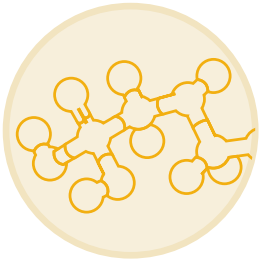
What is Glyphosate?

WHAT IS GLYPHOSATE?

How and **why** are herbicides used?

What is Glyphosate?



What is the foundation of **safety?**

What makes **good science?**

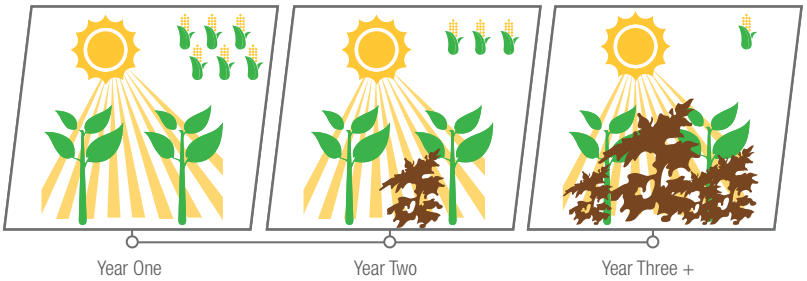
For more information: www.monsanto.com

How and **why** are **agricultural** herbicides used?

THE NEED FOR HERBICIDES

Herbicides are used to sustainably and effectively eliminate unwanted plants in and around a farmer's fields and homestead.

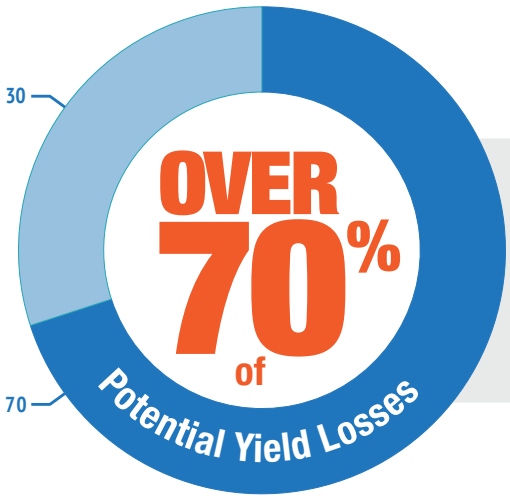
Excessive weed growth requires crops to **compete for for water, sunlight and nutrients**, often leading to **significant yield losses** come harvest time.



HEALTHY CROPS

Weeds represent the highest potential losses in a field's yield.

SPREAD OF WEEDS



from weeds **can be mitigated** through the use of **herbicides**[1]

THEREFORE, WEEDS ARE A VERY TREATABLE PROBLEM

WHAT IS **Conservation Tillage?**

VARIOUS PRACTICES INCLUDING:

Reduced Tillage[2] is defined as any method that retains enough of the previous crop residues such that at least 15% to 30% of the soil surface is covered after planting.[3]

No Till is defined as any method of growing crops that does not disturb the soil through tillage.

According to the USDA's National Resources Inventory data, **soil erosion** from water and wind on U.S. cropland **decreased 43 percent** between 1982 and 2007, with much of this decline coming **from the adoption of conservation tillage**.[4]

[1] Oerke_2006.pdf, Journal of Agricultural Science (2006), 144, 31–43. f 2005 Cambridge University Press,doi:10.1017/S0021859605005708 Printed in the United Kingdom http://cambridgefluids.org/action/displayAbstract?fromPage=online&aid=431724

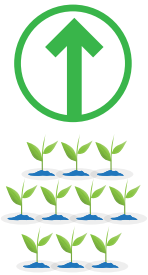
[2] No tillage, minimum tillage, reduced tillage and mulch tillage are terms synonymous with conservation tillage (Willis and Amemiya 1973; Lal 1973, 1974, 1976b; Phillips et al. 1980; Greenland 1981; Unger et al. 1988; Antapa and Angen 1990; Opara-Nadi 1990; Unger 1990; Ahn and Hintze 1990). http://www.fao.org/docrep/t1696e/t1696e09.htm

[3] http://www.ctic.purdue.edu/resourcedisplay/322/

[4] http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs143_012269.pdf

How and why are agricultural herbicides used?

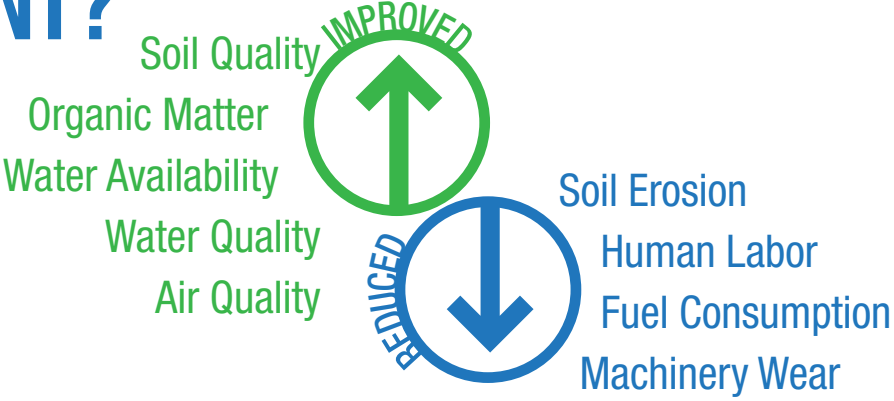
HOW DO HERBICIDES HELP THE FARMER?



Increased Yield: Weeds reduce yields by competing for moisture, nutrients, and light during the growing season. Weeds also harbor insects and disease pests and interfere with harvesting.

Lower Production Costs: When farmers use herbicides in conjunction with herbicide tolerant crops, weeds can be removed in a single, quick application. This means less spraying, less traffic on the field, and lower operating costs.

HOW DOES THE USE OF HERBICIDES BENEFIT THE ENVIRONMENT?



Conservation Tillage:
Without herbicides, growers must till to remove weeds. Herbicide use facilitates low or no tillage practices, and these practices can ***increase water and nutrients*** in the soil as well as ***decrease erosion***.

How and **why** are herbicides used?

THE NEED FOR HERBICIDES

WEEDS ARE A VERY **TREATABLE** PROBLEM

Herbicides are used to eliminate unwanted plants, whether in a farmer's field, utility rights of way, a drainage ditch or **your own backyard**.

Excessive weed growth requires crops to compete for sunlight and nutrients.

Disease-carrying mosquitoes breed in drainage ditches clogged by weeds.

Unwanted vegetation can impede access to critical utility areas.

Poison ivy, ragweed and thorny bushes can be harmful to your family and pets.

How and **why** are herbicides used?

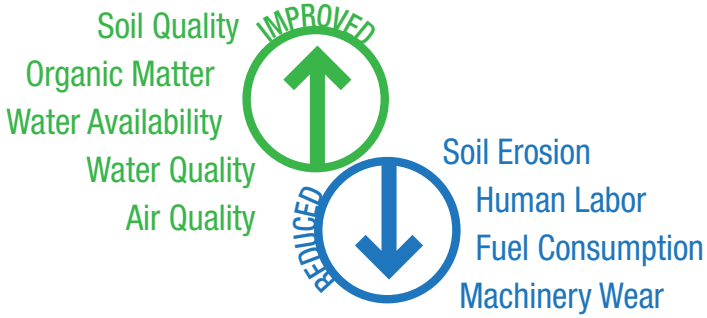
Improved lawn quality:

Weeds impact lawn quality by competing for moisture, nutrients, and light during the growing season. Weeds also harbor insects and disease pests.

Hard to reach areas:

Herbicides are effective in hard to reach areas such as along fences, around poles and on steep slopes where mowing is risky.

HOW DOES THE USE OF HERBICIDES BENEFIT THE ENVIRONMENT?



VEGETATION MANAGEMENT

Which tools to use:

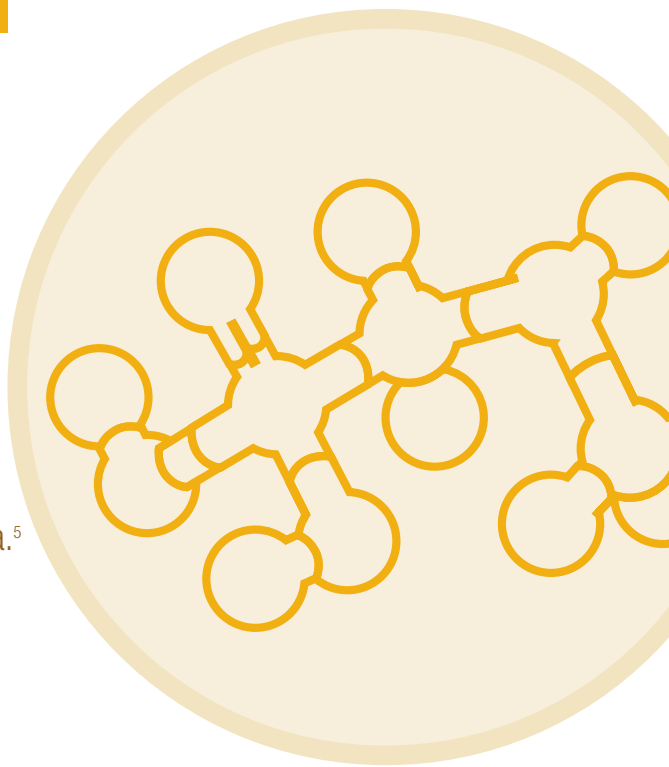
Weighing the pros and cons of alternatives in vegetation management: String trimmers and mowers consume fuel, make noise, contribute to air emissions and pose a risk of injury.

Vegetation Management problems require an integrated approach, which means choosing specific tools and practices for specific weed problems. Sometimes a properly applied herbicide is the best approach.

Applicator safety, efficacy, cost, environmental disruption and time are all important in choosing which tools are best suited to manage unwanted vegetation.

When ***Roundup® branded herbicides*** are applied to green vegetation or applied to freshly cut stumps, the active ingredient moves throughout the plant, destroying leaves and the root system so the plant cannot grow back.

What is Glyphosate?



Glyphosate
The Molecule of Choice

Glyphosate is a 'non-selective' herbicide, meaning an application will kill most plants. It does this by preventing the plants from making three amino acids (components of proteins and vitamins) that are required for growth. Glyphosate stops a specific enzyme, EPSP synthase. This enzyme is found ONLY in plants and many bacteria.[5]

This herbicide has a
40 year history of managing weeds

Regulatory and scientific authorities worldwide have concluded that glyphosate when used according to label directions does not pose an unreasonable risk to human health, the environment or non-target animals and plants.[6]

ROUNDUP® BRANDED HERBICIDES

Most Roundup® branded herbicides primarily contain three components – the active ingredient (glyphosate), water and a soap-like surfactant blend, which enables the active ingredient to adhere to and penetrate leaves.

THE SPRAYED SOLUTION

Application of a one to two percent solution of a Roundup® branded herbicide will provide effective weed control in most situations. This means that the vast majority of applications are more than 98 percent water.

[5] Franz, J. E. , Mao, M. K., Sikorski, J. A. (1997). Glyphosate: A Unique Global Herbicide, ACS Monograph No. 189. American Chemical Society, Washington, DC.
[6] US EPA RED 1993. http://www.epa.gov/oppsrrd1/REDs/old_reds/glyphosate.pdf
European Commission recent re evaluation 2014. http://www.bfr.bund.de/en/the_bfr_has_finalised_its_draft_report_for_the_re_evaluation_of_glyphosate-188632.html
JMPR/WHO 2004 http://www.inchem.org/documents/jmpr/jmpmono/v2004pr01.pdf

What is Glyphosate?

A Popular Technology

Glyphosate-based herbicides are frequently used by farmers because they are a simple and cost-effective way of controlling many types of weeds. But glyphosate-based products are popular outside of agriculture, too. They are also commonly used to control weeds in gardens and non cultivated areas, such as industrial complexes and along railway tracks.

Glyphosate is one of the most widely used broad spectrum herbicides **globally**

Agriculture Markets:

- Enable creation of sustainable agricultural systems that preserve valuable top soil, reduce stream sedimentation and help retain soil moisture.
- Eliminate weeds prior to planting, between fruit tree rows, or in-crop with Roundup Ready crops.
- Reclaim land that has been taken over by weeds for grazing or agriculture.

Industrial Markets:

- Control roadside vegetation to maintain driver visibility, curtail mowing emissions and eliminate mowing residue.
- Remove noxious weeds, such as poison ivy and thorny bushes from schools, parks, recreation areas.
- Manage wildlife habitats that are threatened by uncontrolled growth of unwanted plant species that endanger native plants and animals.

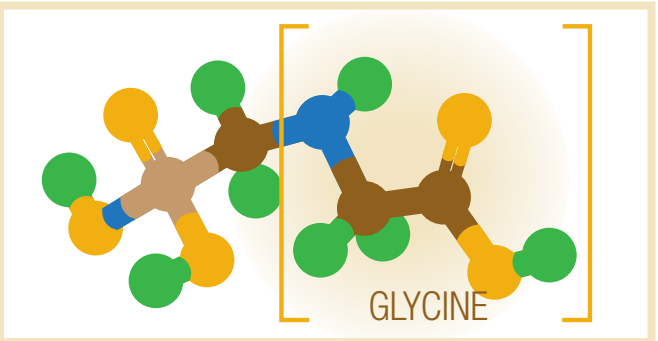
Consumer Markets:

- Eliminate weeds in sidewalks, flower beds, around trees or where ever weeds appear. It is readily available in lawn and garden centers and many supermarkets.

What is Glyphosate?

Glyphosate is the primary active ingredient in Roundup® branded herbicides. "Roundup" was the trade name introduced in 1974. Monsanto may have synthesized the original molecule, but today, because of its effective way of controlling many unwanted weeds, other companies have registered their own glyphosate-based herbicide products, attesting to the success of this herbicide.

GLYPHOSATE



Glyphosate's chemical name is N-(phosphonomethyl)glycine and it is derived from the amino acid glycine and phosphonic acid.

Mode of action
How it works in the plant

Glyphosate-based herbicides are simple mixtures of glyphosate, water and a surfactant system that are extremely effective for controlling unwanted vegetation without the worry of regrowth. Glyphosate specifically inhibits an enzyme that is essential to plant growth; this enzyme is not found in humans or other animals, contributing to the low risk to human health from the use of glyphosate according to label directions. When a Roundup® brand herbicide is sprayed on plant foliage, glyphosate is absorbed and then moved – or translocated – throughout the plant's tissues. The surfactant enhances the delivery of glyphosate into the plant. Once inside the plant, glyphosate inhibits the activity of an enzyme, called EPSP synthase, which in turn prevents the plant from manufacturing certain essential amino acids needed for plant growth and life.[7]

[7] Franz, J. E. , Mao, M. K., Sikorski, J. A. (1997). Glyphosate: A Unique Global Herbicide, ACS Monograph No. 189. American Chemical Society, Washington, DC.

What is Glyphosate?

Overview of History

HISTORY OF GLOBAL USES

1974 — FIRST PHASE
Control of perennial and annual weeds in non-crop and industrial areas.

1976 — SECOND PHASE
Perennial weed control in perennial crops and before planting or following harvest of annual crops with first crop use label.

1978 — THIRD PHASE
Spot spraying of perennial weeds in annual crops like cotton and soybeans.

1979 — FOURTH PHASE
Selective application in annual crops with re-circulating sprayers or rope wick applicators for control of annual and perennial weeds.

1986 — FIFTH PHASE
Control of annual weeds prior to planting annual crops in reduced tillage or no-tillage systems.

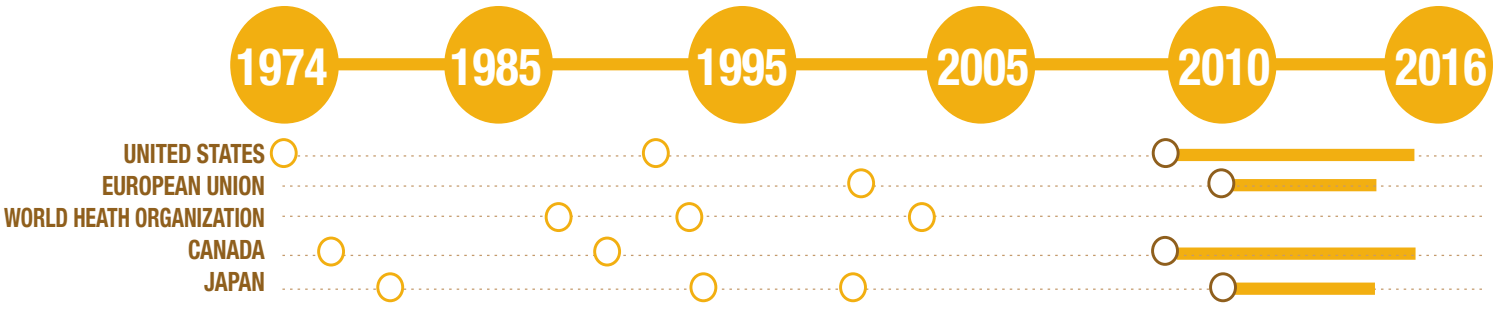
1996 — SIXTH PHASE
Introduction of Roundup Ready® technology permitted direct application for weed control in glyphosate tolerant crops.

In evaluations **spanning four decades**, the overwhelming conclusion of experts worldwide has been that uses of Roundup® brand products according to label directions

do not present an unreasonable risk of adverse effects to humans, wildlife or the environment.

Glyphosate-based products are registered in **more than 160 countries throughout the world.** Most countries have a governmental agency that is equivalent to the U.S. Environmental Protection Agency, which reviews data from required studies before a registration is granted. Registration of a herbicide is not a one time event, in fact periodic reviews are required and may take years to complete. **The data must meet current scientific standards.**

HISTORY OF KEY GLOBAL REGISTRATIONS AND REVIEWS

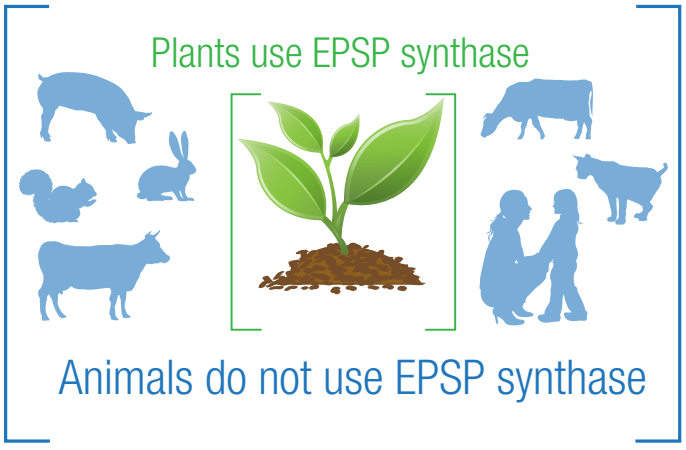


What is the foundation of **Safety?**

The **SCIENCE** behind glyphosate is the foundation of its safety

Glyphosate has been extensively **TESTED** and **REVIEWED**

Science-based evaluations conducted by regulatory bodies and other scientific institutions have concluded that typical glyphosate usage does not pose an unreasonable health risk to humans, non-target animals and plants or the environment.



Glyphosate herbicides all work in the same way – they inhibit an enzyme that plants need to promote growth. The specific enzyme is called EPSP synthase. Without this enzyme, the plant cannot create the proteins required for growth, leading to the plant's death. Because most plants use this enzyme, most are susceptible to glyphosate applications.[8]

Humans and animals do not use EPSP synthase. This contributes to glyphosate not presenting unreasonable toxicity concerns to humans and animals when used according to label directions.

[8] Franz, J. E. , Mao, M. K., Sikorski, J. A. (1997). Glyphosate: A Unique Global Herbicide, ACS Monograph No. 189. American Chemical Society, Washington, DC.

What is the foundation of **Safety?**

Glyphosate-based herbicides have a long history of safe use.

To determine the safety of an herbicide, The US Environmental Protection Agency conducts a risk assessment. In addition, the European Commission, Health Canada and many other regulatory bodies and science organizations, such as the World Health Organization, have reviewed data on glyphosate.

Their overwhelming consensus?

When glyphosate is used according to label directions, it poses no unreasonable risk to people, wildlife or the environment.

The most recent review was conducted by the European Commission's Health and Consumer Protection Directorate-General for the re-registration of glyphosate in Europe. Six data sets, from multiple companies, comprised of hundreds of regulatory studies, as well as publications in the open literature were included in this review.[9]

United States Environmental Protection Agency

European Commission

Health Canada / Santé Canada

World Health Organization

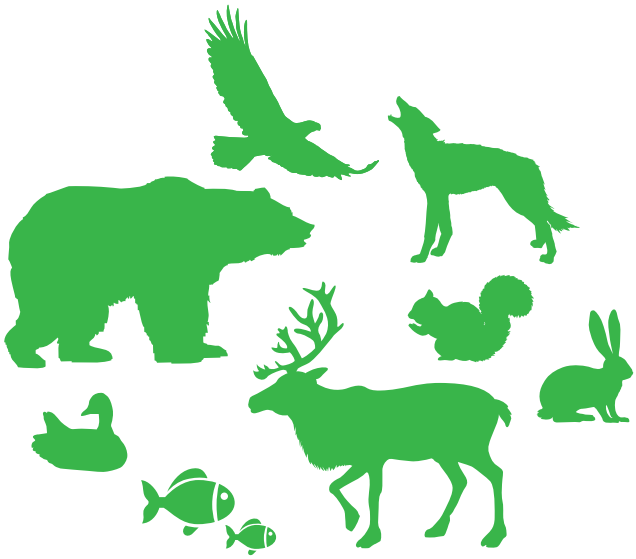
Human Health

Glyphosate has undergone **extensive toxicology testing over the last 40 years**, with at least six separate toxicology data sets generated by different registering companies across the globe, totaling **over 300** separate toxicology studies. These data are remarkably consistent, demonstrating absence of concern for developmental and reproductive toxicity, carcinogenicity, genotoxicity, endocrine disruption potential, neurotoxicity and immunotoxicity.[9] Published literature and the internet are full of allegations against glyphosate, yet regulators have consistently dismissed these allegations because they lack scientific quality, credibility and/or relevancy and they continue to approve glyphosate-based products.

[9] European Commission recent re evaluation 2014. http://www.bfr.bund.de/en/the_bfr_has_finalised_its_draft_report_for_the_re_evaluation_of_glyphosate-188632.html

What is the foundation of **Safety?**

WILDLIFE HEALTH



Glyphosate has undergone extensive ecotoxicology testing over the last 40 years with a wide range of fauna and flora to acquire global regulatory approvals.

Glyphosate does not produce acute or chronic toxicity to higher organisms including wild mammals, birds, fish, aquatic invertebrates and terrestrial invertebrates such as earthworms and honey bees at environmentally realistic exposure levels.

Similarly, environmental exposures to glyphosate-based formulations, when properly used and at realistic levels do not cause unacceptable adverse effects to wildlife.[10]

[10] Giesy, J.P. Dobson, S., Solomon, K.R., 2000. Ecotoxicological risk assessment for Roundup herbicide. Rev Environ Contam Toxicol 167, 35-120. http://www.usask.ca/toxicology/jgiesy/pdf/publications/JA-228.pdf

What is the foundation of **Safety?**

Glyphosate has **many favorable environmental characteristics,** making it suitable for sustainable agriculture, land management and wildlife restoration projects.

Low Volatility

Glyphosate has extremely low volatility, meaning it is highly unlikely to move off-site as a vapor to damage off-site vegetation.

Soil Binding

A key environmental property of glyphosate is that it binds tightly to soil. This characteristic reduces its bioavailability immediately after use, allowing it to be used safely at planting, or adjacent to existing crops, without damaging the crops. The tight binding also limits movement through the soil, meaning it won't affect off-site non-target plants, and minimizes any presence in groundwater.

Microbial Degradation

Glyphosate is biologically degraded over time by soil microorganisms into naturally occurring products, including carbon dioxide and phosphate. The rate of degradation depends on the soil type, microbial content and environmental conditions, with an average half-life across many locations of about a month.

Bioaccumulation

Glyphosate does not bioaccumulate thus does not magnify through the food chain. Studies in animals show that there is minimal retention of glyphosate in tissues, and that if exposure were to occur, the glyphosate would be rapidly eliminated.

Effects on Microoganisms

The effects of glyphosate on soil microorganisms have been extensively evaluated. Some bacteria and fungi are sensitive to glyphosate, but observed effects have been minor and reversible. Studies conducted with annual applications for up to 19 years have demonstrated that glyphosate showed no effects on soil biomass, or microbial respiration.[11] [12]

[11] Giesy, J.P. Dobson, S., Solomon, K.R., 2000. Ecotoxicological risk assessment for Roundup herbicide. Rev Environ Contam Toxicol 167, 35-120. http://www.usask.ca/toxicology/jgiesy/pdf/publications/JA-228.pdf

[12] Hart, M. R.; Brookes, P. C., 1996. Soil microbial biomass and mineralization of soil organic matter after 19 years of cumulative field applications of pesticides. Soil Biol. Biochem. 28, 1641–1649. http://www.sciencedirect.com/science/article/pii/S0038071796002490

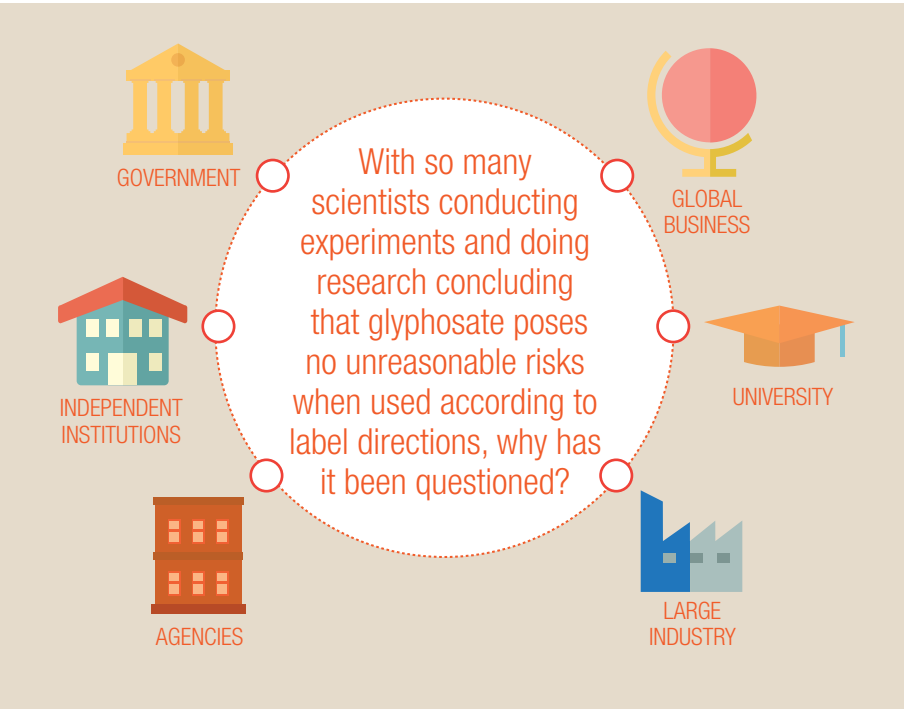
What makes **Good Science?**

On Solid Ground: **Finding Good Science**

When encountering differing findings in science, the first step to identifying fact is examining the methodology. Research must be conducted in a manner that yields valid and dependable results, via the scientific method.

THE SCIENTIFIC METHOD is a way to ask and answer scientific questions by making observations and doing experiments.

Glyphosate herbicides have a history of **over 40 years of safe use** and have been the subject of hundreds of toxicology, ecotoxicology and environmental fate studies in that time. In fact, because glyphosate products are used so widely – in agriculture to wildlife habitats to residential spaces – it is one of the most studied of all herbicides. To get a clear picture of the toxicological and environmental characteristics of glyphosate products, it is important to consider the total weight of evidence provided by this extensive body of research.



The US EPA, Health Canada, the European Commission and many other regulatory bodies and science organizations, such as the World Health Organization have reviewed data on glyphosate.

Their overwhelming consensus?

When glyphosate is used according to label directions, it poses no unreasonable risk to people, wildlife or the environment.[13] The most recent review was completed by the European Commission's Health and Consumer Protection Directorate-General for the re-registration of glyphosate in Europe.[14]

[13] http://www.epa.gov/oppsrrd1/REDs/old_reds/glyphosate.pdf

[14] http://ec.europa.eu/food/plant/protection/evaluation/existactive/list1_Glyphosate_en.pdf. http://www.bfr.bund.de/en/the_bfr_has_finalised_its_draft_report_for_the_re_evaluation_of_glyphosate-188632.html

What makes **Good Science?**

FACT OR SPECULATION
A CASE STUDY

Specific concerns have been raised linking glyphosate to occurrences of cancer.

But take a closer look

When examining the evidence gathered by the broad scientific community, the claim that glyphosate and cancer are connected is found to be false.

In June 1991, the US EPA placed glyphosate in the agency's most positive cancer classification (Category E) "evidence of non-carcinogenicity for humans – based on the lack of convincing evidence of carcinogenicity in adequate studies".[15] Even more compelling, a review in the journal Regulatory Toxicology and Pharmacology (2012) of the scientific evidence claiming glyphosate is linked to cancer. The authors conclude that there is no relationship between glyphosate exposure and the risk of cancer.[16]

How can you discern **good science** from bad?

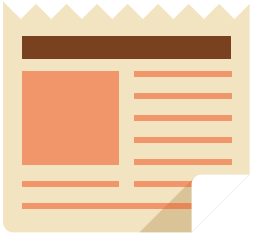
Fact-Finding

1. **Require Peer Review:** Be sure the research findings are evaluated by other professionals and scholars in the field. This indicates that the research has been conducted to a standard that others in the field accept.[17]

2. **The Publication Matters:** Make sure the findings are published in a scholarly journal first. These scientific journals are how scientists share their findings, and these periodical publications propel science forward by reporting new research

3. **Double Check:** Look for other reports of the same research in easily accessible newspapers or science.

4. **Demand Consensus:** It requires more than a single experiment or research paper for results to be accepted as public truth. After the publication of a peer reviewed paper, the findings and conclusions must still be re-tested and judged against other work in the same area.[17]



"A SIMPLE idea underpins science: "trust, but verify". Results should always be subject to challenge from experiment.[18]"

"The false trails laid down by shoddy research are an unforgivable barrier to understanding.[18]"

[15] US EPA RED 1993. http://www.epa.gov/oppsrrd1/REDs/old_reds/glyphosate.pdf
[16] http://www.ncbi.nlm.nih.gov/pubmed/22683395
[17] http://www.senseaboutscience.org/data/files/resources/116/Embargoed_until_00.01Feb8th2013_IDKWTB_web.pdf
[18] http://www.economist.com/news/leaders/21588069-scientific-research-has-changed-world-now-it-needs-change-itself-how-science-goes-wrong