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## Current on-farm glyphosate uses and alternative practices in France

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### 1 – Introduction

With more than 7,500 tons sold in 2016 for agricultural uses, glyphosate is the most widely-used herbicide ingredient in France (Reboud et al., 2017). It is also a subject of public concern, regarding its potential hazards for human health and environment. Thus, in 2017, the French government took the decision to banish glyphosate within three years. This decision challenged farmers using it toward the redesign of their cropping systems, in order to control weeds without glyphosate. In this context, we aimed at better describing the current uses of glyphosate in arable systems, and at identifying existing alternatives already implemented on farm.

### 2 – Materials and methods

This study was based on a public dataset from the French Ministry of Agriculture. Data, describing cropping practices, were derived from an on-farm survey realised on a sample of around 20,000 fields for arable crops. Major crops were covered (i.e. wheat, durum wheat, barley, triticale, oilseed rape, sunflower, pea, silage and grain corn, potato and sugar beet). The whole crop management route for the surveyed year was collected (i.e. all technical operations implemented on the field, from harvest of the preceding crop until the crop harvest). Crop sequence and plowing frequency of the five preceding years were also collected. A full survey was carried out every five years. In between two full surveys, an intermediate partial survey was also carried out, focusing on pest management practices. We used data from the last full (2011) and partial (2014) surveys available. Both contained information about glyphosate use, as well as other pesticides. First, we described current uses of glyphosate. We distinguished four categories of uses according to glyphosate target: (1) grassland destruction, (2) cover-crop destruction, (3) weed management in fallow period between two cash crops, and (4) crop pre-harvest (n.b. glyphosate-ready genetically modified cultivars are not permitted in France). Second, we described existing alternatives to glyphosate use. For each of the four categories of uses identified, we compared fields with and without glyphosate, on various characteristics: farm size, preceding crop, fallow period duration, time between last tillage operation and sowing, number of secondary tillage operations, reliance to other herbicides and yield. All results are given for year 2011. Some results for 2014 are presented to illustrate that glyphosate uses seemed to remain steady within

time. Comparison between fields with and without glyphosate are presented here only for the case study of winter wheat under permanent no plowing, as this situation was the most contributive to French glyphosate use, in terms of acreages.

### 3 – Results – Discussion

Glyphosate concerned 14% of arable land in France in 2011 (15% in 2014). It mainly targeted weed control on bare soil in fallow period (86% in 2011, 87% in 2014). Each other category represented less than 5% of overall uses. Reliance to glyphosate varied according to the following crop, from 6% of potato acreages to 28% of sunflower acreages. Only 11% of winter soft wheat acreages received glyphosate before sowing. But this crop covered the largest area in France. Thus, within the total acreages receiving glyphosate, 31% represented an application in fallow period before winter soft wheat. Reliance to glyphosate also varied according to plowing frequency (Table 1): 6% of acreages yearly plowed received glyphosate, compared to 33% of acreages under permanent no plowing. Whatever the tillage, glyphosate mostly targeted annual weeds control during the fallow period (66% to 77% of acreages in 2011). Even if they remained minor, applications targeting perennial weeds were more frequent under yearly plowing (20% of acreages compared to 8% and 13% for other tillage types). Applications aiming to destroy a covercrop were the most frequent under permanent no plowing (8%) compared to yearly plowing (3%) or occasionally plowing (4%).

*Tabla 1: Part of acreages receiving glyphosate per type of tillage in 2011 and distribution of glyphosate applications per use (1: grassland destruction, 2: covercrop destruction, 3a: annual weeds management in fallow period, 3b: perennial weed management in fallow period, 4: crop pre-harvest)*

	Part of acreages receiving glyphosate	Distribution per use				
		1	2	3a	3b	4
Yearly plowing	6%	9%	3%	66%	20%	2%
Occasional plowing	13%	4%	4%	74%	13%	5%
Permanent no plowing	33%	7%	8%	77%	8%	2%
ALL TILLAGE	14%	6%	5%	74%	12%	3%

Focusing on fields under winter soft wheat and no plowing highlighted some differences between subsamples with and without glyphosate (Figure 1). Fields with glyphosate were observed on larger farms (149 and 156 ha for fields with glyphosate, respectively against annual and perennial weeds, vs 130 ha average size). Winter wheat fields receiving glyphosate were more frequently preceded by an oilseed rape (57% and 78% of acreages with glyphosate targeting respectively annual weeds and perennial weeds), whereas it was the preceding crop for only 32% of the winter wheat fields without glyphosate. Fields with glyphosate presented a slightly higher use of other herbicides (1.67 and 1.65 with glyphosate, respectively against annual and perennial weeds, vs 1.5 average treatment frequency index), indicating no compensation. There is no obvious differences in fallow period duration, time between last tillage operation and wheat sowing, number of tillage operations or wheat yield.

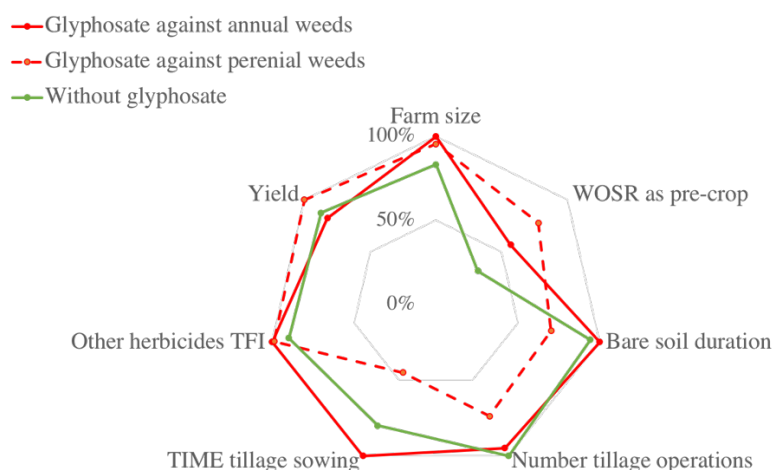


Figure 1: Comparison of winter soft wheat fields under no plowing in 2011, according to glyphosate use and regarding farm size, preceding crop, fallow period duration, number of tillage operation, time between last tillage and sowing, other herbicides treatment frequency index and yield

#### 4 – Conclusions.

Glyphosate is mainly used in France to manage weeds on bare soil in fallow period, especially in no-plowing systems. Trying to identify alternatives allowed us to highlight that reliance to glyphosate (and herbicides in general) was the highest within poorly diversified crop sequences, and large farms. Supporting glyphosate-free agriculture (while reducing reliance to other herbicides) requires deep changes in practices, and cropping system redesign. In large-scale farms, with simplified tillage, crop diversification should facilitate weeds management, requiring to unlock the dominant system (Meynard et al., 2018).

#### References

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