Friends of the Earth Europe

FARMING ON THE CHEMICAL TREADMILL
Why herbicide-resistant crops should not be grown in Europe

December 2011

1. Introduction

Since their introduction in 1995 the cultivation of genetically modified (GM) crops has largely been restricted to North and South America. Over 80% of the GM crops grown are modified to resist sprays of chemical herbicides, and are known as herbicide resistant (HR) or herbicide tolerant (HT) crops. These traits allow crops to withstand being sprayed with broad-spectrum herbicides, which kill weeds and almost all other vegetation whilst the crop itself stays alive. Aimed at simplifying weed control for farmers it has also been a marketing strategy for companies keen to sell more herbicides.

The biotech industry is well advanced in its plans to introduce HR crops into the European Union (EU). This briefing looks at the recorded impacts of growing GM HR crops in the Americas, and the implications for the EU should the crops be grown here.

2. Monsanto's reliance on herbicide resistant crops

Crops modified for herbicide resistance so far include soy, maize, canola, cotton, sugar beet, alfalfa and rice. Nearly all of them are resistant to Monsanto´s Roundup (which contains glyphosate) or to Bayer´s Liberty/Basta (which contains glufosinate).[1] Monsanto's Roundup Ready crops, however, have cornered the global market, and are much more prevalent than Bayer's Liberty Link crops.[2]

HR crops have been grown commercially since 1995[3]. The cultivation of Monsanto's Roundup Ready varieties of soy, corn and cotton started in 1996, and Roundup Ready sugar beet has been grown in the USA since 2005. The only prominent glufosinate resistant crop is Bayer's Liberty Link canola, which is grown primarily in Canada.[4]

According to industry data, in 2010 around 83% of all GM crops grown were HR crops (121.1 million ha out of a total of 148 million ha).[5] Herbicide resistance is thus being prioritised over other traits

[1] GMO database, as of 4 June 2011. http://www.gmo-compass.org/eng/gmo/db/

[2] Krebs, C. 2011. Farmers look to broader strategies to battle weeds. This article says, "Glyphosate now accounts for $5.5 billion in sales worldwide, more than all other herbicides combined." Ag Journal. March 11. http://bit.ly/ehzYie

[3] First HR GM crop was commercially grown in Canada in 1995

[4] ISAAA is funded largely by the GM industry, their figures are frequently inflated and poorly, if at all, referenced.ISAAA 2011, Brief 42, Global status of Commercialized biotech/GM Crops: 2010 by Clive James http://www.isaaa.org/kc/cropbiotechupdate/default.asp

[5] HR crops only: 89.3 million ha (or 61%); stacked traits (HR and insect resistance (IR) combined): 32.3 million ha (or 22%), ISAAA 2011. (Executive Summary, page 14)

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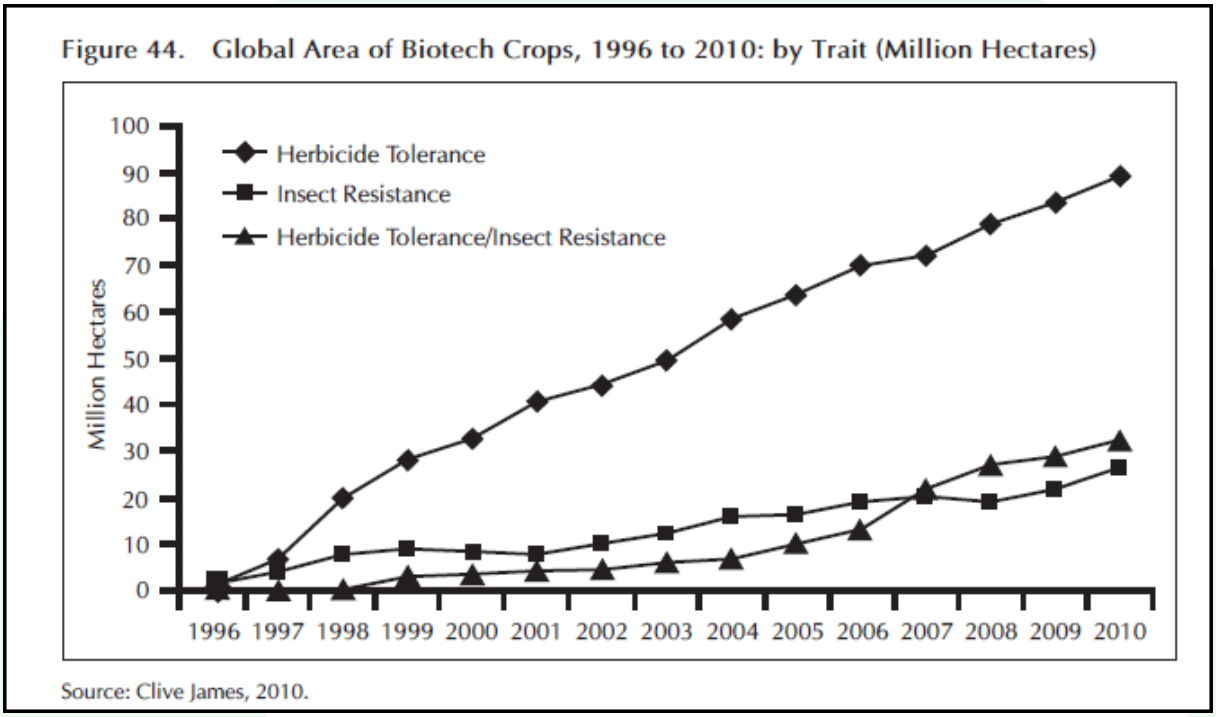
such as insecticide tolerance. In 2010 the main GM crop, HR soy, was grown on 73.3 million ha, and almost all of it was Roundup Ready soy.[6]

However, in spite of the fact that GM crops have been cultivated commercially since 1995, they are not popular in many regions of the world, because of concerns about their health and environmental impacts.[7] At the moment GM crops are mainly grown commercially in just two continents, North and South America; notably in the USA, Argentina, Brazil, Canada and Paraguay.[8]



Graphic 1: Global development of the cultivation of GM crops (ISAAA, 2011).

3. Industry plans for HR crops in the EU

No HR crop has so far been authorised for cultivation in the EU, but biotech companies have submitted applications for 20 different HR crops. This means that commercial cultivation could be imminent.

The applications currently in the EU authorisation 'pipeline' are for: maize (14), canola (2), sugar beet (2), soy (1) and cotton (1).[9] Of these, three of the pending HR maize varieties have already received a positive risk assessment from the European Food Safety Authority (EFSA): Bt 11 (Syngenta)[10] and 1507 (DuPont Pioneer),[11] which are resistant to glufosinate, and NK 603 (Monsanto),[12] which is

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http://www.isaaa.org/resources/publications/briefs/42/executivesummary/pdf/Brief%2042%20-%20Executive%20Summary%20-%20English.pdf

[6] ISAAA, 2011.

[7] Background information about the social impact of the cultivation of GM soy in South America can be found here: http://feedingfactoryfarms.org

[8] ISAAA, 2011.

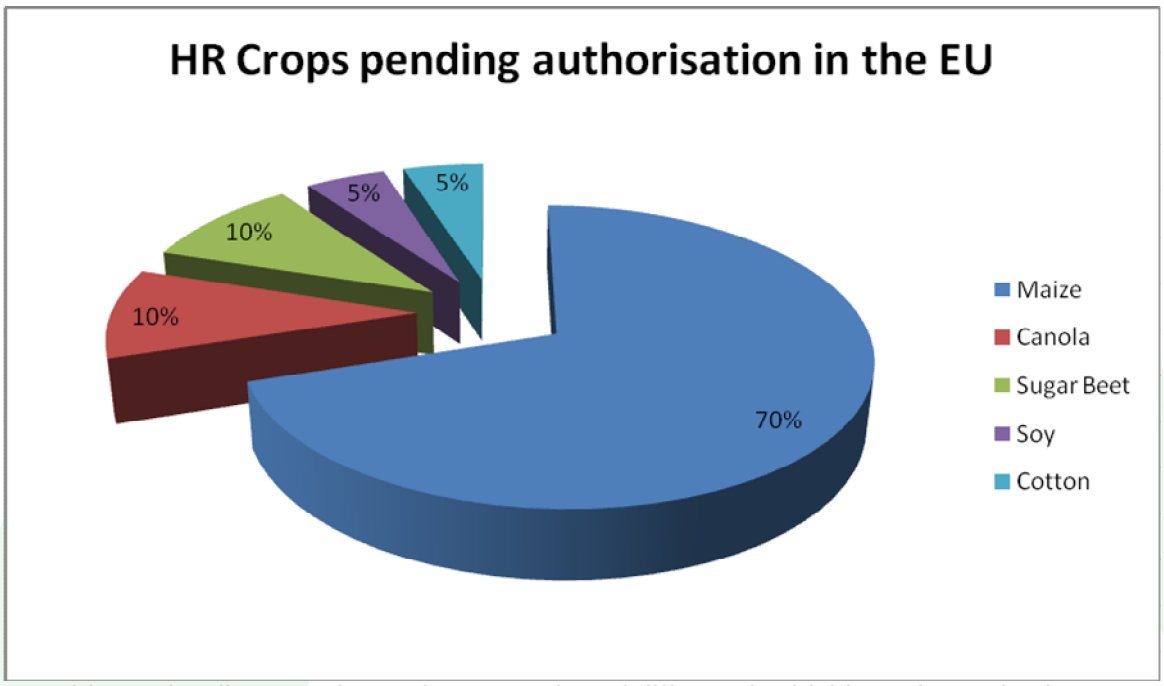
[9] Individual pending applications can either be found in the minutes of the Standing Committee http://ec.europa.eu/food/committees/regulatory/scfcah/modif_genet/index_en.htm or in the ESFA database http://registerofquestions.efsa.europa.eu/roqFrontend/questionsListLoader?panel=GMO&questiontype=2

[10] EFSA opinion about maize BT11 (2008) http://www.efsa.europa.eu/en/efsajournal/pub/213.htm

[11] EFSA opinion about maize 1507 (2008) http://www.efsa.europa.eu/en/efsajournal/pub/181.htm

[12] EFSA opinion about maize NK603 (2009) http://www.efsa.europa.eu/en/efsajournal/pub/1137.htm

resistant to glyphosate. This means that the European Commission is already in a position to start finalising the authorisation process for these three crops.

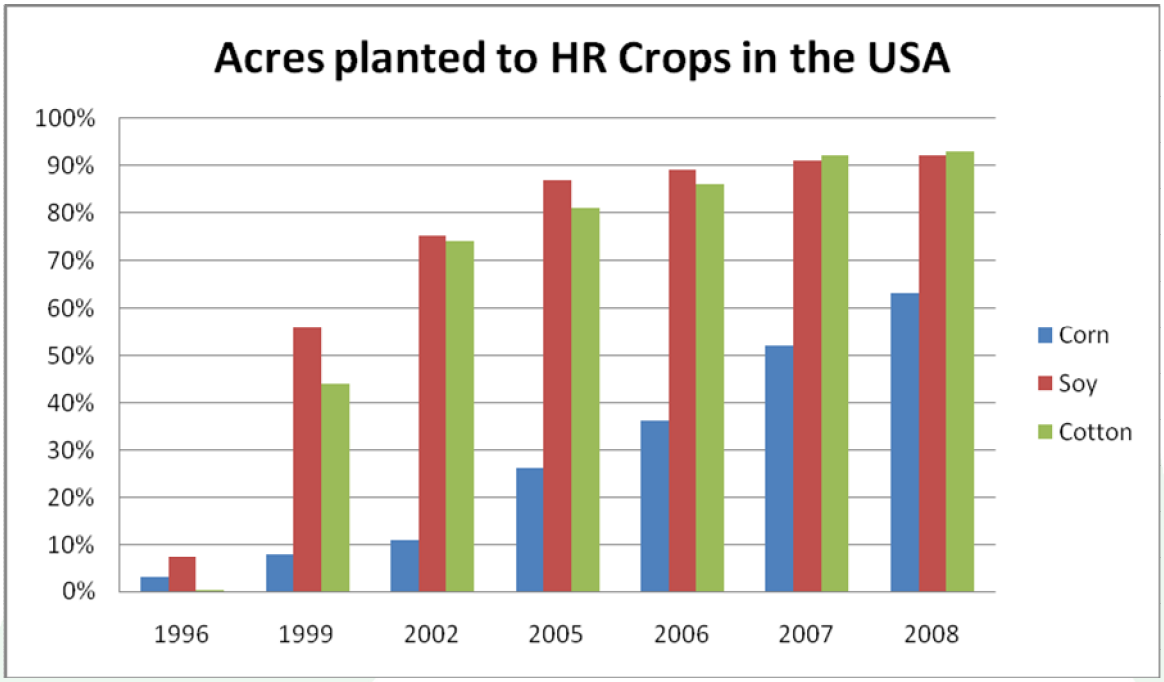


Graphic 2: The diagram shows the proportion of different herbicide resistant (HR) GM crops waiting for EU authorisation.

4. The Americas' experience: exploding use of chemical herbicides

GM crops = more herbicides

Since the introduction of HR crops in the Americas there has been a significant increase in the quantity of herbicides being applied. This is due to the fact that the GM HR crops are often sold as a package of seeds and herbicides, and also as a result of weeds developing resistance to the chemicals (see later).



Graphic 3: Showing the increase of acres planted with HR-crops corn, soybeans and cotton in the USA. It indicates a steady rise in HR crop adoption over the years. Data extracted from Benbrook (2009)

In the USA, the country most committed to GM technology, the cultivation of GM crops led to an additional 174 million kg of herbicides being applied between 1996 and 2009.[13]

Specifically with respect to glyphosate, US Department of Agriculture data shows that between 1994 and 2006 glyphosate use per hectare of soybeans increased by more than 2.5 times, from 0.58 to 1.49 kg/ha/year.[14] Overall, the agricultural use of glyphosate in the USA increased from less than 11 million kg in 1992 to more than 88 million kg in 2007.[15]

Similar developments can be observed in South America. In Argentina, where more than half of the available agricultural land is now planted with Roundup Ready soy, 200 million litres of glyphosate are sprayed on 19 million hectares.[16] In Brazil, 65-70% of the soy being grown is GM soy, and 45% of all pesticides now sold are used for soy cultivation. Between 2003 and 2008, Brazilian herbicide use in soy cultivation increased substantially from 2.8 kg/ha to 4.2 kg/ha.[17]

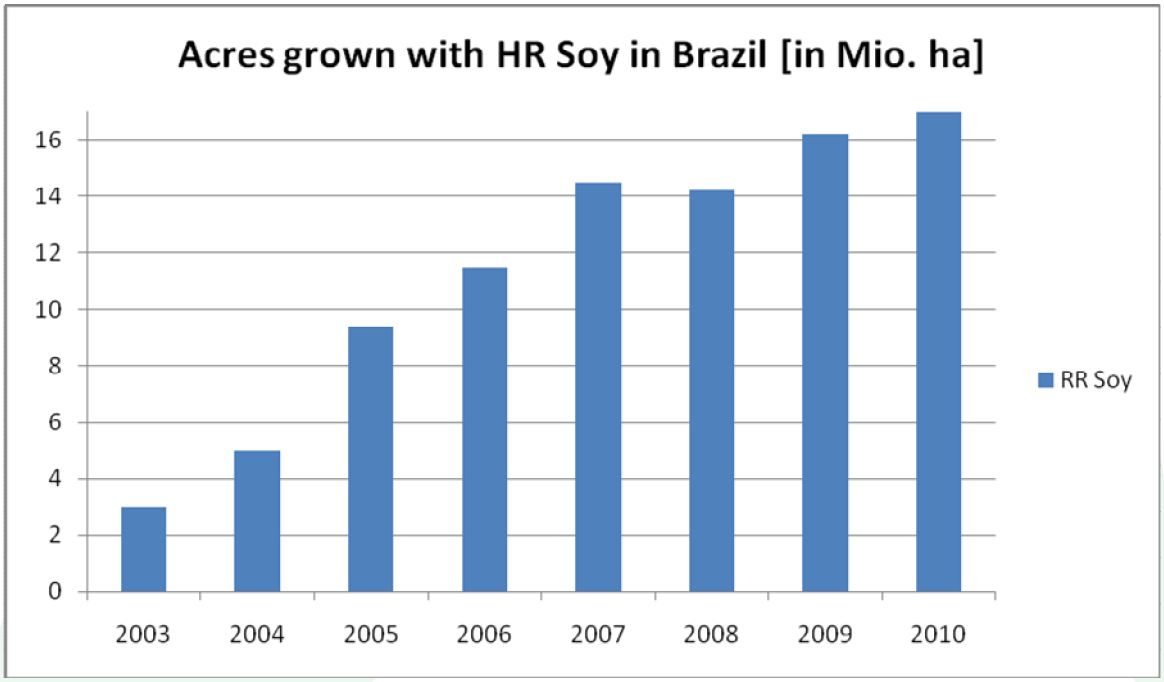
[13] Benbrook, C. M. 2009. Impacts of genetically engineered crops on pesticide use in the United States: the first thirteen years. The Organic Center. November. http://www.organic-center.org/reportfiles/GE13YearsReport.pdf

[14] Friends of the Earth International: Who Benefits from GM Crops? The rise of pesticide use. January 2008. http://www.foei.org/en/resources/publications/pdfs/2008/gmcrops2008full.pdf/view

[15] Paul Capel. 2011. Occurrence and fate of the herbicide glyphosate and its degradate aminomethylphosphonic acid in the atmosphere. Environmental Toxicology and Chemistry. Volume 30. http://onlinelibrary.wiley.com/doi/10.1002/etc.431/full
Paul Capel. 2011. Fate and transport of glyphosate and aminomethylphosphonic acid in surface waters of agricultural basins. Pest Management Science. http://onlinelibrary.wiley.com/doi/10.1002/ps.2212/full

[16] Paganelli, A., Gnazzo, V., Acosta, H., López, S.L., Carrasco, A.E. 2010. Glyphosate-based herbicides produce teratogenic effects on vertebrates by impairing retinoic acid signalling. Chem. Res. Toxicol., August 9. http://pubs.acs.org/doi/abs/10.1021/tx1001749

[17] Meyer D. E., Cederberg Ch. 2011. Pesticide Use and Glyphosate Resistant Weeds – a Case study of Brazilian Soybean Production. Swedish Institute for Food and Biotechnology. http://www.biosafety-info.net/article.php?aid=815



Graphic 4: Showing the increase in acres planted with the glyphosate resistant Soy in Brazil. Data were extracted from ISAAA, Global Status of Commercialized Biotech /GM Crops 2004 – 2010.

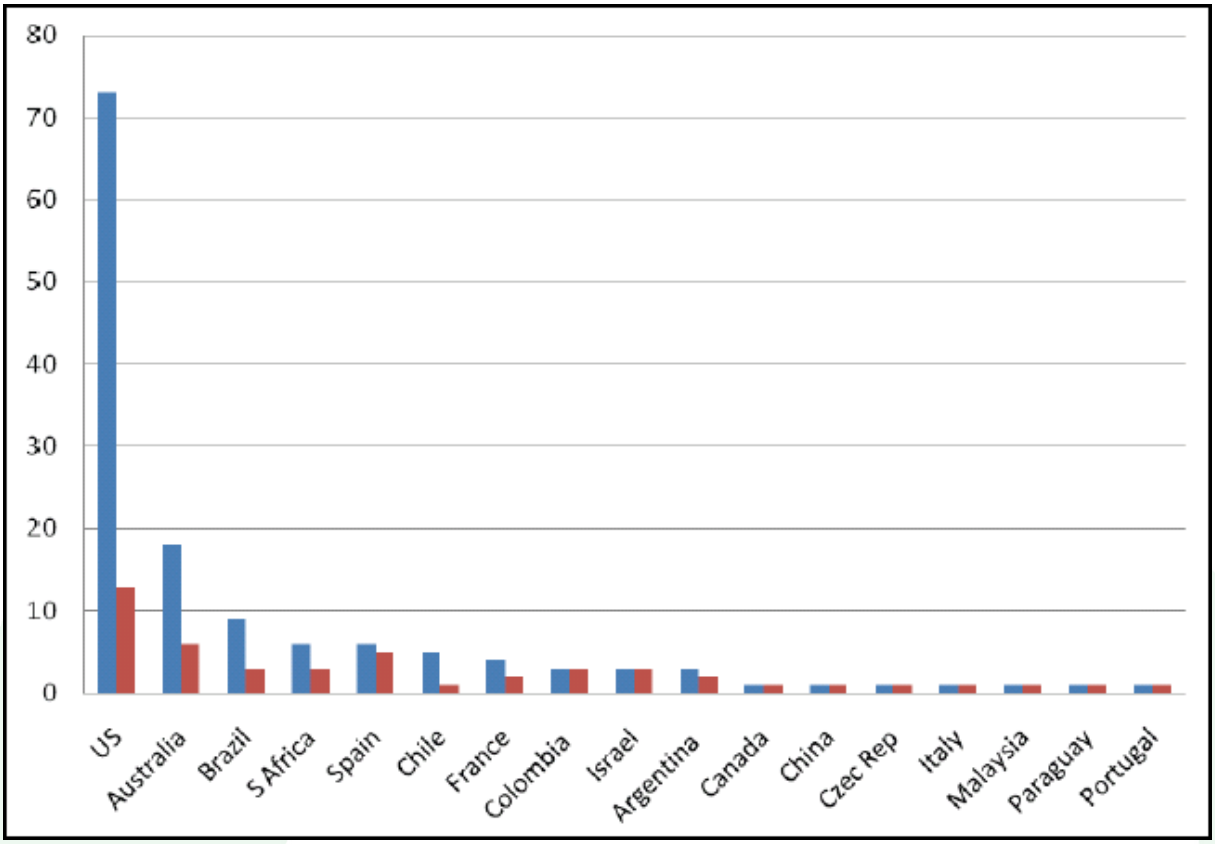
GM crops = superweeds = more herbicides

It has already become apparent that more and more weeds are becoming resistant to glyphosate.[18]

The first resistant weed to be discovered was horseweed (*Conyza canadensis*), found in HR soy just four years after its commercialisation (in 2000, in Delaware).[19] Horseweed is now the most widely spread glyphosate-resistant weed, and is found in over 19 US states on millions of hectares.[20] Weed scientists in the US are seriously concerned about these developments.[21]

In 2010, the first glufosinate-resistant weed species was found: Palmer Amaranth, also called water hemp (*Amaranthus tuberculatus*) in Midwest USA;[22] and in 2011 a glufosinate-resistant Italian Rye Grass was discovered in Oregon[23] in the USA.

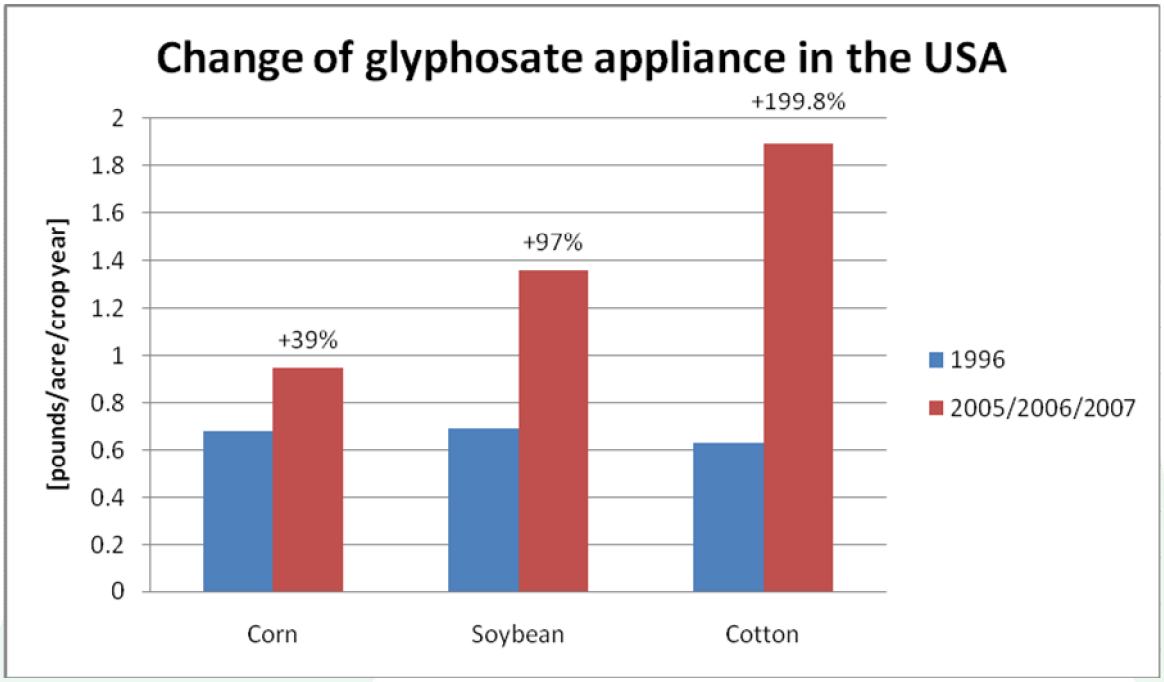
[18] Benbrook, C. M. 2009. Impacts of genetically engineered crops on pesticide use in the United States: the first thirteen years. The Organic Center. November. http://www.organic-center.org/reportfiles/GE13YearsReport.pdf
[19] http://www.weedscience.org/Summary/UspeciesMOA.asp?lstMOAID=12
[20] Zelaya, I. A., Owen, M.D.K., VanGessel, M. Jet al. 2007. Transfer of Glyphosate Resistance: evidence of hybridization in Conyza (Asteraceae). American Journal of Botany 94: 660 – 673. http://www.amjbot.org/content/94/4/660.full
[21] Nichol R, 2011. Pigweed Resistance: How much? To what? And where? Presentation to the Pig Posium organised by the University of Arkansas. See www.youtube.com/watch?v=T2wTlzixSG8
[22] Patrick J. Tranel, Chance W. Riggins, Michael S. Bell, and Aaron G. Hager. November 2010. Herbicide Resistence in *Amaranthus tuberculatus*. A Call for New Option. Journal of Agricultural and Food Chemistry. http://pubs.acs.org/doi/abs/10.1021/jf103797n
[23] Wilson V. Avila-Garcia and Carol Mallory-Smith. 2011. Glyphosate-Resistant Rye-Grass (*Lolium perenne*) Populations also Exhibit Resistence to Glufosinate. Weed Science, 59 (3): 305 – 309. http://www.bioone.org/doi/abs/10.1614/WS-D-11-00012.1



Graphic 5: Number of locations (blue) and weed species (red) with resistance against glyphosate by country (data from International Survey of Herbicide Resistant Weeds, 2011).

By 2011, 21 glyphosate-resistant weed species had been documented worldwide, including five in the EU.[24]
In order to control these glyphosate resistant weeds farmers are using higher doses of glyphosate or resorting to a mixture of glyphosate and other more toxic herbicides. During the period of rapid Roundup Ready corn adoption in the US from 2002 to 2005, glyphosate usage jumped from 0.79 to 1.06 lbs/ha/year, a 35% increase in just three years. At the same time, the use of atrazine on maize fields in the US rose by 12%; and between 2002 and 2006, the use of 2,4-D on soybean fields in the US more than doubled. Clearly glyphosate is not displacing other herbicides. [25]

[24] International Survey of Herbicide Resistant Weeds, 2011
http://www.weedscience.org/Summary/UspeciesMOA.asp?lstMOAID=12&FmHRACGroup=Go
[25] Friends of the Earth International: Who Benefits from GM Crops? The rise of pesticide use. January 2008.
http://www.foei.org/en/resources/publications/pdfs/2008/gmcrops2008full.pdf/view



Graphic 6: The diagram points out the increase of glyphosate dosage from 1996 up until 2005 (corn), 2006 (soybean) and 2007 (cotton) in the USA. Note: The average annual percent change in the noted period is 4.3% for corn, 9.8% for soybean and 18.2% for cotton. Data extracted from Benbrook (2009).

Worryingly, these other herbicides are even more toxic than those they are supplementing, and some are already banned or severely restricted in the EU. The EU announced a ban on atrazine in 2006, for example, because of links to endocrine disruption, neuropathy, breast and prostate cancer, and low sperm counts in men.[26] 2,4-D is an endocrine disruptor and was used in the Vietnam War defoliant Agent Orange.[27] [28]

To try and slow down the development of glyphosate resistance in weeds, Monsanto has even introduced a so-called 'Performance Plus' incentive for US cotton farmers in the southern states. As of 2011, farmers growing Roundup Ready crops and following a specific programme recommended by Monsanto, which mixes quantities of Roundup with other persistent or 'residual' herbicides, can claim a per-hectare cash-back incentive.[29]

Glyphosate

[26] See FOEI 2008, Who Benefits from GM Crops?
[27] See FOEI 2008, Who Benefits from GM Crops?
[28] PAN UK. 2011. 2,4-D information sheet, Pesticides Action Network UK, http://www.pan-uk.org/pestnews/Actives/24d.htm
[29] Monsanto's 2011 Performance plus program. https://www.genuity.com/cotton/Performance%20Plus%20Program/Pages/PerformancePlusProgram.aspx

Glyphosate, the active component in Monsanto's Roundup, is the most commonly used herbicide in the world. It accounts for US$5.5 billion in sales per year, more than all other herbicides combined.[30] It is a broad-spectrum non-selective systemic herbicide, meaning that it kills all plant types.

It has been marketed by Monsanto since 1974, but the US patent expired in 2000. Thus other companies including Syngenta and Dow now have their own glyphosate products on the market.

Globally, glyphosate use has increased substantially since 1996, because of the introduction of genetically modified glyphosate-resistant crops, such as Roundup Ready soy. Glyphosate is also used in arable farming, fruit growing, the production of wine, and to control weeds in private gardens and on railways.

Glyphosate has been authorised for use in the EU since 2002 under Directive 91/414, which deals with 'plant protection products'. The European Commission announced to ignore the deadline in the new pesticide regulation (Regulation 1107/2009 which replaces Directive 91/414) and has rescheduled re-authorisation from 2012 until 2015.

Although originally marketed as being safe to use, glyphosate has now been found to have numerous health impacts.[31] It is teratogenic (causing birth defects) in very low doses,[3233] and it has been found to cause the death of human cells,[34] to damage human embryonic and placenta cells,[35] to damage DNA in human cells,[36] to be an endocrine disruptor (meaning that it interferes with the functioning of hormones),[37] and to promote skin cancer.[38]

Glyphosate can also affect biodiversity in different ways. According to UK farm-scale evaluations, glyphosate use reduces seed banks in arable fields, limiting the food that is available to species further up the food chain, including birds.[39] Glyphosate also has a toxic effect on a range of amphibian species.[40]

[30] Krebs, C. 2011. Farmers look to broader strategies to battle weeds. Ag Journal. March 11. http://bit.ly/ehzYie

[31] GM Freeze and Greenpeace, 2011. Why the World Should Roundup Glyphosate, www.biosaftey-info.net/article.php?aid=811

[32] Paganelli, A., Gnazzo, V., Acosta, H., López, S.L., Carrasco, A.E. 2010. Glyphosate-based herbicides produce teratogenic effects on vertebrates by impairing retinoic acid signalling. Chem. Res. Toxicol., August 9. http://pubs.acs.org/doi/abs/10.1021/tx1001749

[33] Dallegrave, E., 2003. The teratogenic potential of the herbicide glyphosate-Roundup in Wistar rats, et al Toxicology Letters, Vol142, Issues 1–2, 2003, p. 45–52. http://www.sciencedirect.com/science/article/pii/S0378427402004836

[34] Benachour, N., Séralini, G-E.. 2009. Glyphosate formulations induce apoptosis and necrosis in human umbilical, embryonic, and placental cells. Chem. Res. Toxicol. 22, 97-105. http://pubs.acs.org/doi/abs/10.1021/tx800218n

[35] Richard, S. Moslemi, S., Sipahutar, H., Benachour, N., Séralini, G.-E., 2005. Differential effects of glyphosate and Roundup on human placental cells and aromatase. Environmental Health Perspectives 113. 716 – 20. http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1257596/

[36] Gasnier, C., Dumont, C., Benachour, N. Clair, E., Chagnon, M.C., Séralini, G.-E.. 2009. Glyphosate-based herbicides are toxic and endocrine disruptors in human cell lines. Toxicology 262. 184-191. http://www.sciencedirect.com/science/article/pii/S0300483X09003047

[37] Gasnier, C., Dumont, C., Benachour, N. Clair, E., Chagnon, M.C., Séralini, G.-E.. 2009. Glyphosate-based herbicides are toxic and endocrine disruptors in human cell lines. Toxicology 262. 184-191. http://www.sciencedirect.com/science/article/pii/S0300483X09003047

[38] George, J., Prasad, S., Mahmood, Z., Shukla, Y.. 2010. Studies on glyphosate-induced carcinogenicity in mouse skin. A proteomic approach. J. of Proteomics 73. 951 – 964. http://www.sciencedirect.com/science/article/pii/S187439190900390X

[39] Heard, M. S., Rothery, P., Perry J.N. & Firbank, L.G.. 2005. Predicting long-term changes in weed populations under GMHT crop management. Weed Research 45: 323 – 330. http://onlinelibrary.wiley.com/doi/10.1111/j.1365-3180.2005.00465.x/full

[40] Relyea, R.A. 2005, The impact of insecticides and herbicides on the biodiversity and productivity of aquatic communities. Ecol. Appl. 15, 618 – 627. http://www.esajournals.org/doi/abs/10.1890/03-5342

5. The chemical treadmill

Biotech companies have reacted to the problem of increasing weed resistance by developing yet more cultivars capable of withstanding even higher applications of glyphosate, or by creating HR crops that are resistant to other herbicides, or to mixtures of glyphosate and other herbicides.

Monsanto and BASF, for example, are planning to launch a Dicamba-resistant soy in the USA and Canada together,[41] and Dow AgroSciences received approval for its SmartStax maize in 2010 (a variety which contains genes conferring resistance to both glyphosate and glufosinate, based on cross-licensing with Monsanto). In August 2011, Dow AgroSciences announced its "first-ever, three-gene" (glyphosate, glufosinate, and 2,4-D) herbicide-resistant soybean, which it aims to sell in 2015.[42]

From the biotech industry's view this might make perfect sense as they all started off as chemical companies, rather than food producers. By developing and commercialising HR crops they profit twice over – by selling the genetically modified seeds and their 'matching' herbicides. From a business perspective the growing problem of glyphosate resistant weeds may even be seen as a new marketing opportunity, allowing them to sell more of their older herbicides. And it partly explains why other traits have not been developed – after all, why would biotech and chemical companies prioritise research into characteristics like drought tolerance or yield increases, when they can focus on the sale of herbicide resistance seeds and agro-chemicals?

These new market responses seem destined to exacerbate the problem of herbicide resistance, however, rather than resolve it.

6. A ticking time bomb? The impacts of HR crops on humans and the environment

There is growing scientific concern about the toxicity of glyphosate and glufosinate, although it is not necessarily shared by regulating authorities. In 2011, Canadian scientists found glyphosate and glufosinate residues in the blood of non-pregnant and pregnant women and in foetal chord blood. They associated the presence of glyphosate and its metabolite AMPA, and of glufosinate and its metabolite 3-MPPA, with exposure to genetically modified food.[43]

The EU's European Food Safety Agency (EFSA) confirmed the presence of glyphosate and glufosinate in blood, but downplayed any health concerns:

"From the consumer health perspective, the observations described by the authors on the presence of glyphosate and glufosinate in non-pregnant woman blood (5% and 18 % of the subjects, respectively) and of 3-MPPA in non-pregnant women, pregnant women and the fetal chord blood are not unexpected. It is known that pesticides are generally well absorbed by the gastrointestinal tract and that an exposure to the two herbicides investigated through the consumption of food commodities is plausible. The exposure levels described in this report should not necessarily be seen

[41] BASF. 2011. BASF and Monsanto take dicamba tolerant cropping system collaboration to the next level, March, http://www.basf.com/group/pressrelease/P-11-195

[42] Reuters. 2011. Dow takes on Monsanto with new biotech soybean. 22 August. http://af.reuters.com/article/commodtiesNewspageNumber=2&virtualBrandChannel

[43] Aris A, Leblanc S. Maternal and fetal exposure to pesticides associated to genetically modified foods in Eastern Townships of Quebec, Canada. Reprod Toxicol. Volume 31, Issue 4, May 2011, Pages 528–533. http://www.sciencedirect.com/science/article/pii/

as an indication of potential health risk as acceptable daily intakes for both glyphosate and glufosinate have been established not associated to health effects. [44]

The EU rarely investigates glyphosate residues in food. In 2008, only 646 samples were taken across all member states. Furthermore, of those tests, most were on fruit and vegetables rather than imported GM soybeans.[45] This is surprising, because globally glyphosate is the most used pesticide; and because the EU imports around 35 million tons of soy per year (primarily for animal feed and agrofuels).

It is also surprising because recent research also indicates that in communities where people are sometimes sprayed directly with glyphosate - as has happened as a result of aerial spraying in the GM soy producing regions in South America - an increasing number of reports from doctors and rural communities testify to escalating rates of birth defects and different types of cancer.[46]

A study published by the US Geological Survey at the end of August 2011 also documented the overall presence of glyphosate in the environment. It was frequently detected in surface waters, rain and air. According to the study, the greatest glyphosate use results in run-off to the Mississippi River basin, an area where glyphosate is used extensively for weed control on genetically-modified corn, soybeans and cotton.[47] A Danish monitoring programme that has been running for ten years also detected glyphosate leaching through the root zone in the soil down into drainage system, indicating that it could pose a potential risk to the aquatic environment.[48]

Glufosinate

Glufosinate is another broad spectrum herbicide and is toxic to all but a few plants. It is primarily manufactured by Bayer, and sold under a number of names including Liberty.[49]

In 2007, glufosinate was added to the list of active 'plant protection' substances authorised for use in the EU, via Commission Directive 2007/25/EC (which amended Directive 91/414).[50] This authorisation expires in 2017.

The most severe health effects caused by glufosinate relate to early embryonic development. Impacts of glufosinate-ammonium include premature deliveries, abortions and the death of

[44] EFSA. 2011. Letter to DG Sanco, 19 August 2011, Ref PB/HF/AFD/mt (2011) 5863329. "Request for advice from DG Sanco to analyse the articles on residues associated with GMO/maternal and fetal exposure in relation to a previous statement from 2007 ..." European Food Standards Agency.

[45] EFSA. 2008. Annual Report on Pesticide Residues – Appendix, European Food Standards Agency, www.efsa.europa.eu/de/scdocs/doc/ar2008pesticides-axI.pdf

[46] Report from the first national meeting of physicians in the crop sprayed towns. 27-28 August 2010
Dario Aranda, Nina Holland. 2011. 15 years of soy bean cultivation in Argentina. The true costs of monoculture. http://www.mo.be/en/article/15-years-gm-soybeans-argentina

[47] Paul Capel. 2011. Occurrence and fate of the herbicide glyphosate and its degradate aminomethylphosphonic acid in the atmosphere. Environmental Toxicology and Chemistry. Volume 30. http://onlinelibrary.wiley.com/doi/10.1002/etc.431/full
Richard H Coupe, Stephen J Kalkhoff, Paul D Capel, Caroline Gregoire.. 2011. Fate and transport of glyphosate and aminomethylphosphonic acid in surface waters of agricultural basins. Pest Management Science, http://onlinelibrary.wiley.com/doi/10.1002/ps.2212/full

[48] Rosenbom AE, Brueasch W., Juhler, 2010. The Danish Pesticide Leaching Assessment Programme Monitoring Results May 1999 – June 2009. Geological Survey of Denmark and Greenland, Ministry of Climate and Energy and Faculty of Agricultural Sciences.

[49] http://www.pananz.net/resources/Div_Loaded_Files/Documents/Glufosinate/Glufosinate%20monograph%2012%20Dec%202008.pdf

[50] http://www.euissuetracker.com/en/eu-legislation/3225/dimethoate-dimetomorph-glufosinate-metribizin-phosmet-propamocarb-authorisation

foetuses.[51] Independent research confirms the effects of the pesticide on embryos at very low doses and shows a metabolite to be present in foetal chord serum.[5253] Independent research also shows that glufosinate could result in brain damage and might be linked to neurodegenerative diseases.[54]

Under new rules which came into force in June 2011, it can now be argued that the toxicity of glufosinate means that its authorisation cannot be renewed in 2017. The 'cut-off' criteria included in the new pesticide Regulation 1107/2009 state that specific adverse effects of a pesticide, including on reproduction, can lead to a ban.[55] Further data is currently being assessed, and Bayer has been given an opportunity to produce additional research and arguments, which could allow glufosinate's level of toxicity to be considered an acceptable risk.

Glufosinate also has a negative impact on soil bacteria and is toxic to a number of aquatic animals, including the larvae of clams and oysters, daphnia, and some freshwater fish.[56] UK farm-scale evaluations also provide evidence that glufosinate resistant crops reduce the number and diversity of wild plants and the arthropods dependent upon them.[57]

7. Conclusions:

Crops that are genetically modified to be herbicide resistant or tolerant have been grown commercially since 1995, mostly in North and South America. Since their introduction it has become clear that cultivating HR crops promotes increased herbicide use, forcing farmers onto a chemical treadmill. In particular, as increasing quantities of the herbicide glyphosate have been applied to glyphosate tolerant crops, weeds are themselves developing resistance to the herbicide. This dynamic is also appearing with respect to another herbicide, glufosinate. This burgeoning weed control problem, specifically associated with HR crops, is in turn leading to the application of even more glyphosate and glufosinate, and farmers are increasingly resorting to other more toxic herbicides as well (some of which are banned or severely restricted in the EU).

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51 http://www.pananz.net/resources/Div_Loaded_Files/Documents/Glufosinate/Glufosinate%20monograph%2012%20Dec%202008.pdf

52 D. Fabian, J. Bystriansky, J. Burkuš, P. Rehák, J. Legáth, J. Koppel, The effect of herbicide BASTA 15 on the development of mouse preimplantation embryos in vivo and in vitro. Toxicology in Vitro 25 (2011) 73–79, http://www.sciencedirect.com/science/article/pii/S0887233310002316

53 André-Guilhem Calas, Olivier Richard, Sandra Meme, 2008, Chronic exposure to glufosinate-ammonium induces spatial memory impairments, hippocampal MRI modifications and glutamine synthetase activation in mice, NeuroToxicology 29 (2008) 740–747 http://www.sciencedirect.com/science/article/pii/S0161813X08000703

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These consequences demonstrate the unsustainable and damaging nature of this model of farming. Profits from the sale of HR crops may benefit chemical-manufacturing agribusinesses, but the cultivation of HR crops is making life more expensive and more dangerous for farmers, increasing pollution and health risks for consumers, and contributing to the destruction of biodiversity.

There are currently no HR crops authorised for cultivation in Europe, but there are several being considered. It is critical that Europe avoids the mistakes that have been made in the American continents. The evidence is in, the lessons should be learned: HR crops must not be authorised for cultivation in the EU.

Friends of the Earth Europe is calling for:

- **A decision not to authorise any HR crops for cultivation in the EU**.
- **Coherence between the authorisation of herbicide resistant crops and pesticide authorisations.**
  As environmental ministers concluded in December 2008, there is a need for coherence between authorisations of pesticides and authorisations of herbicide resistant crops.
- **Assessment of the socio-economic impacts of herbicide resistance crops.**
  European decision makers cannot ignore the lessons learned in other countries, and should give socio-economic impacts a prominent role in the approvals process.
- **Control over glyphosate and glufosinate residues in food, feed and water.**
  The EU and national governments should, without delay, start to monitor residues of glyphosate and glufosinate in aquatic systems and in food, as well as in imported GM animal feed crops.
- **Suspension of glyphosate use on agricultural land**
  Faced with a growing list of negative impacts the authorisation of the herbicide glyphosate should be reassessed, and reduction strategies implemented.
- **Strict implementation of the new pesticide regulation for glufosinate.**
  Clear risk criteria should not be bypassed; the herbicide glufosinate should not be re-authorised for use in Europe.
- **Support for home grown protein crops.**
  In order to reduce our dependence on imported soy as an animal feed, more support for the cultivation of home grown protein crops should be provided, in particular through the reform of the Common Agricultural Policy.

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