A survey on the uses of glyphosate in European countries

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Quoting this report

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Glossary

A.i. (active ingredient or active substance): The active component against pests, weeds or plant diseases in plant protection products is called the 'active ingredient'.

Bioherbicides: Bioherbicides are substances of natural origin with herbicidal activity. Plant extracts, allelochemicals and some microbes are marketed as bioherbicides.

Desiccation: Pre-harvest crop desiccation refers to the application of an agent (herbicide and/or defoliant) to a crop just before harvest to kill the leaves or plants so that the crop dries more quickly and evenly than it would using environmental conditions alone.

TFI (Treatment Frequency Index): This indicator is used for measuring pesticide use. The treatment frequency index expresses the average number of times a field is treated with the legally approved full dose rate of a pesticide. Summing up all the treatments applied to a crop over the growing season makes it possible to calculate the total TFI at the field level[1]. An average TFI at the farm level can then be obtained based on the TFI of each field.

UAA: Utilised agricultural area, abbreviated as UAA, is the total area taken up by arable land, permanent grassland, permanent crops and kitchen gardens used by the holding, regardless of the type of tenure or of whether it is used as a part of common land[2].

EU 28: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, United Kingdom.

EU 28+3: All countries from EU 28 plus Norway, Switzerland and Turkey.

EU 28+4: All countries from EU 28 plus Norway, Serbia, Switzerland and Turkey.

Systemic herbicides: Herbicides that are absorbed by foliage or roots and translocated to other parts of the plant. In contrast, contact herbicides only kill the plant parts exposed to the herbicide.

[1] E.g. a wheat field receiving two herbicides, one insecticide and three fungicides all applied at their respective recommended dose would have a TFI of 6.

[2] http://ec.europa.eu/eurostat/statistics-explained/index.php/Glossary:Utilised_agricultural_area_(UAA)

Summary

In 2019, the ENDURE network[3] launched a survey on the agricultural use of glyphosate in European countries. This report presents the results obtained through the survey and proposes a framework for understanding and monitoring glyphosate uses.

The share of herbicides among all pesticide sales varies from one country to another. It is particularly high in Sweden (where herbicides represented 85% of the total volume of pesticides sold in 2017), Norway (83%), Denmark (82%), Estonia (76%), Ireland (73%), Latvia (73%), Lithuania (63%), United Kingdom (62%) and Poland (61%) and is particularly low in Malta (2%), Cyprus (13%) and Italy (17%). When reported by hectare of agricultural area, the countries with the highest average use of herbicides are Belgium, Netherlands, Cyprus, France, Germany, Denmark and Poland. The average use of herbicides in the agricultural sector at the EU 28+3 level can be estimated at 0.62 kg of a.i. per hectare. The total volume of herbicides sold in all EU 28+3 countries remained rather stable from 2011 to 2017, while at the national level, herbicide sales numbers showed a high degree of fluctuation.

The ENDURE survey made it possible to collect data on glyphosate sales in 25 countries. In addition, an estimation was calculated for the other seven countries for which no data could be obtained. The total sales of glyphosate are estimated at 46,527 tonnes of a.i. in 2017 across the EU 28+3 (47,452 tonnes of a.i. across the EU 28+4). Overall, sales of glyphosate represent 33% of total herbicide sales in the EU 28+3. Therefore, glyphosate is one of the most widely used herbicides in European agriculture. Similar to overall herbicide sales, glyphosate sales (in volume of active ingredients) appear to be the highest in France (20% of the EU 28+4 total glyphosate sales volume in 2017), Poland (14%), Germany (10%), Italy (8%) and Spain (8%). Glyphosate represents 15% to 78% of total herbicide active ingredient sales in the countries surveyed. According to the survey, glyphosate is mainly used in the agricultural sector. Across the 13 countries for which the share of glyphosate sales to the agricultural sector was available, the agricultural sector consumes on average 90% of total national glyphosate sales (by volume). When reported by hectare of agricultural area, the average use of glyphosate at the EU 28+3 level is 0.20 kg a.i. per hectare. The five countries with the highest use of glyphosate in 2017 were Denmark, Poland, Netherlands, Portugal and France (≥0.32 kg of a.i. per ha). The five countries with the lowest use of glyphosate were Turkey, Lithuania, Latvia, UK and Switzerland (≤0.12 kg of a.i. per ha)[4].

This report offers a framework for understanding and monitoring glyphosate uses in the agricultural sector, based on the identification of the cropping systems in which glyphosate is used, the agronomic purposes for which it is used and the nature of this use (from occasional to systematic). Glyphosate is widely used in annual cropping systems, perennial crops and grasslands. In annual cropping systems, it is mostly used prior to sowing, shortly after sowing of the crop (at the pre-emergence stage) or at the post-harvest stage for controlling weeds and volunteers. Annual cropping systems in which glyphosate

[3] ENDURE is a network of organisations focusing on Integrated Pest Management (IPM): www.endure-network.eu/what_is_endure/endure_partner_organisations

[4] Only countries for which glyphosate sales data were obtained through the survey are listed here.

is used include a large variety of crops (such as maize, oilseed rape, cereals, legume crops, sugar and fodder beet etc.). It is also used for the destruction of cover crops, and for ensuring the desiccation of certain annual crops at the pre-harvest stage. In perennial crops (such as vineyards, fruit orchards, olives groves etc.), glyphosate is used for controlling weeds within or between crop rows. Finally, glyphosate is used for the destruction of temporary grassland, for local control of perennial weeds in permanent grassland and for grassland renewal. Overall, the survey shows that the herbicide is used for at least eight agronomic purposes.

Statistical data regarding glyphosate use in annual cropping systems is limited. In addition, the allocation of glyphosate treatments that are applied in the intercropping period may vary across countries. Four different allocation rules were identified through the survey: allocation from harvest to harvest, allocation from field preparation to post-harvest treatments, allocation to the intercrop period and allocation to the cropping system. In some countries, several allocation rules may apply depending on the statistical dataset. As a consequence, comparisons of glyphosate uses in annual cropping systems between countries or crops must be considered as a preliminary indication.

Within the scope for which data could be obtained through the survey, 32% of the wheat acreage, 25% of the maize acreage and 52% of the oilseed rape acreage were treated with glyphosate in any single year. The treated acreage varies greatly from one country to another: the use of glyphosate in maize fields was almost inexistent in some countries, while it reached up to 40% of the crop area in other countries. In oilseed rape fields, the share of the crop area treated with glyphosate varied from less than 10% to more than 70%. Similarly, in winter wheat fields, the share of the crop area on which glyphosate is used varied from less than 10% to 90%. Those percentages include: treatments for controlling weeds applied before cultivation (at the pre-sowing or pre-emergence stage) that may occur for each new sowing in the crop rotation; treatments for controlling weeds that are applied only once in the crop rotation (at a post-harvest stage or during an intercropping period); and desiccation/harvest aid for some of the crops (in countries in which this is allowed). As the percentages are for any single year, the area treated with glyphosate in any region over a full crop rotation period may be greater. Additional research is needed for assessing the total uses of glyphosate throughout the crop rotations in EU countries.

In perennial systems, within the scope for which data was available in the EU 28+4, 39% of the fruit orchard acreage, 32% of the vineyard acreage and 45% of the olive grove acreage were treated with glyphosate. Across countries, the use of glyphosate ranged from 13% to 95% of the national vineyard acreage, from 20% to 92% of the fruit orchard acreage and from 13% to 80% of the olive grove acreage. Finally, 19% of the temporary grassland acreage was treated with glyphosate annually.

A diversity of non-chemical alternatives to glyphosate treatments can be identified. Their effectiveness, cost and adoption implications for crops and the environment can vary widely, or may not be quantified. They include both preventive measures and curative control measures, such as mechanical and biological control. In annual cropping systems, these practices include: use of cover crops and of a roller-crimper for their destruction, mulching, crop rotation diversification, delaying crop sowing dates, higher seed rates, increasing crop competitiveness, inter-row cultivation, tillage for controlling weeds at the post-harvest and pre-sowing stages, use of early-ripening varieties and weed seed removal during

harvest. In perennial crops, the following alternatives were identified: greening, grazing, mowing, mulching, cover crops, tillage, mechanical weeding and the use of bioherbicides for weed control.

Different approaches to using glyphosate were identified through the survey. *Occasional uses* are related to exceptional contexts, such as meteorological conditions or specific farm constraints. *Recurrent uses* are widespread practices that are already embedded in farming systems. Other agronomic solutions may exist but are not mobilised; instead farmers plan to, and recurrently do, use glyphosate. Two types of recurrent uses can be distinguished: *uses related to structural conditions* and *systematic uses that are not related to structural conditions*. First, uses related to structural conditions appear when equipment or infrastructure are not compatible with alternative practices. Examples of such structural conditions include irrigation systems that are located above ground in fruit orchards and narrow rows in orchards or vineyards which prevent weed management using mechanical methods. For replacing glyphosate with non-chemical alternatives, a change in these structural aspects is required, which may involve significant investments. Second, *systematic uses not related to structural conditions* result from the evolution of farming systems generally characterised by reduced tillage systems, large-scale farms and the availability of highly efficient, low-priced herbicides such as glyphosate. Examples of systematic uses include the use of glyphosate for crop desiccation, for the destruction of cover crops and temporary grasslands, and for weed management in annual and perennial crop systems. In the case of systematic uses, multiple inter-related factors may hinder the shift to non-chemical alternatives. These include: limited, and in some cases no, availability of and access to alternative inputs and adapted machinery; constraints and opportunities due to regulations and subsidies; lack of advice, knowledge and references regarding alternative practices; uncertainties, risks and variability in agronomic performance and profitability of alternative practices; constraints in farm resources; commercial context; challenges in terms of labour organisation; and cultural and cognitive aspects.

Further research is needed to assess the conditions, including the economic and technical aspects as well as systemic contexts, that are required for enhancing the adoption of non-chemical alternatives to glyphosate.

Introduction

Glyphosate is known as the most widely used herbicide in the world. Intense controversies have arisen in Europe (as well as in the USA, Latin America and Asia) regarding the direct and indirect effects of glyphosate on the environment and human health. Studies assessing the impact of the active ingredient and its commercial formulations have been challenged. Debates have taken place in multiple arenas (social networks, public policy decision arenas etc.) and have led, for example, to a European Citizens' Initiative (*Ban glyphosate and protect people and the environment from toxic pesticides*)[5] as well as the decision by the Austrian parliament to ban glyphosate[6] and to a statement by the German government that glyphosate use should be significantly reduced by 2023[7].

Although glyphosate use is being widely discussed in terms of its impact, little information is available on its quantitative aspects, such as the extent to which it is used in EU countries. This is why, in 2019, the ENDURE network[8] launched a survey on the uses of glyphosate and the existing alternatives in European countries. This report presents an analysis of the data collected with a focus on the following aspects: *What is the relative importance of glyphosate compared to other pesticides in Europe?* (Chapter 2); *where in Europe is glyphosate used the most?* (Chapter 3); *in which cropping systems is glyphosate used, and for which agronomic purposes?* (Chapter 4); and *what are the lock-in factors that hinder the substitution of glyphosate with alternative practices?* (Chapter 5).

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[5] Citizens' Initiative ECI(2017)000002 registered on 25/01/2017: https://ec.europa.eu/citizens-initiative/public/initiatives/successful/details/2017/000002

[6] https://www.reuters.com/article/us-austria-glyphosate/austrian-parliament-backs-eus-first-total-ban-of-weedkiller-glyphosate-idUSKCN1TX1JR

[7] https://www.dw.com/en/germany-set-to-ban-glyphosate-from-end-of-2023/a-50282891

[8] ENDURE is a network of organisations focusing on Integrated Pest Management (IPM): http://www.endure-network.eu/what_is_endure/endure_partner_organisations

1. Methodology

1.a. Data collection

This report is based on a survey undertaken and led by the ENDURE network in 2019 that was rolled out in 32 countries: the EU-28 countries plus Norway, Serbia, Switzerland and Turkey (EU 28+4) (Table 1). For this survey, more than 40 points of contact in research and public policy institutions in these countries were asked to provide national data, in three successive data collection steps, regarding the volume and uses of glyphosate in their country. This report provides data for the year 2017 and, as much as possible, the historical background and future perspectives.

The ENDURE survey made it possible to collect data on glyphosate sales in 25 countries (Table 2), covering 88% of the agricultural area in conventional agriculture in the EU 28+4. For the other seven countries for which no sales data could be obtained, an estimation was calculated. This estimation is based on the total volume of herbicides sold in the country and the average share that glyphosate represents among herbicides in EU countries for which data was available (see Chapter 3). The estimated figures were reviewed by national points of contact to ensure consistency with local knowledge.

In addition to survey data, national pesticide and herbicide sales and agricultural acreages were obtained from the Eurostat database. At the EU level, pesticide active substances are classified according to their purpose (herbicide, insecticide, fungicide etc.) and composition[9]. Sales volumes are recorded in Eurostat annually, with the most recent data available for 2017. An overview of these data is provided in Chapter 1. Eurostat provides total pesticide sales but the data are not reported by sector (agriculture, forestry, railways and infrastructures, industrial uses, non-professional uses etc.). Data on the share of the use of pesticides in the agricultural sector versus other sectors were collected during the survey.

[9] See Commission Regulation 2017/269 of 16 February 2017: eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32017R0269&from=FR

Table 1: Scope of the survey: EU 28+4 countries and their agricultural area in 2017

Country	Total UAA (1,000 ha)	UAA in conventional agriculture[2] (1,000 ha)	Share of the EU 28+4 UAA in conventional agriculture (%)
Austria	2,656	2,035	1%
Belgium	1,329	1,246	1%
Bulgaria	5,030	4,893	2%
Croatia	1.497	1,400	1%
Cyprus	122	116	0%
Czech Rep.	3,521	3,025	1%
Denmark	2,631	2,405	1%
Estonia	1,002	806	0%
Finland	2,272	2,014	1%
France	29,101	27,357	13%
Germany	16,687	15,549	7%
Greece	5,152	4,742	2%
Hungary	5,352	5,153	2%
Ireland	4,489	4,415	2%
Italy[1]	12,843	10,935	5%
Latvia	1,932	1,663	1%
Lithuania	2,935	2,701	1%
Luxembourg	131	126	0%
Malta	12	12	0%
Netherlands	1,790	1,734	1%
Norway[1]	983	935	0%
Poland	14,498	14,003	7%
Portugal	3,603	3,349	2%
Romania	13,378	13,119	6%
Serbia	3,438	3,425	2%
Slovakia	1,911	1,722	1%
Slovenia	481	435	0%
Spain	23,841	21,759	10%
Sweden	3,011	2,435	1%
Switzerland	1,518	1,368	1%
Turkey[1]	38,328	37,760	18%
UK	17,472	16,974	8%
Total EU 28	**178,680**	**166,120**	**79%**
Total EU 28+4	**222,946**	**209,608**	**100%**

Data: Eurostat.

[1]For Italy, Norway and Turkey, the total UAA is of 2016 instead of 2017 (as 2017 data is not available in Eurostat).

[2]The conventionally-managed agricultural acreage was calculated as the utilised agricultural area (UAA) excluding the acreage under organic certification (Eurostat data).

Table 2: Data completion in EU 28+4 through the survey

	Glyphosate total sales from 2013 to 2017	Share of glyphosate sales volume that is sold to the agricultural sector	Percentage of each crop[2] acreage treated with glyphosate each year	Average glyphosate dose per treatment
Austria	Yes	Yes	Yes	Yes
Belgium	Yes	Yes	Yes	Yes
Bulgaria	No	No	No	No
Croatia	Yes	Yes	Partial	Partial
Cyprus[1]	No	No	No	No
Czech Rep.	Yes	No	No	No
Denmark	Yes	Yes	No	No
Estonia	Partial	No	Yes	Yes
Finland	Yes	Yes	Yes	Yes
France	Yes	Yes	Partial	Partial
Germany	Yes	No	Yes	No
Greece	Partial	No	Partial	No
Hungary	Yes	Yes	Yes	Yes
Ireland	No	No	Yes	No
Italy	Yes	No	Partial	No
Latvia	Yes	No	Yes	Yes
Lithuania	Yes	Yes	Yes	Yes
Luxembourg[1]	No	No	No	No
Malta[1]	No	No	No	No
Netherlands	Partial	Yes	Yes	No
Norway	Yes	Yes	Yes	Yes
Poland	Yes	No	No	No
Portugal	Yes	No	Yes	No
Romania	No	No	No	No
Serbia	Yes	No	Yes	Yes
Slovakia	No	No	No	No
Slovenia	Yes	No	No	No
Spain	Yes	No	Partial	No
Sweden	Yes	Yes	Partial	Partial
Switzerland	Yes	No	Yes	Yes
Turkey	Yes	Yes	Partial	Partial
UK	Partial	Yes	Yes	Yes

[1]Cyprus, Luxembourg and Malta were not included in the survey.

[2]Crops that were included in the survey: annual crops (maize, oilseed rape, winter wheat, winter barley, spring wheat, spring barley, legume crops, sugar/fodder beet) and perennial crops (vineyards, fruit orchards, olive groves) as well as grassland (permanent and temporary grassland).

1.b. Data analysis

Indicators regarding the use of pesticides were chosen based on data availability across the EU 28+4 countries. The use of pesticides can be characterised through indicators of the *quantity* of active substances (relative to the unit area or the unit produced) or through indicators of *frequency* of use (number of uses per cropping season at the labelled dose rate). The quantity indicators make it possible to estimate the volumes used. However, they do not take into account the concentration of the products (i.e. their phytosanitary effect relative to the product dose). So, a decrease in the volume of active ingredients may be due to a shift to products having equivalent effects at lower doses. Frequency of use indicators (such as the Treatment Frequency Index, TFI[10], used for example in Denmark, France and Germany) take into account the applied dose rate compared to the labelled rate and provide insight into the overall dependence on pesticides for agricultural use. In this report, only quantity indicators are provided because TFI data was only available for a limited number of countries. In addition, at the European level, only information on the quantity of active substances sold are available. In this survey, we therefore used the volume of active substances as an indicator in consistency with Eurostat public data.

1.c. A warning for data interpretation

In the context of annual cropping systems, the glyphosate treatments applied right before or after a crop, or during the intercropping period itself, can be recorded in different ways. Through the survey, four allocation rules were identified in different statistical databases (Table 3).

It was not possible in this survey to verify the specificities of data collection in each country. In addition, the data on glyphosate use being very scarce, the data collected through this survey comes from different sources (national statistics and experts' estimations) and diverse years (2012 to 2017). So, any comparison of the use of glyphosate in annual cropping systems must be considered as a preliminary indication and should be refined before further use for other studies or informing policy development.

Table 3: Rules for the allocation of glyphosate treatments applied before or after a crop, during the intercropping period

Allocation rule	Details
Allocation from harvest to harvest	After harvest, all treatments are considered as a preparation for future cultivation and are therefore allocated to the next crop. Glyphosate applied after harvest/on stubble is allocated to the next crop. Glyphosate applied right before sowing is allocated to the crop being sown.
Allocation from field preparation to post-harvest treatments	Glyphosate applied right before sowing is allocated to the crop being sown. Glyphosate applied after harvest/on stubble is allocated to the crop being harvested.
Allocation to the intercrop period	Glyphosate applied after harvest/on stubble is allocated to the intercrop period. If any application of glyphosate for cover crop destruction (that may also serve for field preparation before sowing of the next crop), the treatment is also allocated to the intercrop period.
Allocation to the cropping system	Glyphosate is assumed to benefit all crops in the crop rotation and is therefore allocated to the crop rotation. It is not linked to a specific crop in the statistics.

Note: In some countries, several allocation rules may apply depending on the statistical dataset.

[10]A definition is provided in the glossary.

2. Annual pesticide sales in the EU 28+3 countries

This chapter introduces quantitative data on pesticides (including herbicides, fungicides and insecticides) in the EU 28+3 countries, with a focus on herbicides. A focus on glyphosate is then provided in the next chapter.

2.a. EU data on pesticides

The volume of pesticides sold in 2017 was highest in France (17% of the total EU 28+3 pesticide sales), Spain (16%), Turkey (12%), Germany (12%), Italy (11%) and Poland (6%) (Figure 1, Table 4)[11]. Together, these six countries accounted for more 75% of total pesticide sales in the EU 28+3.

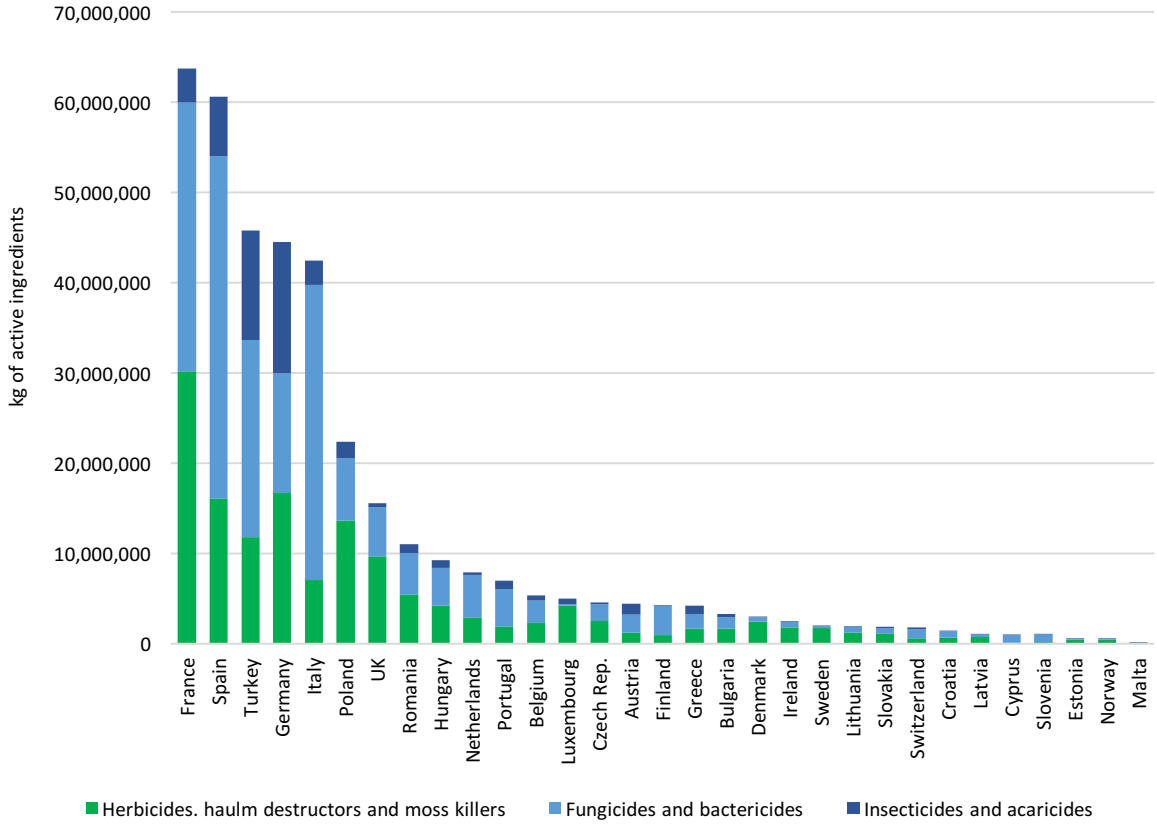

Figure 1: Sales volume of pesticides in the EU 28+3 countries in 2017

Data source: Eurostat (see Table 29 in appendix).

Data provided in Figure 1 are total quantities of pesticides. The statistics cover active substances in plant protection products placed on the market in the reporting countries (as described in Eurostat Pesticide Sales Metadata information[12]). In most countries, these are not exclusively sold to the agricultural sector. An estimation of the share of sales to the agricultural sector is provided below.

[11] At the EU 28 level, the sales of pesticides in France are 19% of total EU pesticides sales, in Spain 18%, in Germany 14%, Italy 13% and Poland 7%.

[12] ec.europa.eu/eurostat/cache/metadata/en/aei_fm_salpest09_esms.htm

Eurostat provides total sales but not the distribution of sales per sector (agriculture, forestry, railways and infrastructure, industrial uses, non-professional uses etc.). According to experts' estimates in the ENDURE survey, on average 90% of pesticide sales are to the agricultural sector (Table 17 in appendix). We used this figure as a proxy for the share of the agricultural sector in total pesticide sales across the EU 28+4 countries. When reporting by hectare of agricultural area, the countries with the highest average pesticide use are Cyprus, Malta, Netherlands, Belgium, Italy and Germany (Figure 2). The average use of pesticides in the agricultural sector at the EU 28+3 level in 2017 can be estimated at 1.64 kg of a.i. per ha[13], of which 0.62 kg is herbicide a.i., 0.81 kg is fungicide a.i. and 0.21 kg is insecticide a.i. (Table 29). The differences in the volume of pesticides per hectare in countries can be related to a variety of aspects. Factors that can explain high pesticide rates per hectare of UAA include: more intensive agricultural systems; climate conditions that are favourable to weed and/or disease development; low proportion of low-pesticide crops (such as grassland) in the national UAA; or use of low-effect pesticides (which require a bigger quantity of a.i. per hectare than pesticides with high-effect a.i.).

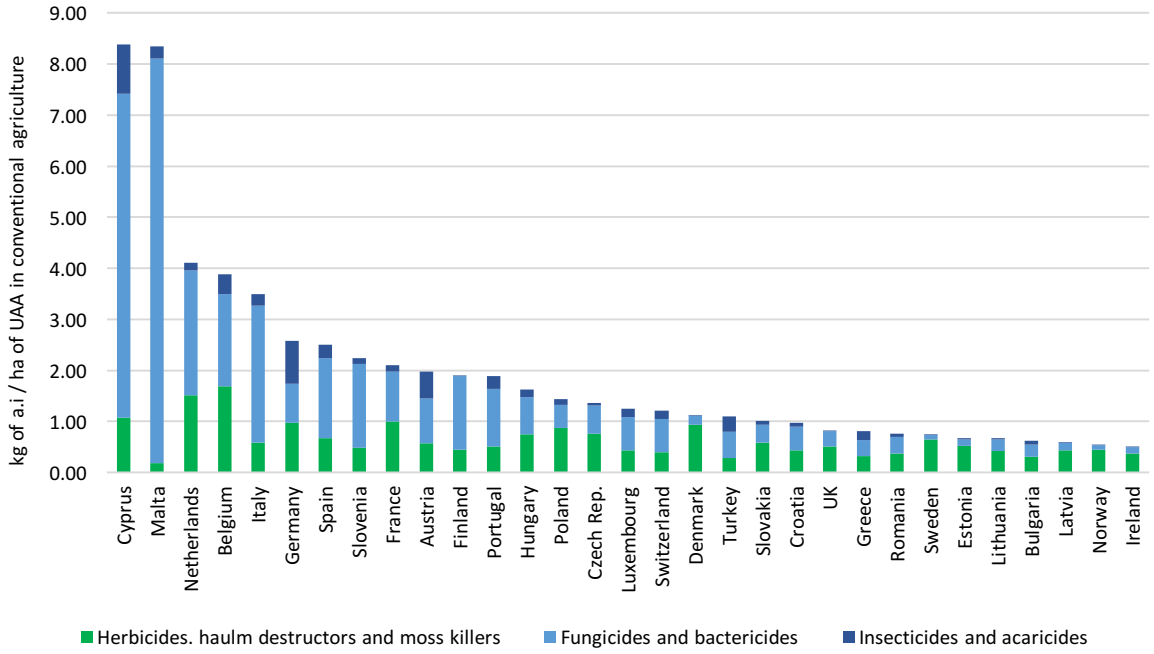

Figure 2: Estimated average use of pesticides by the agricultural sector per hectare of UAA in the EU 28+3 countries in 2017

Source: Eurostat data for total herbicide, fungicide and insecticide sales and UAA in conventional agriculture.

Notes:

Estimated share of the agricultural sector in pesticides sales: 90% (proxy from the ENDURE survey - see above).

Data from year 2017 except: Italy: UAA in 2016; Luxembourg: fungicides from 2012, herbicides from 2016, insecticides were estimated; Norway: pesticide use in 2015 and UAA in 2016, Turkey: UAA in 2016.

Figures are provided in Table 29 in appendix.

[13]hectares of agricultural area in conventional agriculture.

2.b. A focus on herbicides

The share of herbicides among all pesticides varies significantly across countries. In 2017, it was particularly high in Sweden (where herbicides represented 85% of the total volume of pesticides sold in 2017), Norway (83%), Denmark (82%), Estonia (76%), Ireland (73%), Latvia (73%), Lithuania (63%), United Kingdom (62%) and Poland (61%). It was particularly low in Malta (2%), Cyprus (13%) and Italy (17%) (Table 4, Figure 1). The total volume of herbicides sold was highest in France (30 kt, 21% of the total EU 28+3 herbicide sales), Germany (17 kt, 12% of the total EU 28+3 herbicide sales), Spain (16 kt, 11% of the total EU 28+3 herbicide sales), Poland (14 kt, 10% of the total EU 28+3 herbicide sales), Turkey (11 kt, 8% of the total EU 28+3 herbicide sales), UK (10 kt, 7% of the total EU 28+3 herbicide sales) and Italy (7 kt, 5% of the total EU 28+3 herbicide sales) (Figure 1, Table 4). However, when reporting by hectare of agricultural area, the countries with the highest average use of herbicides are Belgium, Netherlands, Cyprus, France, Germany, Denmark and Poland (Figure 3)[14]. The average use of herbicides in the agricultural sector at the EU 28+3 level can be estimated at 0.62 kg of a.i. per ha[15] (Table 4).

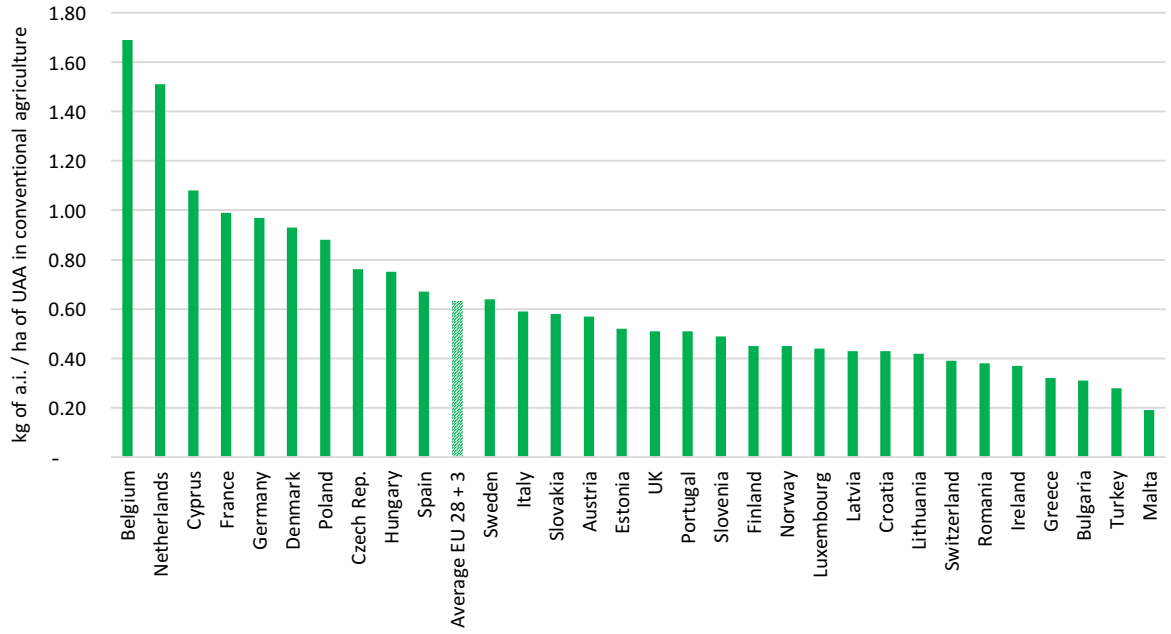

Figure 3: Estimated average use of herbicides in the agricultural sector per hectare of UAA in the EU 28+3 countries in 2017

Sources: Eurostat data for total herbicide sales and UAA in conventional agriculture.

Notes:

All herbicides from the group of "Herbicides. Haulm Destructors and Moss Killers" (under code H in EU classification) included.

Data from year 2017 except: UAA in 2016 for Italy, Norway and Turkey; herbicide use in 2015 for Norway and 2016 for Luxembourg.

Ratio used as per the share of agriculture sector in herbicide sales: 90% (ENDURE survey - see above).

[14]Factors that can explain high rates of herbicide per hectare include: very intensive agricultural systems; climate conditions that are favourable to weed development; small proportion of low-herbicide systems (such as permanent grassland) in the national UAA; or use of low-effect herbicides (which require a larger quantity of a.i. per hectare than herbicides with high-effect a.i.).

[15]Hectares of agricultural area in conventional agriculture.

Table 4: Volume of pesticides sold in the EU 28+3 countries (all sectors) and estimated average use of herbicides in the agricultural sector per hectare in 2017

	All pesticides[a]	Share of pesticides in each country vs total in the EU 28+3	Of which herbicides[b]	Share of herbicides vs all pesticides in the country/area	Share of herbicides in each country vs total in the EU 28+3	Average herbicide use by the agricultural sector, per ha[c]
	tonnes of a.i.	%	tonnes of a.i.	%	%	kg a.i/ha UAA in conventional agriculture
Austria	4,474	1%	1,297	29%	1%	0.57
Belgium	5,366	1%	2,334	44%	2%	1.69
Bulgaria	3,360	1%	1,699	51%	1%	0.31
Croatia	1,511	0%	0,669	44%	0%	0.43
Cyprus	1,081	0%	0,139	13%	0%	1.08
Czech Rep.	4,590	1%	2,562	56%	2%	0.76
Denmark	3,013	1%	2,485	82%	2%	0.93
Estonia	0,606	0%	0,463	76%	0%	0.52
Finland	4,259	1%	1,006	24%	1%	0.45
France	63,774	17%	30,230	47%	21%	0.99
Germany	44,522	12%	16,706	38%	12%	0.97
Greece	4,252	1%	1,674	39%	1%	0.32
Hungary	9,300	2%	4,270	46%	3%	0.75
Ireland	2,508	1%	1,820	73%	1%	0.37
Italy	42,483	11%	7,114	17%	5%	0.59
Latvia	1,101	0%	0,801	73%	1%	0.43
Lithuania	1,996	1%	1,252	63%	1%	0.42
Luxembourg	0,175	0%	0,061	35%	0%	0.44
Malta	0,107	0%	0,002	2%	0%	0.19
Netherlands	7,912	2%	2,902	37%	2%	1.51
Norway	0,564	0%	0,467	83%	0%	0.45
Poland	22,402	6%	13,655	61%	10%	0.88
Portugal	7,024	2%	1,899	27%	1%	0.51
Romania	11,031	3%	5,486	50%	4%	0.38
Slovakia	1,929	1%	1,105	57%	1%	0.58
Slovenia	1,080	0%	0,235	22%	0%	0.49
Spain	60,608	16%	16,077	27%	11%	0.67
Sweden	2,027	1%	1,731	85%	1%	0.64
Switzerland	1,840	0%	0,599	33%	0%	0.39
Turkey	45,828	12%	11,825	26%	8%	0.28
UK	15,600	4%	9,682	62%	7%	0.51
Total EU 28	**328,091**	**87%**	**129,359**	**39%**	**91%**	**0.70**
Total EU 28+3	**376,324**	**100%**	**142,251**	**38%**	**100%**	**0.62**

Source of data: Eurostat.

Year: 2017 except:

- UAA in 2016 for Italy, Norway and Turkey;

- Herbicide use in 2015 for Norway and 2016 for Luxembourg.

[a]Includes: Fungicides and bactericides; Herbicides. Haulm destructors and moss killers; Insecticides and acaricides.

[b]All herbicides from the group of "Herbicides. Haulm Destructors and Moss Killers" are included.

[c]Ratio used to estimate the share of the agricultural sector versus other sectors: 90% (ENDURE survey - see above).

Historical evolution of herbicide sales

At the EU 28+3 level, the volume of herbicide active ingredients sold were 139,646 tonnes of a.i. in 2011 and 142,251 tonnes in 2017 (Table 5), showing that the volume remained rather stable (+2%). The volume of herbicide sold significantly decreased in Malta (-61%) and Denmark (-44%). However, it increased in Poland (+10%), Latvia (11%), Greece (+15%), Spain (+16%), Hungary (+16%), Estonia (30%) and Bulgaria (+120%) (Figure 4). Changes in the volume of herbicides may be due to different reasons: an effective change in agricultural practices leading to a lower or higher need for herbicides (for example, a shift to/from low-input or organic agriculture, mechanical destruction of cover crops instead of chemical destruction; halting the use of herbicides between rows in perennial crops); a shift to pesticide products with a different concentration (which therefore require a lower/higher dose of a.i. for a similar effect); or a change in the distribution of crops in the agricultural area (crops requiring more or less herbicides for their cultivation). In addition, the types of herbicides vary across countries.

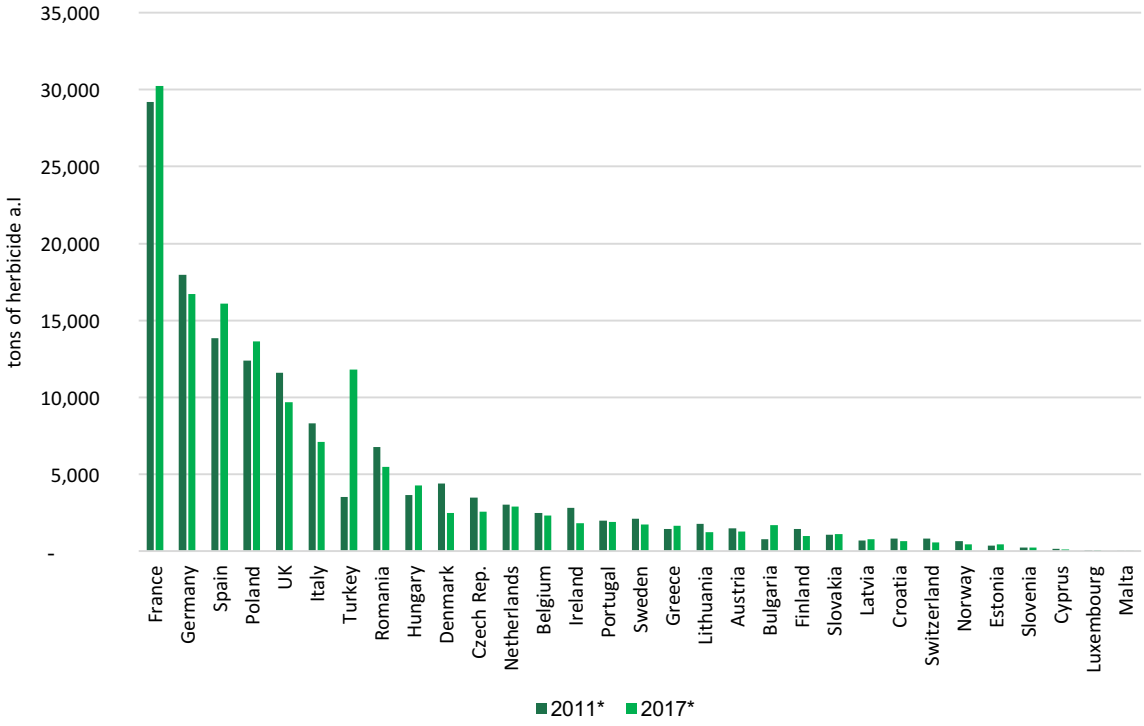

Figure 4: Volume of herbicide a.i. sold in the EU 28+3 countries in 2011 and 2017

Source: Eurostat data

Data from 2011 and 2017 except: for Turkey (data 2016 instead of 2011), Bulgaria (data 2012 instead of 2011), Croatia (2013 instead of 2011), Norway (2015 instead of 2017), Cyprus (2014 instead of 2011) and Luxembourg (2016 instead of 2017) due to lack of 2011 or 2017 data.

Table 5: Total volume of herbicide (tonnes of a.i.) sold in the EU 28+3 countries annually from 2011 to 2017

	2011	2012	2013	2014	2015	2016	2017	Average 2011–2017	Comparison 2011–2017[a]
Austria	1,505	1,545	1,227	1,376	1,317	1,281	1,297	1,364	-14%
Belgium	2,483	2,720	2,486	2,520	2,373	2,261	2,334	2,454	-6%
Bulgaria	nd	774	706	652	636	2,007	1,699	1,079	+120%
Croatia	nd	nd	829	889	821	743	669	790	-19%
Cyprus	nd	nd	nd	153	nd	158	139	150	-9%
Czech Rep.	3,473	3,607	3,145	2,755	2,889	2,893	2,562	3,046	-26%
Denmark	4,420	4,564	2,936	1,243	1,903	1,910	2,485	2,780	-44%
Estonia	357	437	434	426	472	604	463	456	+30%
Finland	1,452	1,224	1,133	1,305	1,368	1,264	1,006	1,250	-31%
France	29,209	27,713	27,834	30,965	30,575	30,043	30,230	29,510	+3%
Germany	17,955	19,907	17,896	17,877	16,806	15,038	16,706	17,455	-7%
Greece	1,455	2,139	2,572	1,195	1,315	1,744	1,674	1,728	+15%
Hungary	3,668	3,824	3,562	4,011	4,270	4,580	4,270	4,027	+16%
Ireland	2,831	1,996	2,005	2,039	2,098	2,243	1,820	2,148	-36%
Italy	8,327	8,056	7,159	7,864	7,951	7,486	7,114	7,708	-15%
Latvia	722	789	728	847	861	987	801	819	+11%
Lithuania	1,773	1,715	1,422	1,394	1,289	1,433	1,252	1,468	-29%
Luxembourg	102	96	83	89	83	61	nd	86	-40%
Malta	6	8	7	8	5	6	2	6	-61%
Netherlands	3,025	3,042	2,766	3,266	2,881	2,746	2,902	2,947	-4%
Norway	679	628	615	692	467			616	-31%
Poland	12,408	12,654	12,518	12,073	12,190	12,693	13,655	12,599	+10%
Portugal	1,996	1,769	1,611	2,411	2,122	1,905	1,899	1,959	-5%
Romania	6,771	6,614	6,034	5,025	6,353	5,066	5,486	5,907	-19%
Slovakia	1,080	1,257	1,157	1,215	1,218	1,080	1,105	1,159	+2%
Slovenia	264	257	223	239	224	247	235	241	-11%
Spain	13,835	13,985	14,720	14,908	15,587	15,224	16,077	14,905	16%
Sweden	2,136	2,087	1,773	2,104	1,829	1,633	1,731	1,899	-19%
Switzerland	835	767	711	745	nd	624	599	714	-28%
Turkey	nd	nd	nd	nd	nd	3,519	11,825	7,672	+236%
UK	11,604	10,979	10,467	12,419	11,464	9,810	9,682	10,918	-17%
Total EU 28[b]	**134,613**	**134,742**	**127,588**	**131,269**	**131,061**	**127,149**	**129,359**	**130,826**	**-4%**
Total EU 28+3[b]	**139,646**	**139,656**	**132,433**	**136,226**	**135,671**	**131,760**	**142,251**	**136,806**	**+2%**

Source: Eurostat data.

[a]When data in 2011 or 2017 was not available, data from the year closest to 2011 or 2017 was used for the comparison.

[b]When data was not available for a given year, data from the closest year is used for the total.

nd: no data available.

Types of herbicides

Herbicide active ingredients are classified in seven categories (Table 6). The type of herbicide substances mostly used in EU countries varies (Figure 5). The share of "other herbicides" (in which glyphosate is included) is significant, as it represents at least 40-50% of the volume of herbicide substances (in Germany, Malta, Austria, Romania and UK) and up to 90% (Denmark).

Table 6: Classification of herbicide active ingredients in the EU regulation

Category of herbicides	Code
Herbicides. Haulm Destructors and Moss Killers	H
Herbicides based on phenoxy-phytohormones	H1
Herbicides based on triazines and triazinones	H2
Herbicides based on amides and anilides	H3
Herbicides based on carbamates and bis-carbamates	H4
Herbicides based on dinitroaniline derivatives	H5
Herbicides based on derivatives of urea, of uracil or of sulphonylurea	H6
Other herbicides (*including glyphosate*)	H7/H99

Source: Regulation (EC) No 1185/2009 of the European Parliament and of the Council of 25 November 2009 concerning statistics on pesticides: eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32009R1185&from=EN

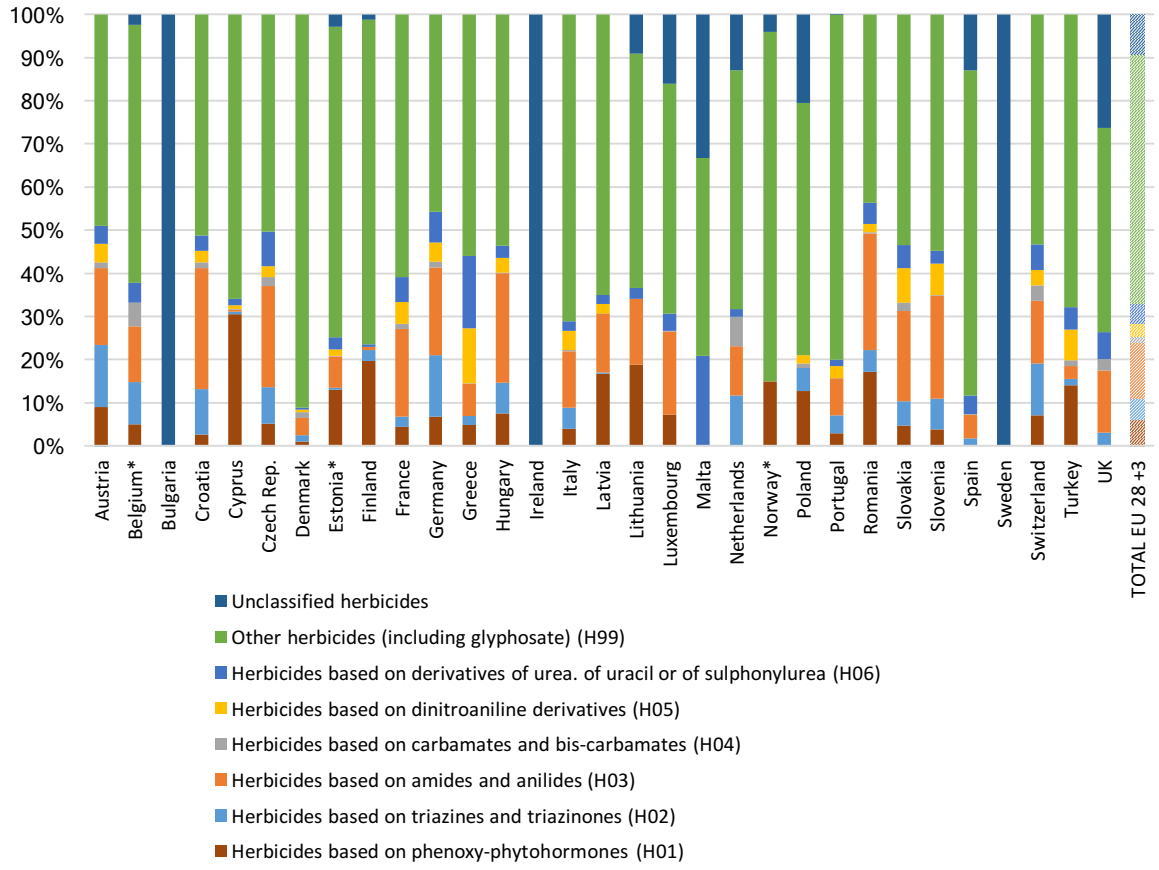

Figure 5: Share of the different categories of herbicide substances in the EU 28+3 countries (sales, in kg of a.i. in 2017)

Source: Data from Eurostat except specific mention. For Belgium: *fytoweb*. For Estonia: national statistics (*Statistika andmebaas*). For Norway: national statistics on pesticide sales. The data table is available in appendix (Table 28).

Data from 2017 except for Luxembourg, Spain and Italy (data 2016) and Norway (average 2014-2018).

3. Data on glyphosate sales from 2013 to 2017

3.a. Volume of glyphosate sales in the EU 28+4 countries

The tables below provide estimates of glyphosate sales in the EU 28+4 countries from 2013 to 2017 (Table 7, Table 8). The ENDURE survey produced glyphosate sales data in 25 countries[16]. Additional estimates were calculated for the other seven countries for which no data was obtained through the survey[17] by using the average ratio of glyphosate with respect to all herbicides in EU countries for which data was available[18]. Overall, glyphosate sales can be estimated at 46,527 tonnes in 2017 in the EU 28+3[19] (Table 8), that is 33% of total herbicides sales[20] (Table 9). Glyphosate sales[21] appear to be highest in France (20% of the EU 28+4 sales volume), Poland (14%), Germany (10%), Italy (8%) and Spain (8%) (Figure 6).

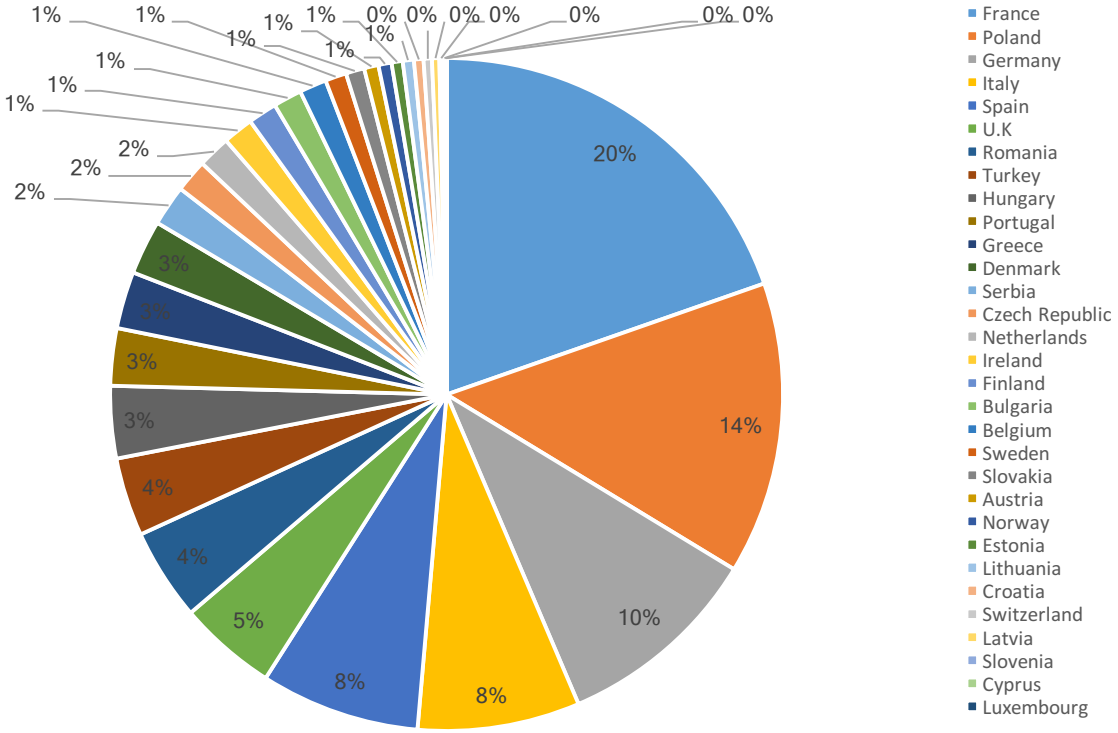

Figure 6: Distribution of glyphosate sales in the EU 28+4 countries (% of the a.i. total sales volume) in 2017

Source: ENDURE survey 2019

[16]Austria, Belgium, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Italy, Latvia, Lithuania, Netherlands, Norway, Poland, Portugal, Serbia, Slovenia, Spain, Sweden, Switzerland, Turkey, UK.

[17]Bulgaria, Cyprus, Ireland, Luxembourg, Malta, Romania, Slovakia.

[18]Across the 25 countries for which data was available, glyphosate represented an average 38% of total herbicide sales in 2017 (Table 7).

[19]Respectively 47,452 tonnes in 2017 in the EU 28+4 (Table 8).

[20]33% is the weighted average of glyphosate sales versus herbicides sales (142,251 tonnes) in the EU 28+3 in 2017. The non-weighted average is 38%.

[21]Total sales, in volume of active ingredients.

Table 7: Glyphosate sales (tonnes of a.i.) in 25 of the EU 28+4 countries from 2013 to 2017 based on the ENDURE survey and proportion of glyphosate compared to all herbicides in 2017

	2013	2014	2015	2016	2017	Data source	Herbicides sales in 2017 (tonnes of a.i.)	Proportion of glyphosate compared to all herbicides in 2017 (%)
Austria	174	338	327	312	329	Survey (national statistics)	1,297	25%
Belgium	587	596	512	503	619	Survey (national statistics)	2,334	27%
Bulgaria							1,699	nd
Croatia	231	302	285	268	217	Survey (national statistics)	669	32%
Cyprus							139	nd
Czech Rep.	935	859	698	772	751	Survey (national statistics)	2,562	29%
Denmark	1,371	610	842	1,126	1,241	Survey (national statistics)	2,485	50%
Estonia	nd	277	nd	412	253	Survey (national statistics)	463	55%
Finland	550	710	860	840	660	Survey (national statistics)	1,006	66%
France	9,370	10,070	9,110	9,110	9,324	Survey (national statistics)	30,230	31%
Germany	5,065	5,426	4,797	3,780	4,694	Survey (national statistics)	16,706	28%
Greece	nd	nd	nd	nd	1.300	Survey (experts' estimate)	1,674	78%
Hungary	885	1,296	1,423	1,769	1,647	Survey (national statistics)	4,270	39%
Ireland							1,820	nd
Italy	4,566	4,504	4,460	4,225	3,699	Survey (national statistics)	7,114	52%
Latvia	153	178	181	207	168	Survey (national statistics)	801	21%
Lithuania	502	470	502	422	253	Survey (national statistics)	1,252	20%
Luxembourg							nd	nd
Malta							2	nd
Netherlands	nd	nd	nd	nd	742	Survey (research studies)	2,902	26%
Norway	299	300	355	346	299	Survey (national statistics)	467[2]	64%
Poland	5,056	4,992	4,397	5,392	6,665	Survey (national statistics)	13,655	49%
Portugal	1,120	1,687	1,459	1,307	nd	Survey (national statistics)	1,899	69%
Romania							5,486	nd
Serbia	549	1,042	935	856	924	Survey (national statistics)[3]	nd	nd
Slovakia							1,105	nd
Slovenia	51	73	73	92	86	Survey (national statistics)	235	36%
Spain	2,879	2,883	3,120	3,787	3,633	Survey (experts' estimate)	16,077	23%
Sweden	632	626	683	657	485	Survey (national statistics)	1,731	28%
Switzerland	308	296	228	204	189	Survey (national statistics)	599	32%
Turkey	1,657	1,698	1,709	1,755	1,798	Survey (national statistics)	11,825	15%
UK	1,494	1,911	1,927	2,240	nd	Survey (national statistics)	9,682	23%
Average[1]								**38%**
Total in 24 countries[1]					**42,590**		**131,938**	**33%**

Sources: Glyphosate sales: ENDURE survey, 2019. Herbicides sales: Eurostat.

Total sales, including sales to the agricultural sector and to other sectors.

nd: no data

[1]Non-weighted average and total in the 24 countries for which glyphosate and total herbicide sales data were available for 2017.

[2]Data 2015 (data for 2016 and 2017 are not available in Eurostat).

[3]In Serbia, national statistics provide glyphosate use in liters of phytopharmaceutical products. Data in kg of a.i. were estimated with the assumption that the average content of a.i. is 420 g a.i. per L.

Table 8: Glyphosate sales (tonnes of a.i.) in the EU 28+4 countries from 2013 to 2017 based on the ENDURE survey and complementary estimates

	2013	2014	2015	2016	2017	Shift from 2013 to 2017 (%)	Estimated average over 5 years[1]	Share of total EU 28+4 sales in 2017[4]	Data source
Austria	174	338	327	312	329	89%	296	1%	s
Belgium	587	596	512	503	619	5%	563	1%	s
Bulgaria	261	242	236	744	629	141%	435	1%	e
Croatia	231	302	285	268	217	-6%	261	<1%	s
Cyprus	57	57	57	58	51	-9%	58	<1%	e
Czech Rep.	935	859	698	772	751	-20%	803	2%	s
Denmark [2]	1,371	610	842	1,126	1,241	-9%	1,038	3%	s
Estonia	nd	277	nd	412	253	nd	314	1%	s
Finland	550	710	860	840	660	20%	724	1%	s
France	9,370	10,070	9,110	9,110	9,324	0%	9,397	20%	s
Germany	5,065	5,426	4,797	3,780	4,694	-7%	4,752	10%	s
Greece	nd	nd	nd	nd	1,300	nd	1,300	3%	s
Hungary	885	1,296	1,423	1,769	1,647	86%	1,404	3%	s
Ireland	742	755	777	831	674	-9%	779	1%	e
Italy	4,566	4,504	4,460	4,225	3,699	-19%	4,291	8%	s
Latvia	153	178	181	207	168	10%	177	<1%	s
Lithuania	502	470	502	422	253	-50%	430	1%	s
Luxembourg	31	33	31	23	nd	nd	30	<1%	e
Malta	3	3	2	2	1	-66%	2	<1%	e
Netherlands [3]	nd	nd	nd	nd	742	nd	742	2%	s
Norway	299	300	355	346	299	0%	320	1%	s
Poland	5,056	4,992	4,397	5,392	6,665	32%	5,300	14%	s
Portugal	1,120	1,687	1,459	1,307	nd	nd	1,393	3%	s
Romania	2,235	1,861	2,353	1,877	2,032	-9%	2,135	4%	e
Serbia	549	1,042	935	856	924	+68%	861	2%	s
Slovakia	429	450	451	400	409	-5%	441	1%	e
Slovenia	51	73	73	92	86	68%	75	<1%	s
Spain	2,879	2,883	3,120	3,787	3,633	26%	3,260	8%	s
Sweden	632	626	683	657	485	-23%	617	1%	s
Switzerland	308	296	228	204	189	-39%	245	<1%	s
Turkey	1,659	1,698	1,709	1,755	1,789	8%	1,722	4%	s
UK	1,494	1,911	1,927	2,240	nd	nd	1,893	5%	s
EU 28[4]	**42,738**	**44,279**	**42,924**	**44,243**	**44,250**	**+6%**	**42,738**	**93%**	
EU 28+3[4]	**45,005**	**46,573**	**45,216**	**46,549**	**46,527**	**+6%**	**45,005**	**98%**	
EU 28+4[4]	**45,554**	**47,615**	**46,151**	**47,405**	**47,452**	**+6%**	**45,554**	**100%**	

Sources: **s:** ENDURE survey, 2019; **e:** complementary estimates: when no data was available through the survey (numbers in grey: Bulgaria, Cyprus, Ireland, Luxembourg, Malta, Romania, Slovakia), an estimation is offered, based on the total volume of herbicides sold in each country and the average share that glyphosate represents among herbicides in European countries for which data was available (an average of 38% of the volume of herbicide sales - see Table 7). In total, data from the ENDURE survey account for more 90% of the estimated EU 28+4 glyphosate sales; complementary estimates account for less 10%.

Note: nd: no data

[1]Based on available data from 2013 to 2017.

[2]The decrease in 2014 and 2015 was due to a change in the taxation of pesticides rendering glyphosate more expensive.

[3]Sales to the agricultural sector and private entities. Sales to other sectors (railways, etc.) are not included.

[4]When no 2017 data was available, data from the closest year was used.

3.b. Use of glyphosate per hectare in EU 28+4 countries

According to the ENDURE survey, glyphosate is mainly consumed by the agricultural sector: across the 13 countries for which details of glyphosate sales per sector was available, the agricultural sector consumed an average 90% of glyphosate sales by volume (Table 16 in appendix).

When reporting by hectare of agricultural area, the five countries with the highest use of glyphosate in 2017 were Denmark, Poland, Netherlands, Portugal and France (≥0.32 kg of a.i. per ha); the five countries with the lowest use of glyphosate were Turkey, Lithuania, Latvia, UK and Switzerland (≤0.12 kg of a.i. per ha) (Figure 7)[22]. The average at the EU 28+3 level was 0.20 kg of glyphosate per ha (Table 9) while the total use of herbicides per hectare was an estimated 0.62 kg of a.i (Table 4)[23]. Glyphosate represented from 15% to 78% of herbicide active ingredient sales in the countries studied (Table 9, Figure 8). On average in the EU 28+3 countries, glyphosate represented 38% of herbicide a.i. sales[24].

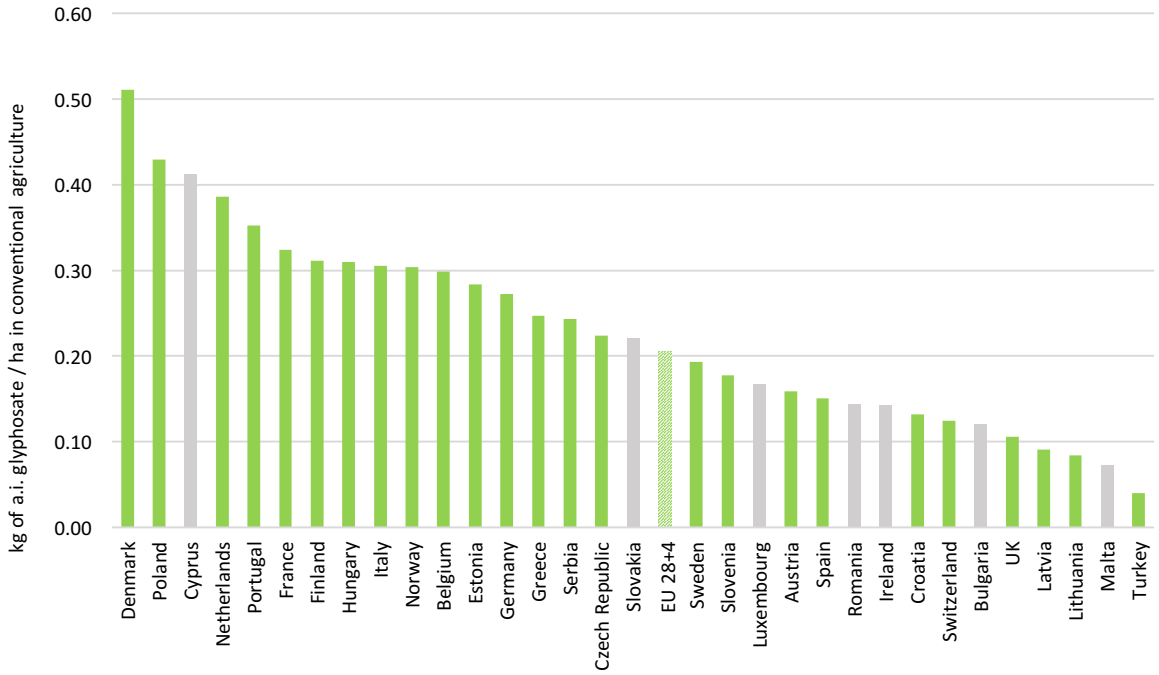

Figure 7: Estimated average use of glyphosate by the agricultural sector, per hectare of UAA in conventional agriculture, in the EU 28+4 countries in 2017

Source: ENDURE survey 2019.

Year 2017 except for Portugal and UK: data 2016.

Ratio used to estimate the share of the agricultural sector versus other sectors regarding glyphosate sales: 90% (Table 16).

In green: data obtained in the ENDURE survey. In grey: estimated data (see Table 7 and Table 8).

EU 28+4: weighted average: 0.21 kg of a.i./ha. The weighted average at the EU 28+3 level is 0.20 kg of a.i./ha.

[22] Only countries for which glyphosate sales data could be obtained through the survey are mentionned in the sentence. Other countries for which glyphosate sales were estimated are displayed in grey in Figure 7.

[23]These figures are average uses reported for the whole acreage in conventional agriculture. In reality, glyphosate may not be used across the whole acreage (as other practices and other herbicides may be used). The figures reported for the surface area on which glyphosate is actually used would be higher.

[24]Non-weighted average. The weighted average is 33% (see Table 9).

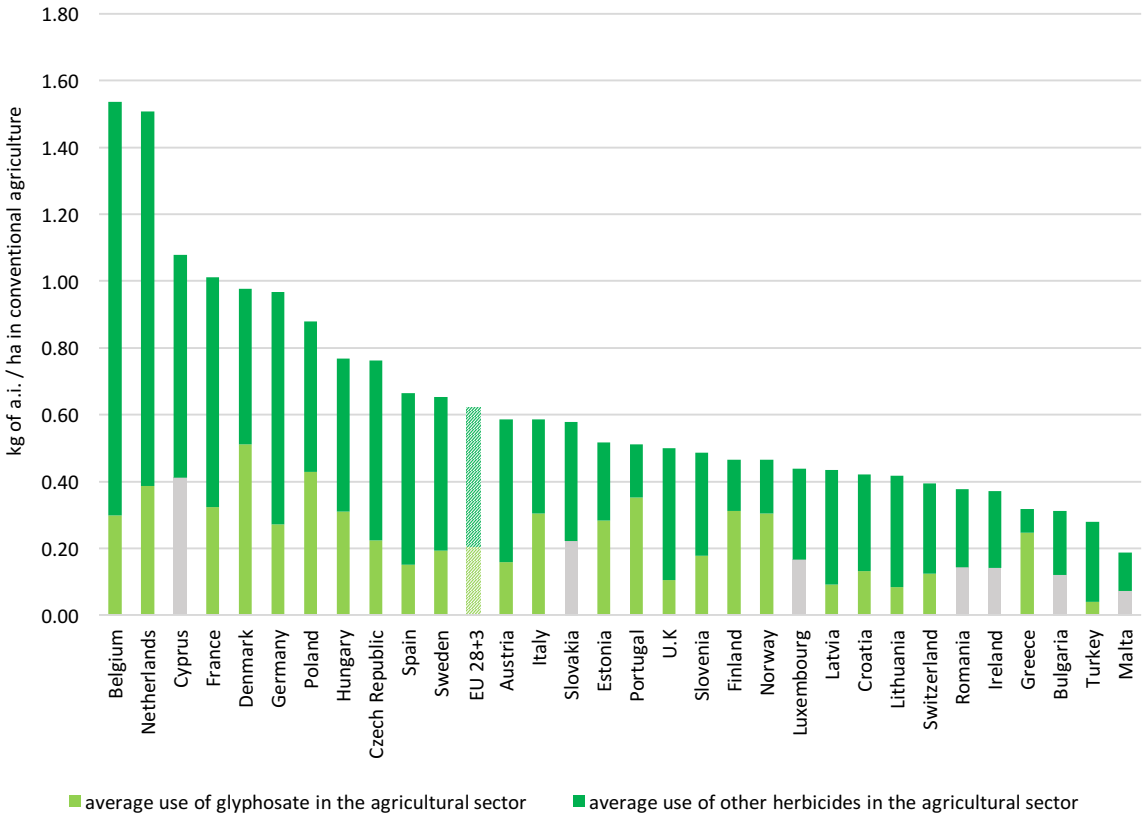

Figure 8: Average use of herbicides in the agricultural sector per hectare in the EU 28+3 countries in 2017, with a distinction of glyphosate vs other herbicides

Source: ENDURE survey 2019.

All herbicides from the group of “Herbicides. Haulm Destructors and Moss Killers” (under the code H) are included.

Factors that can explain high rates of herbicide per hectare include: very intensive agricultural systems; climate conditions that are favourable to weed development; small share of low-herbicide systems (such as permanent grassland) in the national UAA; or use of low-effect herbicides (which therefore require a larger quantity of a.i. per hectare than herbicides with high-effect a.i.).

Ratio used to estimate the share of glyphosate sales to the agricultural sector versus other sectors: 90%. See Table 16 in appendix.

Ratio used to estimate the share of other herbicides to the agricultural sector versus other sectors: 90%. See Table 17 in appendix.

In grey: glyphosate sales were estimated in seven countries, as no data were reported by experts in the ENDURE survey (see Table 7 and Table 8).

Table 9: Estimation of average glyphosate use in the agricultural sector per hectare of UAA in EU 28+4 countries in 2017

	Herbicide sales in 2017[a] (tonnes of a.i.)	Glyphosate sales in 2017[b] (tonnes of a.i.)	Data source of glyphosate sales[b]	Proportion of glyphosate compared to all herbicides in 2017 (%)	Estimated share of glyphosate sales used by the agriculture sector[c]	UAA in conventional agriculture[a] (1,000 ha)	Average use of glyphosate in the agriculture sector (kg of a.i./ha)
Austria	1,297	329	S	25%	98%	2,035	0.16
Belgium	2,334	619	S	27%	60%	1,246	0.30
Bulgaria	1,699	649	E	38%	*90%*	4,893	0.12
Croatia	669	217	S	32%	85%	1,400	0.13
Cyprus	139	53	E	38%	*90%*	116	0.40
Czech Rep.	2,562	751	S	29%	*90%*	3,025	0.22
Denmark	2,485	1,241	S	50%	99%	2,405	0.51
Estonia	463	253	S	55%	*90%*	806	0.28
Finland	1,006	660	S	66%	95%	2,014	0.31
France	30,230	9,324	S	31%	95%	27,357	0.32
Germany	16,706	4,694	S	28%	*90%*	15,549	0.27
Greece	1,674	1,300	S	78%	*90%*	4,742	0.25
Hungary	4,270	1,647	S	39%	97%	5,153	0.31
Ireland	1,820	695	E	38%	*90%*	4,415	0.14
Italy	7,114	3,699	S	52%	*90%*	10,935	0.30
Latvia	801	168	S	21%	*90%*	1,663	0.09
Lithuania	1,252	253	S	20%	90%	2,701	0.08
Luxembourg	61	23[2]	E	38%	*90%*	126	0.16
Malta	2	1	E	38%	*90%*	12	0.07
Netherlands	2,902	742	S	26%	90%	1,734	0.39
Norway	467 [1]	299	S	64%	95%	935	0.30
Poland	13,655	6,665	S	49%	*90%*	14,003	0.43
Portugal	1,899	1,307[2]	S	69%	*90%*	3,349	0.35
Romania	5,486	2,095	E	38%	*90%*	13,119	0.14
Serbia	nd	924	S	nd	*90%*	3,425	0.24
Slovakia	1,105	422	E	38%	*90%*	1,722	0.21
Slovenia	235	86	S	36%	*90%*	435	0.18
Spain	16,077	3,633	S	23%	*90%*	21,759	0.15
Sweden	1,731	485	S	28%	97%	2,435	0.19
Switzerland	599	189	S	32%	*90%*	1,368	0.12
Turkey	11,825	1,789	S	15%	85%	37,760	0.04
UK	9,682	2,240[2]	S	23%	80%	16,974	0.11
Total EU 28	**129,359**	**44,250**	**S, E**	**34%**	**91%**	**166,120**	**0.24**
Total EU 28+3	**142,251**	**46,527**	**S, E**	**33%**	**91%**	**206,184**	**0.20**

Sources:

[a]Eurostat: Where no data were available for 2017, the gaps were filled using data from the closest year, with preference given to the previous year, when available: the herbicide sales volume in Luxembourg is from 2016 and in Norway is from 2015.

[b]ENDURE survey (S, in black) or estimate (E, in grey) (see Table 7 and Table 8). Total sales, all sectors included.

[c]Countries for which data were obtained though the ENDURE survey: Austria, Belgium, Croatia, Denmark, Finland, France, Hungary, Lithuania, Netherlands, Norway, Sweden, Turkey, UK. See Table 16 in appendix. For other countries (in italics), an average ratio is used: 90%.

Notes: [1]Data 2015; [2]Data 2016 instead of 2017.

3.c. Historical evolution of glyphosate sales

Between 2013 and 2017, the total volume of glyphosate sold in the EU 28+4 fluctuated between 45,554 and 47,615 tonnes with no clear trend. The sales volume increased in Austria, Belgium, Bulgaria, Finland, Hungary, Ireland, Poland, Romania, Spain and Turkey, while it decreased in Croatia, Cyprus, the Czech Republic, Denmark, Germany, Italy, Lithuania, Luxembourg, Malta, Netherlands, Slovakia, Sweden and Switzerland. The evolution of sales varied greatly between countries, ranging from -50% to +89%[25] (Table 8). However, the evolution of glyphosate sales is not necessarily representative of the evolution in total herbicides sales: in some countries, the volume of glyphosate decreased while the total herbicide sales increased (for example, Italy), and the opposite happened in other countries (Figure 9). Over the longer term (2000 to 2017), glyphosate sales seem to be decreasing in several countries; however, few data were obtained and a clear trend cannot be established (Figure 15 in appendix).

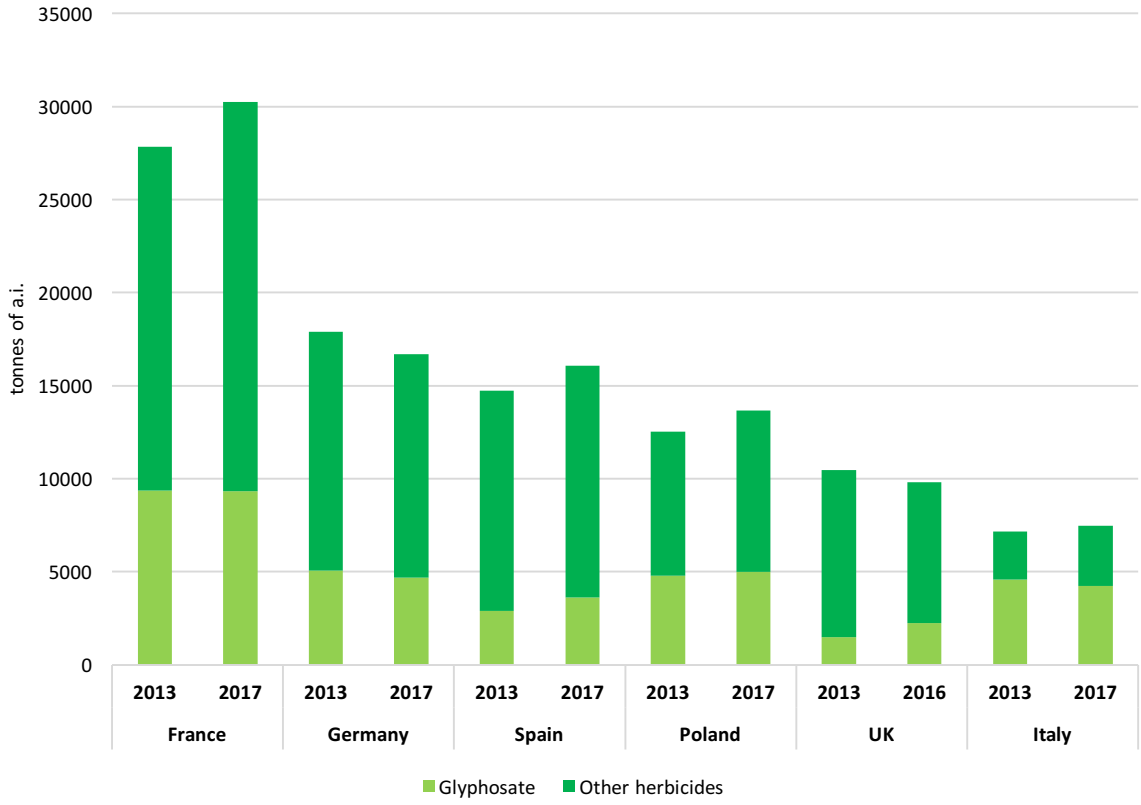

Figure 9: Evolution of herbicides sales with a focus on glyphosate from 2013 to 2017 in six EU countries

Sources: Glyphosate: ENDURE survey 2019. Other herbicides: Eurostat.

[25] Only countries for which glyphosate sales data could be obtained through the survey are taken into account in this sentence. The evolution in countries for which glyphosate sales were estimated are also available in Table 8.

4. The agronomic uses of glyphosate

This report provides a framework for understanding and monitoring glyphosate uses by the agricultural sector. The framework is based on the identification of the cropping systems in which glyphosate is used, the agronomic purposes for which it is used and the nature of this use (from occasional to systematic).

4.a. The agronomic purposes for which glyphosate is used

Glyphosate is a broad-spectrum, non-persistent, post-emergent systemic herbicide and crop desiccant. Glyphosate is used in the context of the cultivation of a large variety of annual crops (such as maize, oilseed rape, cereals, legume crops, sugar and fodder beets etc.) and perennial crops (such as vineyards, fruit orchards, olive groves etc.). The survey shows that the herbicide is widely used for at least eight agronomic purposes:

- In annual cropping systems, glyphosate is used for a variety of purposes before, during and/or after a crop: for eliminating cover crops prior to sowing, for controlling weeds at the pre-sowing, pre-emergence or post-harvest stages, and for ensuring desiccation of certain annual crops at the pre-harvest stage.
- In perennial crops, glyphosate is used for controlling weeds within or between crop rows.
- In grassland, glyphosate is used for terminating temporary grassland, for local destruction of perennial weeds in permanent grassland and for grassland renewal (Figure 10).

Specific legislation in each country forbids certain types of uses (see Table 15 in appendix).

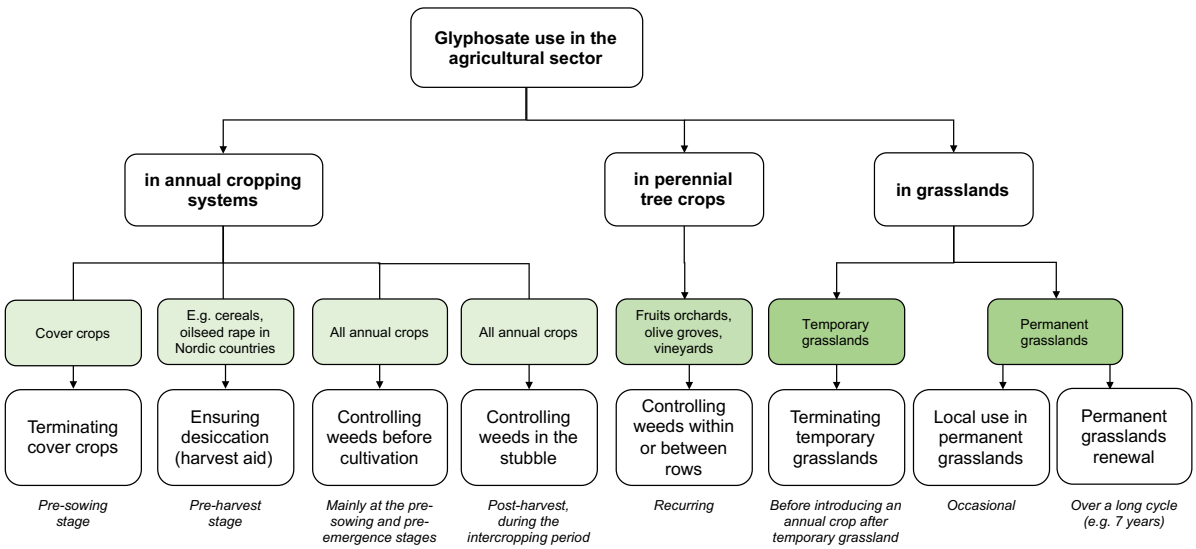

Figure 10: A framework for analysing glyphosate uses: the main agronomic purposes and type of cropping systems in which glyphosate is used

Source: ENDURE survey.

Notes:

Other agronomic contexts in which glyphosate is used include tree plantations and seed production fields (ANSES 2019). In other geographical areas with GMO crops, such as the USA, glyphosate is also used within glyphosate-tolerant crops.

The figure includes treatments that may be applied several times per year, once every year or every few years.

4.b. Glyphosate uses in annual cropping systems

Data availability and interpretation in annual cropping systems

The survey provided data on glyphosate use recorded in winter wheat fields from 18 countries (corresponding to an acreage of about 17 million hectares, 49% of the total common wheat[26] acreage in the EU 28+4); in maize fields from 15 countries (corresponding to an acreage of about 10 million hectares, 59% of the total maize acreage[27] in the EU 28+4); and in oilseed rape fields from 13 countries (corresponding to an acreage of about 4 million hectares, 60% of the total rape acreage[28] in the EU 28+4).

The data on glyphosate use being very scarce, the data presented here are from various sources and years. Those sources may follow different statistical rules. In particular, there might be differences in the recording of treatments applied only once in the crop rotation[29]. Similarly, the glyphosate treatments applied right before or after a crop, or during the intercropping period itself[30], can be recorded in different ways: in this regard, four allocation rules were identified in statistical databases (Table 3). So, data on glyphosate use in annual cropping systems must be considered as a preliminary indication and comparisons between countries should be refined before further analysis (see *A warning for data interpretation*, p. 15).

Glyphosate in wheat, maize and oilseed rape acreage

The uses of glyphosate vary greatly from one country to another. Its use in maize fields is almost non-existent in some EU countries (less than 10% in Belgium, Croatia, Estonia, Hungary, Lithuania and Portugal) while it rises to more than 30% of the crop area in other countries (France, UK and Serbia). In oilseed rape fields, the share of the crop area on which glyphosate is used varies from less than 10% (Austria and Belgium) to more than 60% (Germany, Ireland and UK). Similarly, in winter wheat fields, the share of the crop area in which glyphosate is used varies from less than 10% (Austria and Portugal) to more than 45% (Finland, Lithuania, Serbia and UK) or even 90% (Hungary) (Table 10). The differences in the percentage of the annual crop area treated with glyphosate may be related to different agronomic and economic factors: more or less intensive practices, use of other herbicides, use of non-chemical alternative practices, use of cover crops, duration of the intercropping period etc. The differences in the percentage of the crop area treated with glyphosate may also partly result from differences in statistical rules (cf. *supra*).

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[26] The total common wheat acreage includes wheat and spelt (code C 1100 in Eurostat).

[27] The total maize acreage includes grain maize and corn-cob-mix (C1500) and green maize (code G3000 in Eurostat).

[28] The total rape acreage includes rape and turnip rape seeds (I1110 in Eurostat).

[29] Treatments occurring once in the crop rotation may be recorded as a unique treatment applied to the next crop, as a partial treatment equally applied to each of the crop in the rotation etc.

[30] i.e. all treatments in the context of annual cropping systems except treatments within a crop as a harvest aid.

Table 10: Share of annual crop acreage treated with glyphosate and average use in kg of a.i. per hectare in the EU 28+4 countries

	Maize		Oilseed rape[a]		Winter wheat[b]	
Agronomic purposes for which glyphosate may be used	Includes eliminating previous cover crops, controlling weeds		Includes eliminating previous cover crops, controlling weeds, ensuring desiccation/harvest aid[1]		Includes eliminating previous cover crops, controlling weeds, ensuring desiccation/harvest aid[1]	
	Percentage of the crop area treated with glyphosate	Average dose per year[2] kg of a.i./ha	Percentage of the crop area treated with glyphosate	Average dose per year[2] kg of a.i./ha	Percentage of the crop area treated with glyphosate	Average dose per year [2] kg of a.i./ha.
Austria	15%	1.50	3%	1.50	5%	1.50
Belgium[3]	8%	0.72-1.08	5%	0.72-1.08	17%	0.72-1.08
Croatia	5%	1.80	ni	ni	>20%	1.80
Estonia	7%	2.70	17%	1.60	25%	1.80
Finland	na	na	10%	1.08	50%	0.70-1.08
France[4]	35%	0.60	35%	0.40	20%	0.50
Germany	28%	ni	72%	ni	31%	ni
Hungary	1%	1.80	40-50%	1.40	>90%	2.00
Ireland	22%	na	66%	na	30%	na
Latvia[5]	10%	na	22%	1.20	25%	1.15
Lithuania	<5%	1.08-2.00	50-60%	1.08-2.00	50-60%	0.72-1.08
Netherlands	5%	ni	na	na	16%	ni
Norway	na	na	20-40%	1.08-1.44	20-40%	1.08-1.44
Portugal	1%	ni	na	na	2%	ni
Serbia	40%	1.00	na	na	40-50%	1.80
Spain	ni	ni	ni	ni	27%	ni
Sweden	na	na	ni	ni	>11%	0.99-1.22
Switzerland	22%	1.60	25%	1.70	14%	1.70
Turkey	15%	1.00	na	na	ni	ni
UK	36%	0.81	71%	1.01	48%	0.71
All countries[6]	25%		52%		32%	

Source: ENDURE survey (statistical data or experts' estimations).

Year: Austria: 2017; Belgium: 2015; Croatia: 2017; Estonia: 2015; Finland: 2018; France: no date; Germany: 2013; Hungary: 2017; Ireland: 2012; Latvia: 2013-2017; Lithuania: 2017; Norway: 2014-2017; Portugal: 2017; Serbia: 2016; Spain: 2013; Switzerland: 2009-2017; Sweden: 2017; Turkey: no date; UK: 2017-2018.

In annual cropping systems, the allocation of glyphosate treatments to one crop or another may vary across countries (Table 3). Figures should be refined before further use for other studies or informing policy development.

This table focuses on glyphosate uses. Other herbicides may be used on the crop area and are not highlighted here. In Austria, for example, only 5% of the winter wheat crop area is treated with glyphosate while 85% of the crop area is treated with another herbicide (ENDURE survey) (see Table 21 in appendix).

ni: no information; na: not applicable (no or very small acreage <1% of the total EU 28+4 acreage).

[a]Oilseed rape: includes both winter and spring oilseed rape (depending on countries).

[b]Winter wheat: includes both soft wheat and durum wheat (depending on countries).

[1]According to the ENDURE survey (see appendix), the use of glyphosate for desiccation/harvest aid is partially or completely authorised in Bulgaria, Croatia, Czech Republic, Denmark, Germany, Hungary, Ireland, Netherlands, Poland, Romania, Serbia, Spain, Sweden, Turkey and UK. Restrictions may apply for specific years, agronomic conditions or crops' use.

[2]Average in fields in which glyphosate is used.

Country specificities: [3]Data from the Flanders region; [4]Data from sample; [5]Proxy: percentage of surveyed fields.

[6]Countries for which data was available. See Figure 11 below and Table 18, Table 19 and Table 20 in appendix.

Focus on winter wheat

As mentioned above, across the countries for which data was available, 32% of the wheat acreage is treated with glyphosate annually. Additional data (Table 21 in appendix) shows that the use of other herbicides is highly significant (85% to >99% of the winter wheat acreage[31]) and largely overlaps with the area in which glyphosate is used. The use of glyphosate in annual cropping systems addresses a variety of purposes. Table 11 provides data on the use of glyphosate in winter wheat fields for different purposes (controlling weeds at the pre-sowing and post-harvest stages, desiccation) in 13 of the EU 28+4 countries.

Table 11: Share of the winter wheat acreage in which glyphosate is used at pre-sowing, pre-harvest and post-harvest stages in 13 countries (experts' estimations)

	Share of the national winter wheat acreage in which glyphosate is used for each purpose			
Agronomic stage	Pre-sowing	Pre-harvest	Post-harvest	*All stages*
Purposes for which glyphosate is used	Controlling weeds	Desiccation[1]	Controlling weeds	*All purposes*
Austria	1%	no use	4%	*5%*
Belgium[2]	4%	no use	5%	*9%*
Croatia	<5%	ni	20%	*20-25%*
Finland	25%	no use	25%	*50%*
France	ni	no use	ni	*20%*
Germany	11%	2%	18%	*31%*
Greece	<10%	no use	<10%	*<20%*
Hungary	ni	ni	90%	*90%*
Ireland	10%	15%	30%	*30%*
Lithuania	<5%	35-40%	50-60%	*ni*
Portugal	2%	no use	ni	*ni*
Serbia	ni	ni	40-50%	*40-50%*
Sweden	1%	no use	11%	*11%*

Scope: Countries included in the table are the ones for which the information was obtained through the survey.

Notes:

In annual cropping systems, the allocation of glyphosate treatments to one crop or another may vary across countries (Table 3). The comparisons between countries must be considered as a preliminary indication and figures should be refined before further interpretation.

[1]According to the ENDURE survey (see Table 15 in appendix), the use of glyphosate for desiccation/harvest aid is partially or completely authorised in Bulgaria, Croatia, Czech Rep., Denmark, Germany, Hungary, Ireland, Netherlands, Poland, Romania, Serbia, Spain, Sweden, Turkey and UK. Restrictions may apply for specific years, agronomic conditions or crops' use.

[2]Data for the Flanders region.

[31]In countries in which data was available.

Summary of the acreage treated with glyphosate in annual cropping systems

The average dose of glyphosate used in maize, oilseed rape and winter wheat fields varied from 0.40 to 2.00 kg of a.i./ha per year (Table 10).

In total, across the countries for which data was available, 32% of the wheat acreage was treated with glyphosate annually while 68% was not treated with glyphosate; 25% of the maize acreage was treated with glyphosate while 75% was not; and 52% of the oilseed rape acreage was treated with glyphosate while 48% was not (Figure 11) in any single year[32,33]. Those percentages include: treatments for controlling weeds applied before cultivation at the pre-sowing or pre-emergence stage, that may occur every year in the crop rotation i.e. for each new sowing; treatments for controlling weeds that are applied only once in the crop rotation either at a post-harvest stage or during an intercropping period; and desiccation/harvest aid for some of the crops (in countries in which this is allowed). As these percentages are for any single year, the area treated with glyphosate in any region over a full crop rotation period may therefore be greater. Additional research is needed for assessing the total uses of glyphosate throughout crop rotations in EU countries.

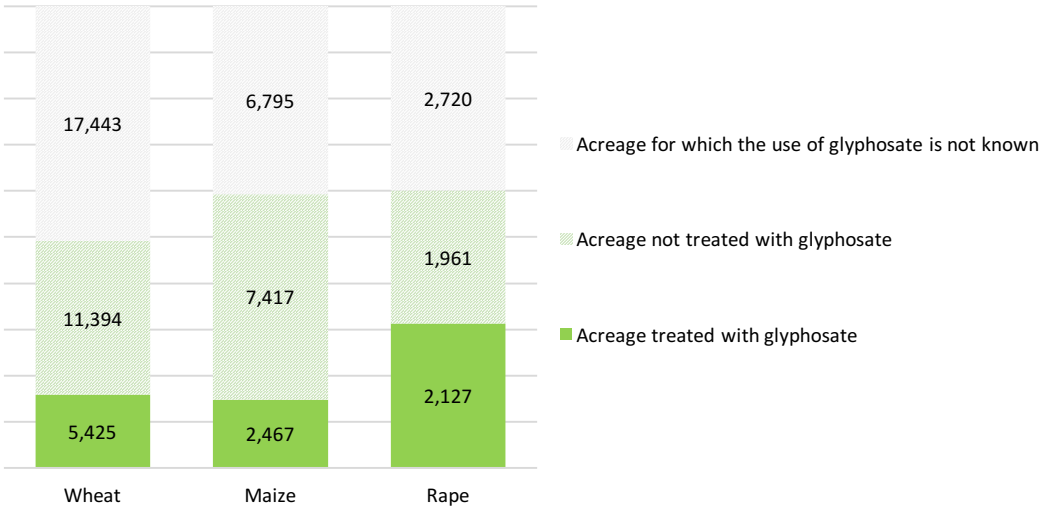

Figure 11: Share of the acreage (in thousand hectares) of annual crops treated with glyphosate at the EU 28+4 level

Source: ENDURE survey.

Notes:

The acreage of "wheat" that is presented here includes wheat and spelt (code C 1100 in Eurostat); "maize" includes grain maize and corn-cob-mix (C1500) and Green maize (G3000); "rape" includes rape and turnip rape seeds (I1110).

This table focuses on glyphosate. The acreage might be treated with other herbicides.

Data is detailed in Table 18, Table 19 and Table 20 in appendix.

[32] NB: This survey focused on glyphosate. Both the area treated and not treated with glyphosate might be treated with other herbicides.

[33] Statistical data regarding glyphosate use in annual cropping systems is limited and the allocation of glyphosate treatments to a crop may vary across countries (see in p. 15). As a consequence, comparisons of glyphosate uses in annual cropping systems between countries or crops must be considered as a preliminary indication.

4.c. Glyphosate uses in perennial crops

Data availability in perennial crops

The survey provided data on glyphosate use in fruit orchards in 19 countries (4.3 million ha, 79% of the total fruit orchard acreage[34] in the EU 28+4) (Table 22), in vineyards in 14 countries (about 2.9 million ha, 92% of the total grapes for wine[35] acreage in the EU 28+4) (Table 23) and in olive groves in six countries (about 5.9 million ha, more than 99% of the total olive groves acreage[36] in the EU 28+4) (Table 24).

Glyphosate in fruit orchards

Across the countries for which data was available, the percentage of the fruit orchard treated with glyphosate varied from 20% to 92% of the national acreage[37] (Table 12). In total, 64% of the fruit orchard acreage was treated with glyphosate annually[38]. The average dose varied from 0.45 to 2.50 kg a.i./ha. The use of herbicides other than glyphosate varied greatly across countries: from less than 5% to more than 90% of the fruit orchard area was treated with another herbicide. Preventive weed control approaches were used in only 0% to 50% of the orchard acreage. The use of mechanical control varied from less than 10% of the acreage to 80%[39] (Table 25 in appendix).

Glyphosate in vineyards

Across the countries for which data was available, the percentage of the national vineyard area treated with glyphosate varied from 13% to 95%. In total, 32% of the vineyard acreage was treated with glyphosate annually[40]. The average dose varied from 0.20 to 2.50 kg a.i./ha (Table 12). In some countries, glyphosate was the most used herbicide (Turkey and Croatia) while in other countries (Hungary and Serbia) the use of other herbicides concerned up to 50% of the vineyard acreage (Table 26 in appendix). Mechanical weed control concerned 40% to 60% of the vineyard acreage.

Glyphosate in olive groves

Across the six countries for which data was available, the percentage of the national olive grove area treated with glyphosate varied from 13% to 80%. The average dose varied from 1.67 to 2.50 kg a.i./ha (Table 12). In total, 45% of the olive grove acreage was treated with glyphosate annually[41].

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[34] Fruits, berries and nuts (excluding citrus fruits, grapes and strawberries) (F000) + Citrus fruits (T000).

[35] Grapes for wines (W1100).

[36] Olives (O1000 in Eurostat).

[37] Regarding fruit orchards, a French study (Cellule d'Animation Nationale DEPHY Ecophyto 2018) showed that there is a high variability among species (on average, within the sample studied, one application per hectare per year for apricot, apple and pear trees, two applications for peach and plum trees, and three for clementines).

[38] Across the countries for which data was available (4,316 thousand ha), 64% of the fruit orchards acreage (2,778 thousand hectares) was treated with glyphosate annually. Part of these crops were treated only in the row (42% of the acreage, i.e. 1,829 thousand ha). On the rest of the acreage treated with glyphosate (22%), crops may be treated over the whole surface or not: the information was not available.

[39] In countries in which data was available. See related tables.

[40] Across the countries for which data was available (2,871 thousand ha), 32% of the vineyard acreage (906 thousand ha) was treated with glyphosate annually. Part of these crops were treated only in the row (16% of the vineyards acreage on which data was available, i.e. 455 thousand ha). On the rest of acreage treated with glyphosate (16%), crops may be treated over the whole surface or not: the information was not available.

[41] Crops may be treated over the whole surface or not: the information was not available.

Table 12: Share of the perennial tree crop acreage treated with glyphosate and average dose in the EU 28+4 countries

	Vineyards		Fruit orchards		Olive groves	
Agronomic purposes for which glyphosate may be used	Controlling weeds between or within rows		Controlling weeds between or within rows		Controlling weeds between or within rows	
	Percentage of the crop area treated with glyphosate	Average dose per year[1] kg of a.i./ha	Percentage of the crop area treated with glyphosate	Average dose per year[1] kg of a.i./ha	Percentage of the crop area treated with glyphosate	Average dose per year[1] kg of a.i./ha
Austria	55%	1.80	40%	1.80	na	na
Belgium[2]	50%	0.72-1.08	92%	0.72-1.08	na	na
Croatia	80%	2.50	70%	2.50	80%	2.50
Finland	na	na	20%	1.80	na	na
France[3]	36%	0.20-1.00	90%	0.81	ni	ni
Germany	60-80%	ni	90%	ni	na	na
Greece	60%	ni	70%	ni	60%	ni
Hungary	90%	2.00	92%	2.00	na	na
Ireland	na	na	49%	ni	na	na
Italy	26%	ni	ni	ni	13%	ni
Latvia	na	na	73%	1.70	na	na
Lithuania	na	na	90%	1.30	na	na
Netherlands	na	na	62%	ni	na	na
Norway	na	na	91%	1.08-2.16	na	na
Portugal	35%	ni	21%	ni	19%	ni
Serbia	50%	1.80	50%	1.80	na	na
Spain	13%	ni	33%	ni	47%	ni
Sweden	na	na	61%	0.57	na	na
Switzerland	83%	0.90	60%	0.70	na	na
Turkey	95%	1.80	85%	1.80	75%	1.67
UK	65%	0.36	79%	0.45	na	na
All countries[4]	32%		64%		45%	

Source: ENDURE survey.

Year: Austria (vineyards): 2013; Austria (fruit orchards): 2017; Belgium: 2015; Croatia: 2017; Finland: 2018; France: year not mentioned; Germany: 2018; Hungary: 2017; Ireland: year not mentioned; Lithuania: 2017; Serbia: 2016; Spain: 2013; Sweden: 2017; Switzerland: see below; Turkey: year not mentioned; UK: 2016.

Notes:

[1]Average in fields in which glyphosate is used.

[2]Data from the Flanders region.

[3]Data from sample.

[4]Countries for which data was available. See Figure 12 below.

ni: no information. na: not applicable (no or very small acreage <1% of the total EU 28+4 acreage).

This table focuses on glyphosate uses. Other herbicide may be used on the crop area and are not highlighted here.

Summary of the acreage treated with glyphosate in perennial crops

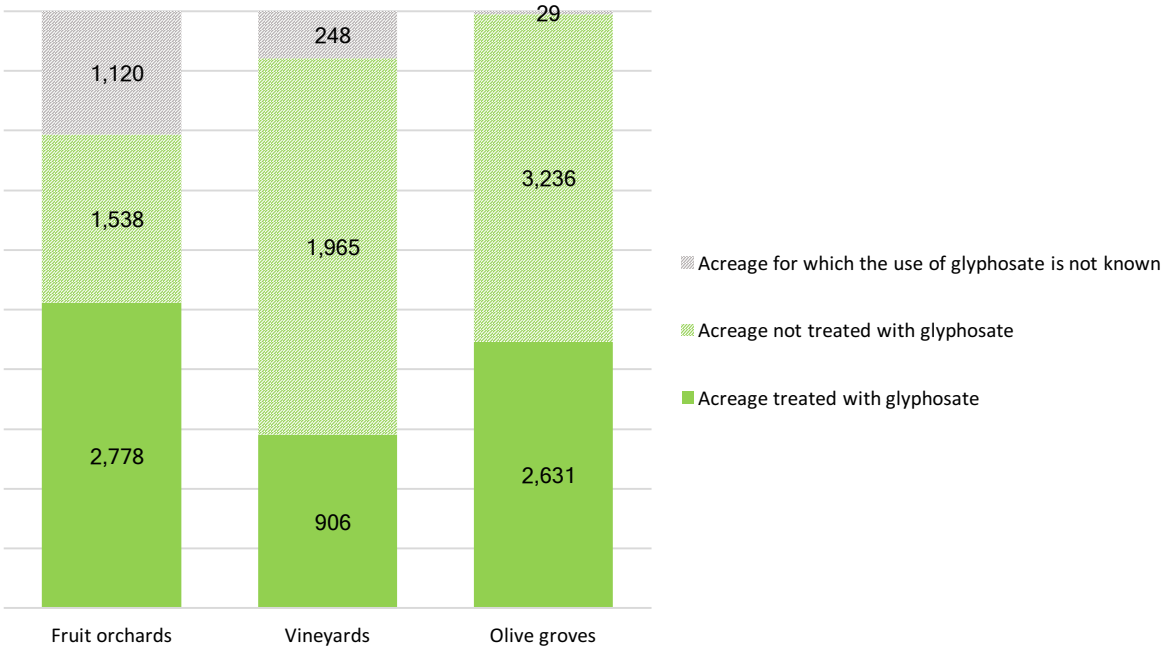

Figure 12: Acreage (in thousand hectares) of perennial crops treated with glyphosate at the EU 28+4 level

Source: ENDURE survey.

Data: see Table 22, Table 23 and Table 24 in appendix.

Note: The acreage of 'fruit orchards' that is presented here includes Fruits, berries and nuts acreage nuts (excluding citrus fruits, grapes and strawberries) (code F000 in Eurostat) and citrus fruits (T000); 'vineyards' includes grapes for wine (W1100); 'Olive groves' corresponds to O1000.

4.d. Glyphosate uses in grasslands

Glyphosate is used in temporary grasslands for grassland termination before crop cultivation. The survey provided data on glyphosate use in temporary grassland in seven countries, covering 66% of the total acreage in the EU 28+2[42] (Table 27 in appendix). Across the countries for which data was available, 19% of the temporary grassland acreage was treated with glyphosate annually. In addition, the survey shows that glyphosate is also used on permanent grassland, for grassland renovation[43] and for local treatments of perennial weeds.

[42] EU 28 + Serbia, Switzerland.

[43] Grassland renovation is undertaken once every seven years, for example, in some countries.

5. Non-chemical alternatives to glyphosate

This chapter provides examples of non-chemical alternatives to glyphosate and a classification of glyphosate uses, in line with the framework provided above (Figure 10).

5.a. Non-chemical alternatives in annual cropping systems and perennial crops

Apart from using chemical herbicides, non-chemical weed control practices can be applied. According to the European Food Safety Agency, two main categories of non-chemical alternative weed control measures can be discerned: preventive measures[44], and curative control measures, such as mechanical and biological control (European Food Safety Authority (EFSA) *et al.*, 2016). Below we present lists of non-chemical alternatives identified through the survey for each agronomic purpose in annual cropping systems (Table 13) and perennial tree crops (Table 14). Effective non-chemical alternatives may vary across countries (according to the climate conditions, types of weeds, crops etc.). The effectiveness, cost and adoption implications for crops and the environment can vary widely, or may not yet be quantified.

Table 13: List of non-chemical alternatives to glyphosate treatments at each agronomic stage in annual cropping systems (ENDURE survey 2019)

	Non-chemical alternatives for eliminating cover crops	Non-chemical alternatives for controlling weeds at post-harvest and pre-sowing stage	Non-chemical alternatives for desiccation at pre-harvest stage
Preventive methods	• Roller-crimper	• Weed seed removal during harvest • Repeated stubble tillage • Cover crops + roller-crimper • Mulching + above-ground destruction of mulch cover • Diversification of crop rotation • Primary tillage • Stale seedbed • Late sowing dates • Higher seed rates • Increased crop competitiveness • Inter-row cultivation	• Varieties with early ripening in local conditions
Curative methods: Mechanical control		• Tillage (ploughing, disking, hoeing, harrowing etc.)	
Curative methods: Thermal control		• Flaming • Electrocution	

Note: The list of non-chemical alternatives may not be exhaustive.

[44]Preventive measures can be defined as "any adjustment to the general management of the crop or cropping systems that contributes to the regulation of weed populations and reduces the negative impact of weeds on crop production" (Bastiaans, Paolini, and Baumann, 2008).

Table 14: List of non-chemical alternatives to glyphosate treatments in vineyards, fruit orchards and olive groves (ENDURE survey 2019)

	Non-chemical alternatives for weed control in vineyards	Non-chemical alternatives for weed control in fruit orchards	Non-chemical alternatives for weed control in olive groves
Preventive methods	• Greening • Cover crops (full or inter-row) • Grazing • Mowing • Mulching	• Greening • Mowing • Mulching • Cover crops • Grass/legume crops • Grazing	• Greening • Grazing • Mowing • Mulching • Cover crops
Curative methods: Mechanical control	• Tillage (disking, harrowing etc.) • Mechanical weeders	• Tillage (disking, hoeing etc.) • Roller-crimper • String trimming • Chopping (active/passive)	• Tillage (disking, harrowing, string trimming etc.)
Curative methods: Thermal control	• Flaming	• Flaming, burning • Hot water	• Flaming
Others	• Bioherbicides • Hand-held weed cutting equipment	• High water pressure • Manual weeding; hand-held weed cutting equipment	• Hand-held weed cutting equipment

Note: the list of non-chemical alternatives may not be exhaustive.

5.b. Glyphosate treatments: recurrent uses versus occasional uses

Three types of use

Different approaches to the use of glyphosate were identified through the survey (Figure 13). *Occasional uses* are related to exceptional contexts, such as meteorological conditions or specific farm constraints. *Recurrent uses* are widespread practices that are already embedded in farming systems while other agronomic solutions exist but are not employed. Two types of recurrent uses can be distinguished: *uses related to structural conditions* and *systematic uses that are not related to structural conditions*.

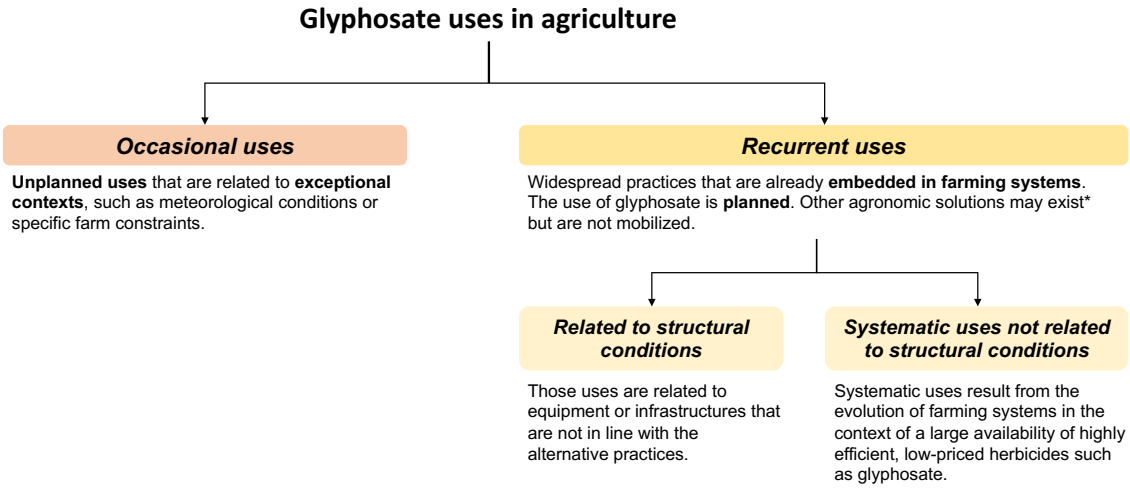

Figure 13: Types of glyphosate uses identified through the survey

Note: *The effectiveness of alternative solutions, their cost and the implications for crops and the environment can vary widely, or may not yet be quantified. In addition, alternative solutions may not be effective in all situations.

Examples of uses related to structural conditions

Glyphosate uses can in some cases be related to structural conditions, when an equipment or infrastructure is not compatible with non-chemical alternative practices. To replace glyphosate with non-chemical alternatives, a change of structural aspects is required, which may involve significant investments and would have an impact on direct and indirect costs, agronomic practices and may have complex interactions with productivity, product quality, pests and environmental impact.

Examples of glyphosate uses due to structural conditions include:

- In vineyards and fruit orchards, the type of planting sets a certain space between rows. Narrow rows may not be compatible with weed control using mechanical methods.
- In fruit orchards, the superficial location of irrigation systems rules out mechanical weed management (whereas if the irrigation system is underground or at height, mechanical weed management can be used).

Examples of systematic uses

Systematic uses are glyphosate-based practices that are embedded in farming systems. Those include treatments that may occur every year or that are applied only once in a few years[45]. They result from the evolution of farming systems often characterised by reduced tillage systems[46], large scale-farms and the availability of highly efficient, low-priced herbicides such as glyphosate. Examples of systematic uses include:

- The systematic use of glyphosate against perennial weeds: farmers often plan to use glyphosate every third year, for example, to maintain infestations of perennial weeds at an acceptable level. In this case, the major non-chemical alternative for several perennial species is intensive tillage. The main disadvantages of intensive tillage are less effective weed control, soil carbon loss, soil structure damage, the risk of soil erosion and a higher cost and lower efficacy compared to glyphosate against perennial weeds.
- The use of glyphosate to destroy cover crops and prepare fields for sowing: this use is common in both conservation agriculture and conventional systems. In addition, the requirement for compulsory cover crops may hinder mechanical weed control of perennial weeds (but may, on the other hand, provide some weed control if well established). If weeds are not controlled before sowing by tillage or the use of glyphosate, increased use of selective herbicides can be expected in the crop.

[45] In the case of annual cropping systems, those include: treatments for controlling weeds that may occur every year in the crop rotation (i.e. for each new sowing) mainly at pre-sowing stage; treatments for controlling weeds that are applied only once in the crop rotation either at a post-harvest stage or during an intercropping period; treatments for cover crops termination; and desiccation/harvest aid for some of the crops (in countries in which this use is allowed). In perennial tree crops, glyphosate treatments for weed control may also be applied once or several times each year (Figure 10).

[46] The use of non-inversion tillage or no-till/direct drill as currently practiced is effectively dependent on a total herbicide. There are concerns about the viability of these systems without an effective total herbicide. Further research is needed to assess the conditions and relevant agronomic practices for no-till systems not based on a total herbicide.

- The use of glyphosate before harvesting to ensure desiccation, especially in Northern Europe. Varieties with earlier maturity exist (or could be bred) and would mean that chemical desiccation is required only under occasional environmental conditions.
- The application of glyphosate treatment in biannual crops such as lucerne. Glyphosate is often applied in between the two years for controlling weeds.
- The use of glyphosate for weed control in contexts in which mechanical control is not allowed or has disadvantages. For example, soil cultivation is not allowed in fields dedicated to spring crops until late autumn, to minimise nitrogen leaching in Denmark. This eliminates the option of mechanical control of perennial weeds as an alternative to glyphosate. Similarly, in fields that are highly sensitive to erosion (for example, steep slopes), glyphosate may be preferred versus mechanical weed control.

Example of occasional uses

Occasional uses are related to exceptional contexts, such as meteorological conditions or specific, occasional farm constraints. Although farmers usually rely on other practices and had therefore not planned to use glyphosate, the context may turn it relevant for addressing the specific situation. A threshold could be defined for defining occasional uses more precisely[47].

An example of occasional use is flax retting in rainy years. After being cut, flax is left on the ground in order to allow partial degradation to occur so the fibres can then be recovered more easily. In very rainy years, this can lead to massive weed emergence making it difficult to harvest flax on the ground. Glyphosate may then be used. Another example is the preparation of fields in exceptional dry conditions, when tillage may lead to the loss of remaining moisture and further difficulties for crop growth. In this context, farmers may lead farmer to use glyphosate rather than tillage or others methods for weed control.

5.c. Lock-in factors to the adoption of alternative methods

Lock-in factors to the adoption of alternative methods in annual cropping systems

Lock-in aspects to the use of non-chemical alternatives and their relevance in annual cropping systems include: limited availability of and access to effective alternative inputs and adapted machinery; lack of favourable regulations and subsidies; lack of advice, knowledge or references regarding alternative practices; cultural and cognitive aspects; commercial context; limited or unstable performance of alternative practices; farm resources constraints (Figure 14). Factors vary across countries and depend on the crops in question. Factors are inter-related and in general cannot be tackled separately from some other factors. Economic aspects and factors related to management and organisation were very often cited in the survey.

[47] I.e. less than once every x years of a crop cultivation.

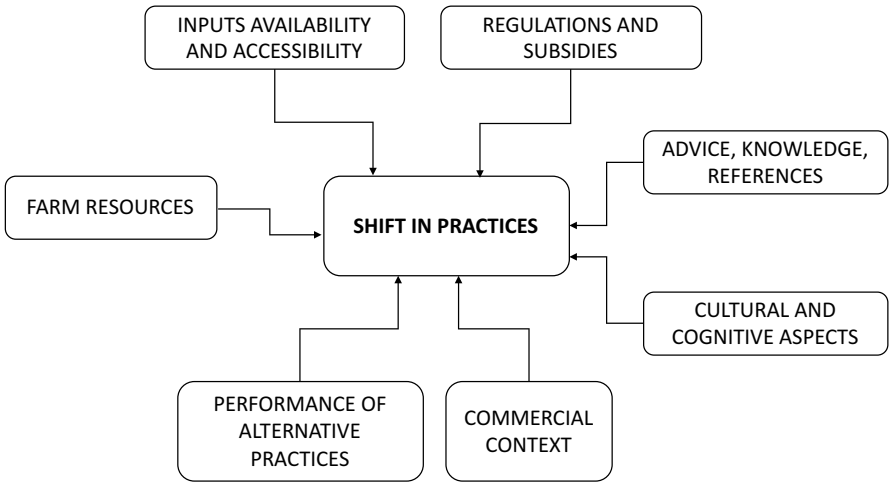

Figure 14: Aspects that hinder or facilitate the shift to alternative practices

Based on the grid of lock-in factors from (Morel 2018).

Lock-in factors to the adoption of alternative methods in perennial crops

In perennial crops (vineyards, fruit orchards and olive groves), the major lock-in factors quoted by local experts included: the complexity of alternative practices; challenges in terms of labour organisation; the lack of knowledge and references on the impact of chemical and non-chemical practices; the investment required to purchase adapted machinery if alternative practices are to be implemented; the uncertainties, risks and variability of agronomic performance and profitability of alternative practices.

Conclusion

The objectives of this ENDURE survey were to get a better understanding of where in Europe glyphosate is mostly used, to what extent and in which cropping systems it is used, and for which purposes. This report provides data regarding glyphosate use in the agricultural sector in 32 countries and offers an overview at the EU 28+4 level. In addition, the report provides examples of alternative practices and highlights the lock-in factors that may hinder the transition to alternative practices at the farm level.

The total sales of glyphosate were an estimated 46,527 tonnes of a.i. in 2017 at the EU 28+3 level (47,452 tonnes of a.i. at the EU 28+4 level). Overall, sales of glyphosate represented 33% of total herbicide sales in the EU 28+3. This hides significant differences among countries, where glyphosate represented between 15% and 78% of herbicide active ingredient sales. Glyphosate sales (by volume of active ingredient) appear to be highest in France, Poland, Germany, Italy and Spain. According to the survey, glyphosate is mainly consumed by the agricultural sector. Across the 13 countries for which the share of glyphosate sales to the agricultural sector was available, the agricultural sector consumes on average 90% of total national glyphosate sales. When reporting by hectare of agricultural area, the average use of glyphosate at the EU 28+3 level was 0.20 kg of glyphosate per hectare. The five

countries with the highest use of glyphosate in 2017 compared to their agricultural area were Denmark, Poland, Netherlands, Portugal and France.

Glyphosate is widely used in annual cropping systems and perennial tree crops. Within the scope for which data was available, 32% of the wheat acreage, 25% of the maize, 52% of the oilseed rape acreage, 39% of the fruit orchard acreage, 32% of the vineyard acreage, 45% of the olive grove acreage and 19% of the temporary grassland acreage were treated with glyphosate in any single year. Closer examination reveals that the application of glyphosate varies greatly from one country to another.

Regarding annual cropping systems, the recording of glyphosate treatments in statistical databases varies across countries. Four different allocation rules were identified: allocation from harvest to harvest, allocation from field preparation to post-harvest, allocation to the intercrop, and allocation to the cropping system. As a consequence, comparisons of glyphosate uses in annual cropping systems between countries or crops must be considered as a preliminary indication. In addition, as the percentages provided are for any single year, the area treated with glyphosate in any region over a full crop rotation period may therefore be greater. Additional research is needed for assessing the total uses of glyphosate throughout the crop rotations in EU countries.

The survey shows that glyphosate is largely used for at least eight agronomic purposes, including weed management, eliminating cover crops, as a harvest aid, and for the termination of grassland. In addition, different approaches to glyphosate use were identified: *occasional uses*, *recurrent uses related to structural conditions* and *systematic uses that are not related to structural conditions.* These different uses, as well as the different agronomic purposes for which glyphosate is used, can serve as a framework for further monitoring of glyphosate use in the agricultural sector.

In the case of systematic uses, multiple inter-related factors may hinder the shift to non-chemical alternatives, such as: limited, and in some case no, availability of and access to effective alternative inputs and adapted machinery; constraints and opportunities due to regulations and subsidies; lack of advice, knowledge and references regarding alternative practices; uncertainties, risks and variability of agronomic performance and profitability of alternative practices; constraints in farm resources; commercial context; challenges in terms of labour organisation; and cultural and cognitive aspects. Further research is needed to assess the conditions, including the economic and technical aspects as well as systemic contexts, that are required for enhancing the adoption of non-chemical alternatives to glyphosate.

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Appendix

Table 15: Authorised uses of glyphosate in countries

Usage situation by country	Belgium	Bulgaria	Croatia	Czech Republic	Denmark	Estonia	Finland	France	Germany	Greece	Hungary	Ireland	Italy	Latvia	Lithuania	Netherlands	Norway	Poland	Portugal	Romania	Serbia	Slovakia	Spain	Sweden	Switzerland	Turkey	UK
Pre-planting	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y
Pre-emergence / Post plant	Y	Y	Y		Y	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y			Y	Y		Y
Pre-harvest (cereals / other crops)	N	Y	Y	Y	Y	Y	Y	Y	Y		Y	Y		Y	Y	Y	Y	Y		Y		Y		Y			Y
Harvest aid / Desiccation	N	Y	Y	Y	Y	N			Y		Y	Y			N	Y	N	Y		Y	Y		Y	Y		Y	Y
Post-harvest / Stubble	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y
Vineyards / Orchards / Olive groves	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Grassland renewal	Y	Y	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y
Set-aside	Y		Y				Y	Y	Y		Y	Y	Y	Y	N	Y		Y	Y	Y			Y	Y	Y	Y	Y
Forestry / Christmas trees	Y	Y	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y	N	Y		Y	Y	Y	Y	Y	Y
Crop inter-row	Y		Y			Y	Y	Y	Y	Y	Y	Y	Y		N	Y			Y	Y			Y		Y		
Railway / Amenity / Non-crop use	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Aquatic use / Water ditches			Y	Y						Y		Y			N				Y		Y	Y	Y				Y

Source: ENDURE survey 2019.

Y stands for Yes (this type of use is allowed in the country, possibly with specific restrictions);

N stands for No (this type of use is not allowed in the country).

Empty square: information not available.

Table 16: Share of glyphosate sales to the agricultural sector

	Share of the agricultural sector in glyphosate sales volume	Data year	Source
Austria	98%	2017	National statistics
Belgium	50-70%	2015	Experts' estimate
Croatia	85%	2019	Experts' estimate
Denmark	99%	2017	National statistics
Finland	95%	2019	Experts' estimate
France	95%	2013-2016	National statistics
Hungary	97%	2019	Experts' estimate
Lithuania	90%	2019	Experts' estimate
Netherlands	97%	2019	Experts' estimate
Norway	95%	2019	Experts' estimate
Sweden	97%	2017-2018	National statistics
Turkey	85%	2019	Experts' estimate
UK	80%	2012	National statistics
Average (13 countries)	**90%**		

Source: ENDURE survey 2019.

Table 17: Share of total pesticide sales to the agricultural sector

	Share of the agricultural sector in pesticide sales volume	Data year	Source
Belgium	90%	2019	Experts' estimate
Denmark	99%	2019	Experts' estimate
Estonia	90%	2019	Experts' estimate
Finland	>95%	2019	Experts' estimate
Hungary	>99%	2019	Experts' estimate
Latvia	90%	2019	Experts' estimate
Norway	85-90%	2019	Experts' estimate
Spain	90%	2019	Experts' estimate
Sweden[1]	72%	2017-2018	National statistics
UK	90%	2019	Experts' estimate
Average (10 countries)	**90%**		

Source: ENDURE survey 2019.

[1]Not accounting for sales to industry, mainly for wood treatments.

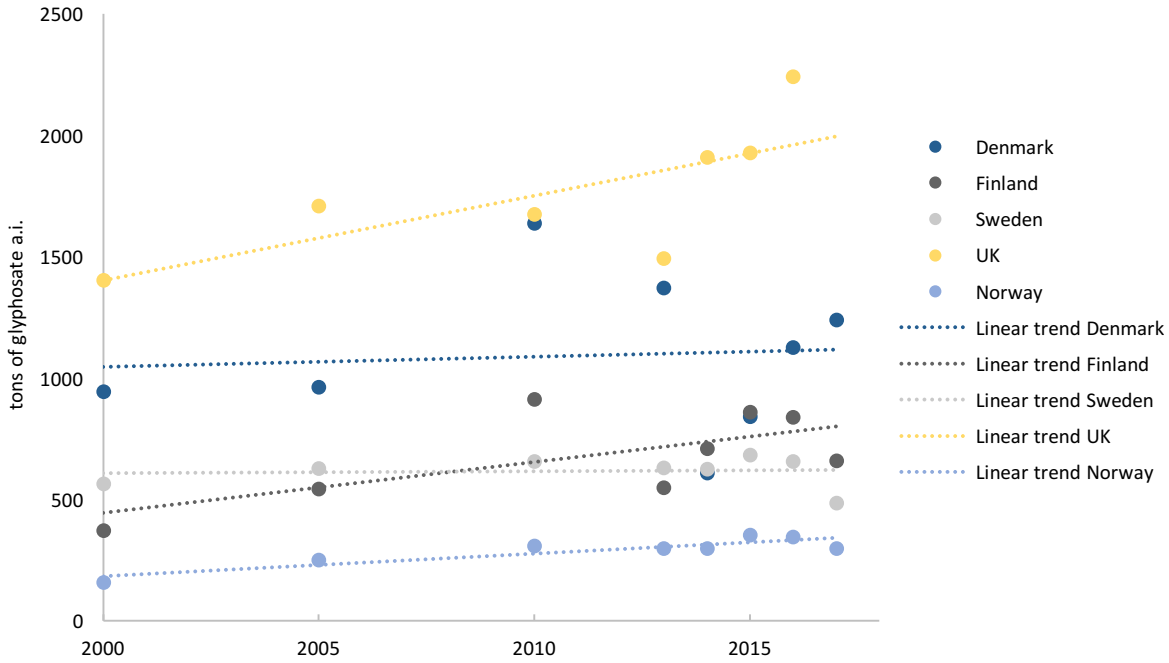

Figure 15: Evolution of glyphosate sales from 2000 to 2017 in five European countries

Source: ENDURE survey 2019.

Table 18: Estimated wheat acreage treated with glyphosate in the EU 28+4 countries in 2017

	Acreage (1,000 ha)	% of total acreage	% of the acreage treated with glyphosate	Estimated acreage treated with glyphosate	Acreage not treated with glyphosate	Acreage for which the use of glyphosate is not known
Austria	297	1%	5%	15	282	
Belgium	198	1%	17%	34	164	
Bulgaria	1,145	3%	ni			1,145
Croatia	118	0%	20%	24	95	
Cyprus	9	<1%	na			9
Czech Republic	832	2%	ni			832
Denmark	587	2%	ni			587
Estonia	170	<1%	7%	12	158	
Finland	194	1%	50%	97	97	
France	5,332	16%	20%	1,066	4,266	
Germany	3,203	9%	31%	993	2,210	
Greece	416	1%	ni			416
Hungary	966	3%	90%	870	97	
Ireland	67	<1%	30%	20	47	
Italy	1,807	5%	ni			1,807
Latvia	447	1%	25%	112	335	
Lithuania	812	2%	55%	447	365	
Luxembourg	14	<1%	na			14
Malta	0	0%	na			0
Netherlands	116	<1%	na			116
Norway	16	<1%	30%	5	11	
Poland	2,392	7%	ni			2,392
Portugal	29	<1%	2%	1	28	
Romania	2,053	6%	ni			2,053
Serbia	556	2%	45%	250	306	
Slovakia	374	1%	ni			374
Slovenia	28	<1%	na			28
Spain	2,063	6%	27%	557	1,506	
Sweden	472	1%	11%	52	420	
Switzerland	87	<1%	14%	12	75	
Turkey	7,672	22%	ni			7,672
United Kingdom	1,792	5%	48%	860	932	
EU 28+4	**34,246**			**5,425**	**11,394**	**17,443**
				16%	**33%**	**51%**
				32%	**68%**	
Number of countries providing data						18
Acreage for which we have data						16,819
Percentage of the EU 28+4 crop acreage						49%

Sources:

- Crop acreage: Wheat and spelt (under code C1100**),** Eurostat, 2017, except for Norway.
- Crop acreage in Norway: ENDURE survey, average 2012-2016
- Percentage of the crop area treated with glyphosate: ENDURE survey 2019.

Note: ni stands for no information; na stands for not applicable (no or very small acreage <1% of the total EU 28+4 acreage).

Table 19: Estimated maize acreage treated with glyphosate in the EU 28+4 countries in 2017

	Crop acreage (1,000 ha)	% of total acreage	Percentage of the crop area treated with glyphosate	Estimated acreage treated with glyphosate	Area not treated with glyphosate	Acreage for which the use of glyphosate is not known
Austria	292	2%	15%	44	248	
Belgium	220	1%	8%	18	203	
Bulgaria	428	3%	ni			428
Croatia	275	2%	5%	14	262	
Cyprus	0	0%	na			0
Czech Republic	309	2%	ni			309
Denmark	172	1%	ni			172
Estonia	9	<1%	7%	1	9	
Finland	0	0%	na			0
France	2,842	17%	35%	995	1,847	
Germany	2,528	15%	28%	708	1,820	
Greece	258	2%	ni			258
Hungary	1,058	6%	1%	11	1,047	
Ireland	12	0%	22%	3	9	
Italy	988	6%	ni			988
Latvia	22	<1%	10%	2	20	
Lithuania	34	<1%	5%	2	33	
Luxembourg	15	<1%	na			15
Malta	0	0%	na			0
Netherlands	216	1%	ni			216
Norway	ni		ni			
Poland	1,158	7%	ni			1.158
Portugal	165	1%	1%	2	163	
Romania	2,455	15%	ni			2.455
Serbia	1,036	6%	40%	414	621	
Slovakia	269	2%	ni			269
Slovenia	67	<1%	na			67
Spain	441	3%	ni			441
Sweden	18	<1%	na			18
Switzerland	63	<1%	22%	14	49	
Turkey	1,125	7%	15%	169	956	
United Kingdom	202	1%	36%	73	130	
EU 28+4	**16,679**			**2,467**	**7,417**	**6,795**
				15%	**44%**	**41%**
				25%	**75%**	
Number of countries providing data						15
Acreage for which we have data						9,883
Percentage of the crop acreage in the EU 28+4						59%

Sources:

- Crop acreage: Grain maize and corn-cob-mix (C1500) and Green maize (G3000), Eurostat, 2017.
- Percentage of the crop area treated with glyphosate: ENDURE survey 2019.

Note: ni stands for no information; na stands for not applicable (no or very small acreage <1% of the total EU 28+4 acreage).

Table 20: Estimated rape acreage treated with glyphosate in the EU 28+4 countries in 2017

	Acreage (1,000 ha)	% of total acreage	Percentage of the crop area treated with glyphosate	Estimated acreage treated with glyphosate	Area not treated with glyphosate	Acreage for which the use of glyphosate is not known
Austria	41	1%	3%	1	39	
Belgium	11	<1%	5%	1	10	
Bulgaria	161	2%	ni			161
Croatia	49	1%	ni			49
Cyprus	0	0%	na			0
Czech Republic	394	6%	ni			394
Denmark	178	3%	ni			178
Estonia	74	1%	17%	13	61	
Finland	55	1%	10%	6	50	
France	1,406	21%	35%	492	914	
Germany	1,309	19%	72%	942	366	
Greece	6	<1%	na			6
Hungary	303	4%	45%	136	167	
Ireland	10	<1%	66%	7	3	
Italy	16	<1%	na			16
Latvia	113	2%	22%	25	88	
Lithuania	181	3%	55%	100	81	
Luxembourg	3	<1%	na			3
Malta	0	0%	na			0
Netherlands	2	<1%	na			2
Norway	2	<1%	30%	1	2	
Poland	914	13%	ni			914
Portugal	0	0%	na			0
Romania	598	9%	ni			598
Serbia	19	<1%	na			19
Slovakia	150	2%	ni			150
Slovenia	3	<1%	na			3
Spain	96	1%	ni			96
Sweden	114	2%	ni			114
Switzerland	20	<1%	25%	5	15	
Turkey	17	<1%	na			17
United Kingdom	563	8%	71%	400	163	
EU 28+4	**6,808**			**2,127**	**1,961**	**2,720**
				31%	**29%**	**40%**
				52%	**48%**	
Number of countries providing data						13
Acreage for which we have data						4,088
Percentage of the crop acreage in the EU 28+4						60%

Sources:

- Crop acreage: Rape and turnip rape seeds (I1110), Eurostat, 2017.
- Percentage of the crop area treated with glyphosate: ENDURE survey 2019.

Note: ni stands for no information; na stands for not applicable (no or very small acreage <1% of the total EU 28+4 acreage).

Table 21: Glyphosate and alternative approaches in winter wheat acreage in the EU countries (ENDURE survey, experts' estimates)

	Share of the acreage treated with glyphosate (%)	Share of the area treated with another herbicide (%)	Share of the area managed through preventive weed control methods[1] (%)	Share of the area managed through mechanical weed control (%)	Share of the area managed through other type of weed control (%)
Austria	5%	85%	<5%	15%	<1%
Belgium[2]	17%	>99%	<1%	<1%	<1
Finland	50%	95%	20%	2%	0%
France	20%	ni	ni	ni	ni
Serbia	45%	ni	0%	20%	20%
Switzerland	14%	ni	>4%	ni	ni

[1]Ex: cover crops + roller-crimper; higher seed rate etc.

[2]Data from the Flanders region.

Note: ni stands for no information.

Table 22: Estimated fruit orchards acreage treated with glyphosate in the EU 28+4 countries in 2017

	Acreage (1,000 ha)	% of total acreage	Percentage of the crop area treated with glyphosate	Estimated acreage treated with glyphosate	Area not treated with glyphosate	Acreage for which the use of glyphosate is not known
Austria	9	0%	40%	4	6	
Belgium	18	0%	92%	17	1	
Bulgaria	37	1%	ni			37
Croatia	28	1%	70%	20	8	
Cyprus	8	<1%	na			8
Czech Republic	14	<1%	na			14
Denmark	3	<1%	na			3
Estonia	2	<1%	na			2
Finland	3	<1%	20%	1	3	
France	164	3%	90%	147	16	
Germany	59	1%	90%	53	6	
Greece	179	3%	70%	125	54	
Hungary	82	2%	92%	75	7	
Ireland	1	<1%	49%	0	0	
Italy*	566	10%	ni			566
Latvia	6	<1%	73%	4	1	
Lithuania	22	<1%	90%	19	2	
Luxembourg	<1	<1%	na			0
Malta	<1	<1%	na			-
Netherlands	19	<1%	na			19
Norway**	2	<1%	91%	2	0	
Poland	323	6%	ni			323
Portugal	214	4%	21%	45	169	
Romania	140	3%	ni			140
Serbia	175	3%	50%	88	88	
Slovakia	4	<1%	na			4
Slovenia	4	<1%	na			4
Spain	1,289	24%	33%	425	863	
Sweden	2	<1%	61%	1	1	
Switzerland	6	<1%	60%	4	3	
Turkey	2,033	37%	85%	1,728	305	
United Kingdom	25	<1%	79%	20	5	
Total EU 28+4	**5,436**	**100%**		**2,778**	**1,538**	**1,120**
				51%	**28%**	**21%**
				64%	**36%**	
Number of countries providing data						19
Acreage for which we have data						4,316
% of the total crop acreage in EU 28+4						79%

Sources:

- Crop acreage: Eurostat: Fruits, berries and nuts (excluding citrus fruits, grapes and strawberries) (F000) + Citrus fruits (T000), Eurostat, 2017, except: Crop acreage in *Italy: 2016 instead of 2017; Crop acreage in **Norway: ENDURE survey (no data in Eurostat), average 2012-2016.
- Percentage of the crop area treated with glyphosate: ENDURE survey 2019.

Note: ni stands for no information; na stands for not applicable (no or very small acreage <1% of the total EU 28+4 acreage).

Table 23: Estimated vineyard acreage treated with glyphosate in the EU 28+4 countries in 2017

	Acreage (1,000 ha)	% of total acreage	Percentage of the crop area treated with glyphosate	Estimated acreage treated with glyphosate	Area not treated with glyphosate	Acreage for which the use of glyphosate is not known
Austria	48	2%	55%	26	22	
Belgium	<1	<1%	50%	<1	<1	
Bulgaria	32	1%	ni			32
Croatia	22	1%	80%	17	4	
Cyprus	5	<1%	na			5
Czech Republic	16	1%	ni			16
Denmark	0	0%	na			0
Estonia	0	0%	na			0
Finland	0	0%	na			0
France	745	24%	36%	268	477	
Germany	100	3%	70%	70	30	
Greece	62	2%	60%	37	25	
Hungary	64	2%	90%	57	6	
Ireland	0	0%	na			0
Italy	634	20%	26%	165	469	
Latvia	0	0%	na			0
Lithuania	0	0%	na			0
Luxembourg	1	<1%	na			1
Malta	1	<1%	na			1
Netherlands	0	0%	na			0
Norway	0	0%	na			0
Poland	0	0%	na			0
Portugal	177	6%	35%	62	115	
Romania	168	5%	ni			168
Serbia	17	1%	50%	8	8	
Slovakia	8	<1%	na			8
Slovenia	16	1%	ni			16
Spain	922	30%	13%	120	802	
Sweden	0	0%	na			0
Switzerland	15	<1%	83%	12	3	
Turkey	64	2%	95%	61	3	
United Kingdom	2	<1%	65%	1	1	
EU 28+4	**3,118**	**100%**		**906**	**1,965**	**248**
				29%	**63%**	**8%**
				32%	**68%**	
Number of countries providing data						14
Acreage for which we have data						2,871
Percentage of the total EU 28+4 crop acreage						92%

Sources:

- Crop acreage: Grapes for wines (W1100), Eurostat 2017.
- Percentage of the crop area treated with glyphosate: ENDURE survey 2019.

Note: ni stands for no information; na stands for not applicable (no or very small acreage <1% of the total EU 28+4 acreage).

Table 24: Estimated olive grove acreage treated with glyphosate in the EU 28+4 countries in 2017

	Acreage (1,000 ha)	% of total acreage	Percentage of the crop area treated with glyphosate	Estimated acreage treated with glyphosate	Area not treated with glyphosate	Acreage for which the use of glyphosate is not known
Austria	0	0%	na			0
Belgium	0	0%	na			0
Bulgaria	0	0%	na			0
Croatia	19	0%	80%	15	4	
Cyprus	11	<1%	na			11
Czech Republic	0	0%	na			0
Denmark	0	0%	na			0
Estonia	0	0%	na			0
Finland	0	0%	na			0
France	17	<1%	na			17
Germany	0	0%	na			0
Greece	939	16%	60%	564	376	
Hungary	0	0%	na			0
Ireland	0	0%	na			0
Italy	1,149	19%	13%	149	1,000	
Latvia	0	0%	na			0
Lithuania	0	0%	na			0
Luxembourg	0	0%	na			0
Malta	0	0%	na			0
Netherlands	0	0%	na			0
Norway	0	0%	na			0
Poland	0	0%	na			0
Portugal	359	6%	19%	68	291	
Romania	0	0%	na			0
Serbia	0	0%	na			0
Slovakia	0	0%	na			0
Slovenia	1	0%	na			1
Spain	2,555	43%	47%	1,201	1,354	
Sweden	0	0%	na			0
Switzerland	0	0%	na			0
Turkey	846	14%	75%	635	212	
United Kingdom	0	0%	na			0
EU 28+4	**5,897**	**100%**		**2,631**	**3,236**	**29**
				45%	**55%**	**0%**
				45%	**55%**	
Number of countries providing data						6
Acreage for which we have data						5,867
Percentage of the total EU 28+4 crop acreage						100%

Sources:

- Crop acreage: Olives, Eurostat, 2017.
- Percentage of the crop area treated with glyphosate: ENDURE survey 2019.

Note: ni stands for no information; na stands for not applicable (no or very small acreage <1% of the total EU 28+4 acreage).

Table 25: Glyphosate and alternative approaches in fruit orchard acreage in the EU 28+4 countries (ENDURE survey 2019, experts' estimate)

	Share of the area treated with glyphosate (%)	Share of the area treated with another herbicide (%)	Share of the area managed through preventive weed control methods (%)	Share of the area managed through mechanical weed control (%)	Share of the area managed through other type of weed control (%)
Austria	40%	10%	<5%	50%	<5%
Belgium	92%	92%	8%	8%	8%
Croatia	70%	<5%	45%	No data	No data
Finland	20%	20%	50%	20%	50%
Germany	90%	No data	No data	No data	No data
Hungary	92%	40%	0%	60%	0%
Serbia	50%	50%	No data	50%	No data
Turkey	85%	10%	5%	80%	20%

Table 26: Glyphosate and alternative approaches in vineyard acreage in the EU 28+4 countries (ENDURE survey 2019, experts' estimate)

	Share of the area treated with glyphosate (%)	Share of the area treated with another herbicide (%)	Share of the area managed through preventive weed control methods (%)	Share of the area managed through mechanical weed control (%)	Share of the area managed through other type of weed control (%)
Austria	55%	10%	<5%	40%	<5%
Croatia	80%	<5%	45%	No data	No data
Germany	70%	No data	No data	No data	No data
Hungary	90%	40%	0%	60%	0%
Serbia	50%	50%	No data	50%	No data
Turkey	95%	2%	3%	60%	40%

Table 27: Temporary grassland acreage treated with glyphosate in the EU 28+2 countries

	Acreage (1,000 ha)	% of total acreage treated with glyphosate	Estimated acreage treated with glyphosate	Area not treated with glyphosate	Acreage for which the use of glyphosate is not known
Austria	50	1%	1	50	
Belgium	91	ni			91
Bulgaria	1	ni			1
Croatia	24	ni			24
Cyprus	<1	ni			0
Czech Republic	34	ni			34
Denmark	276	ni			276
Estonia	114	ni			114
Finland	647	20%	129	518	
France	2,967	30%	890	2,077	
Germany	276	ni			276
Greece	101	ni			101
Hungary	27	ni			27
Ireland	97	82%	79	17	
Italy	843	ni			843
Latvia	241	ni			241
Lithuania	149	ni			149
Luxembourg	12	ni			12
Malta	<1	ni			0
Netherlands	248	ni			248
Poland	212	ni			212
Portugal	58	ni			58
Romania	21	ni			21
Serbia	19	ni			19
Slovakia	57	ni			57
Slovenia	23	ni			23
Spain	287	ni			287
Sweden	1,035	4%	41	994	
Switzerland	124	24%	30	94	
United Kingdom	1,144	<1%	0	1,144	
EU 28+2	**9,180**		**1,171**	**4,894**	**3,115**
			13%	**53%**	**34%**
			19%	**81%**	
Number of countries providing data					7
Acreage for which we have data					6,065
% of the EU 28+2 crop acreage					66%

Sources: acreage from Eurostat (2017); percentage of the crop area treated with glyphosate from the ENDURE survey.

Scope: EU 28 + Serbia, Switzerland.

Note: ni: no information.

Table 28: Herbicides sales in the EU 28+3 countries in 2017

	Herbicides. Haulm Destructors and Moss Killers (PES_H)	Herbicides based on phenoxy-phytohormones (H01)	Herbicides based on triazines and triazinones (H02)	Herbicides based on amides and anilides (H03)	Herbicides based on carbamates and bis-carbamates (H04)	Herbicides based on dinitroaniline derivatives (H05)	Herbicides based on derivatives of urea, of uracil or of sulphonylurea (H06)	Other herbicides (including glyphosate) (H99)	Unclassified herbicides
Austria	1,296,943	117,228	187,041	230,168	18,025	54,286	54,665	635,531	0
Belgium	2,334,151	115,769	228,307	302,134	130,285		106,942	1,393,292	57,422
Bulgaria	1,698,979								1,698,979
Croatia	668,739	17,610	70,158	188,204	8,844	17,787	23,380	342,756	0
Cyprus	138,932	42,492	833	559	201	1,257	1,939	91,651	0
Czech Rep.	2,562,124	131,305	218,132	598,186	55,558	62,059	208,209	1,288,675	0
Denmark	2,485,284	23,090	38,500	99,070	34,277	15,570	9,192	2,265,585	0
Estonia	462,644	60,569	2,028	33,539	225	7,166	13,105	333,052	462,644
Finland	1,006,413	197,873	25,660	6,965	:	:	7,180	756,804	11,931
France	30,230,424	1,351,833	708,742	6,124,704	391,097	1,509,190	1,758,647	18,386,211	0
Germany	16,706,254	1,129,487	2,374,090	3,397,158	237,396	741,835	1,174,599	7,651,689	0
Greece	1,673,681	80,306	34,734	125,730	2,084	213,135	280,966	936,726	0
Hungary	4,269,854	321,293	306,647	1,080,395	8,143	142,201	123,808	2,287,368	-1
Ireland	1,820,404	:	:	:	:	:	:	:	1,820,404
Italy*	7,486,495	298,508	369,716	977,687	14,089	331,878	175,844	5,318,773	0
Latvia	801,179	133,761	2,358	109,228	391	18,099	16,147	521,195	0
Lithuania	1,251,548	235,985	:	190,691	:	:	32,313	678,802	113,757
Luxembourg*	61,078	4,401	:	11,755	100	:	2,459	32,573	9,790
Malta	2,406	:	:	:	:	:	504	1,103	799
Netherlands	2,901,786	:	339,112	332,170	198,620	:	51,469	1,604,534	375,881
Norway*	467,297	69,817	:	:	:	:	:	368,685	28,796
Poland	13,655,478	1,740,060	728,113	:	148,863	250,314	:	7,989,380	2,798,748
Portugal	1,899,471	55,376	79,692	162,566	1,623	52,103	28,225	1,519,884	2
Romania	5,486,476	939,728	281,369	1,475,207	22,559	105,197	268,973	2,393,443	0
Slovakia	1,105,104	52,172	61,658	232,023	20,811	87,884	59,974	590,582	0
Slovenia	235,302	9,104	16,567	56,405	58	17,139	6,981	129,048	0
Spain*	15,224,454	:	276,540	814,780	25,912	:	658,196	11,465,276	1,983,750
Sweden	1,731,236	:	:	:	:	:	:	:	1.731,236
Switzerland	599,260	42,801	71,732	86,892	21,214	21,176	36,404	319,041	0
Turkey	11,825,475	1,668,190	162,290	365,615	154,385	829,780	614,560	8,030,655	0
UK	9,681,731	:	300,577	1,390,405	253,647	:	609,798	4,582,777	2,544,527
EU 28 +3	**141,770,602**	**8,838,758**	**6,884,596**	**18,392,236**	**1,748,407**	**4,478,056**	**6,324,479**	**81,915,091**	**13,188,979**

Source: Data from Eurostat except specific mentions. For Belgium: *fytoweb*. For Estonia: national statistics (*Statistika andmebaas)*. For Norway: national statistics on pesticide sales.

Data from 2017 except for Luxembourg, Spain and Italy (data 2016 instead of 2017) and Norway (average 2014-2018).

Table 29: Pesticides sales in the EU 28+3 countries in 2017

	Total sales in tons of a.i.				Estimated use by the agricultural sector[1] in kg of a.i./ha[2]			
	Fungicides and bactericides	Herbicides. haulm destructors and moss killers	Insecticides and acaricides	Total	Fungicides and bactericides	Herbicides. haulm destructors and moss killers	Insecticides and acaricides	Total
Austria	1,992	1,297	1,186	**4,474**	0.88	0.57	0.52	**1.98**
Belgium	2,496	2,334	536	**5,366**	1.80	1.69	0.39	**3.88**
Bulgaria	1,287	1,699	374	**3,360**	0.24	0.31	0.07	**0.62**
Croatia	727	669	115	**1,511**	0.47	0.43	0.07	**0.97**
Cyprus	818	139	124	**1,081**	6.34	1.08	0.96	**8.38**
Czech Rep.	1,854	2,562	174	**4,590**	0.55	0.76	0.05	**1.37**
Denmark	484	2,485	44	**3,013**	0.18	0.93	0.02	**1.13**
Estonia	117	463	26	**606**	0.13	0.52	0.03	**0.68**
Finland	3,228	1,006	25	**4,259**	1.44	0.45	0.01	**1.90**
France	29,770	30,230	3,773	**63,774**	0.98	0.99	0.12	**2.10**
Germany	13,266	16,706	14,549	**44,522**	0.77	0.97	0.84	**2.58**
Greece	1,686	1,674	893	**4,252**	0.32	0.32	0.17	**0.81**
Hungary	4,171	4,270	860	**9,300**	0.73	0.75	0.15	**1.62**
Ireland	634	1,820	54	**2,508**	0.13	0.37	0.01	**0.51**
Italy*	32,643	7,114	2,726	**42,483**	2.69	0.59	0.22	**3.50**
Latvia	267	801	33	**1,101**	0.14	0.43	0.02	**0.60**
Lithuania	690	1,252	54	**1,996**	0.23	0.42	0.02	**0.66**
Luxembourg*	91	61	23	**175**	0.65	0.44	0.16	**1.25**
Malta	102	2	3	**107**	7.92	0.19	0.24	**8.35**
Netherlands	4,725	2,902	286	**7,912**	2.45	1.51	0.15	**4.11**
Norway*	93	467	4	**564**	0.09	0.45	0.00	**0.54**
Poland	6,927	13,655	1,819	**22,402**	0.45	0.88	0.12	**1.44**
Portugal	4,181	1,899	943	**7,024**	1.12	0.51	0.25	**1.89**
Romania	4,600	5,486	945	**11,031**	0.32	0.38	0.06	**0.76**
Slovakia	685	1,105	139	**1,929**	0.36	0.58	0.07	**1.01**
Slovenia	795	235	50	**1,080**	1.64	0.49	0.10	**2.23**
Spain*	37,982	16,077	6,549	**60,608**	1.57	0.67	0.27	**2.51**
Sweden	265	1,731	31	**2,027**	0.10	0.64	0.01	**0.75**
Switzerland	990	599	251	**1,840**	0.65	0.39	0.16	**1.21**
Turkey	21,831	11,825	12,171	**45,828**	0.52	0.28	0.29	**1.09**
UK	5,484	9,682	434	**15,600**	0.29	0.51	0.02	**0.83**
EU 28	**161,965**	**129,359**	**36,767**	**328,091**	**0.88**	**0.70**	**0.20**	**1.78**
EU 28 +3	**184,880**	**142,251**	**49,192**	**376,324**	**0.81**	**0.62**	**0.21**	**1.64**

Sources: Total sales from Eurostat in 2017 except specific mentions. For Luxembourg and Norway: data from the closest previous year for which data was available.

[1]The estimated use by the agricultural sector is calculated with a ratio of 90% (see Table 17).

[2]ha of UAA in conventional agriculture (see Table 1).

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