> “More glufosinate, maybe more paraquat.”
> “I would have to find a different burn down chemical, likely paraquat. Would use more atrazine combos on corn. Would likely mean less cover crop options post harvest”
> “It would mess with our no-till operation. I’m not sure what else we could use to effectively kill an established grass seed crop?”
> “Higher rates of pre-emergence control combined with 2,4D, or Gramoxone (paraquat), possibly Liberty/glufosinate but that is more costly. We do already rotate modes of action so if we burn down cover crop with glyphosate we will use gramoxone in our pre-emergent spray. With soybeans we’d have use more STS trait and come through with a sulfonylurea. If they are conventional, we can come through with a grass herbicides like avatar and a broadleaf like Cadet (fluthiacet-methyl).”
> “I used diquat this year as a defoliant but use glyphosate for no-till. We don’t have paraquat here and I’d not use it anyway due to the toxicity.”
> “Our glyphosate free rotation strategies would become our status quo. Even on years we don’t plan on glyphosate we plant RR because the substitutions can sometimes be ineffective and it’s far more efficient to use targeted glyphosate application than apply more of the inefficient and oftentimes ineffective applications.”

Those were some of the responses when I asked farmers what weed control strategies they are likely to adopt or apply more frequently in the event of glyphosate being pulled from the market.

With the jury award against Monsanto in California last week of $289 million to a man with non-Hodgkin’s lymphoma and 800 more cases lined up behind it, it’s worth considering what impact it would have if glyphosate was removed from the market, for farmers and for sustainable agriculture.

The decision could still be overturned on appeal since the jury seems to have disregarded scientific evidence entered in the case, but the decision and the parade of splashy headlines will be used as agitprop for the misguided activist (supposedly environmental) groups pushing to remove glyphosate from farming. In the event that the jury award stands and

Monsanto/Bayer starts to lose other cases, the death of glyphosate may come from a decision by manufacturers to pull the product from the market, rather than a threat from misguided regulators. That decade long propaganda campaign is already starting to take its toll.

In the UK, we already have news that three home improvement chains are going to review whether or not to continue to sell Roundup as a result of the jury's decision.

Of greater consequence, the French environmental ministry announced it will oppose the EU's move to reauthorize glyphosate for another ten years (independent of the jury award, but certainly as a result of the propaganda campaign). French farmers are warning that losing glyphosate would kill conservation agriculture, an important part of France's climate change strategy.

> Speaking at the AGRI Committee of the European Parliament in July, Gottlieb Basch, President of the European Conservation Agriculture Federation (ECAF), told MEPs, "Glyphosate is an important substance for agriculture, not just for Conservation Agriculture but for conventional agriculture too".
> Conservation farmers claim that glyphosate is a crucial element in the development of conservation systems. The active ingredients used in the pre-seeding weed control are diverse, but normally glyphosate alone or in combination with other herbicides, such as hormonal ones, are a common choice among farmers.

As those remarks and those of the farmers quoted above make clear something that anti-agriculture activists seem to be oddly unaware of — there are lots of other herbicides besides glyphosate and other weed control strategies besides herbicides. Nearly all of them come with greater environmental impacts than glyphosate, especially in crops where it is a linchpin of no-till agriculture.

Conservation agriculture (CA) is based on three principles: no-till (or minimal soil disturbance), organic soil cover, and diversified crop sequence. The purpose of minimal soil disturbance is to maintain soil structure and minimize erosion (from wind or water).

There are countess benefits to the land, the farmer and the environment from adopting a no-till system. First and foremost, by leaving the soil mostly undisturbed and leaving high levels of crop residues behind, soil erosion is almost eliminated through no-till farming. The USDA’s National Resources Inventory credits the 43 percent reduction in soil erosion in the United States between 1982 and 2003 to the increase in conservation tillage.

The utilization of crop residues in no-till farming also drastically increases water infiltration and therefore retention (i.e. less evaporation) by the soil. This means there is less runoff of contaminated (by fertilizers, pesticides, etc.) water, as well as a reduction in the amount of watering necessary for a given crop.

Some estimates suggest crop residues provide as much as 2 inches of additional water to crops in late summer and the Natural Resources Conservation Service states that no-till farmed soils have a water penetration rate of 5.6 inches per hour, twice as much as for conventionally tilled land. This makes no-till farming an excellent opportunity for drought stricken areas like California.

Furthermore, because the soil is not being frequently agitated, no-till farming promotes biodiversity in and around the soil. Organisms like mycorrhizal fungi, which make commensal (i.e. benefit both the plant and fungus) associations with crop roots, and earthworms, which increase the water retention of the soil, are allowed to flourish through no-till farming.

The farmer also significantly benefits by the adoption of no-till farming, in particular through a reduction in labor. Conventional tillage practices require sometimes as many as

five passes over the land with a plow, however, no-till requires just a single pass—to plant the seeds. An estimate by Purdue University calculates that a farmer will save 225 hours of labor per year for a 500 acre farm; the equivalent of four 60-hour work weeks saved a year. Another study estimated a reduction in labor by as much as 50 percent compared to tillage.

The benefits in reducing farming's global warming footprint are immense. Fuel costs saved by running the tractor less, one estimate suggests, no-till can reduce fuel usage by as much as 80 percent. In addition to the reduced carbon emissions from mechanical equipment used in no-till farming, there are several other benefits to the environment. No-till farming, often when paired with crop covering (a technique in which a crop is planted for the express purpose of soil health), reduces carbon emissions through greater sequestration of carbon dioxide by the soil. Over half of the potential carbon sequestration from farmlands comes from conservation tillage.

Related article: Delving into the GMO traits that cut back pesticide impacts globally

Roundup Ready crops allowed farmers to skip pre-emergence weed control via plowing and let the weeds sprout and then control them with Roundup without harming their crop. Prior to the inevitable development of resistant weeds, farmers would use a combination of plowing and various herbicides to try to control weeds before and after they sprouted. Controlling them after they sprout with herbicides is tricky because you need an herbicide that will kill the weed, but not the crop. That's why atrazine was and is so popular for corn. Corn is naturally resistant to atrazine's mode of action.

How big would the impact on no-till be if glyphosate were taken off the market?

In one paper that tried to model the impact of Roundup Ready soybeans on reductions in tillage found "the adoption of conservation tillage and no-tillage have been about 10% and 20% higher, respectively, due to the advent of glyphosate tolerant soybeans." That's several million acres of no-till and conservation soybean production. When you put together the impact on soybeans, corn, canola, cotton, sorghum, and alfalfa — that's tens of millions of acres that could go back into tillage, the exact opposite direction farming should be moving in terms of sustainability.

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Different herbicides are used for pre-emergent control and post-emergent control. They each have a different mode of action (the process by which they kill plants). Some are selective — they are effective on some weeds, but not others, and others are broad spectrum, they kill nearly any plant the come in contact with. Almost none are as effective as Roundup or lower in toxicity. While it would great to see more farmers practicing more robust Integrated Pest Management for weed control, forcing that by taking away the safest, most effective tool in the toolbox is unlikely to improve results in the way one might wish.

Here are the chronic NOELs for a few of the herbicides that would most likely fill in behind glyphosate if it were pulled from the market. An NOEL refers No Observable Effect Level, that is, the dose at which exposure in an animal study had no effect.

Fluthiacet-methyl – 0.1 mg/kg/day
Paraquat – 1.25 mg/kg/day
Diquat – 0.22 mg/kg/day
Glufosinate – 2 mg/kg
Atrazine – 1.8 mg/kg/day (NOAEL) [PDF]

Studies of glyphosate lasting up to 2 years, have been conducted with rats, dogs, mice, and rabbits, and with few exceptions no effects were observed. For example, in a chronic feeding study with rats, no toxic effects were observed in rats given doses as high as 400 mg/kg/day. Also, no toxic effects were observed in a chronic feeding study with dogs fed up to 500 mg/kg/day, the highest dose tested.

So it takes 4,000 times larger a dose of glyphosate to produce an effect in lab animals than fluthiacet-methyl and 222 time as much glyphosate as atrazine to produce an effect*. Writing in the journal Nature, weed scientist Andrew Kniss found:

> In the final year for which data were available (2014 or 2015), glyphosate

> accounted for 26% of maize, 43% of soybean and 45% of cotton herbicide applications. However, due to relatively low chronic toxicity, glyphosate contributed only 0.1, 0.3 and 3.5% of the chronic toxicity hazard in those crops, respectively.

Though glyphosate accounted for one quarter of herbicides applied by weight to corn, it only accounted for one tenth of one percent of the chronic toxicity hazard associated with weed control in corn. Put another way: the other 74 percent of herbicides accounted for 99.9 percent of chronic toxicity hazard in weed control for corn. Or to put it yet another way, taking glyphosate out of the picture could raise the toxicity hazard in corn by 26 percent, 43 percent in soybeans, and 45 percent in cotton.

These are relatively safe herbicides when used properly, but why anyone who considers themselves an environmentalist would be cheering the prospect of glyphosate being taken off the market boggles the mind. And that's not even raising the body literature on paraquat that, unlike the body research on glyphosate and human health, carries fairly strong evidence of real health risks. If there is a mass market herbicide that might warrant a closer look, environmentalists might follow the evidence instead of the politics and dig into that literature. It is always crazy making to see anti-agriculture campaigners going after the safest, most popular pesticides — glyphosate, neonicotinoids — and then working down the list by popularity rather than going after the highest risk pesticides, and working their way down that list.

But pushing farmers away from no-till farming and back towards paraquat (pigweed in soybeans and cotton is doing that already, thank you very much) makes no sense for any self-respecting environmentalist.

* *These are very loose, ballpark numbers. Straightforward apples to apples chronic NOEL numbers can be hard to pin down, but they accurately depict the wide discrepancy of toxicity between glyphosate and most the of the options for replacing it.*

Marc Brazeau is the GLP's senior contributing writer focusing on agricultural biotechnology. He also is the editor of Food and Farm Discussion Lab. Follow him on Twitter @eatcookwrite.

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