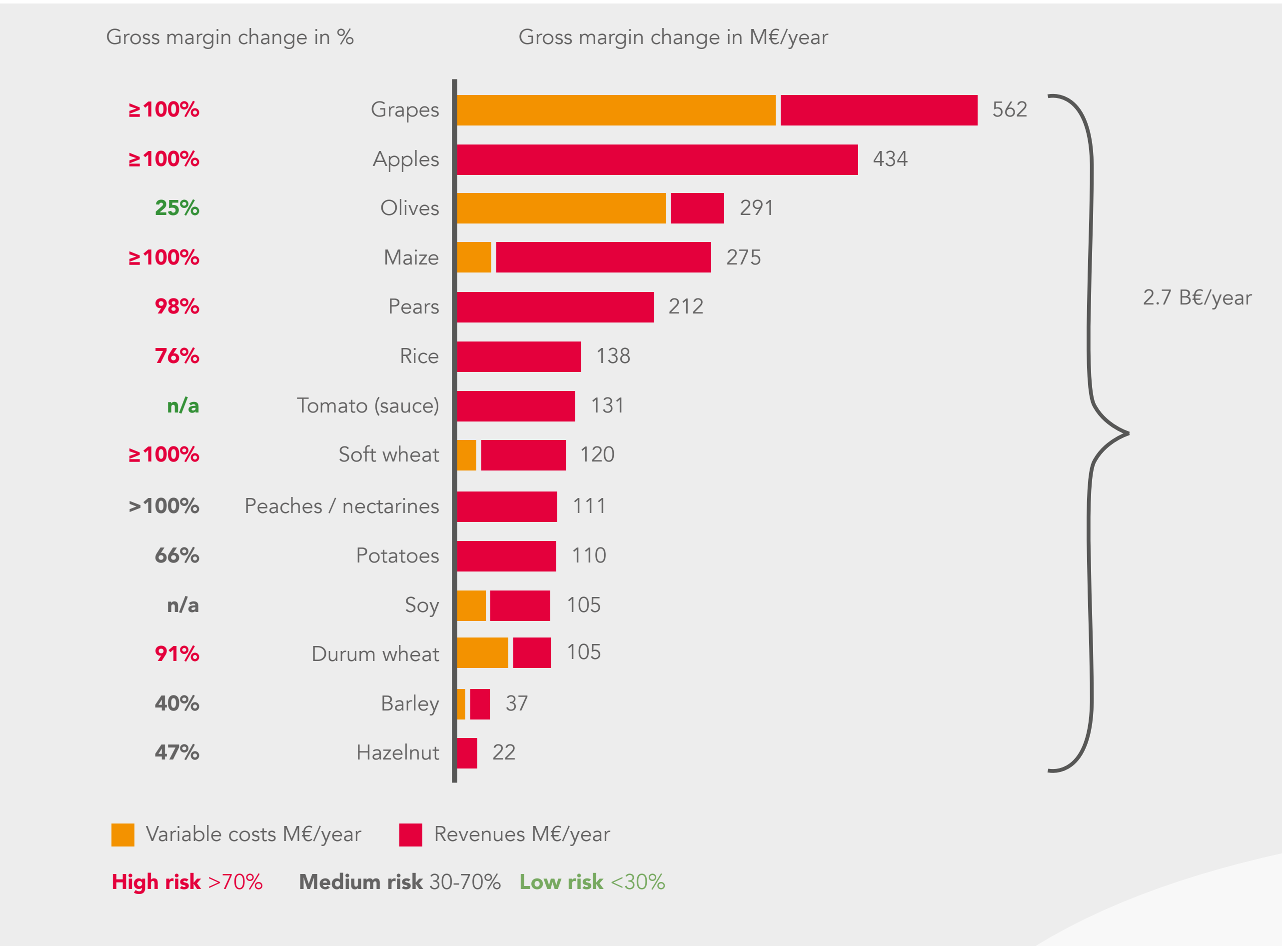
***Exhibit 43**: Output changes (in Mt/year)*



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

Depending on farm-gate prices and changes in variable costs, gross margins are also affected:

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



As shown, Italian farmers gain €2.7 billion in gross margins per year with support of the 75 substances. If these substances could no longer be used, there would be significant revenue losses (€1.9 billion). However, extra production costs would add another €0.8 billion. Of the crops studied, grapes gain the largest gross margin benefit (€0.6 billion), but also apples, maize, olives and pears would lose over €200-400 million in value.

The stark changes to gross margins give insight into the overall economic viability of cultivating the crops. Given the revenue losses, the profitability for grapes, apples, maize and soft wheat would be strongly affected (≥100% gross margin loss), but the pears, rice and durum wheat profitability losses would also be substantial. Such losses could endanger the long-term sustainability of cultivating these crops in Italy by threatening their economic viability. Please, see the EU chapter for the effects on jobs, land use and carbon footprint.


10

The Netherlands

DUTCH KEY EFFECTS

With the currently available farming toolbox, the Dutch production of **four key staple crops**[1] is **3 Mt higher** and generates **€0.3 billion more value** per year than if the
75 substances were not included.
In addition, without the usage of the 75 substances, the **€0.9 billion** value of the **specialty crops**,[2] tulip bulbs, bell peppers and apple trees and their **economic viability** would be challenged.
Further results include:

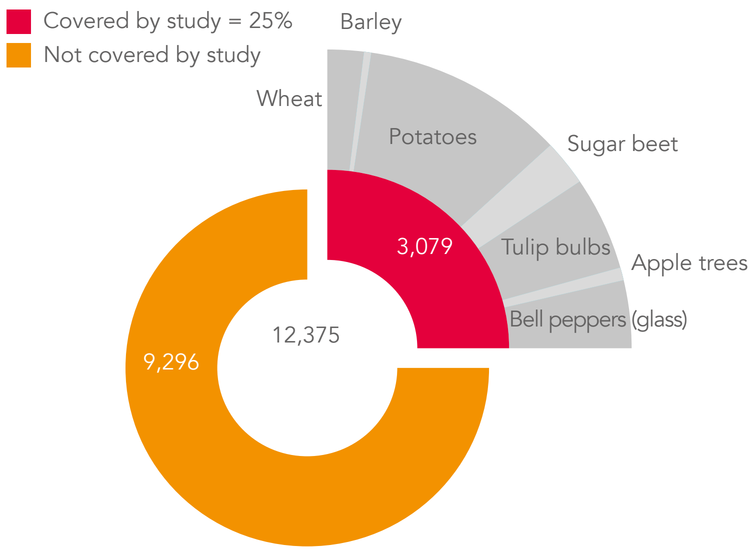
- Wheat, barley and potatoes would face 15-18% lower yields, while the yield of sugar beets would decrease by at least 36%;
- Variable production costs for the staple crops would concurrently increase up by between 6-36% per hectare;
- Yield loss for the specialty crops tulip bulbs, bell peppers and apple trees would range from 70-100%;
- Tulip bulbs would be the most affected with €515m of value loss, while sugar beets would show the largest decrease in profitability (-45%) of the staple crops;
- Dutch crop agriculture is responsible for 92,000 direct jobs; 23,000 of these jobs are dependent on the crops covered by the study.

AGRICULTURE IN THE NETHERLANDS

What is most indicative of the agricultural sector's importance in the Netherlands is that agriculture makes up 2% of the Netherland's GDP. Moreover, 2.6% of the labour force is employed in the agricultural 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. Of total agricultural output, 53% 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 three producers of vegetables and fruit, which, given the modest availability of arable land, indicates very high levels of productivity.
For several specialty crops – tulip bulbs and apple trees among others - it is the largest EU producer. It should also be pointed out that apple trees further affect aspects of apple cultivation based on Dutch apple trees being planted in and outside of the country.

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



The total average annual Dutch agricultural production value[3] of the last five years was €12 billion. The study focusses on the staple crops wheat, barley, potatoes (ware and seed) and sugar beets. In addition, the specialty crops bell peppers (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 potrays, the crops covered by the study represent some 25% (3,079/12,375) of the total Dutch agricultural production value. Table 10: Overview Dutch crops summarizes the production data for the crops in scope.

1 *Wheat, barley, potatoes, sugar beet*
2 *Tulip bulbs, apple trees and bell peppers (glass)*

3 *Eurostat; Economic accounts for agriculture - values at current prices*

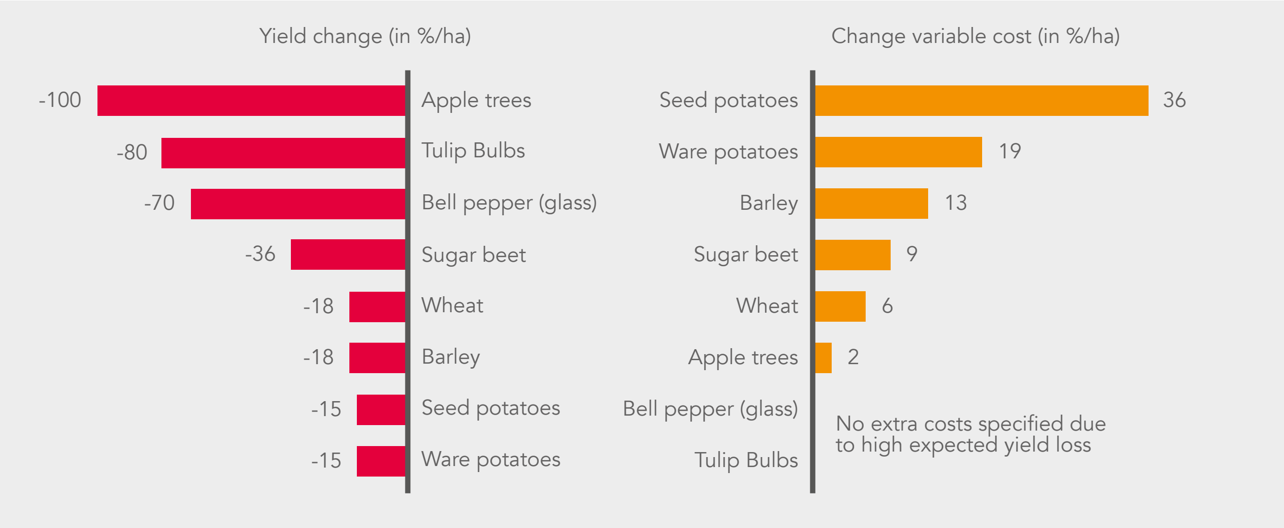
Table 10: Overview Dutch crops[1]

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
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

EFFECT OF THE 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 cost changes (in %/ha)*



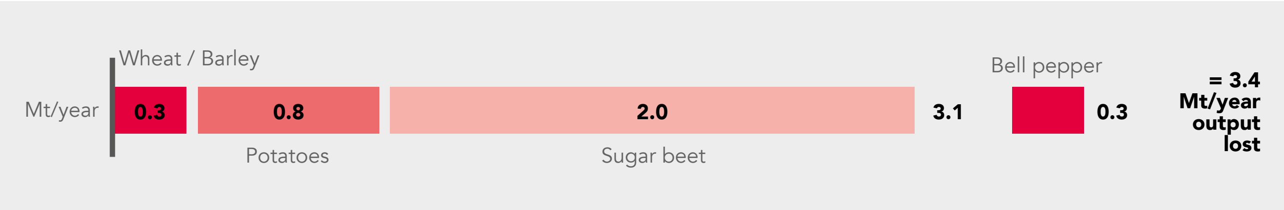
1 *Agricultural economic institute (LEI) of Wageningen University, average 2009-2013. For the specialty crops tulip bulbs and apple trees, the number of bulbs and trees is a more common measure of quantity. Bell pepper prices refer to 2014 averages from GFActueel based on three different auctions.*

Of the staple crops, the 75 substances add the most value to sugar beet production, allowing farmers to harvest 36% more tons per hectare than without the substances. The other staple crops benefit from the active substances with at least 15-18% higher yields. Weed, disease and pest pressure on the crops is lower with the support of the 75 substances, allowing the crop to grow larger.
The value represents the short-term effects.
Under unfavourable pest conditions, yield effects could be higher. Furthermore, a smaller crop protection toolbox would increase the chance of resistance development. For potatoes, yield effects could reach as high as 20-30%, while cereal and sugar beet yields could increase to 46-60% (see appendix).
Variable costs are also an important consideration. The 75 substances reduce the variable production costs through improved effectiveness. For most staple crops, the effect adds less than 13% additional variable costs; however, for potatoes these costs can increase from 19% to 36%. Because fewer pesticides are being applied, and their effectiveness means fewer necessary applications, costs are lower with the usage of the 75 active substances.

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, total Dutch farm output is currently 3.1 Mt higher for staple crops and 0.3 Mt for bell pepper.

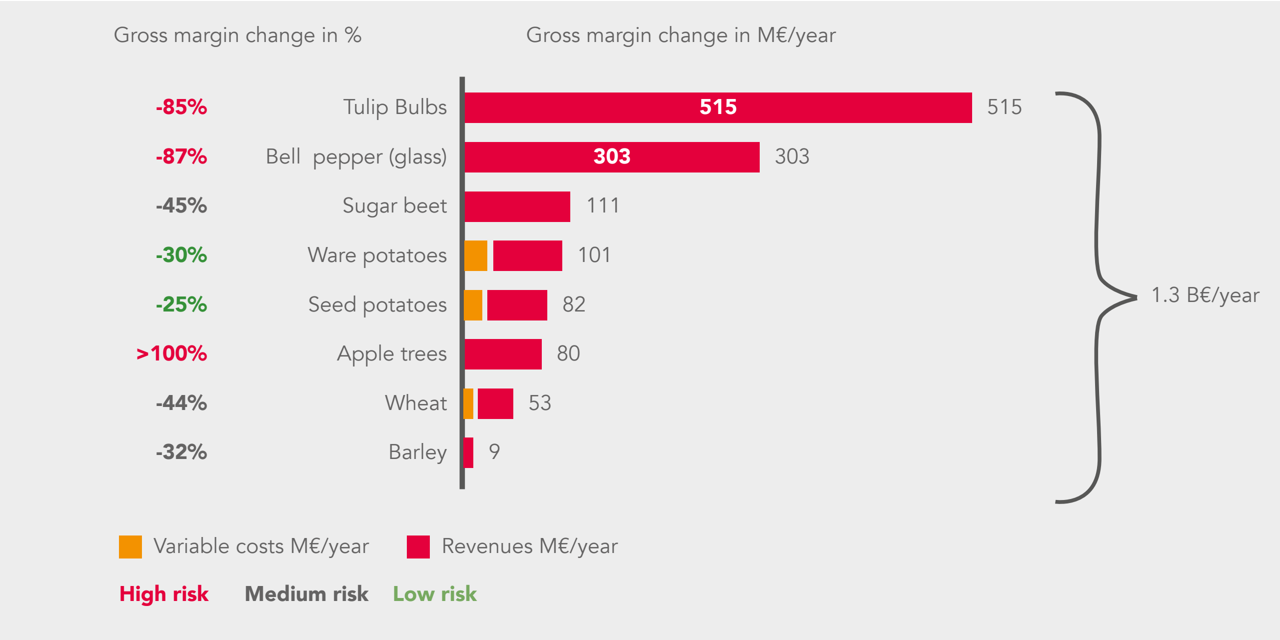
***Exhibit 47**: Output changes (in Mt/year)*



Compared to other crops, the 75 substances have 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 comparatively large area upon which sugar beet is cultivated in the Netherlands (73,000 ha).

Depending on farm-gate prices and the changes in variable costs, the gross margins earned are also affected.

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



Dutch farmers earn €1.2 billion gross margins per year from having the protection of 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). The value of tulip bulbs would be most affected from a decrease of the farming toolbox with a loss of 515 million, while sugar beets would show the largest decrease in profitability (-37%) of the staple crops. Overall, the profitability of apple trees, tulip bulbs and bell peppers would suffer the most. As the production of tulip bulbs and bell peppers is predicted to decrease by 70-80%; there are no additional variable costs specified.

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

Please see the EU chapter for effects on jobs, land use and carbon footprint.

Austria

AUSTRIAN KEY EFFECTS

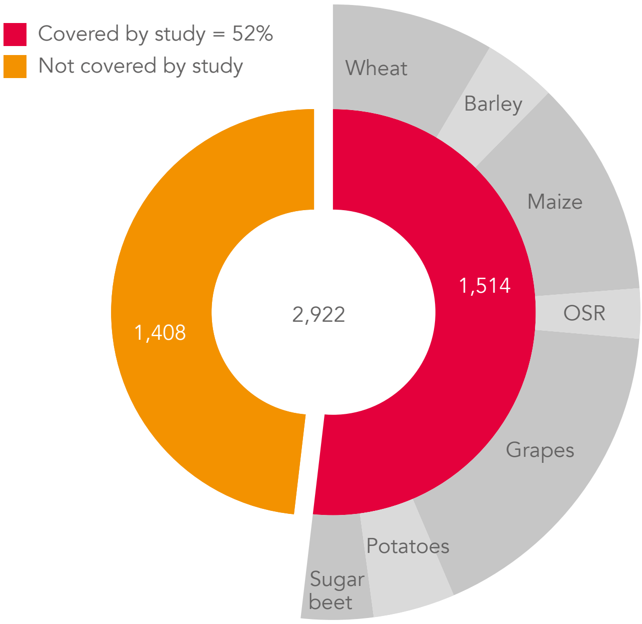
With the current farming toolbox available, the Austrian production of **seven key staple crops**[1] is **2 Mt higher** and generates **€420 million more value** per year than otherwise.
Further results include:

- Sugar beets would face 35% lower yields, while the yield of wheat, barley, maize, potatoes and grapes would decrease by 10-25%;
- At the same time as yields decrease, variable production costs for most of the crops would increase by up to 10% per hectare; sugar beet variable production costs would double;
- Grapes would be most affected with €118 million of value loss; of the staple crops, sugar beets would show the largest decrease in profitability;
- Austrian crop agriculture employs 61,000 people directly. Of these jobs, 30,000 relate to the selected crops covered.

AGRICULTURE IN AUSTRIA

Indicating the relative importance of the agricultural sector in Austria, agriculture makes up 1.3% of the Austrian GDP; approximately 5% of the total employment is with the agricultural sector. The prevailing annual crops include durum wheat, grain maize, soy 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. Because the yearly potential evapotranspiration in these regions has the same magnitude as the precipitation, Austrian crop production is quite sensitive to shifts in soil water availability.[2]

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



The total average annual Austrian agricultural production value[3] of the last five years was around €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 beets and grapes. The selection is based on data availability and relevance of the crops. As Exhibit 49 shows, the crops covered by the study represent 49% (1.460/2.990) of the total Austrian agricultural production value.

1 *Wheat, barley, potato, maize, oilseed rape, sugar beets and grapes*
2 *Climate adoption EU, Agriculture and horticulture in numbers*
3 *Federal Institute of Agricultural Economics Austria- values at current prices, average 2009-2013*

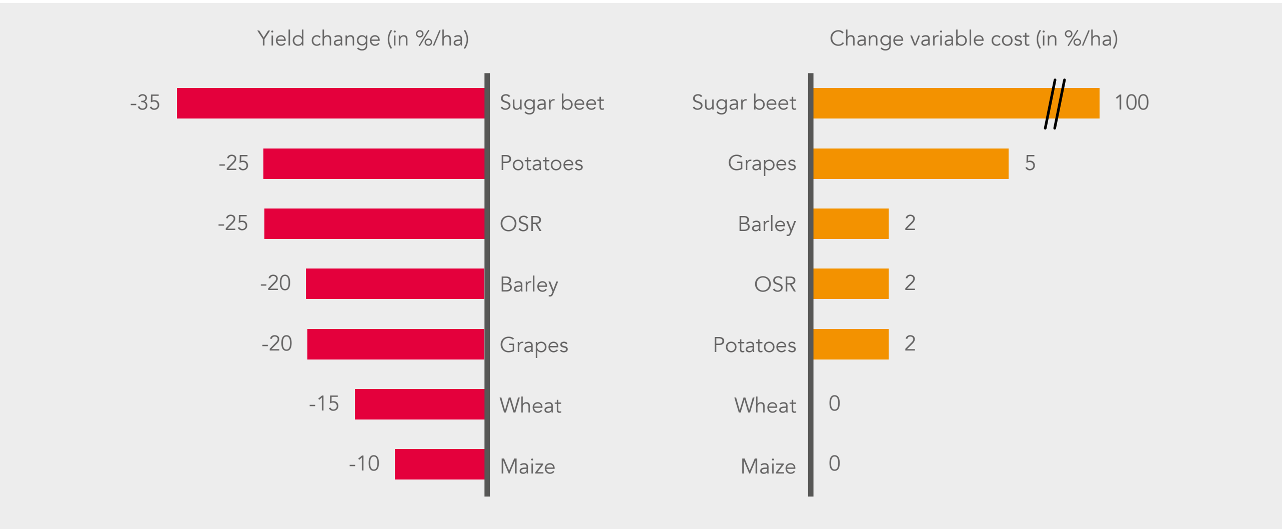
Table 11: Overview Austrian crops[1]

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
GRAPES	44	7	305	1.690

EFFECT OF THE 75 SUBSTANCES ON YIELD AND VARIABLE COSTS

Exhibit 50 provides an overview of the consequences for Austrian crops of losing the 75 active substances.

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



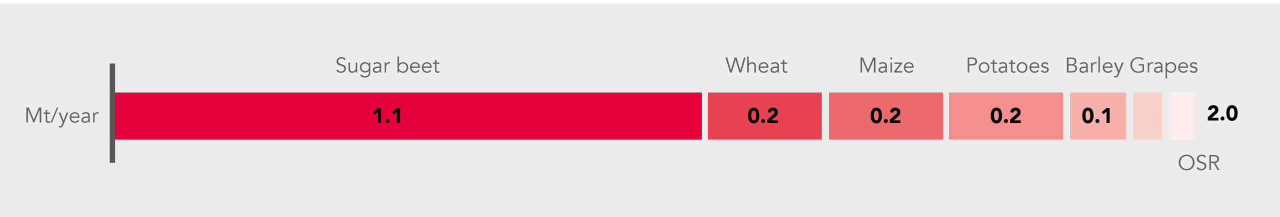
1 *Statistics Austria; Farm statistics, average 2009-2013*

The 75 substances add the most value to sugar beet production, allowing farmers to harvest 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 with 10-20% higher yields. Weed, disease and pest pressure is alleviated with the 75 substances and the crops are able grow mer effectively.
In regards to long-term consequences (not shown in the exhibit above), the 75 substances have the additional value of supporting 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 grapes 5%.
Furthermore, variable production costs are susceptible to the substance removal. The 75 substances reduce the variable production costs through improved effectiveness. For sugar beets, the ban 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 the fact that fewer pesticides are currently being applied and are done so less frequently. The treatment frequency (and thus costs and energy consumption) is likely to increase with changes to the farming toolbox.
The results for potatoes presented in Exhibit 50 combine the change to variable costs of ware and seed potatoes. Barley refers to winter barley and maize to grain maize.

EFFECTS ON INCOMES

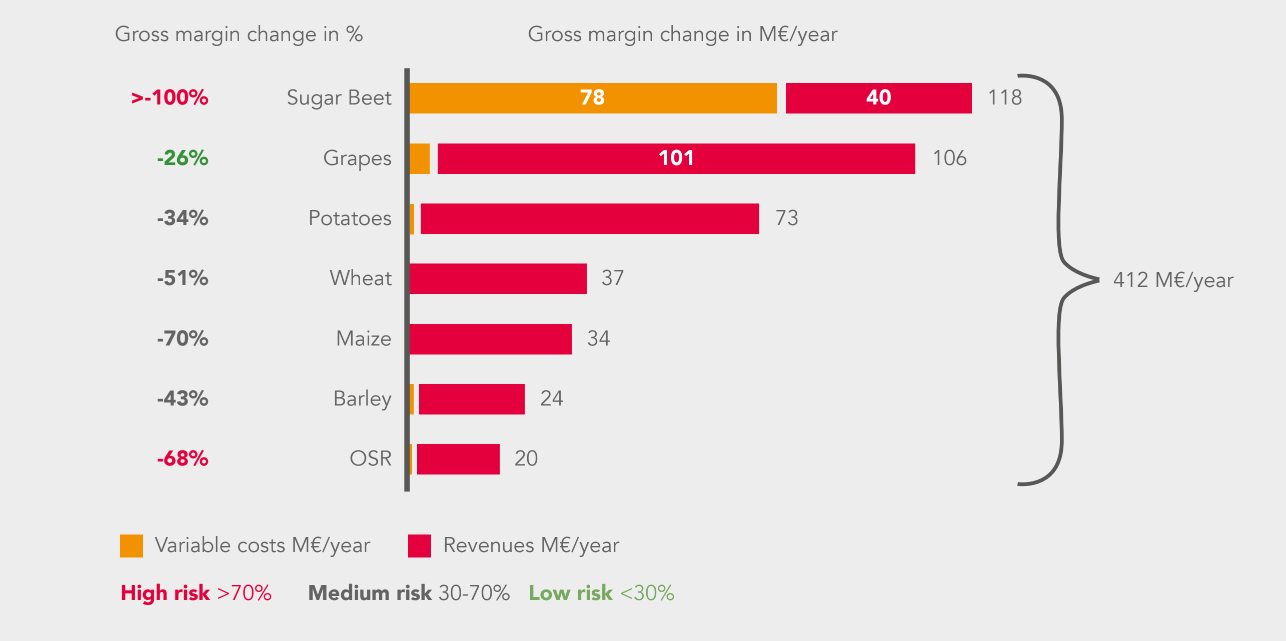
The lower yields (see Exhibit 50), given a fixed arable area, imply that the overall crop production in Austria will decrease without the 75 substances. As Exhibit 51 demonstrates, total Austrian farm output is currently 2 Mt higher than it would be without the 75 active substances.

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



The 75 substances have the largest influence on the amount of sugar beets produced in Austria (1 Mt/year), due to 35% extra yield, as well as the relatively high yield per hectare (72t/ha).
Depending on farm-gate prices and the changes in variable costs, the gross margins earned on cultivating these crops are also affected.
Exhibit 52 summarizes these effects. In total Austrian farmers earn €420 million gross margins per year with support of the 75 substances. The total change is mainly driven by revenue losses (€330 million) and, to a lesser extent, variable costs (€87 million). Gross margin gains in sugar beet and grapes make up the majority of the overall effect. Sugar beets are the most susceptible from a decrease of the farming toolbox with €118 million of value loss. Given the relatively high farm-gate price per ton of output of grapes, the 20% yield change for grapes also results in a significant total gross margin loss.
The gross margin change gives insights into the overall economic viability of cultivating these crops. Given the revenue losses and additional changes to variable costs, the profitability of sugar beet becomes questionable and could endanger the long-term sustainability of cultivating sugar beets in Austria. In other words, sugar beet cultivation is at a high risk of losing its economic viability.

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



Please, refer to the EU chapter for effects on jobs, land use and carbon footprint.


12

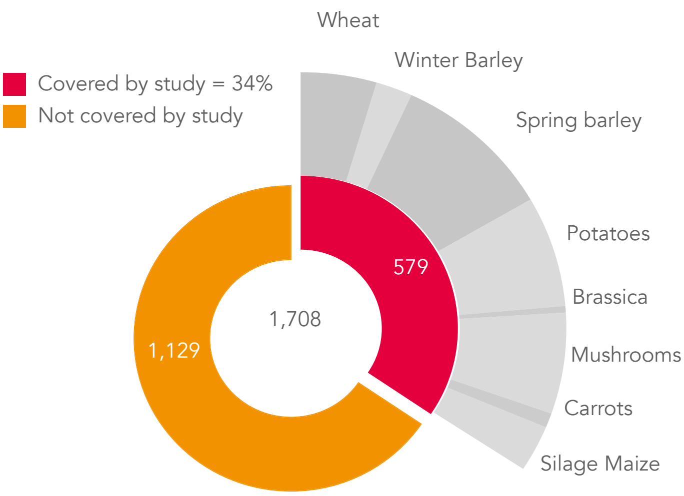
Ireland

IRISH KEY EFFECTS

The Irish production of **four key staple crops**[1] is **1.4 Mt higher** and generates **€0.1 billion more value** per year than it would be without the crop protection substances in the current toolbox.
In addition, the **economic viability** of the production of **specialty crops**[2], *i.e.* **0.1 Mt** of output and **€0.1 billion** in revenues 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 would decrease by 50%;
- Yield loss for the specialty crops mushrooms, brassica and carrots would range from 40-55% and variable production costs would increase by 38-61%.
- Mushrooms would be most severely 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 rely on the crops covered by the study.

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



Note: Other crop value (€1,188m) includes €871m value of grass lands (i.e. CSO category 'other forage plants')

AGRICULTURE IN IRELAND

To illustrate the importance of agriculture in Ireland, it makes up 1.6% of the Irish GDP, and 5.7% of the labour force is employed within the agricultural 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 total land area. Irish agriculture is primarily a grass-based industry (i.e. 90%); only 9% of the agricultural area is allocated to crop production. Of the financial agricultural output 26% is from crops, with 75% accounted for from main crops of wheat, barley, potatoes and silage maize.

The total average annual Irish agricultural production value[3] of the last five years was €1.7 billion. The study focusses on the staple crops wheat, barley, potatoes and (silage) maize. The specialty crops brassica, carrots and mushrooms have also been included for Ireland, based on data availability and relevance of the crops. As depicted in Exhibit 53, the crops covered by the study represent 34% (579/1,708) of the total Irish crop production value.

Mushroom is one of Ireland's most valuable crops: Irish mushrooms are acknowledged as some of the best in the world, and the crop displays positive growth prospects for the near future. It employs about 3,200 people directly and 400 people downstream. A total of 75% mushroom production is exported to the UK, and the British demand is expected to grow steadily.[4]

1 *Wheat, barley, potato, silage maize*
2 *Mushrooms, brassica, carrots*
3 *Eurostat; Economic accounts for agriculture - values at current prices*
4 *Teagasc, Mushroom Sector Development Plan to 2020, October 2013*

Table 12: Overview Irish crops[1]

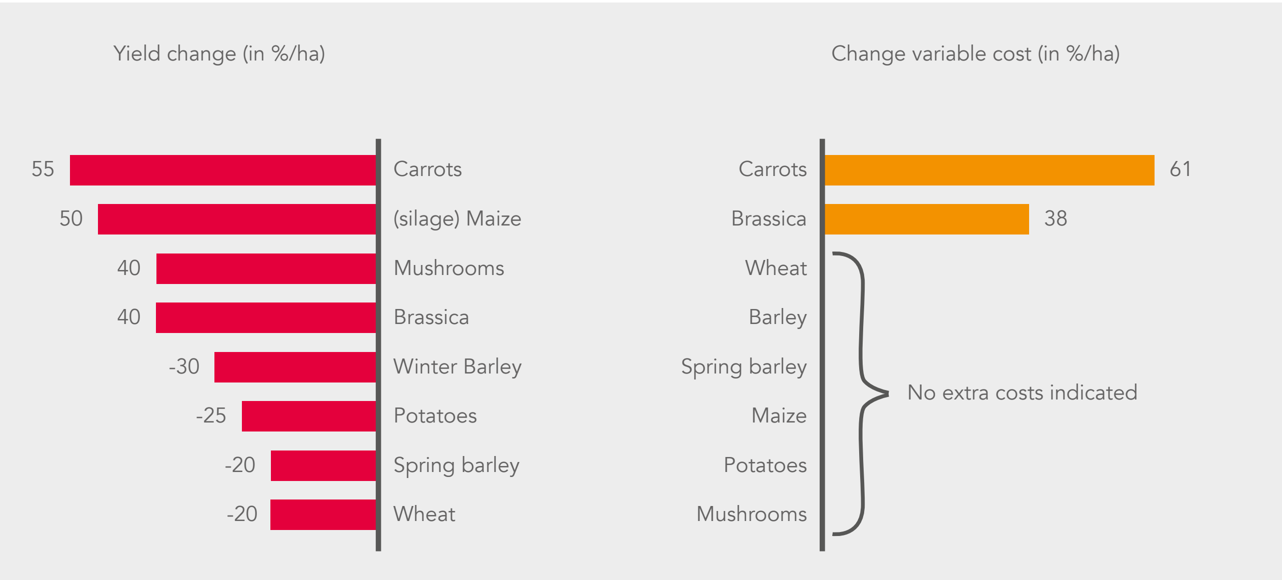
Crop	Area (1000 ha)	Yield (t/ha)	Output (million ton)	Price (€/ton)
WHEAT	66	8.9	585	141
WINTER BARLEY	32	8.7	279	154
SPRING BARLEY	160	6.7	1,078	
POTATOES	11	32.1	351	318
BRASSICA	1	25.8	19	271
MUSHROOMS	n/a	n/a	63	1715
CARROTS	1	56.0	36	353
(SILAGE) MAIZE	12	145.7	1,788	28

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 with one of the highest yields/ha in Europe, but is heavily reliant upon intensive application of pesticides due to high fungi pressure as a result of Irelands wet temperate climatic weather conditions. [2]

EFFECT OF THE 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.

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



1 *Eurostat; Farm statistics, average 2009-2013, CSO/Teagasc farm statistics 2009-2013*

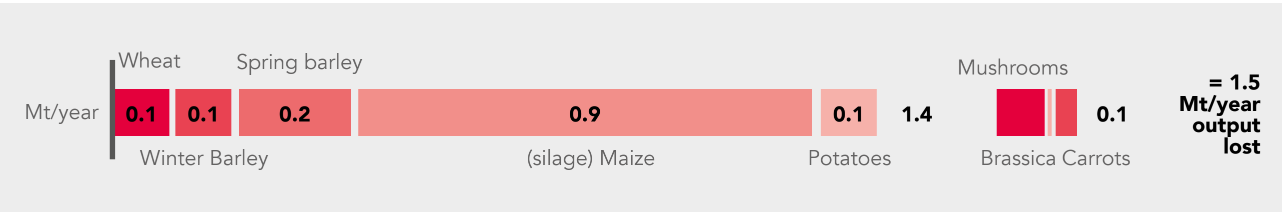
2 *Jess et al, European Union (EU) policy on pesticides: Implications for agriculture in Ireland, 2014*

Of the staple crops, the 75 substances add the most value to (silage) maize production from a yield perspective, allowing farmers to harvest 50% more tons per hectare than without the substances. The main crops of wheat, barley and potatoes benefit from the substances with 20-30% higher yields. With the support provided by the 75 substances, farms are better protected against weeds, diseases and pest pressure, allowing better crop performance. Without these higher yields and healthier crops for market, farmers income could fall and the sector could be endangered as the farm viability would be challenged.
These yield values indicate the lowest expected yield values. Crop experts from Teagasc provided yield ranges including influence of high pest pressure and resistance effects. Under these circumstances, yield effects of wheat and barley could increase up to 50-70% with similar figures for the vegetable crops, carrots and brassica (see yield and cost ranges in the appendix).
The other change is in regards to variable costs. The 75 substances reduce the variable production costs through improved effectiveness. For the staple crops, we have no available data on additional variable costs. For the specialty crops, carrots and brassica (e.g. cabbage), the cost changes range from 38-61%.

EFFECTS ON INCOMES

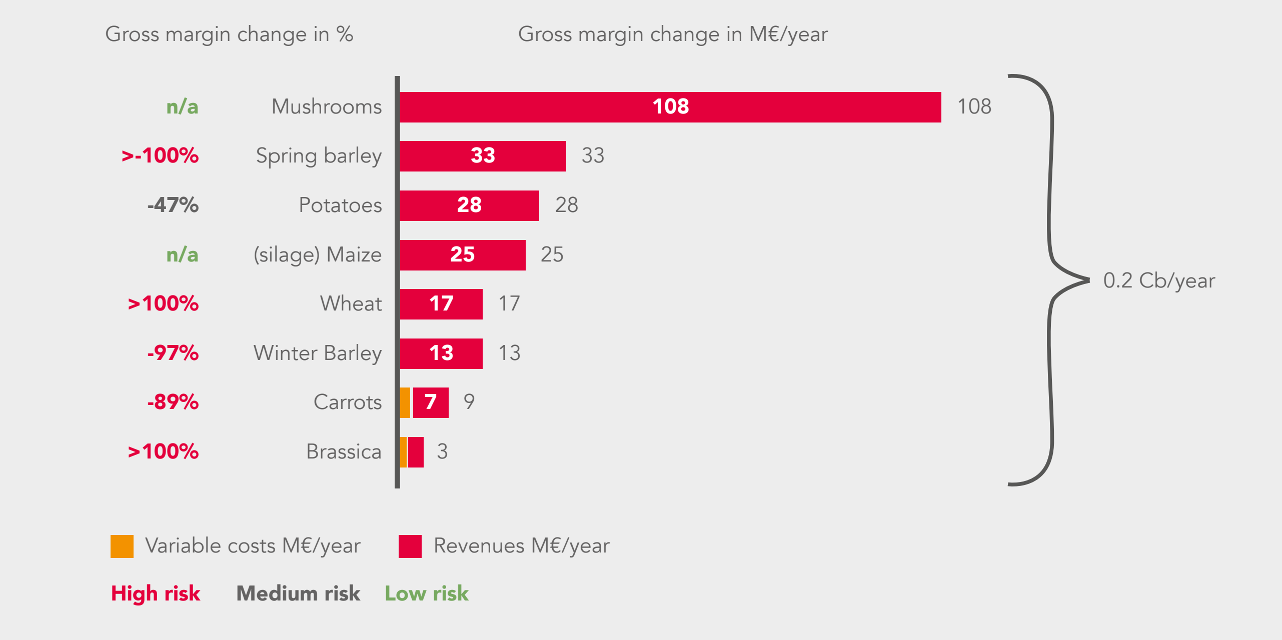
The lower yields (see Exhibit 54), given a fixed arable area, imply that the overall crop production in Ireland will decrease without the 75 substances. As Exhibit 55 shows, in total, Irish farm output is currently 1.4 Mt higher for the staple crops that fal within the scope of this study and 0.1 Mt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

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



Compared to other crops, the 75 substances have 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 farm-gate prices and the changes in variable costs, the gross margins earned are also affected.

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



Irish farmers earn €0.2 billion gross margins per year with the extra proctection of the 75 substances. The total change is a representation of revenue losses (€233 million), as the cost change estimates for most crops are not available. For carrots and brassica, changes in production would increase variable costs by €3 million. Mushrooms would be most affected from a decrease of the farming toolbox with a loss of €108 million, although 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, the risk that cultivation of these crops will cease in Ireland increases. The threat is created as a result of the medium or high risk of these crops losing their economic viability.

Please, refer to the EU chapter for effects on jobs, land use and carbon footprint.

APPENDIX I – Detailed changes

FRANCE

Crop	Pests	Substance name[1]	Substance type	Compared to alternative	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 lambda-cyhalothrin	Insecticide	Cypermethrin, cyfluthrin, alphametrhin, thau fluvalinate, g cyhalothrin	15%	-1%		
	All weeds	pendimethalin ioxynil chlorotolurun	Herbicide		95%	-10%		
BARLEY	**Total**					**-19%**	**3%**	**11**
	Septoria	triazoles	Fungicide	SDHI, strobilurins	95%	-5%		
	Aphids and cicadel	imidacloprid lambda-cyhalothrin	Insecticide	Cypermethrin, cyfluthrin, alphametrhin, thau fluvalinate, g cyhalothrin	60%	-10%		
	All weeds	pendimethalin ioxynil chlorotolurun	Herbicide		95%	-4%		
GRAIN MAIZE	**Total**					**-8%**	**n.a.**	**8**
	Diseases	triazoles	Fungicide		95%	-/+0%		
	Aphids and cicadellae	imidacloprid thiamethoxam clothianidin	Insecticide	Chlorpyriphos Cypermethrin Tefluthrin	95%	-3%		
	All weeds	pendimethalin s-metolachlor	Herbicide		95%	-5%		
OSR	**Total**					**-5%**	**n.a.**	**38**
	Insects	imidacloprid clothianidin thiacloprid thiamethoxam	Insecticide	All other technologies	95%	-5%		
SUGAR BEET	**Total**					**-35%**	**n.a.**	**70**
	Diseases	cyproconazole difenoconazole epoxiconazole propiconazole tetraconazole quinoxyfen hymexazol iprodione mancozeb maneb thiram	Fungicide		95%	-25%		
	Insects	clopyralid dimethenamid-P ethofumesate fluazifop-p-butyl lenacil s-metolachlor triflusulfuron	Herbicide		95%	-7%		
	Weeds	clothianidin imidacloprid thiamethoxam	Insecticide		95%	-3%		

1 *For beans, OSR, grapes 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*

Crop	Pests	Substance name	Substance type	Compared to alternative	Area affected	Immediate yield (change in %)	Add. resistance effect	Change Production costs (€/ha)
POTATO	**Total**					**-10%**	**n.a.**	**5**
	Diseases	multisite fungicides contact fungicides	Fungicide		95%	-10%		
	Wire worms	imidacloprid	Insecticide	Fosthiazate Chlorpyriphos-ethyl	95%	+/- 0%		
	Weeds	metribuzin	Herbicide		95%	+/- 0%		
GRAPES	**Total**					**-22%**	**n.a.**	**350**
	Guignardia bidwellii Downy mildew	triazoles folpet mancozeb	Fungicide	SDHI, strobilurins	95%	-5%		
	Scaphoïdeus titanus	neonicotinoïds	Insecticide	pyrethrinoids	60%	-10%		
	Weeds	amitrole flumioxazine	Herbicide	mechanical solution glyphosate flazasulfuron, isoxaben, oryzalin, penoxulam	0,9	+/-0		
APPLES	**Total**					**-60%**	**n.a.**	**n.a.**
	Mildew	bupirimate myclobutanil tetraconazole	Fungicide		95%	no figures available		
	Scap	captan difenoconazole fenbuconazole fluquinconazole mancozeb maneb tebuconazole	Fungicide	dithianon	95%	up to -100%		
	Fruit storage disease	thiophan-ate-meythl	Fungicide		95%	no longer used		
	Apple scrap Fly speck Sooty blotch	thiram	Fungicide		59%	no figures available		
	Leaf miners	abamectin	Fungicide		95%	no figures available		
	Moth	beta-cyfluthrin	Insecticide	fenoxycarb	95%	-50% to -100%		
	Aphid	deltamethrin esfenvalerate lambda-cyhalo-thrin spinosad thiacloprid	Insecticide	spinosad	59%	-20% to -100%		
	Aphid	deltamethrin lambda-yhalothrin spirotetramat thiacloprid	Insecticide		95%	-20% to -80%		
	Woolly pucernon	thiamethoxam clothianidin	Insecticide		95%	-20% to -50%		

FRANCE

Crop	Pests	Substance name	Substance type	Compared to alternative	Area affected	Immediate yield (change in %)	Add. resistance effect	Change Production costs (€/ha)
APPLES	all weeds	amitrole carbetamide clopyralid fluazifop-p-butyl flumioxazine fluroxypyr glufosinate glyphosate pendimethalin myclobutanil tetraconazole	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 pendimethalin linuron	Herbicide Herbicide Herbicide	no alternative	20% 95% 95%	-20% -20% -30%		
	Ch. Sol	metam sodium	Other		30%	-20%		
BEANS	**Total**					**-100%**	**n.a.**	**646**
	White mold (Sclerotinia sclerotiorum)	iprodione thiophanate-meythl	Fungicide	boscalid	75%	-100%		
	Black night-shade, thorn apple, annual mercury	s-metolachlor	Herbicide	clomazon	100%	-100%		
	Insects	lambda-cyhalothrin deltamethrin	Insecticide		95%	-30%		
	Aphids	deltamethrin lambda-cyhalothrin	Insecticide	no alternative	67%			
	Seed maggots & wireworms	chlorpyrifos	Insecticide	no alternative	30%			
	Caterpillars	not affected	Insecticide		95%	0%		

GERMANY

Crop	Pests	Substance name [1]	Substance type	Compared to alternative	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 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 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 clothianidin thiacloprid 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%		
	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 clothianidin thiacloprid thiamethoxam	Insecticides	All other technologies	60%	-5%		
	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%		

1 *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*

Crop	Pests	Substance name	Substance type	Compared to alternative	Area affected	Immediate yield (change in %)	Add. resistance effect	Change Production costs (€/ha)
OSR	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 Beflubet-amid	5%	-2%		
	Volunteer rape and other weeds	triflusulfuron	Herbicides	no alternatives	20%	-2%		
	Total					**-49%**	**-25%**	**505**
SUGAR BEET	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-cyhalo-thrin	Insecticide	Alpha-cypermetrin, Pirimicarb	0 bis 25%			
		cyproconazole	Fungicide	Quinoxyfen, Strobilurine	bis 100 %	-15%	n.a.	
		difenoconazole	Fungicide	Sulfur				
		thiophan-ate-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 Night-shade	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

Crop	Pests	Substance name	Substance type	Compared to alternative	Area affected	Immediate yield (change in %)	Add. resistance effect	Change Production costs (€/ha)
SUGAR BEET		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 glyphosate	Fungicides	Compared to 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 ioxynil	Herbicides	No alternatives available		up to 100%		
		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 quinoxyfen triademenol	Fungicides	pyraclostrobin+boscalid, potassium hydrogene carbonate, sulfur	100%	-20%	10% plus up to 10% quality loss	+ 100 €/ha
	Monocotylidones	fluazifop-p-butyl tepraloxydim	Herbicides	none	60%	-3%	0%	+ 50 €/ha
	Basal defoliation	flumioxazine	Herbicides	early defoliation: none	35%	0%	0%	+100 €/ha

UK

Crop	Pests	Substance name	Substance type	Compared to alternative	Area affected	Immediate yield (change in %)	Add. resistance effect	Change Production costs (€/ha)
WHEAT	**Total**					**-12%**	**n.a.**	**EUR 62/ha**
WHEAT	Insects	Bifenthrin esfenvalerate thiacloprid	Insecticide	Metaldehyde and ferric phosphate, lambda-cyhalothrin	34%	-2%		
WHEAT	Septoria and other fungal diseases	carbendazim Azoles	Fungicide	Chlorothalonil, mancozeb, folpet, biaxfen, boscalid, fluxapyroxad and isopyrazam	68-100%	-3%		
WHEAT	Blackgrass and other weeds (including broadleaved)	Pendimethalin ioxynil linuron	Herbicide	Chlorotoluron, clopyralid and glyphosate	52-75%	-20%		
BARLEY	**Total**					**-10%**	**n.a.**	**EUR 50/ha**
BARLEY	Fungal diseases (mildew, fusarium)	carbendazim quinoxyfen Azoles	Fungicide		58%	-1%		
BARLEY	Insects	Bifenthrin esfenvalerate thiacloprid	Insecticide	Cypermethrin, cyfluthrin, alphamethrin, thau fluvalinate, ferric phosphate	21%	-1%		
BARLEY	Blackgrass and other weeds (including broadleaved)	Pendimethalin ioxynil linuron	Herbicide	Chlorotoluron, clopyralid and glyphosate	52-75%	-20%		
OILSEED RAPE	**Total**					**-18%**	**n.a.**	**EUR 67/ha**
OILSEED RAPE	Phoma leaf spot	Metconazole flusilazole	Fungicide	Foliar sprays, prothioconazole	90%	-3%		
OILSEED RAPE	Aphids, turnip yellow virus, cabbage stem flea beetle	Clothianidin imidacloprid thiamethoxam cypermethrin	Insecticide	Ferric phosphate, deltamethrin	67%	17%		
OILSEED RAPE	Volunteer cereals, grass weed and other weed	Carbetamide metazachlor propyzamide	Herbicide		4%	24%		
SUGAR BEET	**Total**					**-12%**	**n.a.**	**EUR 123/ha**
SUGAR BEET	Fungal disease	Cyproconazole	Fungicide	Difenoconazole, benfuracarb, fosthiazate and oxamyl	80%	-15%		
SUGAR BEET	Other pests (cutworms, aphids, moths etc)	Cypermethrin methiocarb	Insecticide	Lambda-cyhalothrin	10%	-15%		
POTATOES	**Total**					**-12%**	**n.a.**	**EUR 467/ha**
POTATOES	Blight	Chlorothalonil fluazinam mancozeb maneb	Fungicide	Benfuracarb, fosthiazate and oxamyl	100%	-10%		
POTATOES	Slugs and other pests (aphids, nematodes etc)	Cypermethrin Methiocarb	Insecticide	Metaldehyde and ferric phosphate, lambda-cyhalothrin	80%	-2%		
POTATOES	Volunteer cereals, grass weed and other weed	Pendimethalin linuron	Herbicide		95%	-1%		
PEAS	**Total**					**-12%**	**n.a.**	**EUR 467/ha**
PEAS	Fungal diseases	Chlorothalonil Metconazole	Fungicide		10%	-20%		
PEAS	Potatoe berries, broadleaved weeds and grass weeds	Pendimethalin	Herbicide		30%	-3%		

POLAND

Crop	Pests	Substance name	Substance type	Compared to alternative[1]	Area affected	Immediate yield (change in %)	Add. resistance effect	Change Production costs (€/ha)
WHEAT	**Total**					**-5%**	**-30%**	**EUR 100-250**
	Aphid	Dimethoate Lambda-Cyhalothrin Imidacloprid Deltamethrin Beta-Cyfluthrin Esfenvalerate Thiamethoxam	Insecticide					
	Leaf diseases (rust, septoriosis), fusarium root rot, powdery mildew	tebuconazole Epoxiconazole Propiconazole Prothioconazole Prochloraz Cyproconazole Metconazole Tetraconazole Difenoconazole Fluquinconazole Carbendazim Thiophanate-methyl triadimenol Mancozeb Folpet Thiram	fungicide					
	Monocot and dicot weeds	Glyphosate Tralkoxydim Metribuzin chlorotolurun Pendimethalin Fluroxypyr Clopyralid Pinoxaden	Herbicide					
MAIZE	**Total**					**-5%**	**-30%**	**EUR 25-200**
	Wireworms, european corn borer, frit fly, western corn rootworm	Lambda-Cyhalothrin Thiacloprid Imidacloprid Deltamethrin	Insecticide					
	ear fusariosis, minor leaf blight, corn smut, maize head smut, seedling blight	Epoxiconazole Triticonazole Thiram	fungicide					
	Monocot and dicot weeds	terbuthylazine Fluroxypyr Pendimethalin S-Metolachlor Linuron Dimethenamid-P Glyphosate	Herbicide					
POTAOES	**Total**					**-20%**	**-70%**	**EUR 200-300**
	Colorado potato beetle, soil pests	Lambda-Cyhalothrin Thiacloprid Esfenvalerate Clothianidin Thiamethoxam Deltamethrin Beta-Cyfluthrin Imidacloprid	Insecticide					
	Potato late blight, alternerìa leaf spot	mandipropamid Fluazinam Mancozeb Captan Metiram Folpet	fungicide					

1 *Best alternatives in Poland will be included in the final report.*

Crop	Pests	Substance name	Substance type	Compared to alternative	Area affected	Immediate yield (change in %)	Add. resist-ance effect	Change Production costs (€/ha)
POTAOES	Monocot and dicot weeds	Lambda-Cyhalothrin Thiacloprid Esfenvalerate Clothianidin Thiamethoxam Deltamethrin Beta-Cyfluthrin Imidacloprid	Herbicide					
	Growth control	Chlorpropham	Other					
SUGAR BEET	**Total**					**-20%**	**-70%**	**EUR 280-300**
	Soil pests, foliar pests	Esfenvalerate Dimethoate beta-cyfluthrin Thiamethoxam Clothianidin Imidacloprid Deltamethrin Thiacloprid Lambda-Cyhalothrin	Insecticide					
	Taro leaf blight, powdery mildew	Epoxiconazole Mancozeb Tetraconazole Tebuconazole Cyproconazole thiophanate-methyl Thiram Hymexazol	fungicide					
	Monocot weeds	Glyphosate lenacil Tepraloxydim Triflusulfuron Clopyralid Ethofumesate Fluazifop-P-Butyl S-Metolachlor	Herbicide					
OSR	**Total**					**-20%**	**-50%**	**EUR 200-300**
	Soil pests, foliar pests	Esfenvalerate Dimethoate Thiamethoxam Clothianidin Imidacloprid Deltamethrin Thiacloprid Lambda-Cyhalothrin	Insecticide					
	Taro leaf blight, powdery mildew	Epoxiconazole Mancozeb Tetraconazole Tebuconazole Cyproconazole thiophanate-methyl Thiram Hymexazol	fungicide					
	Monocot weeds	lenacil Tepraloxydim Triflusulfuron Clopyralid Ethofumesate Fluazifop-P-Butyl S-Metolachlor	Herbicide					

Crop	Pests	Substance name	Substance type	Compared to alternative	Area affected	Immediate yield (change in %)	Add. resistance effect	Change Production costs (€/ha)
APPLES	Total					-20%	-50%	EUR 200-300
	Autumn rapeseed pests, weevil, pollen beetle	Lambda-Cyhalothrin Beta-Cyfluthrin Clothianidin Deltamethrin Esfenvalerate Imidacloprid Thiacloprid	Insecticide					
	Growth control, dry rot, cylindrosporiosis, white mold	Metconazole Difenoconazole Prothioconazole Tetraconazole Tebuconazole Carbendazim thiophanate-methyl Prochloraz Thiram	fungicide					
	Monocot and dicot weeds	Glyphosate glufosinate Fluazifop-P-Butyl Clopyralid Picloram Dimethenamid-P	Herbicide					
BLACK CURRANTS	Total					-20%	-100%	EUR 250-500
	Aphid	Lambda-Cyhalothrin Thiacloprid Thiamethoxam Deltamethrin	Insecticide					
	Anthracnose, powdery mildew	Metiram Mancozeb thiophanate-methyl Bupirimate	fungicide					
	monocot & other weeds	Fluazifop-P-Butyl Glyphosate glufosinate	Herbicide					

SPAIN

Crop	Pests	Substance name[1]	Substance type	Compared to alternative	Area affected	Immediate yield (change in %)	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, Whiteflies Aphids	spirotetramat	Insecticide	Metil, Clorpirifos, Aceites, Parafinicos, Feromonas, Piriproxifen	50%	-10%		10% of variable costs
	Aphids, thrips, minelayer	dimethoate thiamethoxam	Insecticide	Flonicamida, Tau-FLu-valinato		-5%		5% of variable costs
	Red mite, red spider mite, leaf miner	abamectina	Insecticide & acaricide	Piridaben, Etoxazol, Fenpiroximato Spiridiclofen, Hexitiazon	60%	-12%		
	Fruit flies	deltamethrin lambda-cyhalo-thrin spinosad	Insecticide	Etofenprox, Lambda, Chialotrin	30%	-5%		20% of variable costs
	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, Diflufeni-can, Pendimetalin, Dif-lufenican, Oxifluorfen	-10%	35%		
TOMATO (OPEN)	**Total**					**-85%**		**250**
		metribuzin	Herbicides	Rimsulfuron	70%	-100%		
		metam sodium	Other	Oxamilo, Dicloropropeno Organic substances	50%	-50%		
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	mandipropamid	Fungicide		40%	-15%	-6%	
		mancozeb						
	Botritis	iprodione	Fungicide		30%	unknown	unknown	
GRAPES	**Total**					**-13%**	**n.a.**	**n.a.**
	Botritis o Pobredumbre gris (Botrytis cinerea)	Fungicide		13%				
	Mildiu (Plasmopora viticola)		Fungicide		57%			

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

Crop	Pests	Substance name	Substance type	Compared to alternative	Area affected	Immediate yield (change in %)	Add. resistance effect	Change Production costs (€/ha)
GRAPES	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, Powdery mildew, Rust	carbendazim cyproconazole difenoconazole epoxiconazole hymexazol mancozeb maneb prochloraz propiconazole tetraconazole thiophanate-meythl carbendazim	Fungicide	No alternative available	70%	-15% to -30%		
	Flea beetles, Aphids, Weevils, Casida, Noctuids	beta-cyfluthrin clothianidin deltamethrin dimethoate esfenvalerate imidacloprid lambda-cyhalothrin thiacloprid	Insecticide		40%	-10% to -30%		
	Composed, Xanthium, Abutillon, Torilis, Mauve, Crop sprouts like sunflower	clopyralid ethofumesate fluazifop-p-butyl glyphosate lenacil S-metolachlor triflusulfuron	Herbicide		100%	-30%		
RICE	**Total**					**-28%**	**n.a.**	**n.a.**
	Pyricularia	tebuconazole prochloraz propiconazole	Fungicide	Triciclazol Azoxistrobin	80%	-25%		
	Aphids	imidacloprid	Insecticide	Etofenprox	10%	-10%		
	All weeds	MCPB	Herbicide	Penoxulan Bednesulfuron Bentazone, Halosulfuron	100%	-7%		

Crop	Pests	Substance name	Substance type	Compared to alternative	Area affected	Immediate yield (change in %)	Add. resistance effect	Change Production costs (€/ha)
SUN-FLOWER	**Total**					**-15%**	**n.a.**	**n.a.**
		imidacloprid	All other technologies available	Other technologies		-15%		
CHERRY	**Total**					**-15%**	**n.a.**	**1.040**
	Weed	glyphosate	Herbicide			-10%		
	Aphids Aphids Cochinillas, Orugas	dimethoate spinosad chlorpropham	Insecticide Insecticide Insecticide			-25% -25% -10%		
		thiamethoxam						
	Maelybugs, caterpillars	Imidacloprid	Insecticide			-10%		
	Miner, aphids Brown rot, anthracnose	mancozeb tebuconazole	Fungicide Fungicide			-12% -25%		

ITALY

Crop	Pests	Substance name	Substance type	Compared to alternative	Area affected	Immediate yield (change in %)	Add. resistance effect	Change 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%		

Crop	Pests	Substance name	Substance type	Compared to alternative	Area affected	Immediate yield (change in %)	Add. resistance effect	Change Production costs (€/ha)
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%**	
		Leptinotarsia decemlineata	imidacloprid thiamethoxam deltamethrin lambda-cyhalothrin	insecticides	metaflumizone, clorantranilprole, bacillus	70%		
		Phytophthora infestans	fluazinam mancozeb metiram mandipropamid	funghicides	zoxamide, propineb, dimetomorf, cyazofamide, ametoctradin	70%		
		Chenopodium spp. Amaranthus spp. Solanum spp. Cuscuta spp.	linuron pendimethalin metribuzin	herbicides	clomazone, aclonifen, metazaclor, metabromunron	80%		
GRAPES GRAPES (EXAMPLE INPUT: EMILIA)	**Total (Emilia, Friuli, Bolzano)**					**-30%**	**-80%**	
		Panonychus ulmi, Tetranychus urticae Scale (Planococcus ficus, Heliococcus boemicus) Scaphoideus titanus, Empoasca vitis Lobesia botrana	abamectin thiamethoxam spirotetramat Spinosad	Insecticides	pyridaben acetamiprid, clorpirifos metile, buprofezin acetamiprid, buprofezin, acrinatrina clorantranilprole, emamectina, bacillus	30-70%		

Crop	Pests	Substance name	Substance type	Compared to alternative	Area affected	Immediate yield (change in %)	Add. resistance effect	Change Production costs (€/ha)
GRAPES GRAPES (EXAMPLE INPUT: EMILIA)		Erysiphae necator, Plasmopara viticola	dinocap quinoxyfen Bupirimate Difenoconazole myclobutanil Penconazole propiconazole tebuconazole fluazinam Mancozeb folpet mandipropamid metiram	fungicide	sulfur, spiroxamina, kresoxym-metyl, boscalid, metrafenone, potassium bicarbonate propineb, ditianon, dimetomorf	90%		
	Total (Emilia)					**-65%**		**n/a**
APPLES (EXAMPLE INPUT: EMILIA)	Dysaphis plantaginea, Aphis pomi, Eriosoma lanigerume	clothianidin Imidacloprid Thiamethoxam Spirotetramat	insecticide	flonicamid, fluvalinate, pirimicarb	90%			
	Venturia inaequalis	fluazinam Mancozeb metiram Captan Difenoconazole	fungicide	ditianon, dodina, copper, sulfur	90%			
	Total (Emilia)					**-70%**		**n/a**
PEARS (EXAMPLE INPUT: EMILIA)	Cacopsylla pyri	Abamectin Spirotetramat	insecticide	none	90%			
	Stemphylium vesicarium Venturia inaequalis	fluazinam iprodione Captan Tebuconazole Thiram metiram mancozeb Difenoconazole	fungicide	pyraclostrobin + boscalid, fludioxonyl, copper ditianon, dodina, copper, sulfur	90%			
	Total (Piemonte, Friuli, Emilia)					**-40%**	**-80%**	**EUR 250-300**
SOY (EXAMPLE INPUT: PIEMONTE)	weeds ragnetto rosso weeds weeds weeds cimici weeds weeds weeds weeds	pendimethalin Abamectin fluazifop-p-butyl Glyphosate glufosinate lambda-cyhalothrin Linuron Metribuzin S-metolachlor tepraloxydim	Herbicides Insecticide Herbicides Herbicides Herbicides Insecticide Herbicides Herbicides Herbicides Herbicides	imazamox, metribuzim,-linuron not available quizalofop p etile altri diserbi altri diserbi not available metribuzim-oxadiazon linuron not available ciclossidim	90% 100% 60% 50% 50% 100% 50% 50% 100% 50%			

Crop	Pests	Substance name	Substance type	Compared to alternative	Area affected	Immediate yield (change in %)	Add. resistance effect	Change Production costs (€/ha)
BARLEY (EXAMPLE INPUT: FRIULI)	Total (Fruili, Veneto)					-14%	-25%	
	Mal del Piede Dicotilendoni, Infestanti Afidi Fusarium Afidi Dicotilendoni, Infestanti Malerbe infes-tanti Non reg Afidi Dicotilendoni, Infestanti Afidi Non reg Septoria Fusarium Malerbe infes-tanti Malerbe infes-tanti Graminacee, Infestanti Mal del Piede Ruggine Fusarium Fusarium Ruggine Mal del Piede	Cyproconazole clopyralid Deltamethrin Epoxiconazole Esfenvalerate Fluroxypyr Glyphosate glufosinate Imidacloprid ioxynil lambda-cyhalo-thrin Linuron Mancozeb metconazole Metribuzin Pendimethalin Pinoxaden prochloraz propiconazole prothioconazole Tebuconazole Tetraconazole thiophanate-me-thyl	fungicide Herbicides Insecticide fungicide Insecticide Herbicides Herbicides Herbicides Insecticide Herbicides Insecticide Herbicides fungicide fungicide Herbicides Herbicides Herbicides fungicide fungicide fungicide fungicide fungicide fungicide	Altro fungicida Aumento densità semina Altro insetticida Altro fungicida Altro insetticida Aumento densità semina Erpicatura con erpice rotante Altro insetticida Aumento densità semina Altro insetticida Altro fungicida Altro fungicida Aumento densità semina Aumento densità semina Aumento densità semina Altro fungicida Altro fungicida Altro fungicida Altro fungicida Altro fungicida Altro fungicida				
OLIVES (EXAMPLE INPUT: TUSCANY)	Total (Tuscany, Piemonte)					-60%	-100%	EUR 200-400
	mosca mosca/tignola mosca/tignola mosca erbe infestanti erbe infestanti erbe infestanti x x occhio pavone	spinosad deltamethrin dimethoate Imidacloprid Glyphosate glufosinate Amitrole fluazifop-p-butyl tebuconazole mancozeb	insetticida insetticida insetticida insetticida erbicida erbicida erbicida erbicida fungicida fungicida	trappole cromotropicheed alimentari nessuna con la stessa efficacia dimetoato maggiori lavorazioni al terreno e sfalci erba Sali rame	90% 90% 90% 90% 20% 20% 20%			
HAZELNUT (EXAMPLE INPUT: TUSCANY)	Total (Tuscany, Piemonte)					-60%	-100%	EUR 300-500
	erbe infestanti erbe infestanti cloesporium marciumi frutti cytospora cimici afidi balanino	Glyphosate glufosinate thiophanate-me-thyl myclobutanil lambda-cyhalo-thrin	erbicida erbicida Fungicida Fungicida insetticida	Sali rame Sali rame Piretro /etofenprox	30% 30% 90% 90% 90%			

THE NETHERLANDS

Crop	Pests	Substance name	Substance type	Compared to alternative	Area affected	Immediate yield (change in %)	Add. resistance effect	Change Production costs (€/ha)
SEED POTATOES	Total					-15%	-30%	EUR 600
	Green fly, colorado beetle	deltamethrin esfenvalerate dimethoate lambda-cyhalothrin imidacloprid esfenvalerate thiacloprid	Insecticide	pirimicarb, fosthiazate, ethroprofos				
	Nematodes	Metam sodium	Nematicide, Fungicide	oxamyl, fosthiazate, ethroprofos				
	Rhizoctonia, Phytophthora and Alternaria	iprodione mancozeb maneb metiram chlorotolurun fluazinam mandipropamid difenoconazole	Fungicide	azoxystrobine, cyazofamid, fluopicolide+propamocarb, thiabendazool (+imazalil)				
	Weed and desiccation	linuron glufosinate metribuzin tepraloxydim	Herbicide	aclinofen, prosulfocarb, cycloxydim, haloxyfo-P-methyl				
WARE POTATO	Total					-15%	-20%	EUR 400
	Green fly, colorado beetle	esfenvalerate dimethoate lambda-cyhalothrin clothianidin lambda-cyhalothrin thiacloprid	Insecticide	pirimicarb, pymetrozine, flonicamid				
	Nematodes, dry rot	Metam sodium mancozeb maneb metiram fluazinam mandipropamid difenoconazole	Nematicide, Fungicide	fosthiazaat, oxamyl, ethoprofos, cyazofamid, fluopicolide+propamocarb, azoxystrobine, thiabendazool (+imazalil)				
	Weed and desiccation	linuron glufosinate metribuzin pendimethalin tepraloxydim	Herbicide	bentazon, rimsulfuron, diquat, carfentrazone-ethyl				
WINTER WHEAT, BARLEY	Total					-18%	-60%	EUR 50
	Greenfly	deltamethrin dimethoate esfenvalerate lambda-cyhalothrin	Insecticide	fluoxastrobin, fludioxonil, fenpropidin, azoxystrobine				
	Nematodes	Metam sodium	Nematicide, Fungicide					
	Fungal diseases	mancozeb maneb thiram tebuconazole metconazole triadimenol prothioconazole prochloraz propiconazole cyproconazole epoxiconazole prothioconazole	Fungicide					

Crop	Pests	Substance name	Substance type	Compared to alternative	Area affected	Immediate yield (change in %)	Add. resistance effect	Change Production costs (€/ha)
WINTER WHEAT, BARLEY	Weed	ioxynil glufosinate pendimethalin ioxynil	Herbicide					
SUGAR BEET	**Total**					**-36%**	**-46%**	**EUR 60**
	Crane fly larvae, other soil insects, greenfly, yellowing disease, caterpillars, other leaf insects	bifenthrin beta-cyfluthrin clothianidin imidacloprid thiamethoxam deltamethrin lambda-cyhalothrin esfenvalerate	Insecticide	pirimicarb, thiacloprid				
	Nematodes	Metam sodium	Nematicide, Fungicide	oxamyl				
	Leaf mold, seed and soil fungi	clothianidin cyproconazole epoxiconazole quinoxyfen thiamethoxam thiram	Fungicide	Hymexazool, Chloridazon, Metamitron				
	Weed	clopyralid tepraloxydim glufosinate glyphosate	Herbicide					
BELL PEPPER (GLASS)	**Total**					**-70%**	**-100%**	**n/a**
	Greenfly, leaf miner, caterpillar, mite, thrips, white fly	imidacloprid thiacloprid deltamethrin abamectin spinosad spiromesifen	Insecticide	pymetrozine, acetamiprid en pirimicarb, hexythiazox, bifenazate, pyridaben*, cyromazin, beauveria bassiana stam GHA, Lecanicillium muscarium, pyriproxyfen, pymetrozine				
	Botrytis, scerotinia, powdery mildew	iprodione thiram 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 deltamethrin imidacloprid spirotetramat thiacloprid thiamethoxam	Insecticide	spirodiclofen, acetamiprid, Lambda cyhalotrin				
	Scab, powdery mildew, rust, grey mold, septoria	bupirimate captan folpet tebuconazole iprodione mancozeb penconazole propiconazole tebuconazole	Fungicide	dodine, a.o., clethodim, diquat, metobromuron				

Crop	Pests	Substance name	Substance type	Compared to alternative	Area affected	Immediate yield (change in %)	Add. resistance effect	Change Production costs (€/ha)
APPLE TREES	Weeds	fluazifop-p-butyl glyphosate linuron						
	Total					**-80%**	**-90%**	**n/a**
TULIP BULBS	aphids	deltamethrin esfenvalerate imidacloprid lambda-cyhalo-thrin thiacloprid	Insecticide	Pirimicarb Pyrethrinen Aluminum fosfide				
TULIP BULBS		captan carbendazim fluazinam folpet iprodione maneb mancozeb prochloraz tebuconazole prothioconazole thiophanate-me-thyl	Fungicide	Chloorthalonil, Flutolanil, Methyl cyclopropeen				
TULIP BULBS	Nematodes	Metam sodium						
TULIP BULBS	Weeds	glufosinate pendimethalin tepraloxydim Metam sodium asulam chlorpropham dimethenamid-P fluazifop-p-butyl glyphosate s-metolachlor	Herbicide	2,4-D, Aluminum fosfide, Diquat, Chloridazon				

AUSTRIA

Crop	Pests	Substance name [1]	Substance type	Compared to alternative	Area affected	Immediate yield (change in %)	Add. resistance effect	Change Production costs (€/ha)
WHEAT	**Total**					**-15%**	**-2%**	**+/-0%**
WHEAT	Fungal diseases	carbendazim cyproconazole difenoconazole epoxiconazole fluquinconazole mancozeb metconazole prochloraz propiconazole prothioconazole quinoxyfen tebuconazole tetraconazole thiophan-ate-meythl triticonazole	Fungicide	Azoxystrobin, bixafen, cyflufenamid, cyprodinil, fluoxastrobin, fluxapy-roxad, fludioxonil, fen-propidin, fenpropimorph, isopyrazam, pyraclostrob-in, spiroxamine, triflox-ystrobin				
WHEAT	Green fly, cereal leaf beetle, biting insects, sucking insects, diptera, frit fly	beta-cyfluthrin deltamethrin esfenvalerate imidacloprid lambda-cyhalo-thrin pirimicarb thiacloprid	Insecticide	Flonicamid, pirimicarb; zeta-cypermethrin, tau-fluvalinate				
WHEAT	Weed	amidosulfuron chlorotolurun clopyralid diflufenican fluroxypyr glyphosate ioxynil MCPA mecoprop metribuzin pendimethalin pinoxaden 2,4-D	Herbicide	Great number of substances				
WINTER BARLEY	**Total**					**-20%**	**-7%**	**2%**
WINTER BARLEY	Fungal diseases	carbendazim cyproconazole difenoconazole epoxiconazole fluquinconazole mancozeb metconazole prochloraz propiconazole prothioconazole tebuconazole triticonazole	Fungicide	Azoxystrobine, bixafen, cyprodinil, fluoxastrobin, fluxapyroxad, fludioxonil, fenpropidin, isopyrazam, spiroxamine				
WINTER BARLEY	Green fly, cereal leaf beetle, biting insects, sucking insects, diptera, fruit fly	beta-cyfluthrin deltamethrin esfenvalerate imidacloprid lambda-cyhalo-thrin thiacloprid	Insecticide	Flonicamid, pirimicarb; zeta-cypermethrin, tau-fluvalinate				
WINTER BARLEY	Weed	chlortholuron clopyralid flyroxypur glyphosate ioxynil metribuzin pendimethalin pinoxaden	Herbicide	Great number of substances				

1 *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*

Crop	Pests	Substance name	Substance type	Compared to alternative	Area affected	Immediate yield (change in %)	Add. resistance effect	Change Production costs (€/ha)
OSR	Total					-25%	-8%	2%
	Fungal diseases	difenoconazole metconazole prochloraz prothioconazole tebuconazole	Fungicide	Azoxystrobine, boscalid, dimoxystrobin, fluopyram, paclobutrazole				
	Rape flee beetle, soil insects, rape stem weevils, blossom beetles, rape flee beetle, leaf insects, snails	clothianidin imidacloprid thiamethoxam beta-cyfluthrin deltamethrin esfenvalerate lambda-cyhalo-thrin thiacloprid metaldehyd	Insecticide	Cypermethrin, tau-fluva-linate, zeta-cypermethrin, acetamiprid, etofenprox, malathion, pymetrozine				
	Weed	Clopyralid dimethenamid-p fluazifop-p-butyl glyphosate S-metolachlor pendimethalin picloram propyzamide	Herbicide	Bifenox, clethodim, clomazone, cycloxidim, dimetachlor, haloxyfop, napropamide, propaquiza-fop-p, quinmerac, quizala-fop-p, quizalafop-p tefuryl				
SUGAR BEET	Total					-35%	-15%	100%
		cyproconazole difenoconazole epoxiconazole propiconazole tetraconazole thiophan-ate-meythl prochloraz thiram hymexazol	Fungicide	Quinoxyfen, netzschwefel, kupferoxiclorid. S, tro-bi-resistenzen				
		beta-cyfluthrin clothianidin imidacloprid thiamethoxam deltamethrin dimethoate lambda-cyhalo-thrin	Insecticide	Tefluthrin, primicarb, spritzung met Wirkstoffen				
		clopyralid dimethenamid-P ethofumesate fluazifop-p-butyl triflusulfuron lenacil glyphosate	Herbicide					
SEED POTATO	Total					-25%	-10%	4%
	Phytophthora, alternaria, silver scurf	difenoconazole fluazinam mancozeb maneb metiram mandipropamid prothioconazole	Fungicide	metalaxyl-M, benal-axyl-M, propamocarb, fluopicolide, cymoxanil, dimethomorph, benth-iavalicarb, valfenalate, famoxadon, copper, zoxamide, ametoctradin, cyzofamid, azoxystrobin, pyraclostrobin, boscalid, imazalil				

Crop	Pests	Substance name	Substance type	Compared to alternative	Area affected	Immediate yield (change in %)	Add. resistance effect	Change Production costs (€/ha)
SEED POTATO	Greenfly, Colorado beetle	clothianidin esfenvalerate lambda-cyhalo-thrin thiacloprid beta-cyfluthrin deltamethrin imidacloprid spinosad thiacloprid thiamethoxam	Insecticide	pirimicarb, pymetrozine, flonicamid metaflumizone, chlor-antraniliprole, phosmet, azadirachtin, acetamiprid, Bacillus thuringiensis, pyrethrine				
	Weeds	fluazifop-p-butyl linuron metribuzin pendimethalin	Herbicide	flufenacet, aclonifen, pro-sulfocarb, flurochloridone, rimsulfuron, propaqizafop, cycloxydim, quizalo-fop-p-tefuryl, clethodim				
WARE POTATO	**Total**					**-25%**	**-10%**	**2%**
	Phytophthora, alternaria, silver scurf	difenoconazole fluazinam mancozeb maneb metiram mandipropamid prothioconazole	Fungicide	metalaxyl-M, benal-axyl-M, propamocarb, fluopicolide, cymoxanil, dimethomorph, benth-iavalicarb, valfenalate, famoxadon, copper, zoxamide, ametoctradin, cyzofamid, azoxystrobin, pyraclostrobin, boscalid imazalil				
	Greenfly, Colora-do beetle	clothianidin esfenvalerate lambda-cyhalo-thrin thiacloprid beta-cyfluthrin deltamethrin imidacloprid spinosad thiacloprid thiamethoxam	Insecticide	pirimicarb, pymetrozine, flonicamid metaflumizone, chlor-antraniliprole, phosmet, azadirachtin, acetamiprid, Bacillus thuringiensis, pyrethrine				
	Weeds	fluazifop-p-butyl linuron metribuzin pendimethalin	Herbicide	flufenacet, aclonifen, prosulfocarb, clomazone, flurochloridone, rimsulfu-ron, propaqizafop, cyclox-ydim, quizalofop-p-tefuryl, clethodim				
	Sprouting	chlorpropham	Growth regulator	maleinsäurehydrazid				
GAIN MAIZE	**Total**					**-10%**	**-2%**	**+/-0%**
	Corn rootworm	neonicotinoids	Insecticide					

IRELAND

Crop	Pests	Substance name	Substance type	Compared to alternative	Area affected	Immediate yield (change in %)	Add. resistance effect	Change 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 prothioconazole metconazole tebuconazole folpet silthiofam	fungicide	SDHIs (bosclaid, bixafen, fluxapyroxad isopyrazm and penthiopyrad), chloro-thalonil	100%			
	Used as des-icant, grass weeds, BLWs	glyphosate Pinoxaden Pendimethalin	herbicide	mesosulfuron, iodo-sulfuron, 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. Rhyn-hcosporium, net blotch, brown rust and Ram-ularia), Stem / root diseases (e.g. eyespot / take-all), Ear diseases (e.g. FHB)	epoxiconazole prothioconazole metconazole tebuconazole folpet silthiofam	fungicide	SDHIs (bosclaid, bixafen, fluxapyroxad isopyrazm and penthiopyrad), chlorothalonil, Qols (azoxystrobin, fluxostrob-in, pyraclostrobin), specific mildewicides	100%			
	Used as desi-cant, wild oats, canary grass, Grass weeds (pre-drilling), Grass and BLW's	glyphosate Pinoxaden Pendimethalin		diquat, fenoxaprop p ethyl, IPU, Prosulfcarb (Defy)	10-75%			
SPRING BARLEY	**Total**					**-20%**	**-50%**	**n/a**
	Foliar diseases (e.g. Rhyn-hcosporium, net blotch, brown rust and Ram-ularia), Stem / root diseases (e.g. eyespot / take-all), Ear diseases (e.g. FHB)	epoxiconazole prothioconazole metconazole tebuconazole folpet silthiofam	fungicide	SDHIs (bosclaid, bixafen, fluxapyroxad isopyrazm and penthiopyrad), chlorothalonil, Qols (azoxystrobin, fluxostrob-in, pyraclostrobin), specific mildewicides	98%			
	Used as desi-cant, wild oats, canary grass, Grass weeds (pre-drilling), Grass and BLW's	glyphosate Pinoxaden Pendimethalin		diquat, fenoxaprop p ethyl, IPU, Prosulfcarb (Defy)	5-75%			

Crop	Pests	Substance name	Substance type	Compared to alternative	Area affected	Immediate yield (change in %)	Add. resistance effect	Change Production costs (€/ha)
POTATOES	**Total**					**-25%**	**-50-100%**	**n/a**
	aphids	lambda-cyhalo-thrin thiacloprid Dimethoate	insecticide	Flonicamid, Pymetrozin, Cypermethrin, Rimisul-furon				
	Potato late blight, early blight	fluazinam mancozeb mandipropamid	fungicide	Cymoxanil, benthiavali-carb-isopropyl (Valbon), fluopicolide and cyazo-famid				
	Broad and narrow leaved weeds	metribuzin linuron	herbicide	Prosulfucarb,, Diquat, Clomazon, cycloxydim, propaquizafop, Carfentra-zone-ethyl				
SILAGE MAIZE	**Total**					**-50%**	**-50%**	**n/a**
	Weeds	terbuthylazine pendimethalin	herbicide	mesotrione	100%			
BRASSICA (CABBAGE)	**Total**					**-40%**	**-60%**	**EUR 1,300/ha**
	Caterpillars, Flea Beetle, Aphids	Spinosad Thiacloprid deltamethrin esfenvalerate lambda-cyhalo-thrin Spirotetramat	insecticide	indoxacarb (Caterpillar) Pyrethrins (Flea Beetle), Aphids (Pymetrozine, Pyrethrins)	50%			
	Fungal diseases	Azoles	fungicide	Signum, Amistar	70%			
	Weeds	Pendimethalin pendimethalin dimethenamid-P	herbicide	metolachlor, clopyralid	90%			
CARROTS MAIZE	**Total**					**-55%**	**75%**	**EUR 2,700/ha**
	Aphids, Root Fly	Thiacloprid lambda-cyhalo-thrin	Insecticides					
	Fungal diseases	Azoles Mancozeb	fungicide					
	Broad leaf and grasses	Pendimethalin linuron metribuzin	herbicide					
MUSH-ROOMS	**Total**					**-40%**	**-40%**	**n/a**
	Cobweb, Verti-cillium, 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 ferti-lizer (€/ha)	Avg crop protection costs (€/ha)	Avg other variable costs (€/ha)	Total vari-able 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
GRAPES	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 ferti-lizer (€/ha)	Avg crop protection costs (€/ha)	Avg other variable costs (€/ha)	Total vari-able 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 ferti-lizer (€/ha)	Avg crop protection costs (€/ha)	Avg other variable costs (€/ha)	Total vari-able 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 ferti-lizer (€/ha)	Avg crop protection costs (€/ha)	Avg other variable costs (€/ha)	Total vari-able 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 CUR-RANTS	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 ferti-lizer (€/ha)	Avg crop protection costs (€/ha)	Avg other variable costs (€/ha)	Total vari-able 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
GRAPES	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					
GRAPES	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	1,200	320,400					64,553

APPENDIX III - Methodology

YIELD EFFECTS

IMMEDIATE YIELD CHANGE (%)

1. To estimate the changes in yields per crop and per country requires various analytical steps:
2. Identification of specific pests/diseases affecting the crop
3. Identification of substances used to treat the crop
4. Estimation of the area size on which the substances are applied
5. Description of remaining available alternatives
6. Assessment of the immediate yield changes
7. Evaluation of future resistance effects

The starting point for the analysis is the identified pests/diseases occurring per crop in a particular country. Subsequently, based on the list of the 75 substances at risk of becoming unavailable, experts distinguished those used treat the identified these pests/diseases. This filtering process is performed for each crop and type of pesticide (insecticide, herbicide, fungicide, disinfection).
In order to complete the estimation, the overall impact is balanced by the area size on which the substance is applied. This is influenced by the share of total agricultural area of a specific crop affected by the pest/disease as well as the market share of the substance and the organic share of production.

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

With this formula, the crop experts estimated the potential yield losses due to the withdrawal of the substance for each pest. Where possible, the estimation was based on agronomic references, consisting of comparing yield per hectare obtained with use of the substance to the yield obtained with remaining alternatives. These alternatives can be other substances or different farming techniques, *etc.*
To illustrate with an example, if neonicotinoids were to be removed, the remaining alternative for protecting barley from 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:

$$\left[\frac{\text{Technical loss=1.25t/ha}}{\text{Average yield= 6,4t/ha}}\right] \times [\text{Area affected = 40\%}]$$

= -9.4%

If a crop is affected by several pests, different categories of loss may be added. However, this should be determined on a case-by-case basis. Particular caution was paid to avoid double counting: in case plants are affected by multiple pests, the individual substances contribute to the overall yield to the lesser extent. E.g. if a crop did not develop optimally due to insects, using fungicides would have a smaller added value etc. For some specialty crops, especially when the number of pesticide solutions is low to begin with, withdrawal of one or more substances may affect the crop heavily. In this case it the yield effect related to losing the 75 substances could be equal to the total average yield of that crop.

RESISTANCE EFFECTS AND CROP PROTECTION COSTS (%)

Long-term effects of the withdrawal of the 75 substances could be an increase in 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 and depending on the amount of alternatives remaining thus taking into account the more frequent risk for the whole modes type of pesticide. For example:

EXTRAPOLATION

The extrapolation is carried out over 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 from EU countries, outside of the nine selected countries.
3. The average farm-gate price and variable crop production costs, relevant to calculating the total gross margin change, double as total EU averages. The farm-gate price is based on EUROSTAT information for EU-28 while the variable crop production costs are the weighted average of the nine countries studied here in detail.

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

	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 of crop protection by 5%
   - Medium risk: increase costs of crop protection by 10 %
   - High risk: increase costs of crop protection by 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.

ENVIRONMENTAL IMPACT

CHANGE IN GREENHOUSE GAS (GHG) EMISSIONS (% OF CO2 EQ T/HA)

This indicator is linked to a change in treatment frequency. According to agro-economists, the amount of GHGs emitted might consequently increase in the same ratio as the number of applications.
Sometimes the alternative solution is a cultivation pass. The energy used by the tractor, however, is higher than what is needed in a sprayer application. The change in GHG must therefore be indicated. The methodology requires no calculations and is based on accurate data.

CHANGE IN TREATMENT FREQUENCY

This indicator may be specifically relevant for some countries. For example, when a seed treatment (neonicotinoids) is replaces by a conventional spray (pyrethrin), at least two treatments are required to obtain the same result. The treatment frequency has thus been increased by 100% (1→2). The experts we worked with recommend including this information close to the "change in protection cost" data as, in many cases, increasing costs also correspond to increased 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[1]
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	Andersons Centre; 'The effect of the loss of plant protection products on UK agriculture and horticulture and the wider economy'; 2014	Study	
INSECTICIDE	Andersons Centre; 'The effect of the loss of plant protection products on UK agriculture and horticulture and the wider economy'; 2014	Study	
HERBICIDE	Anderson Centre; '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 WUR Study	Experts Study Experts	
INSECTICIDE			
HERBICIDE			
IRELAND			
FUNGICIDE	Teagasc	Experts	
INSECTICIDE			
HERBICIDE			
AUSTRIA			
FUNGICIDE	Landwirtschaftskammer Niederösterreich Landwirtschaftskammer Oberösterreich	Experts	
INSECTICIDE			
HERBICIDE			

1 *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*

***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' Arvalis Institute	Study Experts	
HERBICIDES	Arvalis Institute	Experts	
	UK		STUDY
FUNGICIDES	Andersons; 'The effect of the loss of plant protection products on UK agriculture and horticulture and the wider economy'; 2013	Study	
INSECTICIDES	Andersons; 'The effect of the loss of plant protection products on UK agriculture and horticulutre and the wider economy'; 2014	Study	
HERBICIDES	Andersons; 'The effect of the loss of plant protection products on UK agriculture and horticulture 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	Study Wageningen University Piet Spoorenberg, WUR Aaldrik Venhuizen, Agrifirm	Experts Study Experts	
INSECTICIDES			
HERBICIDES			
	IRELAND		
FUNGICIDES	Teagasc	Experts	
INSECTICIDES			
HERBICIDES			
	AUSTRIA		EXPERT
FUNGICIDES	LK NÖ bzw. LK OÖ		
INSECTICIDES			
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 Arvalis Institute	Study Experts	
HERBICIDES	Arvalis Institute	Experts	
	UK		STUDY
FUNGICIDES	Andersons; 'The effect of the loss of plant protection products on UK agriculture and horticulu-tre and the wider economy'; 2013	Study	
INSECTICIDES	Andersons; 'The effect of the loss of plant protection products on UK agriculture and horticulutre and the wider economy'; 2014	Study	
HERBICIDES	Andersons; 'The effect of the loss of plant protection products on UK agriculture and horticulu-tre 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 Expert	
INSECTICIDES	Humboldt Forum for Food and Agriculture; 'The value of neonicotinoid seed treatment in the European Union'; 2013	Study Expert	
HERBICIDES		Study Expert	
	IRELAND		
FUNGICIDES	Teagasc	Experts	
INSECTICIDES			
HERBICIDES			
	AUSTRIA		
FUNGICIDES	Austrian Chamber of Agriculture	Expert	
INSECTICIDES			
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	Andersons	Study	
INSECTICIDES	Andersons	Study	
HERBICIDES	Andersons	Study	
	GERMANY		SRQ
FUNGICIDES	Bavarian State Research Center for Agriculture; Nechwatal, J, Wagber, S. and Zellner, M.: Pflan-zenschutzrückblick 2014	Study	
INSECTICIDES	no information available		
HERBICIDES	Landwirtschaftskammer NRW	Experts	
	POLAND		
FUNGICIDES	Fed of agri producers		
INSECTICIDES			
HERBICIDES			
	NETHERLANDS		STUDY
FUNGICIDES	WUR and Agrifirm Study Wageningen University		
INSECTICIDES		Study + Expert	
HERBICIDES			
	IRELAND		
FUNGICIDES	Teagasc	Experts	
INSECTICIDES			
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 Arvalis Institute	Experts Experts	
INSECTICIDES	Institut Technique de la Betterave Arvalis Institute Humboldt Forum for Food and Agriculture; 'The value of neonicotinoid seed treatment in the European Union'; 2013	Experts Experts Study	
HERBICIDES	Institut Technique de la Betterave Arvalis Institute	Experts Experts	
	UK		STUDY
FUNGICIDES	Andersons; 'The effect of the loss of plant protection products on UK agriculture and horticulture and the wider economy'; 2014	Study	
INSECTICIDES	Andersons; 'The effect of the loss of plant protection products on UK agriculture and horticulture and the wider economy'; 2014	Study	
HERBICIDES	Andersons; '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 Trinity College Dublin, Institut für Agribusiness; 'Restricted availability of azole-based fungicides'; 2011	Expert Study	
INSECTICIDES	Landwirtschaftskammer NRW Humboldt Forum for Food and Agriculture; 'The value of neonicotinoid seed treatment in the European Union'; 2013	Expert Study	
HERBICIDES	Landwirtschaftskammer NRW	Expert	
	SPAIN		SRQ
FUNGICIDES	Aimcra	Experts	
INSECTICIDES	Aimcra	Experts	
HERBICIDES	Aimcra	Experts	
	NETHERLANDS		STUDY
FUNGICIDES	WUR, IRS Study Wageningen University	Experts Study	
INSECTICIDES			
HERBICIDES			

Table 19: Data sources maize

Maize	Source	Type	Total estimate
	GERMANY		
FUNGICIDES	Humboldt Forum	Study Expert	Yes
INSECTICIDES			
HERBICIDES	Landwirtschaftkammer NRW		
	AUSTRIA		
FUNGICIDES	Austrian Chamber of Agriculture / LK Steiermark	Expert	
INSECTICIDES			
HERBICIDES			
	FRANCE		
FUNGICIDES	Arvalis Institute Humboldt Study	Study Expert	
INSECTICIDES			
HERBICIDES			
	POLAND		
FUNGICIDES	Fed of agri producers		
INSECTICIDES			
HERBICIDES			
	ITALY		
FUNGICIDES	Confagricoltura, Coldiretti	Expert	No
INSECTICIDES	Confagricoltura, Coldiretti, Humboldt	Study 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 Agrar-wirtschaft 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	Landwirtschaftskam-mer 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	Grapes	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	Grapes	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 und Produktion-stechnik
GERMANY	Onions	2009-2013	Eurostat		Koordination Pflanzenschutz Gemüsebau Dien-stleistungszentrum 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

Country	Crop	Year	Source base data	Year	Source variable costs data
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/nec-tarines	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
SPAIN	Sunflower	2009-2013	Eurostat	2010	Brookes
SPAIN	Rice	2009-2013	Eurostat		AVA-ASAJA
SPAIN	Grapes	2009-2013	Eurostat	2012	FADN (Spain - Grapes)
SPAIN	Olives	2009-2013	Eurostat	2009-2012	FADN (Spain - Horticulture)
UK	Wheat	2009-2013	Eurostat	2010	Brookes
UK	Barley	2009-2013	Eurostat	2010	Brookes

Country	Crop	Year	Source base data	Year	Source variable costs data
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

(Footnotes)

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

2 *Note that the yield effect refers to banning NNIs only*

3 *Given data availability, as compared to an untreated situation.*

4 *For beans, OSR, grapes 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*

5 *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*

6 *Best alternatives in Poland will be included in the final report.*

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

8 *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*

9 *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*

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