GLYPHOSATE HERBICIDES: an ongoing debate…

Glyphosate is a man-made chemical compound designed to kill grasses, annual and perennial plants, vines, shrubs and trees.[1] Since 1976, it has been used in Canada to kill weeds after harvest, and in crops such as wheat, barley, peas, lentils and seed crops just before harvest.[2] Glyphosate is also used to regenerate conifer forests after clearcutting by commercial forestry and to control weeds along roadsides, railroad rights-of-ways, around industrial sites, and in peoples' yards.[3]

In 1995, canola, soybean and corn crops that are genetically modified (GM) to resist glyphosate were introduced in Canada. These crops have become widely grown since then.[4] Because these GM crops can still grow when sprayed with glyphosate, it can be used more frequently and at any time during the growing season. Since 2008, glyphosate has consistently been the most frequently sold active ingredient in Canada, compared to all other herbicide, insecticides, fungicides and antimicrobials, with more than 25,000 tonnes sold each year.[5,6,7,8,9]

GLYPHOSATE IN THE ENVIRONMENT

To be effective, glyphosate must be sprayed on actively growing weeds. It is drawn into the weed through the leaves and once inside, it interferes with the weed's life cycle by preventing the production of important enzymes. This kills the weed within a matter of days to a few weeks.[10] When used on GM crops, glyphosate does not have this effect, but is still absorbed by plants and small amounts can therefore enter the human food chain. When sprayed just before harvest, ripe grain, legumes and seeds do not absorb glyphosate from outside or take it up from inside the plant, but some residue can remain on the outside of the seed and enter our food chain.[11] People who apply glyphosate-based herbicides can be exposed for short periods of time by inhaling it or absorbing it through their skin, and people can also absorb glyphosate through their skin if they touch plants or lawns recently sprayed.[12]

Glyphosate can enter soil directly when sprayed, and indirectly through sprayed plants rotting after they are killed. Once in the ground, glyphosate sticks tightly to soil particles until it is broken down by microbes. How far it travels and how quickly it is broken down depends on a range of factors, including soil characteristics, the type of microbes present and the soil temperature. Glyphosate can be removed from the soil within several weeks or persist for many years. [13] When it is broken down, it turns into AMPA (aminomethylphosphonic acid) and CO_2 (carbon dioxide).[14]

Glyphosate can enter ponds, lakes, rivers and streams directly when sprayed, and indirectly if heavy rain washes it off plants right after spraying. Contaminated soil particles can also be washed out by heavy rainfall, or blown into the water by wind. Glyphosate that enters the water on contaminated soil particles tends to settle into the sediment relatively quickly, persisting from several days to several weeks.[15] Glyphosate that enters the water directly from spraying generally sticks to particles suspended in the water and settles to sediment, but the amount remaining in the water can stay elevated if there are few particles present in the water to begin with.[16]

HUMAN HEALTH

In March 2015, the International Agency for Research on Cancer identified glyphosate as a 'probable' human carcinogen.[17] The decision was based partly on studies of farm workers in Canada, the US, and Sweden that suggested exposure to glyphosate is linked to an increased risk of non-Hodgkin lymphoma. Only one of these studies accounted for uses of other kinds of pesticides and showed a statistically significant increase (between 1.1 and 4 times higher risk) when comparing farmers with exposure to glyphosate to farmers with no exposure to glyphosate.[18]

Critics of the IARC decision say there are studies showing glyphosate by itself is not linked to cancers; however, glyphosate-based herbicides are always used in combination with other chemicals that make it easier for plants to absorb. These chemicals are called 'surfactants' and POEA (polyethyloxylated tallowamine) is commonly used with glyphosate in Canada. The human studies of cancer reviewed by IARC looked at farm workers who used the herbicide with surfactants, not as pure glyphosate. It may be that the combination of chemicals is responsible, so it is difficult to prove that glyphosate by itself caused the increased rate of non-Hodgkin lymphoma.

The IARC review also cited studies that measured DNA damage in non-farmers exposed to typical amounts of herbicides containing glyphosate, and laboratory studies of live animals, animal cells and human cells that showed cell damage at very high doses. IARC concluded there is strong evidence that glyphosate by itself or in mixtures with other chemicals is genotoxic – that is, it can cause genetic mutations in cells that may lead to cancer.

Further criticism of the IARC decision comes from the fact that studies prepared by companies manufacturing glyphosate were excluded from the review. In general, there are few studies conducted by non-industry scientists that look specifically at glyphosate and cancer in humans and animals and they often have important limitations. This should not be interpreted as proof that glyphosate is not linked to cancer, but rather that there may not be enough data yet, one way or the other. IARC often takes a precautionary approach in such cases.

Glyphosate was recently re-evaluated and proposed for continued use in Canada by Health Canada's Pest Management Regulatory Agency (PMRA). Although the agency is aware of the recent IARC classification of glyphosate as a probable carcinogen, the re-evaluation indicates that pesticides can be registered for use in Canada if the *level of exposure* does not cause any harmful effects, including cancer.[19] Based on a series of risk assessments, the PMRA re-evaluation concluded that there are no human health risks due to glyphosate residues in food and drinking water. They explain that the most likely maximum amounts ingested are far below the guidelines for short-term and long-term ingestion for humans, which are in turn 100 times lower than levels seen to cause health effects in rats (studied for toxicity and carcinogenicity) and rabbits (studied for reproductive impacts). The PMRA re-evaluation also concluded there is no risk of health impacts to adults applying glyphosate herbicides for agricultural or home uses when used as labelled.

ANIMAL and ECOSYTEM HEALTH

Animals, insects and other organisms can be exposed to glyphosate if they are present when agricultural crops or clearcuts are being sprayed. Some may also be exposed when they eat or land on sprayed plants, or eat insects that have been sprayed. Because glyphosate can be unintentionally sprayed onto nearby streams or lakes, or transported there by wind and runoff, aquatic animals, plants and other organisms can be exposed as well.

The PMRA re-evaluation of glyphosate reviewed a large number of studies, primarily from industry, looking at the effects of glyphosate by itself and as mixed with other chemicals. The effects being studied focused on aquatic plants and invertebrates, fish, amphibians, earthworms, bees and other insects, birds, and small mammals (deer mice, mice and rats). The PMRA compared concentrations found to have harmful effects in lab tests with the maximum concentrations expected to occur within crop fields from ground or aerial spraying, on nearby areas from spray drift, and in waterbodies from runoff. In general, they found only freshwater algae and marine fish to be at risk of negative impacts. Although the PMRA re-evaluation review did not find serious risks to the animals and organisms tested, it does show that the mixture of glyphosate and POEA is two to three times more harmful than glyphosate by itself.

Forestry studies conducted in the 1980s and 1990s show that larger animals such as moose and deer do not avoid eating plants sprayed with herbicides, and that use of herbicides reduces the amount of forage available. The studies also found that the meat of snowshoe hare, white-tailed deer and moose showed no levels of glyphosate two months after spraying (with the exception of one sample which was thought to be contaminated during collection).[20] Other studies show that glyphosate does not bioaccumulate within living animals and insects to any great degree.[21] Overall, the use of herbicides to help regenerate clearcuts creates a different path of habitat change compared to other methods of weed control, because the types of plants present at each stage favour different kinds of insects, birds, amphibians and mammals. [22]

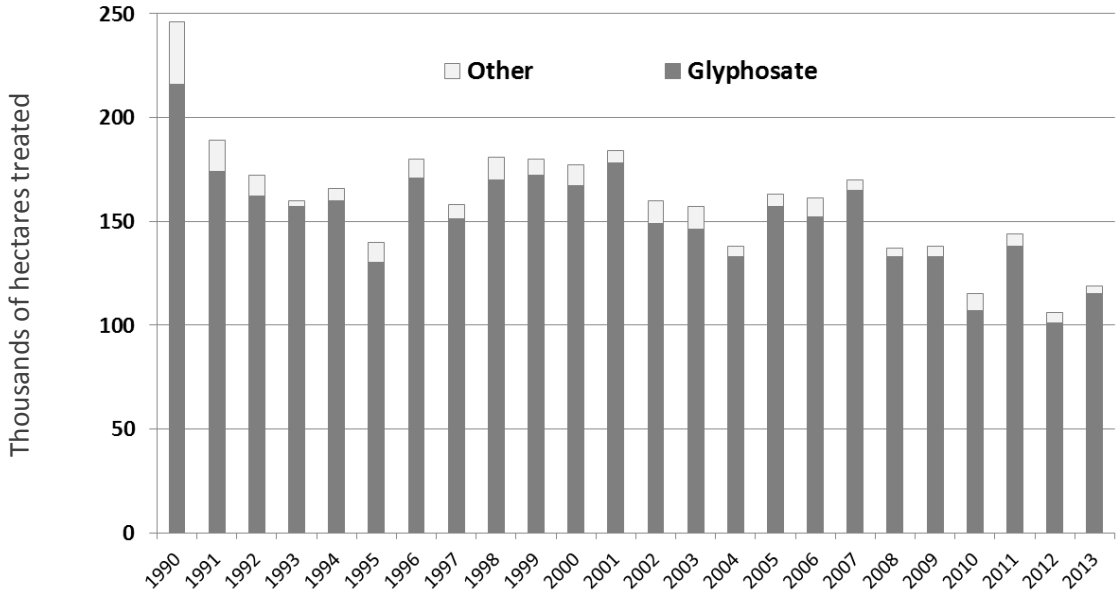
CURRENT CANADIAN GUIDELINES FOR DRINKING WATER AND FRESH WATER

	Guideline (ug/L)	Maximum measured (ug/L)	Notes
Drinking water Maximum allowable concentration[23]	280	--	Not detected in 102 Ontario drinking water systems in 2011[24] at a detection limit of 2 ug/L
Fresh water Short term	27,000	160 [25]	Forestry test spray directly on stream in British Columbia
Fresh water Long term	800	42 in Canada[26] 301 in US lakes, ponds, wetlands[27]	Previously set at 65 ug/L

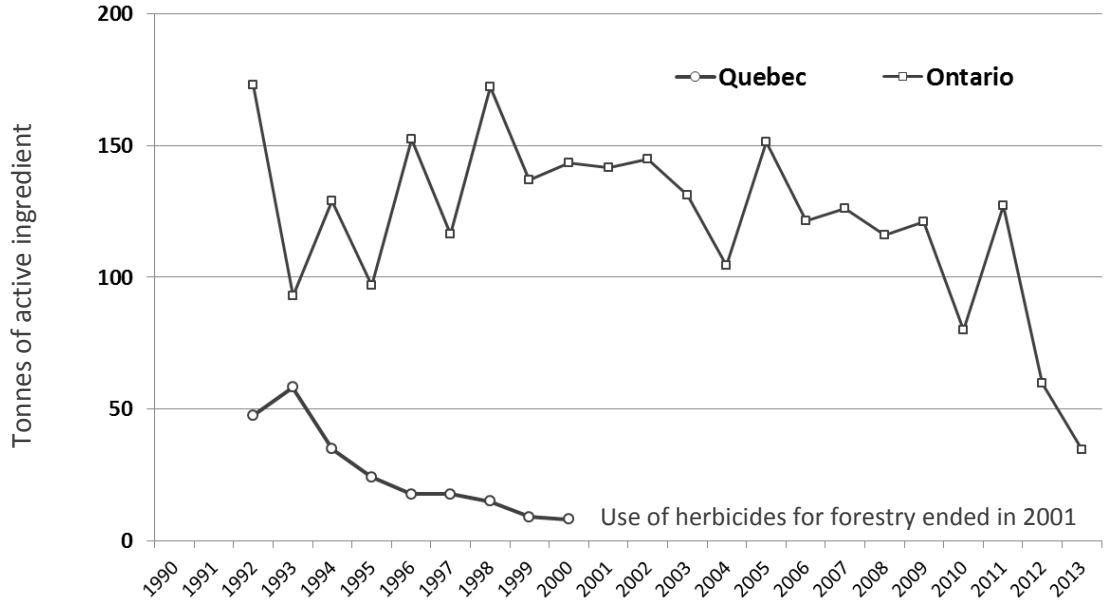
FORESTRY

The waxy coating on the needles of evergreen trees protects them from absorbing glyphosate. For this reason, Canadian foresters use glyphosate after clearcutting to suppress weeds, shrubs and deciduous trees while leaving the evergreen seedlings unharmed. Even so, Quebec banned the use of herbicides on public lands as of 2001, and the amount of glyphosate used for forestry in Ontario has been declining since 2011.

FORESTRY USE IN CANADA: hectares treated with herbicides[28]



FORESTRY USE IN ONTARIO AND QUEBEC: tonnes of glyphosate applied[29]

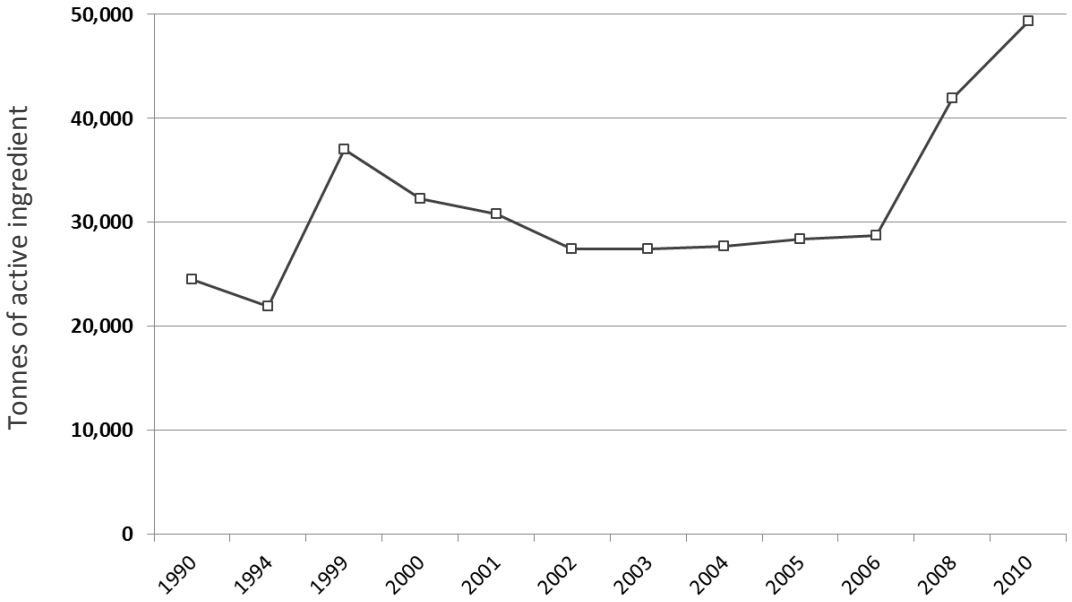


AGRICULTURE

The use of glyphosate-based herbicides for agriculture has become controversial since GM crops resistant to the herbicide were introduced. Concerns include the effect of trace amounts of glyphosate in many commonly eaten foods, and uncertainty about long-term ecosystem effects.

There has been a substantial increase in the use of herbicides for Canadian agriculture since 2006, with an estimated 49,321 tonnes used in 2010.[30] A large proportion of this total is glyphosate-based herbicides: in 2010, phosphonic and phosphinic acids as a group* were the most used active ingredients in Canada, with 34,819 tonnes sold, of which glyphosate accounted for 99 percent of the total.[31]

TOTAL HERBICIDE USE FOR AGRICULTURE IN CANADA: tonnes of active ingredient applied[32]



Glyphosate-resistant crops have been planted in Canada since 1995, but the more often glyphosate is used, the less effective it is becoming. Each time the herbicide is applied, a few weeds that are naturally more resistant survive. With each following application, resistant weeds get stronger and stronger, until the herbicide is no longer as effective. In 2008, the first glyphosate resistant weed (giant ragweed) was reported in southwestern Ontario; in 2010 and 2011, resistant fleabane and common ragweed were observed; and resistant kochia has been reported in Alberta and Saskatchewan.[33] One approach used is a return to a more diverse set of weed management techniques using more types of herbicides and other manual methods. Another is the development of new crops that are resistant to more than one kind of herbicide – called 'stacked' plants – so farmers can alternate which herbicide they use and thereby reduce the risk of developing resistant weeds. Stacked corn, soybean and wheat crops that are resistant to more than one herbicide have been available in Canada since 2006.[34]

* Includes glyphosate, ethephon, glufosinate ammonium, and fosamine ammonium.

We want to move forward in improving environmental quality: the air we breathe, the land we walk on, the water we drink, the food we eat; that's who we are as a people. If our earth is health, we are healthy.[35]

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CONCLUSIONS

Current guidelines for humans exposed to glyphosate through food are based on studies of rats and rabbits. How well these studies represent actual effects in humans is unknown. The studies of farm workers' health looked at data prior to 2000, when much less glyphosate was in use. Future studies of glyphosate-based herbicides and farm worker health may be more accurate, as there are potentially more farmers using glyphosate now than in the past.

The risk assessments conducted by the PMRA use the standard approach taken by many regulatory agencies. They focus on one specific substance at a time in order to understand its effects and determine safe levels of exposure. While this makes sense in some ways, it does not always represent real exposures in the environment or through food and water. In the case of glyphosate, it is applied in a mixture of other chemicals that may also have negative effects. Perhaps more importantly, there are tens of thousands of new chemicals in the environment now compared to 100 years ago, and the cumulative effect of many exposures at the same time, even if at low levels, is not well understood.

Glyphosate-based herbicides are not essential for industrial or residential weed control, and so can be avoided. Many jurisdictions have banned the use of herbicides for cosmetic purposes,[36] with some exceptions, but there are no restrictions on agricultural used in Canada. Glyphosate-based herbicides are an integral part of Canada's forestry and agricultural industries. Reductions in these sectors may be more difficult to achieve, especially for agricultural in the face of strong economic pressure and lobby groups active in promoting the sales of herbicides and seeds of the genetically-modified crops that can survive them.

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