
The cumulative agronomic and economic impact of glyphosate in Europe

TOP-LEVEL EU28 RESULTS AND COUNTRY CHAPTERS
FEBRUARY 2017

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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.

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Track record SEIA

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

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EXECUTIVE SUMMARY

The viability of European agriculture has been put under pressure as a result of the EU moving towards hazard-based legislations putting several substances at risk of being withdrawn. While no definitive decision on the active substances affected has been made yet, glyphosate is currently awaiting its ECHA evaluation before a decision will be made on its re-approval.

A total of 400 substances with varying efficacy are currently available. However, glyphosate is amongst the most efficient substance to protect crops against weed in the farmer's toolbox. And, 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. Second, the pipeline of products waiting for approval for the European market is also diminishing due to rising Research and Development (R&D) time and costs (i.e. 70 substances in the pipeline in the 2000, down to 28 in 2012).

Against this background, this study aims to shed light on the current value of glyphosate for European agriculture. It focuses on seven staple crops at the EU level and selected crops across five EU member states, representing 40% of crop value produced in EU28.¹ 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:

- Another important pillar for this study is Steward Redqueen's previous assessment of the cumulative impact of hazard-based legislation on crop protection products in Europe². That assessment investigated the current added value of 75 substances identified by the Andersons Centre³ for the same staple crops across the nine largest agricultural markets in Europe;
- We studied the five largest EU agricultural markets and extrapolated these effects to the EU level;
- The selection of crops included in the scope of the study is based on relevance of various crops on country level and for extrapolation on their share of total European output;
- We use the best available national and EU databases on crop production and cost structures (e.g. EUROSTAT, FAOSTAT, FADN, WUR, Teagasc, DEFRA).

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

¹ Wheat, barley, sugar beet, potatoes, grapes, OSR and maize at EU28 level and Citrus, Olives (Spain), tomatoes (Italy) and peas (UK) represent €86bn crop value of €198bn total EU28 crop value.

² "Cumulative impact of hazard-based legislation on crop protection products in Europe"; 2016; Steward Redqueen

³"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.

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

1. Usage of glyphosate in the cultivation of seven key staple crops in the EU (potatoes, barley, wheat, sugar beet, rapeseed, maize and grapes) contributes at least 25 million tons of harvested volume or between €4.2 and 9.6bn in crop value:
 - Potatoes, sugar beet and grapes could face 1-3% lower yields
 - Yield for rapeseed, barley, wheat and maize might decrease by up to 7-22%;
 - Higher short-term yields and lower production costs for these crops support farmer income of between €6 and €11bn: between €4.2 and €9.6bn relates to revenues, and €1.9bn to costs;
 - With glyphosate, overall farm profitability is up to 25% higher (€11bn of a total of €44bn);
 - In value, wheat benefits with between €2.4 and €4.8bn revenues the most from using glyphosate;
2. Glyphosate supports the specialty crops peas, tomatoes, citrus and olives with 0.6 up to 0.7 billion of farm income.
3. Glyphosate supports rural employment:
 - In the five countries a total of 1.9 million people are directly engaged in crop agriculture. Out of them, 0.5m jobs are contingent upon the seven staple and four specialty crops covered in this study. Based on changes in profitability, the immediate job security risk seems low to medium.
4. At current crop demand, glyphosate supports the EU's self-sufficiency for wheat, barley, and potatoes, while limiting the import levels of rapeseed, sugar beet and maize:
 - In contrast to the current situation with a positive trade balance, without glyphosate, the exported volume for wheat could reduce with 75%. Overall, the EU could become a net importer for most of its key staple crops;
 - 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;

1 INTRODUCTION

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

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, farm profitability and crop agriculture employment;
- 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 effects of the hazard-based regulation for crop protection products containing the active substance glyphosate in Europe. The insights provided can be used to proactively inform stakeholders, engaging into fruitful debates based on factual arguments.

1.1 Glyphosate, EU Legislation and other socio-economic research

Glyphosate is the most widely used herbicide in agriculture. It is used to treat agricultural area against weed, especially broadleaf and grasses that compete with crops. Various reviews analysed the effects of glyphosate among which the WHO's International Agency for Research on Cancer (IARC) concluded in March 2015 that the substance is "probably carcinogenic in humans". This statement was followed by FAO/WHO's Meeting on Pesticide Residues in May 2016 stating that "glyphosate is unlikely to pose a carcinogenic risk to humans from exposure through the diet". This in addition to EU's food safety body (EFSA), that similarly concluded in November 2015 that "the substance is unlikely to be genotoxic (i.e. damaging to DNA) or to pose a carcinogenic threat to humans".

The current status of glyphosate in the EU is that the European Commission (EC) decided on June 28 (2016) to extend glyphosate's license by 18 months (until end 2017), until the European Chemical Agency (ECHA) provides its opinion on this active substance.⁴

The potential removal of glyphosate from the European market will have significant socio-economic consequences for farmers including self-sufficiency of key EU crops and the broader crop value chains. Several research bodies have examined the effects of a glyphosate ban on crop production, among others the German Institute for Agribusiness (2011) and the agriculture-economic department of the Göttingen University (Germany). Without glyphosate, both studies expect that soil treatments will be intensified as no viable alternative is available. This implies a combination of more use of mechanical tillage and labour, depending on the region, soil and crop type. The 2011 study claims yield losses for OSR (10%), sugar beet (up to 5%), maize (up to 10%), and wheat (10%), while production costs are likely to increase. The 2016 study concludes that yields for winter wheat, rye and winter barley could decrease by 20-60% and production costs will increase. For maize and sugar beet, this study does not expect yield losses, but still significant increases in production costs.

This research will provide more insight the in socio-economic effects of having glyphosate available in five key agricultural countries in Europe and at the EU level.

⁴ Commission prolongs Glyphosate licence by 18 months, EURACTIV, June 2016

1.2 Scope

This study aims to shed light on the current value of glyphosate used in pesticides for European agriculture. This analysis is performed by investigating the implications of withdrawal of these substances.

Table 1: Geographical scope & crops

Member State	Crop 1	Crop 2	Crop 3	Crop 4	Crop 5
France	Wheat	Barley	Potatoes	Sugar beet	
UK	Wheat	OSR	Peas		
Germany	Wheat	Barley	Potatoes	Sugar beet	OSR
Spain	Citrus	Olives			
Italy	Maize	Tomatoes	Grapes		

In terms of crops considered, the study focuses on seven staple crops and four specialty crops⁵ across five EU member states. The implications on national levels are extrapolated to EU28 totals. Altogether, the study covers 40% of the total EU crop value.⁶

1.3 Methodology & Data

1.3.1 Methodology

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

- Withdrawal effects of glyphosate are compared to its best currently available alternative in the farmers' toolbox and to Good Agricultural Practices (including chemical, biological, mechanical and cultural practices);
- All crop protection productions containing glyphosate are withdrawn 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) 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 where possible cost, effects.

The first step is to investigate which weeds, pests and diseases are the main threats to the cultivation of a particular crop. Consequently, the study establishes which substances farmers currently apply to fight these threats. The analysis of the alternatives which remain available after withdrawing glyphosate leads to the new farming toolbox. 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

⁵ Staple crops: wheat, barley, potatoes, sugar beet, OSR, maize and grapes; specialty crops: olives, tomatoes, peas, citrus.

⁶ Wheat, barley, sugar beet, potatoes, grapes, OSR and maize at EU28 level and Citrus, Olives (Spain), tomatoes (Italy) and peas (UK) represent €86bn crop value of €198bn total EU28 crop value.

currently applied. This depends on the share of organic production and areas where pest pressures are low.

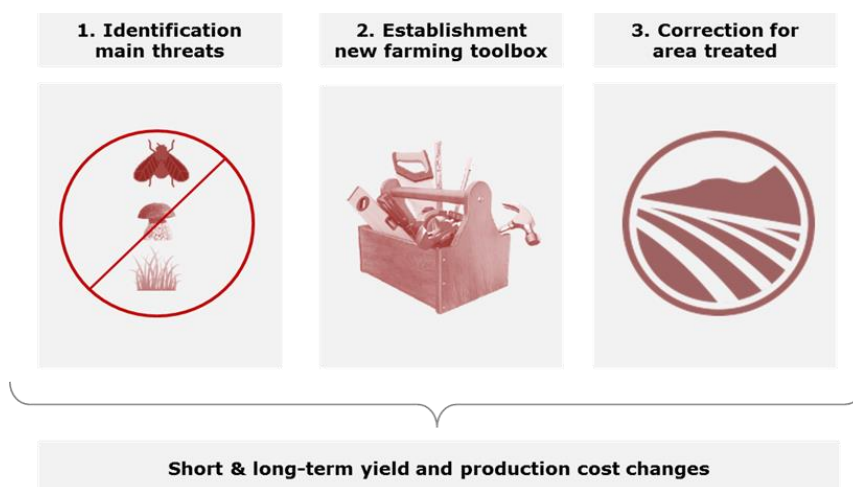


Exhibit 1: Overview of approach

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

The research further distinguishes the short-run substitution and long-run resistance effects of not having glyphosate available. The former refers to the immediate effects of shifting to treatment with best alternatives. Long-term resistance effects might occur over time once weeds 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. 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.

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

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

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

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

1.3.2 Data

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

Table 2: Overview of contributing parties

France	Germany	UK	Italy	Spain
UIPP	IVA	CPA	Agrofarma	AEPLA
FNSEA	DBV	NFU	Coldiretti	Cooperativas Agro-Alimentarias
Arvalis Institute	LK NRW	AHDB	Confi-agricoltura	COEXPHAL
Institut Technique de la Betterave	Bavarian State Research Center for Agriculture	PGRO		
	University of Göttingen			

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

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

2 EU RESULTS

This section analyses the effects of a withdrawal of glyphosate for the staple crops covered in the study on EU level.

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

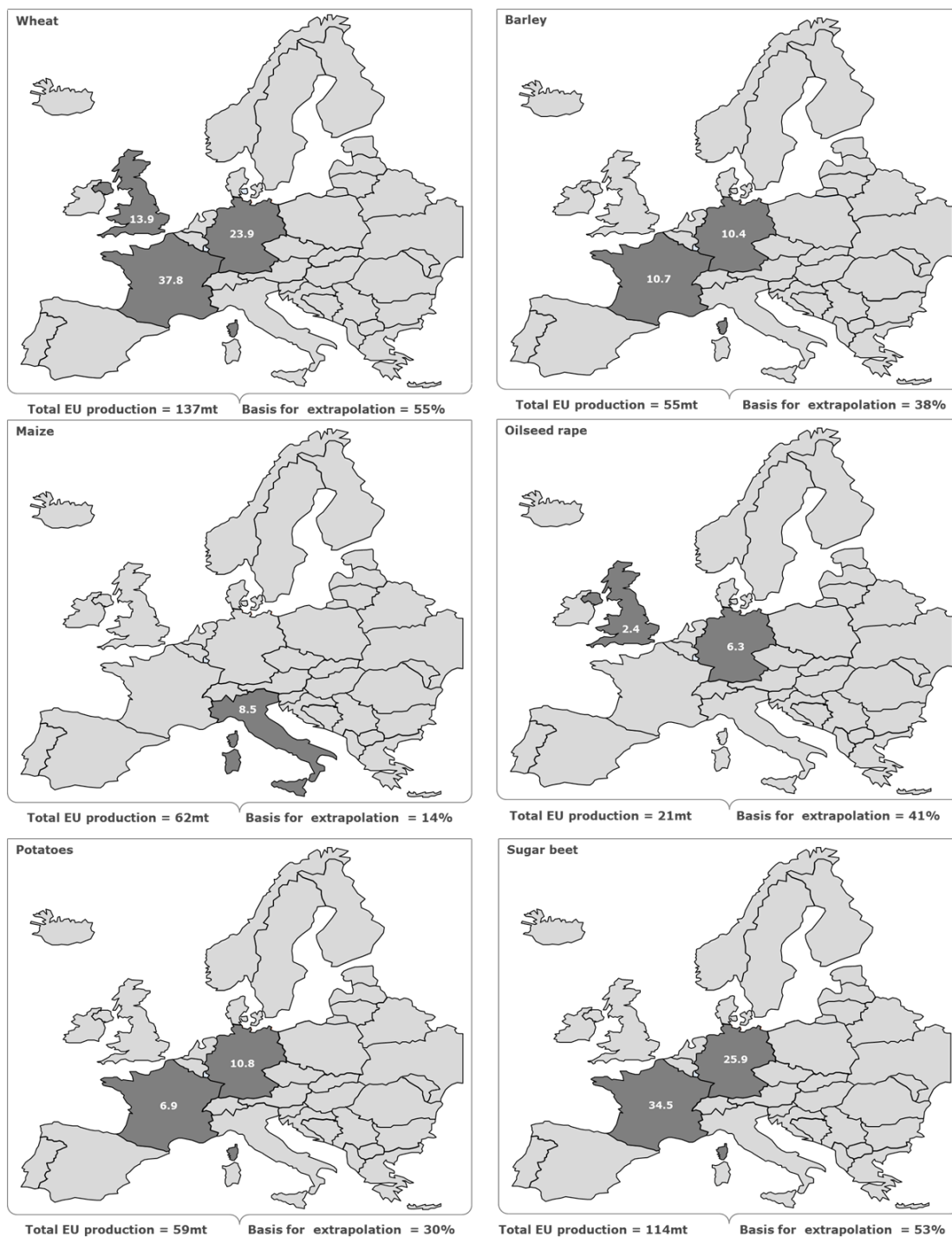


Exhibit 2: EU crop production basis for extrapolation (in million ton)

The farm-level data for wheat, barley, oilseed rape (also OSR hereafter), potatoes and sugar beets cover between 38% and 55% of the total EU production of the particular crop. For grapes (not depicted in Exhibit 2) and maize the percentage is lower: respectively 28% and 14%. The higher the percentage of output covered on a country-by-country level, the more likely the extrapolation will be representative for the EU as a whole. Therefore, the results of maize (14%) are an indication of the EU28 impact of glyphosate, but much representative than other six staple crops.

Applying the weighted average effects to the current situation, the assessment estimates the implications of a possible glyphosate withdrawal. Table 3 below summarizes the total crop production as well as how much land is cultivated in EU28 for an average year⁷. This official information forms the baseline for our comparison.

Table 3: Overview crop agriculture in EU28

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

2.1 Short-term yield, output and income effects

Exhibit 3 below provides an overview of the immediate variations in tons harvested per hectare. The potential short-term yield effects in this exhibit are depicted in ranges as received from the experts (see also Section 2). For OSR the range (8-22%) is the widest. Similar to the results found in the overall cumulative impact assessment, the extent of the expected yield change varies for the crops considered. Glyphosate seem to be most beneficial for the cultivation of OSR, barley, wheat and maize (between 7 to 22%).

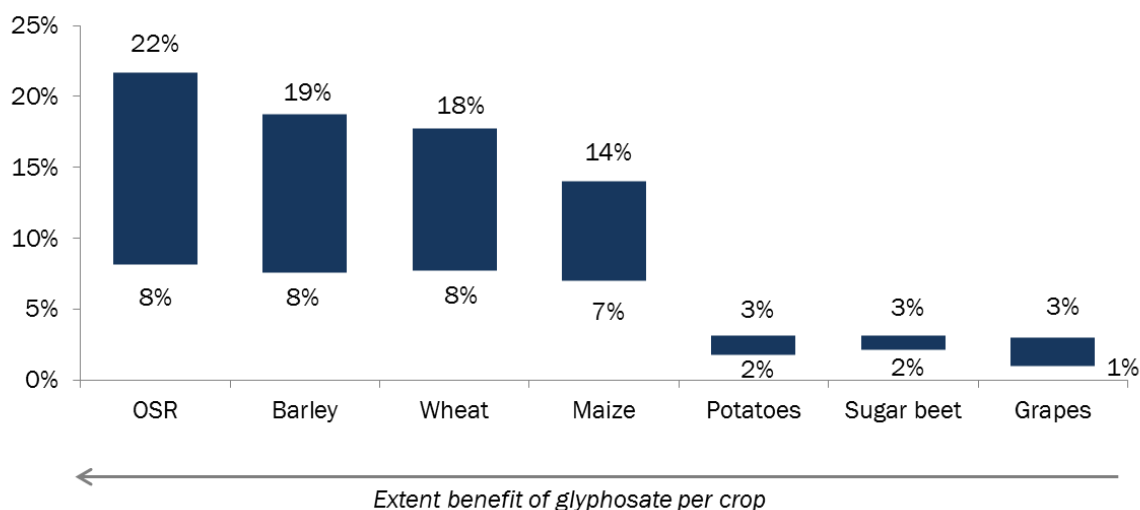


Exhibit 3: EU-level short-term yield change (range %/ha)

⁷ Based on EUROSTAT farm statistics 2009-2013

Glyphosate contributes also significantly to lowering the costs of production. This seems most beneficial for barley, wheat and maize (see Exhibit 5) between 6-7% of variable costs.

Experts involved in the research indicated that glyphosate is crucial in the intercropping period. For instance, in France nearly 80% of glyphosate is used during the intercropping period – and more or less 20% in pre-emergence and before harvest. Without glyphosate, the weed pressure of in particular black grass would increase (higher density). The French situation is similar to the situation in the UK, but with resistance even stronger challenge to control blackgrass, due to the cool climate and continuous growth of weeds during winter. An alternative for glyphosate is mechanical crop control, but experts explain this procedure it is less efficient (time consuming) and demands more fuel.

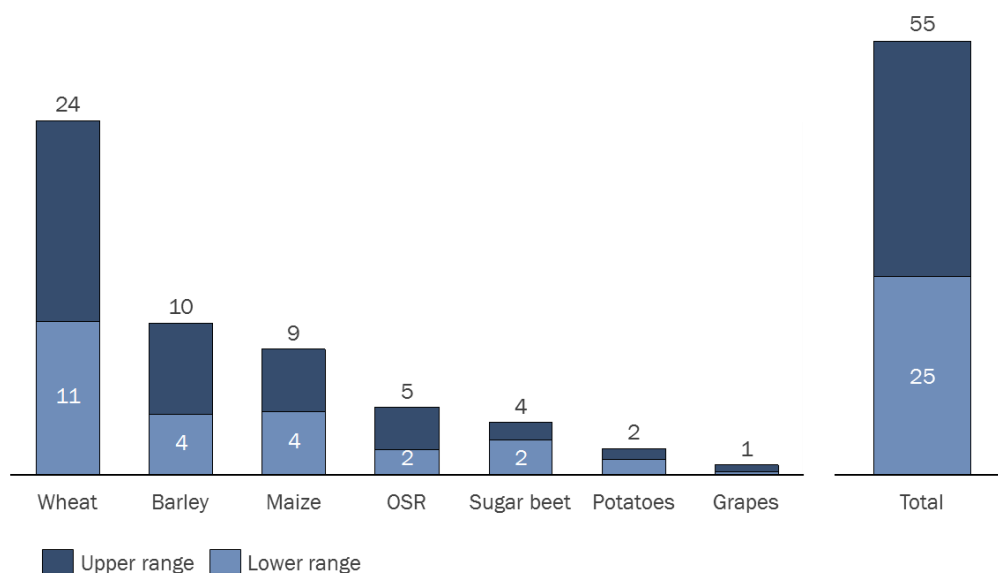


Exhibit 4: Output changes (in million tons per year)

Experts involved in the research indicated that glyphosate is crucial in the intercropping period. For instance, in France nearly 80% of glyphosate is used during the intercropping period – and more or less 20% in pre-emergence and before harvest. Without glyphosate, the weed pressure of in particular black grass would increase (higher density). The French situation is similar to the situation in the UK, but with resistance even stronger challenge to control blackgrass, due to the cool climate and continuous growth of weeds during winter. An alternative for glyphosate is mechanical crop control, but experts explain this procedure it is less efficient (time consuming) and demands more fuel.

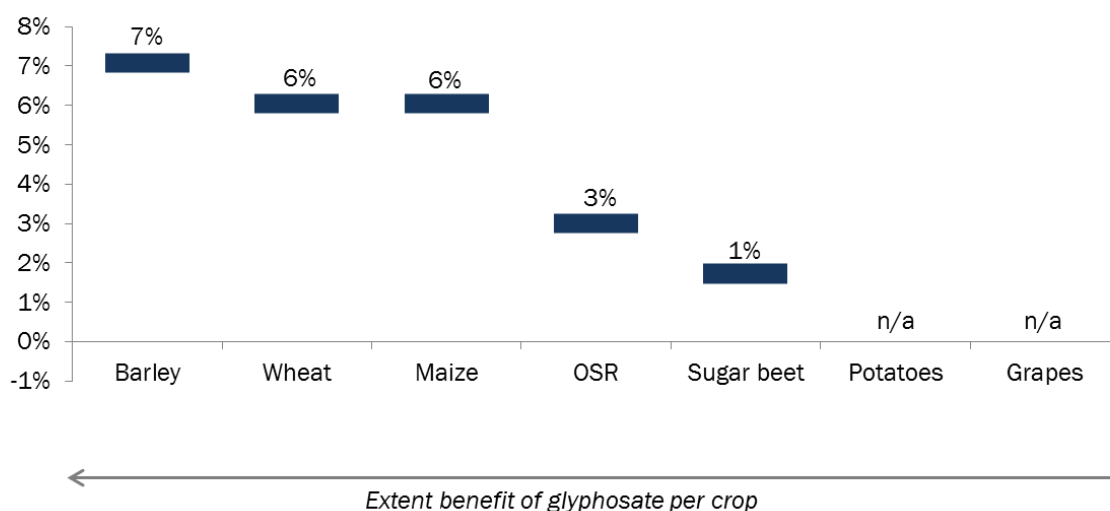


Exhibit 5: EU-level short-term variable costs changes (range %/ha)

In total, EU crop output is currently between 25 and 55 million tons (=Mt) more than would be possible without the use of glyphosate. In other words, having this herbicide in the farming toolbox equates to between 25 and 55 million tons additional crop output, 11 to 24 million tons of which is wheat. These results are driven by the yield change (see Exhibit 3) as well as the area on which they are typically cultivated (see Table 3).

Output changes differently affect farm revenues, production costs and the economic viability of cultivating the crops. The exhibit below focuses on the range of possibly foregone farm revenues and production costs. In absolute terms, wheat is most severely affected with a farm income loss of € 2.4 to 4.8 billion. In total, incomes in European agriculture could decrease by € 6 to 11 billion. The economic viability of potatoes, grapes, and OSR cultivation is most affected (20 to 50%) in terms of gross margin change.

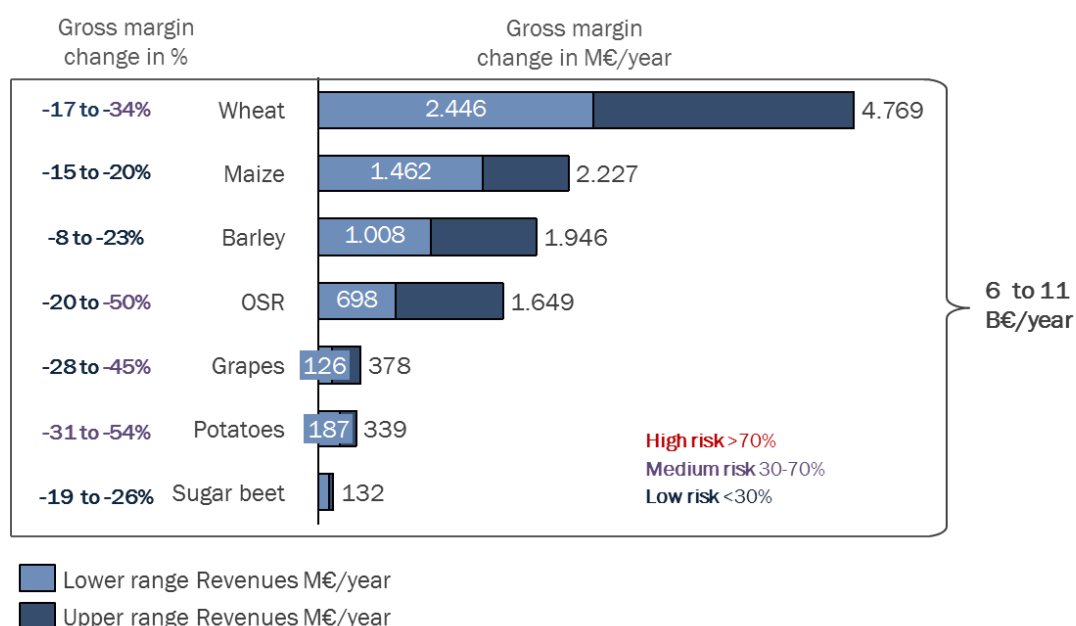


Exhibit 6: EU-wide changes in farm revenues and gross margins

2.2 Farm-employment effects

According to official statistics for the five countries in scope, 1.9 million jobs rely on crop agriculture. Allocating these 1.9 million jobs to the various crops based on the value of the crops reveals that 0.5m jobs are contingent upon the seven staple and four specialty crops⁸ in the scope of this study (see Exhibit 7). As Exhibit 6 shows, glyphosate influences the economic viability of the cultivation of certain crops, ranging from 10-30% gross margin support for barley, wheat, sugar beet and maize, up to a potential 20-50% for OSR, grapes and potatoes. This also translates into job security of employment related to these crops. The lower yield and higher production costs results in some deterioration in the financial sustainability of farm businesses without these substances. This puts employment for 0.5m agricultural workers, especially for farmers involved in producing potatoes, OSR and grapes, at low to medium risk. Furthermore, the results represent the averages for each agricultural crop sector. Individual farm businesses might be pushed beyond their limits and put some jobs at a substantial (high) risk.

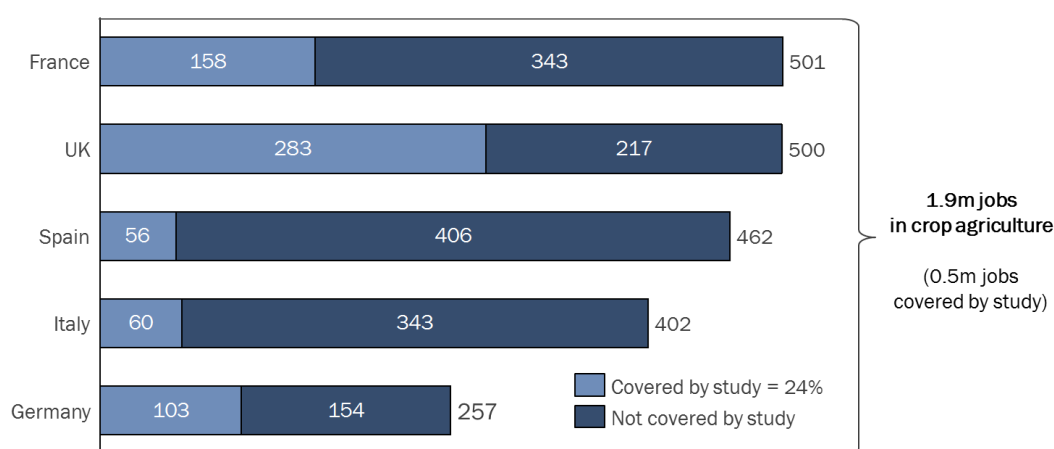


Exhibit 7: Total employment in crop agriculture

2.3 Self-sufficiency and trade effects

The farm-level changes, the changes to yields and costs described above, also affect the competitiveness of EU agriculture and 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. 13.5 Mt of wheat, 3.4 Mt of barley and 0.7 Mt of potatoes are exported to countries outside of the EU. Withdrawal of glyphosate would lead to a situation in which the trade balance worsens and for some crops becomes negative. For wheat for example the estimated yield reduction of between 8 and 22% would cause the exported volume to diminish and the EU would need to import a substantial amount (up to 10 Mt) wheat from outside the EU. Also for barley and potatoes the EU would move from net exporter to net importer to fulfil its demand.

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

⁸ Tomatoes, olives, citrus fruits, peas

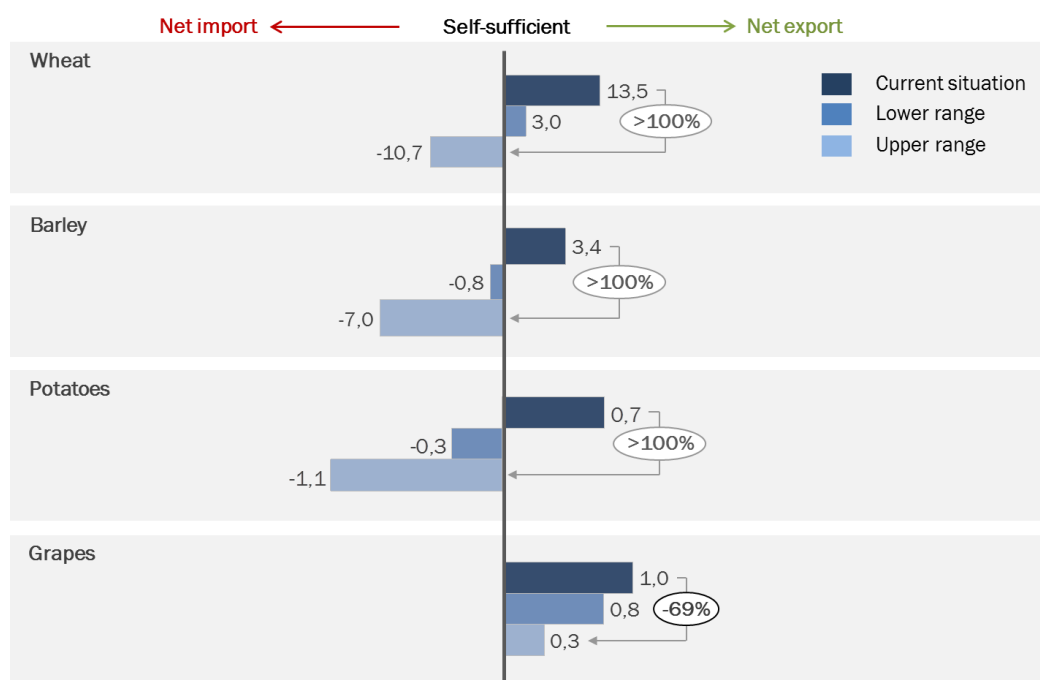


Exhibit 8: Trade balance shift for currently net exported crops (million tons=Mt)

Currently, with glyphosate being available, the EU’s demand for maize and oilseed rape is already partially fulfilled by imports. Out of the 65 Mt of maize consumed in the EU annually, around 4 Mt are currently imported from outside the EU. Based on the analysis of yield changes, we estimate that this will increase to up to 12.5 Mt to be imported consequently to withdrawing glyphosate. For OSR the situation would be similar. For sugar beets the EU would not be self-sufficient anymore after the withdrawal and would need to import 3.7 Mt to fulfil its demand.

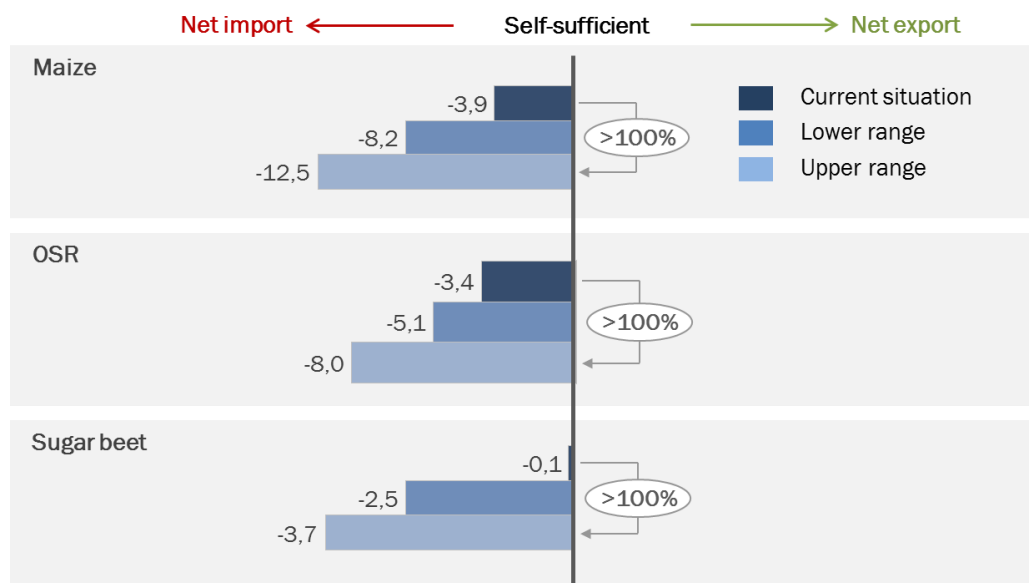


Exhibit 9: Trade balance shift for currently net imported crops (Mt)

Taking the information from the two exhibits above, the increase in imported volumes implies that the EU will not be self-sufficient for most of its key staple crops.

3 FRANCE

With the glyphosate being available as part of the farming toolbox, the French production of the **staple crops analysed**⁹ is between **4 to 7 Mt higher** and generates between **€ 1.0 to 1.6 billion more value** per year than otherwise.

These results are based on the following estimations:

- Wheat and barley would face 7-15% lower yields, potatoes 4-7%, while no yield effects are expected for sugar beet;
- Wheat (between 2.6 and 5.3 Mt volume loss) would be most affected with € 0.7 and 1.2 billion of farm income;
- In terms of viability, barley would also show the largest decrease in profitability.

The study focusses on the staple crops wheat, barley, oilseed rape, potatoes and sugar beets. The selection is based on data availability and relevance of the crops. Table 4 provides the basic information for the crops investigated.

Table 4: Overview French crops¹⁰

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
Potatoes	159	43,4	6,9	237
Sugar beet	387	89,2	34,5	29

Against this background, the study compares the benefits of using glyphosate in French agriculture. These are estimated based on the methodology described before, are expressed in terms of short-term yield changes and depicted in Exhibit 10 (left). At the same time, variable production costs and the quality of the agricultural output are likely to be subject of change for most of the crops as well. The right-hand side in the exhibit below illustrates the effects on production costs. Barley and wheat would be most affected with 18-19% lower variable costs per ha. This translates to ca €45 additional production costs per hectare.

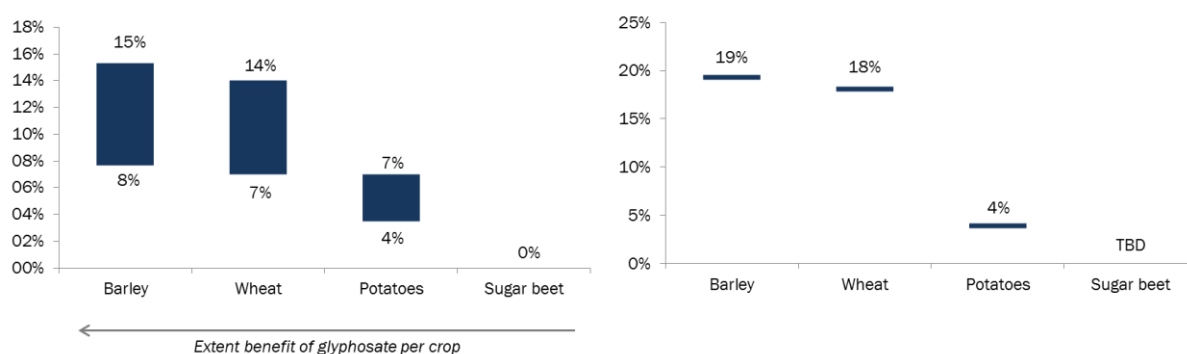


Exhibit 10: French short-term yield (left) & variable cost (right) changes (in %/ha)

Combining the yield effects per hectare with the overall area used to cultivate the various crops (see Table 4) makes it possible to estimate the total revenue and production volume effects for France as a whole.

⁹ Wheat, barley, potato, maize and sugar beets

¹⁰ Eurostat; Farm statistics, average 2009-2013

The lower yields (see Exhibit 10), given a fixed arable area, imply that the overall crop production in France will decrease without glyphosate being available in farmers' toolbox. As Exhibit 11 shows, in total French farm output is currently between 4 and 7 Mt higher for the staple crops investigated. The volume of sugar beet production would be unaffected.

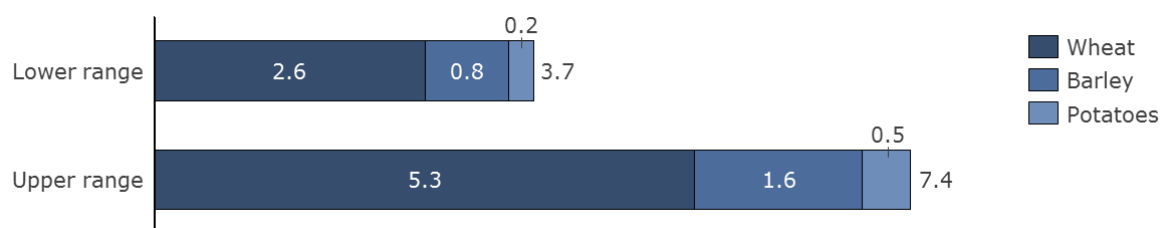


Exhibit 11: Output changes (in million tons per year)

Compared to other crops, glyphosate have relatively the largest influence on the amount of wheat produced in France. This is driven by the relatively large value that the substances add to wheat cultivation (8 to 15% extra yield) and the size of the area where this crop is cultivated in France (5.4 million ha).

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

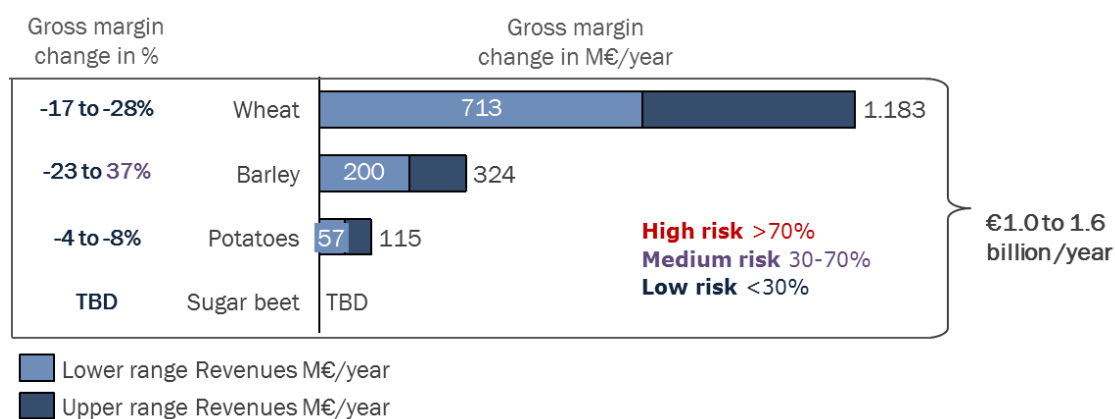


Exhibit 12: Changes in gross margins in France

As shown, glyphosate contribute between €1.0 and 1.6 billion annual income to French farmers. These changes include the lower revenues and changes in variable costs of production. Gross margin gains in wheat make up the majority of the overall effect. The largest overall profitability effect occurs in barley.

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

4 GERMANY

With glyphosate being available as part of the farming toolbox, the German production of the **crops analysed**¹¹ is between **4 to 10 Mt higher** and generates between **€ 0.7 to 1.8 billion more value** per year than otherwise.

These results are based on the following estimations:

- Wheat, barley and OSR would face up to 22% lower yields, the yield of potatoes and sugar beet would decrease by up to 5%;
- In terms of volume, wheat (between 1.8 and 5.3 Mt) would be the most affected and in also terms of farm incomes lost (up to € 0.9 billion);
- In terms of viability, the gross margin would change most severely for sugar beet and barley (-70 to ≥ 100%).

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

Table 5: Overview German crops¹²

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
OSR	1.471	4,3	6,3	308
Potatoes	252	42,9	10,8	134
Sugar beet	381	67,9	25,9	26

Against this background, the study compares the benefits of using glyphosate in German agriculture. These are estimated based on the methodology described before, are expressed in terms of short-term yield changes and depicted in Exhibit 13. At the same time, variable production costs and the quality of the agricultural output are likely to be subject of change for most of the crops as well. The right-hand side of the exhibit summarizes the effects on costs: the largest supportive effects relate to the barley, wheat and OSR (11% of variable costs per ha).

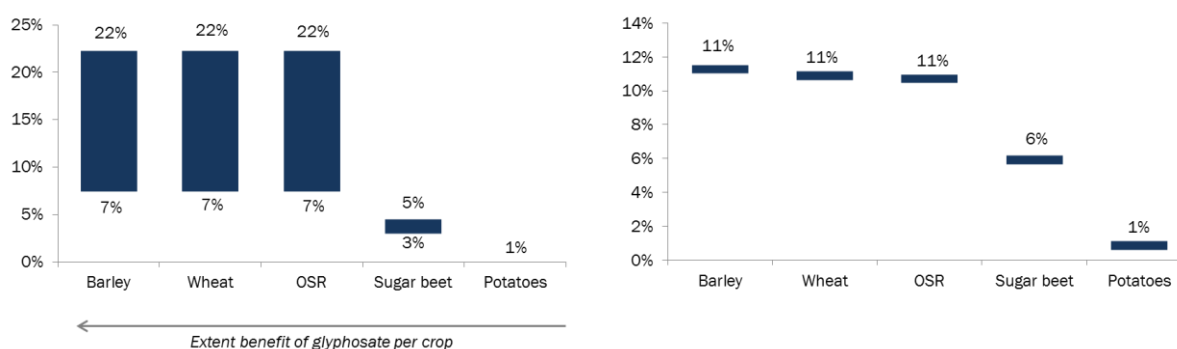


Exhibit 13: German short-term yield (left) & variable cost (right) changes (in %/ha)

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

¹¹ Wheat, barley, oilseed rape, potatoes and sugar beet.

¹² Eurostat; Farm statistics, average 2009-2013

The lower yields (see Exhibit 13), given a fixed arable area, imply that the overall crop production in Germany will decrease without glyphosate. As Exhibit 14 shows, in total German farm output is currently between 4 and 10 Mt higher for the crops investigated.

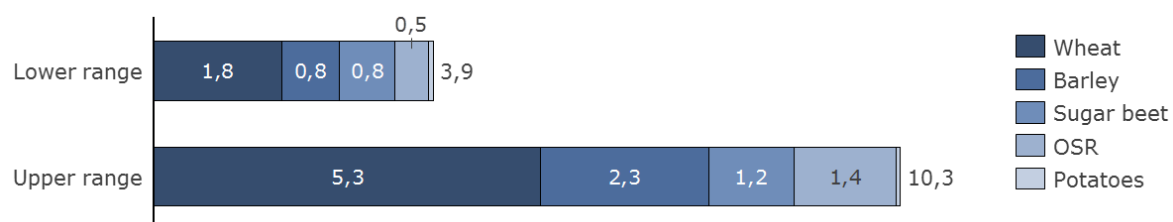


Exhibit 14: Output changes (in million tons per year)

In terms of volume, glyphosate has the largest influence on wheat and barley produced in Germany. This is driven by the rather large value that the substances add to this cultivation (between 7% and 22% extra yield) and the size of the area on which these crops are cultivated in Germany (3.2 and 1.7 million ha).

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

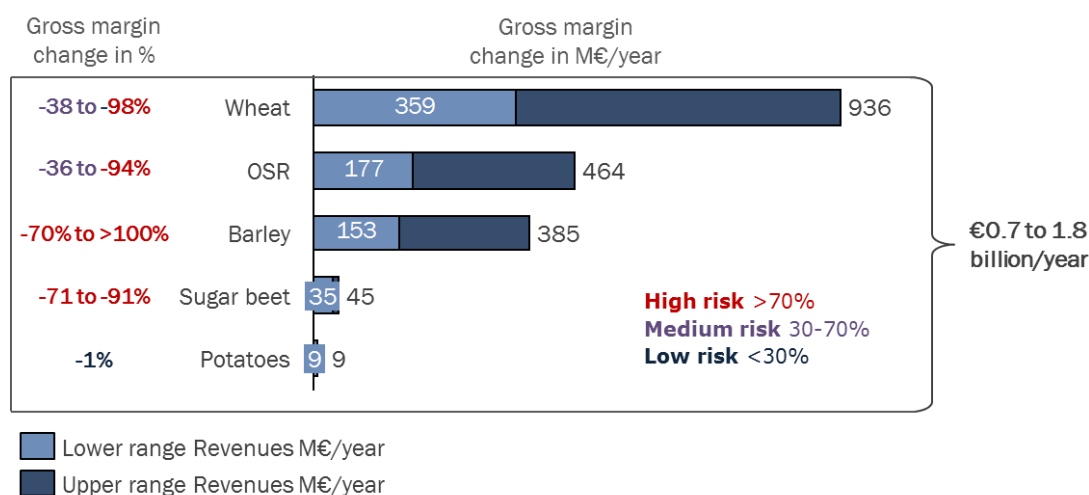


Exhibit 15: Changes in farm revenues and gross margins in the Germany

As shown, glyphosate supports between €0.7 and 1.8 billion annual income at German farms. These benefits include the lower revenues and variable cost of production. Gross margin gains in wheat make up the majority of the overall effect. The largest overall profitability effect occurs in barley and sugar beet.

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

5 UK

With glyphosate being available as part of the farming toolbox, the British production of the **crops analysed**¹³ is between **2 to 3 Mt higher** and generates between **€ 0.4 to 0.8 billion more value** per year than otherwise.

These results are based on the following estimations:

- OSR and wheat would decrease by 10-20%; the yield of peas would decrease by 10-27%;
- Wheat would be the most affected in terms of volume (1.4-1.8 Mt) and value (€0.2 - 0.5 billion);
- In terms of viability, the gross margin would change for the crops studied by 10 to 30%.

The study focusses on the staple crops wheat and oilseed rape. Peas have been included as specialty crop. The selection is based on data availability and relevance of the crops. Table 6 provides the basic information for the crops investigated.

Table 6: Overview British crops¹⁴

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

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

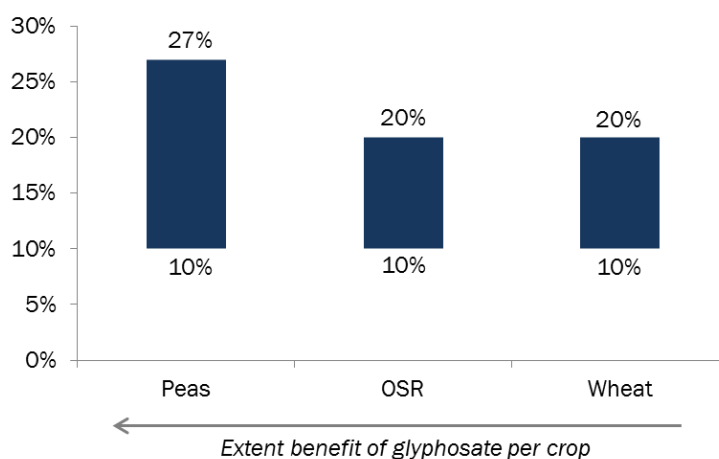


Exhibit 16: British short-term yield changes (in %/ha)

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

The lower yields (see Exhibit 16), given a fixed arable area, imply that the overall crop production in UK will decrease without glyphosate. As Exhibit 11 shows, in total British farm output is currently between 1.6 and 3.3 Mt higher for the crops investigated.

¹³ Wheat, OSR and peas

¹⁴ Eurostat; Farm statistics, average 2009-2013

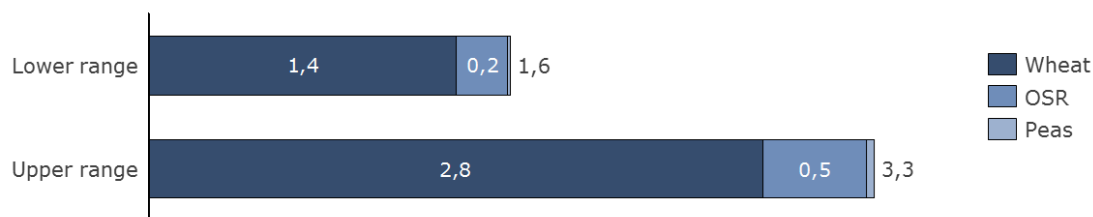


Exhibit 17: Output changes (in million tons per year)

Wheat is most severely affected when glyphosate would be removed from the market in the UK. This is driven by the relatively large value that this herbicide adds to wheat cultivation (between 10% and 20% extra yield) and the size of the area where wheat is cultivated in UK (1.9 m ha).

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

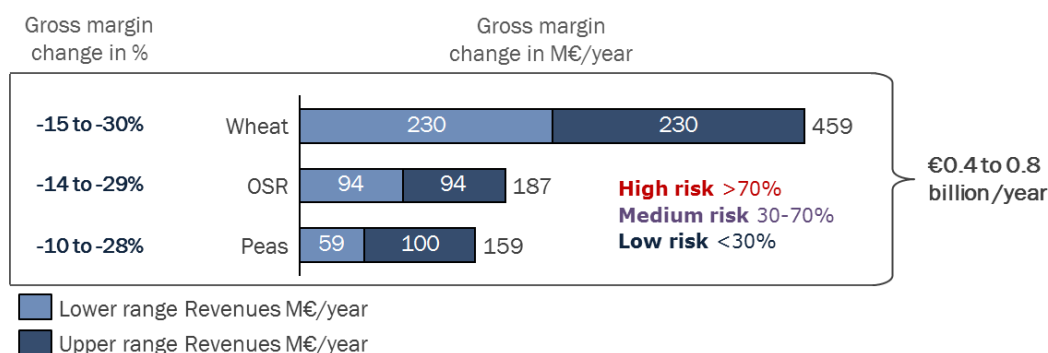


Exhibit 18: Changes in farm revenues and gross margins in the UK

As shown, glyphosate supports between €0.4 and 0.8 billion annual income at British farm producing wheat, OSR and peas. These changes include the lower revenues only. It is likely that glyphosate also affect the production costs. Gross margin gains in wheat make up the majority of the overall effect. In relative gross margin terms , the profitability of the three crops will likely decrease with 10-30%.

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

6 SPAIN

With glyphosate being available as part of the farming toolbox, the Spanish production of the **crops analysed**¹⁵ is **2.1 Mt higher** and generates between **€0.4 billion more value** per year than otherwise.

These results are based on the following estimations:

- Citrus would face 10% lower yields, and olives would decrease by 20%;
- In terms of volume, olives (1.6 Mt) would be the most affected and in terms of value olives and citrus fruits would both lose out €0.2 billion;
- In terms of viability, the gross margin would change for the crops studied by 40-50%.

The study focusses on citrus fruits and olives. The selection is based on data availability and relevance of the crops. Table 7 provides the basic information for the crops investigated.

Table 7: Overview Spanish crops¹⁶

Crop	Area (1000 ha)	Yield (t/ha)	Output (m ton)	Price (€/ton)
Citrus	313	18.9	5.9	330
Olives	2,504	3.1	7.8	121

Against this background, the study investigates the benefits of glyphosate in Spanish agriculture. These are estimated based on the methodology described before, are expressed in terms of short-term yield changes and depicted in Exhibit 19. At the same time, variable production costs and the quality of the agricultural output are likely to be subject to change for most of the crops as well. There was however no information available on these aspects.

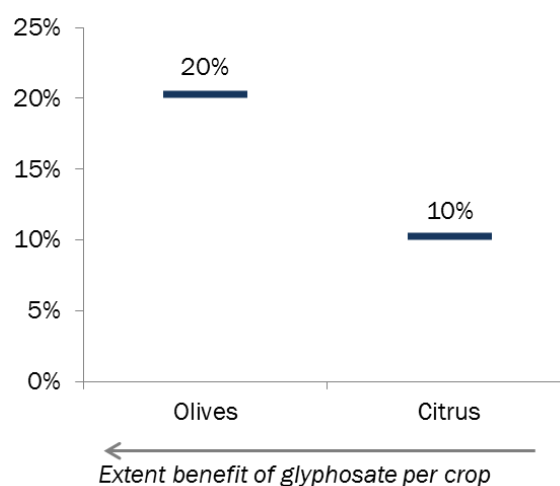


Exhibit 19: Spanish short-term yield changes (in %/ha)

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

¹⁵ Citrus and olives

¹⁶ Eurostat; Farm statistics, average 2009-2013

The lower yields (see Exhibit 19), given a fixed arable area, imply that the overall crop production in Spain will decrease without glyphosate. As Exhibit 20 shows, in total Spanish farm output is currently 2.1 Mt higher for the crops investigated.



Exhibit 20 : Output changes in Spain (in million tons per year)

Glyphosate has relatively the largest influence on the amount of olives produced in Spain. This is driven by the relatively large value that the substance add to this crop’s cultivation (20% extra yield).

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

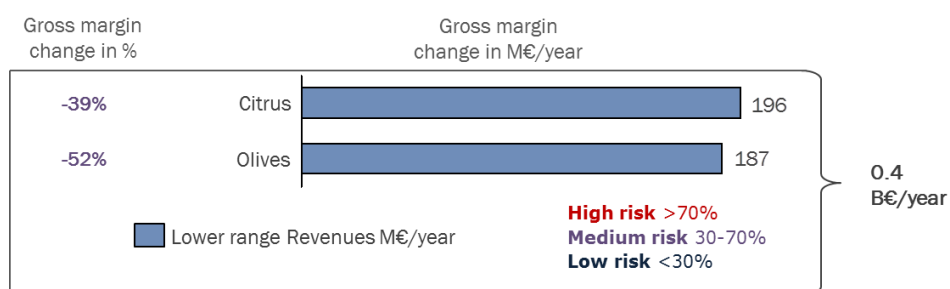


Exhibit 21: Changes in farm revenues and gross margins in Spain

As shown, glyphosate contributes €0.4 billion annual income to Spanish farmers that produce citrus fruits and olives. These changes include the lower revenues only. It is likely that glyphosate also affects the production costs. Gross margin gains for olives and citrus fruits are both €0.2 billion. In relative gross margin terms, the profitability of the two crops will likely decrease with 40-50% .

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

7 ITALY

With glyphosate being available as part of the farming toolbox, the Italian production of the **crops analysed**¹⁷ is between **1.4 to 2.4 Mt higher** and generates between **€0.3 to 0.5 billion more value** per year than otherwise.

These results are based on the following estimations:

- Tomatoes would face up to 15-20% lower yields, the yield of maize 7-14%, and grapes would decrease by 1-3%;
- In terms of volume, tomatoes (between 0.8 and 1.0 Mt) and maize (0.6 up to 1.2 Mt) would be the most affected and in terms of value this would be maize (€0.2 up to 0.3 billion);
- In terms of viability, the gross margin for maize could potentially diminish.

The study focusses on the staple crops grapes and maize, and the specialty crop tomatoes (for sauce production). The selection is based on data availability and relevance of the crops. Table 8 provides the basic information for the crops investigated.

Table 8: Overview of Italian crops¹⁸

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

Against this background, the study investigates the benefits of glyphosate in Italian agriculture. These are estimated based on the methodology described before, are expressed in terms of short-term yield changes and depicted in Exhibit 22. At the same time, variable production costs are likely to be subject of change for most of the crops as well and are estimated to increase by 13% for maize and 1% for grapes.

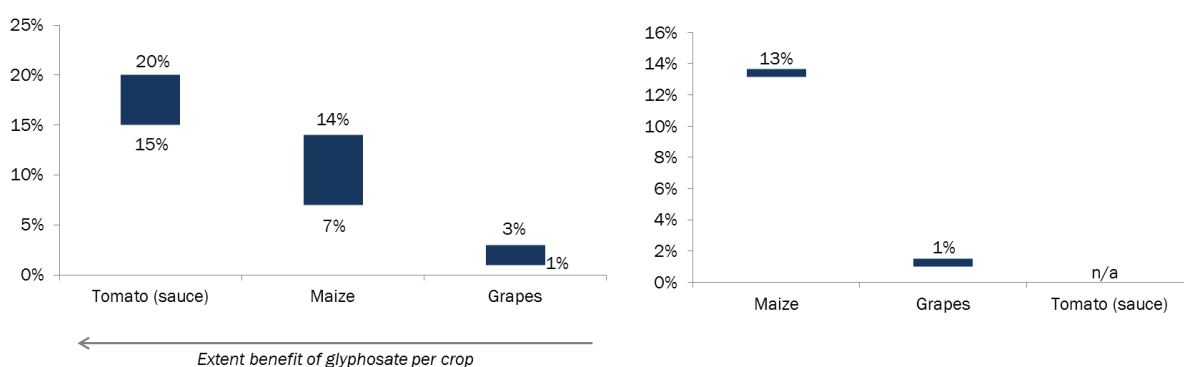


Exhibit 22: Italian short-term yield (left) and variable cost (right) changes (in %/ha)

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

The lower yields (see Exhibit 23), given a fixed arable area, imply that the overall production of tomatoes, maize and grapes in Italy will decrease without glyphosate. As Exhibit 23 shows, in total Italian farm output is currently between 1.4 and 2.4 Mt higher for the crops investigated.

¹⁷ Maize, tomatoes, grapes

¹⁸ ISTAT – agricultural statistics 2009-2013, INEA 2009-2013 average prices

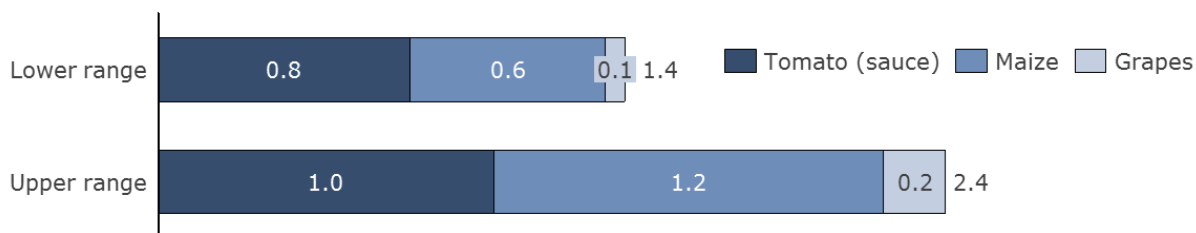


Exhibit 23 : Output changes in Italy (in million tons per year)

This herbicide has a large influence on the production of tomatoes and maize in Italy. This is driven by the relatively large value that the substances add to this cultivation (between 7% and 20% extra yield).

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

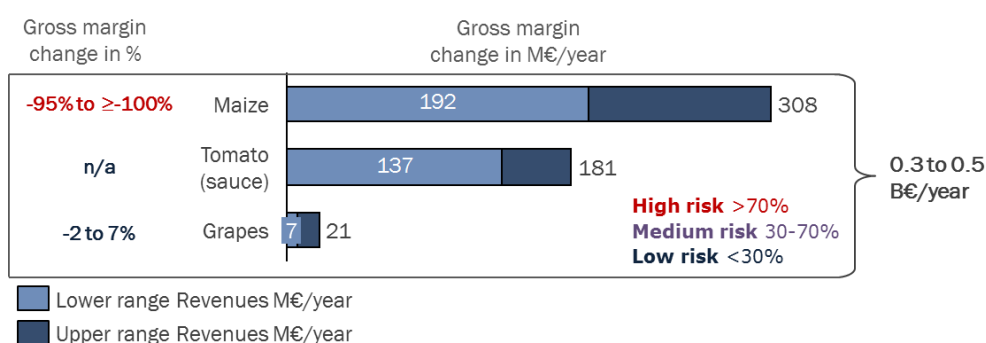


Exhibit 24: Changes in farm revenues and net margins in Italy

As shown, glyphosate supports between €0.2 and 0.4 billion annual income at Italian farms. These benefits include the higher revenues and lower variable costs of production. Gross margin gains in maize make up the majority of the overall effect. The largest overall profitability effect occurs also in maize (up to -100%).

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

ANNEX: GLYPHOSATE DATA PER COUNTRY

Country	Crop	Area affected	Short-term yield (change %) LOW	Short-term yield (change %) HIGH	Additional long term resistance effects	Additional quality effects	Cost (change EUR/ha)	Source
UK	Wheat		-10%	-20%				AHDB
UK	OSR		-10%	-20%				AHDB
UK	Peas	90%	-10%	-27%				AHDB, PGRO
Germany	Wheat	37%	-7%	-22%			€ 22	Landwirtschaftskammer Nordrhein-Westfalen
Germany	Barley	37%	-7%	-22%			€ 22	University of Göttingen
Germany	Potatoes	37%	-1%	-1%				Landwirtschaftskammer Nordrhein-Westfalen
Germany	OSR	37%	-7%	-22%			€ 22	Landwirtschaftskammer Nordrhein-Westfalen
Germany	Sugar beet		-3%	-5%	-5%	-2%	€ 40	Landwirtschaftskammer Nordrhein-Westfalen
France	Wheat		-7%	-14%	-16%		€ 45	Arvalis
France	Barley		-8%	-15%	-15%		€ 45	Arvalis
France	Potatoes		-4%	-7%				Arvalis
France	Sugar beet		0%					Institut Technique de la Betterave
Spain	Citrus	80%	-10%	-10%				Cooperativas Agro-alimentarias, Espana
Spain	Olives	100%	-20%	-20%				Cooperativas Agro-alimentarias, Espana
Italy	Maize	80%	-7%	-14%	0%		€ 80	Confagricoltura
Italy	Tomato (sauce)	5%	-15%	-20%	0%		€ 80	Confagricoltura
Italy	Vine		-1%	-3%				Coldiretti