What next after a ban on glyphosate – more toxic chemicals and GM grops?

Or the transformation of global food systems?







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TWN Third World Network



On 07 April 2015 the African Centre for Biosafety officially changed its name to the African Centre for Biodiversity (ACB). This name change was agreed by consultation within the ACB to reflect the expanded scope of our work over the past few years. All ACB publications prior to this date will remain under our old name of African Centre for Biosafety and should continue to be referenced as such.

We remain committed to dismantling inequalities in the food and agriculture system in Africa and our belief in peoples' right to healthy and culturally appropriate food, produced through ecologically sound and sustainable methods, and their right to define their own food and agriculture systems.

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The Network for a GE-Free Latin America (RALLT) was established in January 1999, inspired by the need for communities to develop global strategies to deal with the increase of genetically modified organisms (GMOs) in the region, and to prevent new introductions into the region.

The objectives of the Network are:

- To avoid the introduction of transgenic organisms into new areas, supporting national and local processes within the region;
- To promote the creation of GE Free Zones; and
- To support communities facing the impacts of the expansion of GE crops and the associated technology package in their demands for full reparations.

The Third World Network (TWN) is an independent non-profit international network of organisations and individuals involved in issues relating to development, developing countries and North-South affairs. Its mission is to bring about a greater articulation of the needs and rights of peoples in the South, a fair distribution of world resources, and forms of development which are ecologically sustainable and fulfill human needs.

TWN's objectives are:

- To deepen the understanding of the development dilemmas and challenges facing developing countries; and
- To contribute to policy changes in pursuit of just, equitable and ecologically sustainable development.

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Acronyms

SINCE STATE

AMPA	A compound that is a specific agonist for the AMPA receptor				
ANVISA	National Health Surveillance Agency (Brazil)				
APHIS	Animal and Plant Health Inspection Service (APHIS)				
CA	Conservation Agriculture				
CIMMYT	International Maize and Wheat Improvement Centre				
CSA	Climate Smart Agriculture				
EC	European Commission				
EFSA	European Food Safety Authority				
FAO	Food and Agriculture Organization				
FESPROSA	Federation of Health Professionals (Argentina)				
GMO	Genetically Modified Organism				
Ha	Hectares				
HT	Herbicide Tolerant				
IAASTD	International Assessment of Agricultural Knowledge, Science and				
	Technology for Development				
IARC	International Agency for Cancer Research				
IR	Insect Resistant				
ISAAA	International Service for the Acquisition of Agri-biotech Applications				
JMPR	Joint FAO-WHO Meeting on Pesticide Residues				
MRL	Maximum residue levels				
PAN	Pesticide Action Network				
RR	Roundup Ready				
SIMLESA	Sustainable Intensification of Maize-Legume systems for food security in				
	Eastern and Southern Africa				
UN	United Nations				
UNCTAD	UN Conference on Trade and Development				
USA	United States of America				
USDA	United States Department of Agriculture				
US EPA	United States Environmental Protection Agency				
WEA	Danish Working Environment Authority				
WHO	World Health Organization				

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Glossary of terms

Active ingredient: The ingredient in a pesticide that is considered biologically active.

Adjuvant: Other chemicals added to the **active ingredient** in commercial herbicide formulations to increase their efficacy. The precise formulations of active ingredients and adjuvants in commercial **herbicides** are closely guarded commercial secrets. Risk assessments of herbicides usually concentrate on the **active ingredient** and not the actual chemical formulations used.

Agroecology: Is the study of **ecological** processes that operate in agricultural production systems. The prefix **agro**- refers to agriculture.

Biotechnology: Is the use of living systems and organisms to develop or make products, or any technological application that uses biological systems, living organisms or derivatives thereof, to make or modify products or processes for specific use.

Carcinogen: Any substance capable of causing cancer in living tissue.

Genetically Modified Organism (GMO): Any organism whose genetic material has been altered in a way that does not occur naturally by mating and/or natural recombination. In agriculture, the majority of GMOs are crops that have had genes added to them that enable an organism to tolerate certain chemicals, or added genes found in soil bacteria that enable the organism to produce certain proteins that are toxic to insect pests.

Glyphosate: A chemical that is the **active ingredient** in many **glyphosate-based herbicides**. Glyphosate is considered a broad-spectrum herbicide because its **mode of action** inhibits a metabolic pathway that is present in all plant life, as well as in some fungi and bacteria.

Glyphosate-based herbicides: Herbicides that contain the active ingredient glyphosate.

Herbicide: A type of pesticide specifically designed to kill weeds, i.e. a formulation containing an **active ingredient** plus **adjuvants**.

Herbicide resistance: This occurs when weeds naturally develop resistance to a **herbicide** over time due to long-term exposure. **Glyphosate-resistant** weeds are a major problem in the USA.

Herbicide tolerance (HT): This occurs when a plant has been **genetically modified** to tolerate the application of certain chemical **active ingredients**. The vast majority of herbicide tolerant plants are tolerant of **glyphosate**.

Mode of action: The overall manner in which a herbicide affects a plant at the tissue or cellular level. For example, **glyphosate** is an amino acid inhibitor. Other herbicides, such as 2,4-D, are auxin growth regulators, which act as an artificial growth hormone.

Pesticide: A broad group of agricultural chemicals that includes herbicides (weed-killers), insecticides (for insect pests), and fungicides (for plant diseases).

Roundup: Monsanto's brand of commercial glyphosate-based herbicides.

Roundup Ready (RR) crops: Monsanto's varieties of **genetically modified crops** that have been specifically designed to tolerate the application of **glyphosate-based herbicides**. For example, Roundup Ready maize and soya.

About this briefing

This briefing has been prompted by the recent conclusion of the International Agency for Cancer Research (IARC), of the World Health Organization (WHO), that glyphosate, the world's most-used chemical ingredient for weed control, is a "probable human carcinogen".

In recent years, the use of glyphosate has come to be associated with herbicide-tolerant (HT) genetically modified (GM) crops, with glyphosate use increasing dramatically in all major GM HT crop-producing countries. The consequences for human health and the environment have been disastrous in many communities. A number of countries have already taken action to reduce or halt the use of glyphosate in response to the IARC assessment.

While glyphosate is still in use and is heavily relied upon for GM soya production in particular, Monsanto and other biotechnology and agro-chemical companies are already planning for business after glyphosate. A plethora of GM crops that are tolerant to multiple herbicides are already approved for the market, while Monsanto has recently sought the potential acquisition of Syngenta, the world's largest producer of herbicides.

It is imperative that the IARC's findings take the debate further—beyond simply replacing glyphosate with other toxic chemical herbicides—into deeper conversations about the characteristics of our food and agriculture systems and how they interact with and impact upon people and the environment.

Key Issues

• The introduction of genetically modified (GM) herbicide-tolerant (HT) crops, such as Monsanto's Roundup Ready (RR) varieties, has led to dramatic increases in the use of glyphosate. Between 1997 and 2014 the global area exploited by these HT crops increased from 6.9 million ha to 154 million ha. In the USA overall herbicide use increased by 237 million kg from 1996 to 2011; RR soya alone



Javiera Rulli. BASEIS. Presentation: Latinoamerica Sojera. Socio & enviro impacts of soy monoculture in Paraguay & Argentina. www.lasojamata.net

accounted for 70% of this increase. In South America, the introduction of RR soya has seen glyphosate use in Argentina and Uruguay increase tenfold, while Brazil is now the world's largest pesticide market.

- This huge increase in glyphosate use has resulted in mass outbreaks of glyphosateresistant weeds, to the extent that in 2013 glyphosate-resistant weeds covered approximately 28 million ha in the USA. By way of response biotechnology and agrochemical companies have begun developing GM crops with resistance to multiple herbicides, many of which are older and even more toxic than glyphosate. Monsanto is on the verge of releasing a new GM soya variety that is resistant to glyphosate and dicamba, suggesting that the company intends to eke as much profit from glyphosate as possible. (Dicamba is another herbicide; it is a chemical compound comprising an organochloride (a compound containing carbon, chlorine and hydrogen) and a derivative of benzoic acid.) At the time of writing Monsanto is also in the middle of a takeover bid for the world's largest herbicide producer, Syngenta.
- The impacts of this massive increase in glyphosate use, for both human health and the environment, have been catastrophic.
 RR soya growing areas in Argentina have witnessed fourfold increases in the rates of birth defects and childhood cancers. Similar relationships between glyphosate use and negative health impacts have been found in Canada and Paraguay. High levels of glyphosate have also been found as residues in harvested soybeans and in water sources. In addition, the expansion of RR soya in South America has produced massive deforestation,

loss of biodiversity and land-loss for indigenous communities.

- The IARC's finding that glyphosate is a "probable human carcinogen" has been rejected by biotechnology and pesticide corporations, who cite findings of 'safety' from a number of regulatory bodies. However, these same companies have been intimately involved in the assessments conducted by the regulating agencies.
- The IARC, on the other hand, has looked at all available studies, including those that examine formulated products, and its assessment is up-to-date. In response, severe restrictions on the use of glyphosate, or outright bans, have been put in place in numerous countries. In Argentina and Brazil the federation of public health professionals and the public prosecutor respectively have called for the banning of glyphosate.
- While the bans on glyphosate are timely and appropriate, given the evidence, other toxic herbicides, such as 2,4-Dichlorophenoxyacetic acid (2,4-D) and dicamba, similarly must come under urgent review. (2,4-D is a common systemic herbicide, a synthetic auxin (plant hormone)). The IARC itself has recently classified 2,4-D as 'possibly carcinogenic to humans'. Comprehensive independent assessments of these herbicides and their impacts on human health and the environment must be conducted.
- Appropriate international bodies must initiate a programme of fair and equitable reparations to affected peoples, together with the restoration and remediation of contaminated environments.
- A shift from chemical input-intensive weed management and chemical input agriculture in general, to agroecological methodologies is urgently needed.

Introduction

Glyphosate is the active ingredient in many chemically based herbicides. Glyphosate's mode of activity (how it works) is based on the inactivation of an enzyme of the shikimate metabolic pathway (the EPSPS enzyme). This enzyme is critical for the production of three different amino acids essential for plant growth, as well as several other metabolites that play a critical role in protecting organisms at different stages of development. Because the shikimate pathway is present in all plant life, as well as some fungi and bacteria, glyphosate is referred to as a 'non-selective' or 'broad-spectrum' herbicide.¹ Other chemicals known as adjuvants or surfactants are added to glyphosate in commercially available herbicide formulations, such as Monsanto's Roundup brand.²

Glyphosate was first synthesised in 1950 but it was not until 1974 that a scientist working for Monsanto identified the chemical's potential for use in agriculture. It has subsequently become the world's top selling herbicide. Monsanto's patent on glyphosate expired in 2000, leading to dramatic increases in generic production, particularly in China. Monsanto still holds patents and trademarks over a number of glyphosate-based herbicide formulations and continues to make billions of dollars every-year from glyphosate, thanks to the rapid spread of genetically modified (GM) glyphosate-tolerant crops (for which Monsanto's Roundup Ready (RR) varieties are by far the most common).³

In 1995, when the first glyphosate-tolerant crops were approved, the global market for glyphosate was worth around US\$ 1.2 billion.⁴ By 2012 this had increased to approximately US\$ 5.5 billion and it is expected to increase to US\$ 8.8 billion by 2019.⁵

Glyphosate and Genetically Modified (GM) Crops

Despite the promise of numerous benefits such as enhanced nutrition and climate change resilience, nearly all GM crops grown today have been engineered to survive exposure to chemically based herbicides (herbicidetolerant (HT) varieties), or to produce their own internal toxins to kill insect pests (insectresistant (IR) varieties). Many crops combine both of these traits and are known as 'stacked' varieties. Among the HT varieties, those tolerant to glyphosate-based herbicides, such as Monsanto's branded Roundup herbicides, are by far the most common. It must be noted that while the exact figures on glyphosate tolerant hectares planted are hard to come by as industry figures refer to overall HT hectares planted, which could include varieties tolerant to other chemicals such as glufosinate. However, it is fair to say that glyphosate tolerance accounts for the vast majority of overall HT variety cultivation.

The adoption of herbicide-tolerant GM crops, though confined to a handful of countries, has been spectacular. In 1997 they were planted on 6.9 million hectares (ha) worldwide, accounting for 54% of the total global area of GM crops. By 2014 this had increased to 154.3 million ha, accounting for 85% of GM crops planted globally (either as single trait herbicide tolerance or 'stacked' with insect-resistant varieties).⁶

Over 86% of the world's GM crops are grown in North and South America. The main driver behind the widespread growing of GM crops in South America has been the use of glyphosatetolerant (or Roundup Ready) soya, which is now planted on over 55 million ha. Brazil and Argentina are the major HT soya producers in South America, having grown 29 million and 20.8 million ha respectively, in 2014. In Argentina this area has more than doubled since the turn of the century, while in Brazil the area under HT soya has increased by a staggering 778% over the same period.⁷

Similar trends have been observed in other HT soya growing countries in South America. In Paraguay, the soya area has trebled since the mid-1990s to 3.2 million ha, covering 80% of the country's agricultural land; 95% of this soya is one of Monsanto's Roundup Ready varieties.⁸ In Bolivia over 1 million ha of HT soya were cultivated in 2014/15, which is a 400,000 ha increase since HT soya was first grown there in 2008.⁹ Between 2003/14 and 2014/15 the HT soya area in Uruguay increased from 77,000 ha to over 1.35 million ha.¹⁰

Glyphosate was already the world's best-selling herbicide by the time the first HT crops were grown in the mid-1990s, but the rapid adoption of HT crops has resulted in huge increases in glyphosate use itself. In the USA, overall herbicide use increased by 237 million kg from 1996 to 2011, with HT soya alone accounting for 70% of this increase. Canada saw a threefold increase in glyphosate use from 2005 to 2011, from 34 million litres to 102 million litres."

In Argentina glyphosate use has increased from 20–26 million litres per year in 1996 to



Global GM and GM HT crop plantings (millions Ha), 1996–2014

Source: International Service for the Acquisition of Agri-biotech Applications (ISAAA).

Glyphosate, Climate Change and No-Till Agriculture

Climate change and predictions over population growth have made sustainability (itself a much disputed term) a fundamental component of current agricultural debate. Mechanical tillage of the soil, whether by hand, draught animal or tractor-power, has been a standard agricultural practice since ancient times. However, in more recent times this has been acknowledged as a cause of soil degradation and erosion and also as a large source of greenhouse gas emissions—a significant amount of carbon dioxide is held in the world's agricultural soils.¹⁴

In a no-till system, minimal soil disturbance should prevent soil erosion and allow the build-up of organic matter in the soil. There is currently some debate regarding precise definitions of what constitutes no-till agriculture. The Food and Agriculture Organisation (FAO) of the United Nations (UN) states that soil disturbances should be "reduced to an absolute minimum or avoided". By default this rules out the majority of manual weeding methods which would need to be replaced with alternatives; these could include the use of herbicides or other methods (such as bio-pesticides, crop cover or crop rotation).

The FAO is ambiguous over the role of herbicides in no-till systems, saying only that, along with other external inputs they should be "applied optimally", though it does emphasise that for best results no-till should be practiced in conjunction with other methods.¹⁵ Naturally the biotechnology and agrochemical industries have been quick to promote the use of herbicides (such as glyphosate) and the potential for HT crops, claiming that these are tailor-made to fit into no-tillage systems and that they will therefore make a contribution to sustainable practices.¹⁶

Conservation Agriculture (CA) holds zero or minimum tillage as one of its three central principles (along with leaving crop residues in fields and inter-cropping or crop rotation). Many projects promoting CA in Sub-Saharan Africa, such as the Sustainable Intensification of Maize-Legume systems for Food Security in Eastern and Southern Africa (SIMLESA), which is managed by the International Maize and Wheat Improvement Centre (CIMMYT), have been actively promoting the use of herbicides, including glyphosate as a minimum tillage practice.¹⁷

Climate Smart Agriculture (CSA), a controversial concept originating from the UN FAO and subsequently taken on by the World Bank and the governments of the USA and the Netherlands, has cited HT canola in Canada as being a CSA best practice due to its minimum tillage aspect.¹⁸ However, tilling is also now recommended as a tool to deal with the evolution and spread of herbicide-resistant weeds, particularly in maize and soya, resulting from the overuse of herbicides with HT crops.

It is hugely ironic that GM crops, which at present are further entrenching systemically unsustainable agricultural production methods, are now being touted as a solution to the climate crisis. Herbicide-tolerant crops may well reduce soil disturbances in the short term, but are the practices that are complementary to no-till—such as crop cover or inter-cropping feasible in the large-scale, mono-cropped systems within which HT crops are currently grown? 200 million litres by 2013. In Brazil the overall sales of pesticides increased by 360% from 2000–2009, and the country surpassed the USA as the world's largest pesticide market. Over the same period, sales of glyphosate increased from just under 50,000 tons to 300,000 tons and in 2010 soybean fields accounted for 44% of all pesticides applied in Brazilian agriculture.¹² Uruguay's glyphosate consumption increased tenfold from 1998–2010, from 1.22 million kg to 12.29 million kg, while in Bolivia the use of glyphosate increased from 3.18 million litres in 2004 to 11.19 million in 2008.¹³

Weed resistance and other pesticides

Despite repeated warnings from weed scientists and environmentalists that glyphosatetolerant crops would lead to the emergence of glyphosate-resistant weeds, these fears were dismissed by the biotechnology and agrochemical industries. In 1997, shortly after the first HT crops were planted globally, Monsanto stated that 'the probability of glyphosate-resistant weeds evolving will not increase significantly'.¹⁹

However, according to a database run by the Weed Science Society of America, 32 species of weed around the world have developed resistance to glyphosate. In the early 2000s most of these documented cases pertained to fields of GM glyphosate-tolerant crops, and most cases overall are in countries where GM glyphosate-tolerant crops are grown: 14 in the USA, 10 in Australia, 7 in Argentina, 5 in Canada and 6 in Brazil. In the United States the situation has reached epidemic proportions, with the United States Department of Agriculture (USDA) estimating that 28.3 million ha of US farmlands were infested with glyphosate-resistant weeds in 2013. This, in turn, has driven up overall herbicide use by between 25% and 50%.20

In response to this, the biotechnology and agrochemical industries have been encouraging farmers to use other herbicides and are developing new GM HT crops that are tolerant to other toxic herbicides, such as glufosinate, 2,4-D, dicamba and Isoxaflutole (see Annexure).²¹ Many of these new GM varieties will be stacked for multiple herbicide tolerance, resulting in huge overall increases



Photograoh contributed by Elizabeth Bravo, and taken in Paraguay. Source unknown.

in herbicide use and widespread combinations of toxic chemicals not previously seen. Dow Chemical, for example, plans to release its 'Enlist' GM soybean varieties in 2016. These will be stacked with tolerance to glyphosate and 2,4-D, a chemical that has been linked with various forms of cancer for a number of years.²² 2,4-D has been recently classified by the IARC as 'possibly carcinogenic to humans', which is one level lower than that of glyphosate ('probably carcinogenic to humans'). Nonetheless, a 'substantial minority' of the IARC working group (which also included members of the industrysponsored 2,4-D working group) considered there to be limited evidence of carcinogenicity in humans and sufficient evidence of carcinogenicity in animals, which would place 2,4-D in the category of a 'probable' human carcinogen, the same level as glyphosate.²³ Dow hopes its Enlist system will generate up to US\$ 1 billion in extra revenues by 2018, and plans to market in both North and South America.²⁴

For Monsanto in particular, these developments could have severe ramifications for its business model. In 2014 the company made over US\$ 5 billion from agrochemicals, the bulk of which came from its Roundup herbicides.²⁵ In January 2015 Monsanto received regulatory approval in the USA for a new GM cotton variety that is tolerant to glyphosate, glufosinate and dicamba, and a new GM soya variety that is tolerant to dicamba. Dicamba, like 2,4-D, is a synthetic 'auxin' herbicide that acts as an artificial growth hormone in virtually all broadleaf plants, causing deformities and ultimately plant death. The Pesticide Action Network (PAN) has listed dicamba as a developmental or reproductive toxin and as a

possible endocrine (hormone) disruptor.²⁶ In common with 2,4-D, dicamba is highly drift prone, being responsible for the third highest incidents of crop damage in the USA. According to projections from Monsanto and the USDA, dicamba-tolerant soybeans are expected to result in a 500-fold increase in general dicamba use in soya cultivation.²⁷ Monsanto is set on increasing production of dicamba and plans on investing a whopping \$1 billion in a dicamba production facility in Luling, Louisiana.¹

However, far from replacing glyphosate, it appears that dicamba will be used as a complementary herbicide to kill the weeds that are now resistant to glyphosate. Monsanto's original application for its dicamba-tolerant soya variety, MON87708, states that it "will be combined with MON89788 (Roundup Ready 2 Yield)" and that "the combination of dicamba and glyphosate tolerance in soybeans will also provide the basis for delaying or preventing the evolution of further weed[s] resistance to glyphosate, dicamba and herbicides in general".²⁸ This stacked GM soya variety is expected to be released during 2016, while Monsanto intends also to introduce an accompanying dicamba and glyphosate based herbicide mixture.²⁹ Now that Pioneer Hi-Bred has confirmed it will be licensing Monsanto's new stacked GM soybean variety, industry analysts predict it could be grown on approximately 90% of the US soybean area.³⁰

Though the biotechnology industry insists that approvals of GMOs should be purely 'sciencebased', regulatory approval of a GM crop for import purposes is often sought by a major GM grain importer to strengthen applications for commercial cultivation. Monsanto has already gained import approval for its dicambatolerant soya variety (as food or feed) in the European Union (EU), the Philippines, Taiwan and South Korea. Though its stacked dicamba and glyphosate-tolerant variety will not be available until 2016, it too has been granted import approval in Japan and South Korea (see Annexure).³¹

More recently, Monsanto's high profile attempt to acquire Syngenta, the global market leader in agrochemicals, suggests that Monsanto still sees a lucrative future in chemical herbicides and pesticides and a longer-term shift away from glyphosate. At the time of writing (June 2015) Syngenta had just rejected a second offer of approximately US\$ 45 billion; it said that Monsanto's offer undervalued the company and cited concerns that such a deal would not pass muster with various anti-trust authorities around the world, including in the US. Industry analysts predict that, in order to appease antitrust regulators, Monsanto will have to sell parts of Syngenta's business, including its seed and (possibly) glyphosate units. There would be no shortage of potential suitors for Syngenta's seed business should this happen, with all the major seed and agrochemical companies linked to this.32

Should Monsanto be successful in its acquisition of Syngenta, the new entity would control almost one-third of the global agrochemical market (worth US\$ 57 billion in 2014). It would also dramatically expand Monsanto's global footprint, as about 50% of Syngenta's revenues come from "fastgrowing emerging markets".³³ In the major GM producing regions of North and South America, Monsanto's new pesticide market shares would be 42% and 28% respectively.³⁴ Reports have emerged that Monsanto will also seek to incorporate the newly combined company in the United Kingdom, a move that could reduce Monsanto's annual tax bill by more than US\$ 500 million.35

Health and environmental risks

Industry-linked sources claim that glyphosate and commercial herbicide formulations, such as Monsanto's Roundup, are safe. But these claims are based on outdated and largely unpublished studies commissioned by pesticide companies in support of the product's registration. Further, these studies test only glyphosate, the active ingredient, and not the commercially sold herbicide formulations. Independent laboratory studies with mammals and human cells have found these formulations, and the adjuvant chemicals in them, to be even more toxic than glyphosate itself.³⁶

i. Gillam, C. June 2014. Reuters. Monsanto to invest more than \$1 bln in dicamba herbicide production. http://finance.yahoo.com/news/monsanto-invest-more-1-bln-203825246.html In Argentina the impacts of spraying glyphosate used in conjunction with RR soya have been devastating. A report commissioned by the provincial government of Chaco found that the rate of birth defects had increased fourfold and that rate of childhood cancers had tripled within a decade of the adoption of GM HT crops, singling out glyphosate in particular. A group of Argentine physicians and scientists, using clinical data, found increased incidences of toxic liver disease, neurological developmental problems in children, kidney failure and respiratory problems.³⁷

Similarly, epidemiological studies carried out in Paraguay and Canada have shown a relationship between exposure to glyphosatebased herbicides and birth defects and miscarriages.³⁸ Exposure to Roundup has also been linked to an epidemic of chronic kidney disease in farming regions of Sri Lanka.³⁹

In addition to direct exposure from spraying, the consumption of RR maize and soya containing pesticide residues is another long-term and largely un-investigated source of health risk. In 2014 an independent, peer-reviewed study compared compositional differences in RR soybeans with those grown under a conventional agricultural system (non-GM but still using chemical inputs) and an organic system (i.e. no chemical inputs). All individual samples of GM soya contained residues of both glyphosate and its breakdown product, AMPA (a compound that is a specific agonist for the AMPA receptor and which mimics the effects of the neurotransmitter glutamate) with average concentrations of 3.26 mg/kg and 5.74 mg/kg respectively.⁴⁰ This is well above levels of glyphosate that have been found to induce the proliferation of cancer cells in vitro.⁴¹ By comparison, no samples of conventional or organic soybeans showed any residues of glyphosate or AMPA. The authors concluded that "lack of data on pesticide residues in major crop plants is a serious gap of knowledge with potential consequences for human and animal health".42

There are regulations in place that govern the maximum residue levels (MRLs) of pesticides in food, but there is some controversy over how these are calculated and who actually sets these limits. For example, after the commercialisation



http://horizontesur.org/radio/index.php/paren-de-fumigar.html. Source unknown.

of HT soya in 1996, the European Union MRL for imported soya increased 200-fold, from 0.1 mg/ kg to 20 mg/kg.⁴³ Though the majority of RR soya grown worldwide is used for animal feed, this is not the case with all GM crops. In South Africa, for example, where maize is a staple food, HT maize accounted for over 60% of the entire maize crop in 2013/14.⁴⁴

There are also considerable environmental impacts associated with glyphosate use. These range from impacts on soil biodiversity and plant nutrient intake, to declining bird populations (the wild plants and weeds that glyphosate and other herbicides eradicate are an important food source for many species of bird).⁴⁵ In North America, Monarch Butterfly populations have fallen by 90%, chiefly because huge increases in glyphosate use in the US maize belt has eradicated millions of ha of milkweed in the breeding grounds of the Monarch Butterfly.⁴⁶ In Argentina and Paraguay, the expansion of RR soya has resulted in massive deforestation and loss of natural vegetation, as well as loss of the traditional territories of indigenous communities.

Agricultural pesticides such as glyphosate are a major source of water pollution and can enter rivers and streams via soil run-off or leaching, or directly when applied aerially.⁴⁷ Once in water glyphosate is highly soluble and therefore mobile in water systems. Studies have revealed glyphosate-based herbicide formulations to be highly toxic to aquatic life and amphibians.⁴⁸ From 2008–2010 the government of Quebec, Canada, tested four rivers in maize and soya growing areas for pesticides; glyphosate was found in 86% of the samples.⁴⁹ A US geological survey from 2001–2006 detected glyphosate and its breakdown product, AMPA, in 32% of 608 water samples collected. In areas with near continual applications (common in areas with HT crops), glyphosate and AMPA were detected in nearly every sample.⁵⁰

Glyphosate: IARC/WHO assessment and the global response

Against this backdrop, in March 2015 the IARC, the body tasked with providing evidence to guide the cancer control policies of the WHO, announced that glyphosate is a "probable human carcinogen". The IARC had drawn this conclusion following a year-long review of the scientific literature on the herbicide, in which it found "convincing evidence" that glyphosate causes cancer in laboratory animals, "limited evidence" that it does so in agricultural workers, and evidence that it causes DNA and chromosomal damage in human cells.⁵¹

International reaction to the IARC's findings has been swift, and is not merely confined to the global north. Colombia has suspended aerial spraying of glyphosate on coca plantations, while Bermuda and Sri Lanka have both banned glyphosate imports. In Europe the Danish Working Environment Authority (WEA) concurred with the findings of the IARC, while Germany's state consumer protection ministers called for "the supply to and use by private persons to be banned for precautionary reasons";⁵² and the French environment and energy minister has asked garden centres to stop self-service sales of Roundup.53 In Argentina the Federation of Health Professionals (FESPROSA), which represents more than 30,000 doctors and health professionals, has called for the banning of glyphosate.⁵⁴ The Brazilian public prosecutor has written to the country's National Health Surveillance Agency (ANVISA) asking the agency to perform an urgent toxicological reevaluation of glyphosate with the expectation of a domestic ban on herbicides based on the chemical.

Understanding the industry's response

Predictably, the IARC's findings have been met with a fierce backlash from the agrochemical industry. Monsanto claimed to be "outraged" by the assessment and accused the IARC of "cherry-picking" data and having a clear "agenda-driven bias".⁵⁵ A common response has been to cite numerous regulatory agencies around the world that have found glyphosate safe, including the United States Environmental Protection Agency (US EPA), the European Food Safety Authority (EFSA) and the recent German government's assessment of glyphosate, conducted on behalf of the European Commission (EC).

However, unlike these and other regulatory bodies, the IARC has looked at all available and up-to-date studies in the scientific literature, including studies performed on the formulated product.⁵⁶ Large parts of the much recently cited German government review of glyphosate were actually carried out by the European Glyphosate Task Force, an agrochemical industry group.⁵⁷ In addition, in 1985 the US EPA had originally classified glyphosate as "possibly carcinogenic to humans", based on tumours found in mice; a finding which was downgraded to "non-carcinogenicity in humans" in 1991. This re-interpretation reportedly followed input from Monsanto.⁵⁸ The European Food Safety Authority (EFSA), whose findings on glyphosate contradict those of the IARC's, for years has been accused of conflicts of interest and a lack of transparency.59

Interestingly, two of the other pesticides reviewed by the IARC at the same time as glyphosate, i.e. tetrachlorvinphos and parathion, were both classified as "possibly carcinogenic to humans", which is a level below glyphosate, but both are subject to restricted use, unlike glyphosate. Tetrachlorvinphos is banned in the European Union while the use of parathion has been severely restricted since the 1980s. All authorised uses in both the EU and USA were cancelled by 2003.⁶⁰

It is worrying to note that in response to the IARC classification the Joint FAO-WHO Meeting on Pesticide Residues (JMPR), a body whose primary function is to advise on pesticide MRLs in food, has decided to undertake a review of the data that the IARC used in reaching this new classification. As noted in a recent letter, signed by nine NGOs⁶¹, the task force set up by the JMPR to this end contains 'several members with actual or apparent conflicts of interest, including ties to glyphosate users and producers including Monsanto'. The letter called upon the JMPR to accept the IARC's classification and 'not establish a process to second-guess the recent work of IARC'.⁶²

Real Alternatives

In light of the accelerated use of glyphosate with the use of GM herbicide-tolerant crops, and the development of GM crops tolerant to the herbicides 2,4-D and dicamba, including in combination with glyphosate, the IARC's conclusion that glyphosate is a "probable human carcinogen" indicates that serious action is needed to protect the environment and human health. This should start with:

- 1. An immediate ban on all uses of glyphosate.
- Adequate measures should be put in place to ensure other more toxic chemicals do not replace glyphosate.
- 3. An immediate suspension of the use of 2,4-D and dicamba-tolerant crops and a halt to any new approvals for GM herbicide tolerant crops.
- 4. A comprehensive assessment of the impacts and use of GM herbicide-tolerant crops and accompanying herbicides on human health and the environment, in particular in all RR soya producing areas. The assessment should include full participation by the affected peoples and local communities.
- 5. Subject to the outcomes of these assessments, measures should be taken to initiate a thorough programme of reparations to affected peoples and the comprehensive restoration and remediation of contaminated ecosystems.
- 6. A shift from chemical input-intensive weed management, and agriculture in general, to agroecological methodologies.

Biotechnology and agrochemical companies are already investing significantly in the



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development of new GM HT crops and the use of other chemical herbicides in addition to glyphosate. The introduction of new GM HT crops will inevitably lead to a vicious cycle of increasing the use of chemicals such as 2,4-D and dicamba, and the evolution and spread of resistant weeds, increasing the risk to human and environmental health.

It is vital at this juncture that the storm of controversy around glyphosate becomes a catalyst for deeper conversations about the future directions of agricultural policy and food production. There is a growing recognition that the status quo of high chemical inputs and mass-produced monocultures, is untenable—in both their environmental and social costs—and will not be able to feed a growing global population in the era of climate change. This was a conclusion reached by the ground breaking International Assessment of Agricultural Knowledge, Science and Technology for Development (IAASTD), the largest study on agriculture undertaken to date, which called for a "thorough and radical" overhaul of agricultural policies in the 21st century.63

Instead, the IAASTD called for governments to strengthen their focus on agroecological sciences. Agroecology, which uses ecological principles for the design and management of sustainable agricultural systems, has consistently proven capable of increasing productivity sustainably and has far greater potential for fighting hunger, particularly during economic and climatically uncertain times. This call to focus on agroecology has since been taken up for example, by the then UN Special Rapporteur on the right to food⁶⁴ and the UN Conference on Trade and Development (UNCTAD) in its Trade and Environment Review 2013.⁶⁵

There are no silver bullets to end this struggle and circumstances will differ depending on particular agroecological and socio-economic contexts. However, alternative farming and food systems, encompassed by agroecology, food sovereignty and sustainable food systems⁶⁶ offer a set of principles that can guide us forward. Chief amongst these are principles around environmental sustainability, social equity, democratic participation in decisionmaking, and accountability. These are a long way from what is currently being offered by the key architects of global food systems, who will not give up their privileged positions lightly. There is much work still to be done.

Annexure: New GM herbicide-tolerant varieties in the USA

Company	Crop	Event	Herbicides	Approved
Dow	Cotton	DAS-8191Ø-7	2,4-D, glufosinate	Under assessment
Monsanto	Soybean	MON 87708	Dicamba	2015
Monsanto	Cotton	MON-887Ø1-3	Dicamba, glufosinate	2014
Bayer/Syngenta	Soybean	SYHToH2	Glufosinate, HPPD	2014
Dow	Soybean	DAS-444Ø6-6	2,4-D, glufosinate, glyphosate	2014
Dow	Soybean	DAS-68416-4	2,4-D, glufosinate	2014
Dow	Maize	DAS-40278-9	2,4-D, ACCase- Inhibitor	2014
BASF	Soybean	BPS-CV127-9	Imidazolinone	2014
Bayer & M.S. Technologies	Soybean	FG72	Glyphosate, Isoxaflutole	2013

Source: Animal and Plant Health Inspection Service (APHIS) of the USDA.

Global approvals for MON 87708 x MON89788 (MON89788)

Country	Food	Feed	Cultivation
Australia	(2012)		
Brazil	2010	2010	
Canada	(2012)	(2012)	(2012)
Colombia	2012	2012	2012
European Union	(2015)	(2015)	
Japan	2014		2013 (2012)
Mexico	2013 (2012)		
New Zealand	(2012)		
Philippines	lippines (2014)		
South Korea	2012	2012 (2012)	
Taiwan	(2013)		
Uruguay			2012
USA	(2011)	(2011)	(2015)

Source: International Service for the Acquisition of Agri-biotech Applications (ISAAA).

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