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More and more "superweeds" with genetically-engineered crops

The first genetically engineered (GE) soybean plants were praised by the genetic engineering industry as being a panacea. They would be resistant to a herbicide, which would, in theory, put an end to unwanted plants in fields, i.e. weeds. This would lead to lower costs and less use of pesticides, that is, of chemical weed killers. However, one of the predictions that critics of GE have been making for several years is now becoming a reality: over time, the "weeds" are becoming as resistant to the herbicide as the GE plants. The consequence is that other herbicides have to be applied and costs rise.

GE crops are a nightmare, not a dream.

Two-in-one package of poison and plants

When genetically engineered (GE) soybeans (Monsanto "Roundup Ready") began to be grown in the USA in 1996, this was industrial agriculture of a totally new kind. The GE soybeans had been made resistant to the herbicide "Roundup" (containing the active ingredient glyphosate), also made by the Monsanto company. Many US farmers decided to use the GE soybeans because it meant savings on costs. The system of using the GE soybeans with Roundup was easier to manage than the complex regime of herbicide spraying they were accustomed to.

In addition, less herbicide was supposed to be needed through using the GE soybeans[1]. Monsanto had the herbicide and GE seeds patented in order to sell the GE soya seed and Roundup herbicide together in one package.

Monsanto claimed that the unique form of action of Roundup meant that evolution of resistant weeds was unlikely[2]. However, there were warnings[3] early on that the unwanted plants, i.e. weeds, would swiftly adapt to herbicides and so the application of pesticides and contamination of the environment would increase.

Recent findings confirm these fears. In several US states, diverse species of Roundup resistant weeds are now growing in Roundup Ready GE crop fields[4]. It has become clear that growing and releasing GE seeds not only involves an incalculable risk to the environment; it can also considerably aggravate problems in industrial agriculture. Against this background, Greenpeace calls for a stop to the release of GE organisms and more support for sustainable agriculture.

[1] Benbrook, C. (2003) Impacts of Genetically Engineered Crops on Pesticide Use in the United States: The First Eight Years. AgBioTech InfoNet Technical Paper Number 6 http://www.biotech-info.net/troubledtimesfinal-exsum.pdf

[2] Bradshaw, L.D., Padgette, S.R., Kimball, S.L. & Wells, B.H. (1997) Perspectives on glyphosate resistance. Weed Technology, 11, 189-198.

[3] Robert S & Baumann U (1998) Resistance to the herbicide glyphosate. Nature, 395, 25-26 and Heap, I.M. 1997) The occurrence of herbicide-resistant weeds worldwide. Pesticide Science, 51, 235-243.

[4] Benbrook (2003) op. cit.and Pennylvannia State University (2003) Herbicide- resistant weed may invade Pennsylvania crops. Press release 30th May 2003. http://aginfo.psu.edu/news/may03/herbicide.html.

Resistant weeds on the move

The first resistance to the Monsanto company's Roundup herbicide (with glyphosate as the active ingredient) was found in the mid 1990's, in annual ryegrass (*Lolium rigidum*) in Australia[5]. The Roundup herbicide had been used intensively in the region affected for over 15 years, before GE crops existed. Since the first resistant ryegrass was discovered, incidences of glyphosate resistance appear to have spread around the country. These weeds cannot be killed off using Roundup or related glyphosate herbicides. A combined use of paraquat and glyphosate is now recommended as the best strategy to delay glyphosate resistance in weeds[6]. There are increasing incidences of glyphosate-resistant weeds from around the world: glyphosate-resistant ryegrass has been confirmed in California[7], glyphosate-resistant goosegrass (*Eleusine indica*) in Malaysia[8], glyphosate-resistant Italian ryegrass (*Lolium multiflorum*) in Chile[9] and hairy fleabane (*Conyza bonariensis*) has been reported to be glyphosate-resistant in South Africa[10].

In the US, there have been many reports about glyphosate-resistant weeds in direct association with Roundup GE crop cultivation. The most frequently found and widespread is horseweed or marestail (*Conyza canadensis*). First discovered in Delaware, this horseweed can withstand 8-13 times as strong a dose of the herbicide[11]. By the summer of 2003 glyphosate-resistant horseweed has been reported in nine US states: Delaware (2000); Tennessee (2001); Indiana (2002); Maryland (2002); New Jersey (2002),Ohio (2002); Arkansas (2003); Mississippi (2003), North Carolina (2003)[12]. Another weed much feared in farming is waterhemp (*Amaranthus rudis*). Populations of waterhemp have now been found in Iowa and Illinois that cannot be combated by the usual amounts of glyphosate[13].

The mechanisms that have led to the creation of resistant species of weed are relatively simple and well known. There are always individual plants whose genetic make-up differ slightly and can, as a result, survive an attack by a herbicide. They exist at first in small numbers but the frequent application of the herbicide supplies a selection pressure, enabling these herbicide resistant plants to survive better than non-resistant plants, and hence reproduce more.

Roundup Ready soybean, maize, cotton and wheat?

The development of resistance is accelerated when a particular herbicide having only one active agent is used for a long time. This is precisely what happens with GE plants. Even where GE Roundup Ready cotton or maize is grown after GE soybeans in the same field the following year, the herbicide does not have to be

[5] Powles, S.B., Lorraine-Colwill, D.F., Dellow, J.F. &Preston, C. (1998) Evolved resistance to glyphosate in rigid ryegrass (*Lolium rigidum*) in Australia. Weed Science 46,604 –607.

[6] Neve, P., Diggle, A.J., Smith, F.P. & Powles, S.B. (2003) Simulating evolution of glyphosate resistance in *Lolium rigidum* II: past, present and future glyphosate use in Australian cropping. Weed Research, 43, 418-427.

[7] Simarmata, M., Kaufmann, J.E. & Penner, D. (2003) Potential basis of glyphosate resistance in California rigid ryegrass (*Lolium rigidum*) Weed Science, 51, 678-682.

[8] Baerson, S.R., Rodriguez, D.J., Tran, M., Feng, Y.M., Biest, N.A., Dill, G.M. (2002) Glyphosate-resistant goosegrass. Identification of a mutation in the target enzyme 5-enolpyruvylshikimate-3-phosphate synthase. Plant physiology, 129, 1265-1275.

[9] Perez A, Kogan M (2003) Glyphosate-resistant *Lolium multiflorum* in Chilean orchards. Weed Research, 43, 12-19.

[10] http://www.weedscience.org/Case/Case.asp?ResistID=5192

[11] van Gessel, M.J. (2001) Glyphosate-resistant horseweed from Delaware. Weed Science, 49, 703-705.

[12] http://www.weedscience.org/Summary/UspeciesMOA.asp?lstMOAID=12

[13] Zelaya, I.A., Owen, M.D.K. (2000). Differential response of common water hemp *Amaranthus rudis* Sauer) to glyphosate in Iowa. Proc. North Cent. Weed Sci. Soc., 55, 68. and Patzoldt, W.L., Tranel, P.J., & Hager, A.G. (2002) Variable herbicide responses among Illinois waterhemp (Amaranthus rudis and A-tuberculatus) populations Crop Protection, 21, 707-712.

changed because these GE crops are also resistant to Roundup. Even agrochemical companies warn against extending cultivation of these GE maize and cotton varieties year after year[14]. The fact that Monsanto has even made wheat resistant to Roundup and is keen to see it grown in the USA and Canada has caused many concerns, among which are implications for herbicide resistance in weeds [15].

Other factors besides increased cultivation with Roundup GE seeds are encouraging resistant weeds, such as not ploughing (or tilling) the soil. Particular weeds used to be able to be combated very effectively by ploughing up fields. Ploughing is not practised so frequently with herbicide-tolerant GE crops in the US because it is less necessary with herbicide applications, which greatly encouraging resistance in weed species[16]. For all these reasons herbicide-tolerant GE crop production has, for several years now, been regarded by experts as a form of agriculture in which resistant weeds are more or less systematically grown with the crop.[17]

The illogic of industrial agriculture

Even before GE soybeans were introduced, the US soybean and other agricultural industries were already in a precarious situation because resistant weeds had been increasing dramatically. Resistances had already formed against the most commonly used herbicides.

Up until 1995, herbicides of the ALS type (acetolactate synthase) were most frequently used. World-wide, over 80 biotypes resistant to these herbicides have now formed, over half of them in the USA[18]. The increase in weeds resistant to the ALS herbicides led to a steady growth in the number of herbicides being sprayed for growing soybeans. According to the US National Center for Food and Agricultural Policy (NCFAP), in 1995 23% of land used for growing soybean had to be treated with a combination of four (or more) different weed killers. On only 12% of this land did the use of a single herbicide suffice[19]. Waterhemp has been particularly problematic for soybean cultivation in the past and is becoming problematic again because of the reliance on glyphosate.

In this increasingly difficult situation, growing GE soybeans and other Roundup Ready crops seemed to many farmers the solution because the GE crops were resistant to a herbicide not normally used on those crops.

A worker at the US National Center for Food and Agricultural Policy writes: "*Significantly large resistant weed populations had developed for the most widely-used herbicides .. one of the reasons for rapid adoption of Roundup Ready soybeans is the excellent control it provides of common waterhemp which had grown resistant to many of the conventional herbicides ...*"[20].

Before GE was introduced it was used mainly to free fields of unwanted plants before the fields were sown. It is an effective herbicide that kills a large number of weeds. It blocks an important enzyme in plants so that amino acids, vital to the plant, cannot be produced. In the GE herbicide-tolerant plants, this blockage is removed by the protein produced by a

[14] http://www.syngentacropprotection-us.com/Resources/Prod/Touchdown/Land_Values.pdf
[15] Canadian Wheat Board (CWB) (2002) Agronomic assessment of Roundup Ready wheat. http://www.cwb.ca/en/publications/farmers/pdf/rrw.pdf
[16] Neve, P., Diggle, A.J., Smith, F.P. & Powles, S.B. (2003) simulating evolution of glyphosate resistance in *Lolium rigidum* II: past, present and future glyphosate use in Australian cropping. Weed Research, 43, 418-427.
[17] Freudling C., Linkages between resistance problems, resistance, management and genetically modified crops*?* www.biotech-info.net/linkages.html
[18] http://www.weedscience.org/Summary/UspeciesMOA.asp?lstMOAID=3
[19] (NCFAP, *Agricultural Biotechnology: benefits of transgenic soybeans*, April 2000, www.ncfap.org/reports/biotech/rrsoybeanbenefits.pdf pg. 49.
[20] Gianessi LP et al, June 2002 www.ncfap.org/40CaseStudies/CaseStudies/SoybeanHT.pdf, 32 pp.

bacterial gene in the GE insert. Several agrochemical companies now make this herbicide.

According to the NCFAP, the areas used to grow soybean expanded with the introduction of GE soybeans: *"Weed populations resistant to many commonly-used soybean herbicides had developed to a significant level in the mid 1990s ...Following the introduction of Roundup Ready soybeans, soybean growers had an effective alternative to control these resistant weed populations. As a result, many more acres of soybeans were planted. .."* [21]

In the short term, a solution using GE herbicide resistant crops seemed attainable – glyphosate was relatively cheap, easy to apply, effective against a almost all weeds and, for the moment, didn't have to be combined with other herbicides. In the crisis that developed in the US during the mid-1990s, a technical solution made possible by the agrochemical industry thus presented itself as attractive but, in reality, has increased farmers' dependency on herbicides even further.

Looking at the problem another way, the introduction of GE herbicide resistant crops in the USA has hindered the long overdue introduction of more environmentally minded agriculture using far less pesticide and improved methods for combating weeds. Genetic engineering has led to agrochemical corporations and farmers being able, in the short term, to continue doing business as before – but in the long term the crisis in industrial agriculture threatens to become much worse.

The consequences – increased herbicide usage

In the view of many experts the resistant weeds can, at the moment, be largely combated. But experts warn against allowing the problem to increase any further. In the view of experts at Iowa State University the amounts of herbicide are increasing: *"Higher rates of glyphosate are currently being used than when Roundup Ready soybeans were first introduced, and the percentage of Roundup Ready soybean fields treated with pre-emergence herbicide has increased dramatically."* [22]

The amount of glyphosate applied per acre increased 22 % from 2001 to 2002 in the US and was caused by *"the major price reductions offered to farmers, the need to control more difficult sets of weeds, and the emergence of resistance and/or lessened sensitivity in many weed species that were once fully controlled by one glyphosate application"* [23].

Other herbicides, which are supposed to be used with glyphosate so that it remains effective, are published in specialist publications[24]. For pre planting herbicides these include the notorious 2,4-D and paraquat/ gramoxone, which give cause for extreme environmental concern. Even Monsanto, much like its competitors, has recognised the true state of affairs and suggests that Roundup Ready GE corn should be treated not only with glyphosate but also with atrazine[25]. Atrazine has already been prohibited in several European countries and is now facing an EU wide ban on account of its persistence in the environment[26].

What is certain is that the herbicide is an excellent business. Monsanto earns about 40 per cent of its total income of 4.6 billion dollars (in 2002) with it. Another 470

[21] NCFAP, *Agricultural Biotechnology: benefits of transgenic soybeans*, April 2000 www.ncfap.org/reports/biotech/rrsoybeanbenefits.pdf

[22] Harztler, B., Jan 2003 www.weeds.iastate.edu/mgmt/qtr98-4/roundupfuture.htm

[23] Benbrook (2003) op. cit.

[24] see, for example http://ohioline.osu.edu/b789/b789_25.html

[25] Readymaster ATZ contains both glyphosate and atrazine. http://www.monsanto.com/monsanto/us_ag/layout/crop_pro/ready_master_atz/default.asp

[26] see, e.g. Sissell, K. (2003) EU to withdraw atrazine approval. Chemical Week, October 22nd 2003, http://www.findarticles.com/cf_dls/m3066/38_165/109570131/p1/article.jhtml

million dollars of income is reported from its GE plants.[27] Other companies are also increasingly investing in business with glyphosate, but Monsanto is the market leader by far.

Besides the environment and consumers, farmers are also victims of these developments – economic victims. The winner once again is the agrochemical corporations, which can sell increased amounts of its herbicide together with the patented seeds. The fairy tale of a patented solution with the aid of herbicide-resistant GE crops is losing its magic. The costs to farmers and use of herbicides are increasing and, as prior to 1996 (when GE crops were first introduced), the number of fields having to be treated with more, and greater amounts of, herbicides is steadily increasing.

Undeterred by these developments, companies like Monsanto promote continued expansion of the use of GE crops, including herbicide tolerant ones. The agrochemical business now wants to advance sales of herbicides unimpeded with the assistance of GE crops. Many experts, however, expect there to be a rapid increase in new weed resistances through the use of herbicide tolerant GE crops.

Problems with Roundup

Agrochemical corporations avow again and again that the herbicide is particularly environmentally friendly. Its swift degradability, in particular, ensures that no residues can get into groundwater. But Danish researchers investigating how glyphosate behaves in soils have found, against all predictions, that the herbicide certainly does endanger groundwater. Restrictions on the use of glyphosate were for this reason imposed by the Danish government in June 2003.[28]

New problems are also emerging as a result of the unexpected side effects of using glyphosate. It has recently been reported that glyphosate usage in previous years encourages the growth of the fungus, fusarium, on wheat[29]. Fusarium produces toxins, which are damaging to human and animal health.

Given this background, it can be seen that the genetic engineering and pesticide industries are pursuing a common (il)logic of industrialised agriculture, which endangers the environment and consumers. Genetic engineering is, at present, used primarily to see the continuation of intensive agriculture. This is largely determined by the interests of agrochemical corporations despite environmental pollution, the drawbacks for consumers and economic risks for farmers.

Greenpeace demands:

- **No release of GE organisms**
- **Support ecologically and socially responsible solutions for agriculture**
- **A ban on patents on plants, seeds and living organisms**

[27] New York Times, Jan 14, 2003

[28] www.pesticidvarsling.dk, www.geus.dk, http://www.mim.dk/nyheder/presse/Dep/040603_glyphosat.htm

[29] Coghlan, A. (2003) Weedkiller may encourage blight. New Scientist, 16th August 2003, pg. 6.