

10 reasons we don't need GM foods

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1. GM crops do not increase yield potential

Genetically modified (GM) crops do not increase yield potential and sometimes decrease it. While the yields of major crops have increased over recent decades, this is due to conventional breeding, not GM.¹ High yield is a complex genetic trait resulting from many genes working together in ways that are not fully understood by scientists. It cannot be genetically engineered into crops with the existing crude techniques – or with any techniques in the development pipeline. Good farming methods, such as maintaining soil fertility, are equally or more important to maximizing yields.

A study comparing agricultural productivity in the United States and Western Europe over the last 50 years, focusing on the staple crops of maize, canola, and wheat, found that the US's mostly GM production was lowering yields and increasing pesticide use compared to Western Europe's mostly non-GM production. Contrary to claims that Europe's reluctance to embrace GM is causing it to fall behind the US, the opposite is true: the US's adoption of GM crops appears to be causing it to lag behind Europe in both productivity and sustainability.²

2. GM crops increase pesticide use

GM herbicide-tolerant crops are engineered to survive being sprayed with herbicide, most often glyphosate-based herbicides such as Roundup. All plant life in the field is killed except for the GM herbicide-tolerant crop. Over 80% of all GM crops grown worldwide are engineered to tolerate one or more herbicides. Around 98% of commercialized GM crops are engineered to tolerate herbicides or to express Bt toxin insecticides.³ Herbicides and insecticides are technically pesticides.

GM herbicide-tolerant crops have led to massive increases in herbicide use.^{4,5,6,7,8,9} Data collected by the US Department of Agriculture shows that GM herbicide-

tolerant crops have led to a 239 million kilogram (527 million pound) increase in herbicide use in the United States between 1996 and 2011, swamping the small reduction in chemical insecticide sprays of 56 million kilograms (123 million pounds) due to GM Bt insecticidal crops. Overall pesticide use increased by an estimated 183 million kg (404 million pounds), or about 7%, compared with the amount that would have been used if the same acres had been planted with non-GM crops.⁵

GM Bt crops are not even an efficient way of decreasing insecticide use in farming. In contrast with the small reduction in chemical insecticide sprays due to GM Bt crops, by 2007 France reduced both herbicide use (to 94% of 1995 levels) and chemical insecticide use (to 24% of 1995 levels). By 2009 herbicide use was down to 82% and insecticide use was down to 12% of 1995 levels. Similar trends have occurred in Germany and Switzerland. These benefits were achieved without the use of GM crops.²

These progressive trends do not have to mean a severe drop in yield or farmer income. A 2011 study by French government scientists found that pesticide use could be reduced by 30% through adoption of integrated agriculture techniques, with only a small reduction in production (96.3% of the current level) and without impacting farm income.¹⁰

Even GM Bt crops do not reduce or eliminate insecticide use when it is considered that the plant itself becomes a pesticide. GM Bt crops generally produce more insecticide than the amount of chemical insecticide that they replace – up to 19 times the amount in the case of multiple (“stacked”) trait GM Bt maize.⁵

GMO proponents claim that the Bt toxin engineered into GM Bt crops is harmless to non-target organisms and to mammals. They base this claim on the assumption that natural Bt toxin, which is derived from a common soil bacterium, has a history of safe use when used as an insecticidal spray in chemically-based and organic farming.

But the Bt toxin engineered into GM Bt crops is different from the natural Bt toxin, both in structure and mode of action.^{11,12,13} Unlike natural Bt toxin, which only becomes activated in the insect pest’s gut and degrades rapidly in daylight, the Bt toxin in GM Bt crops is present in preactivated form and is “switched on” constantly. GM Bt crops have been found to harm butterflies^{14,15,16} and beneficial pest predator insects that are helpful to farmers, such as ladybirds^{17,18} and lacewings.^{18,19,20} GM Bt crops have been found to be toxic to mammals in laboratory and farm animal feeding experiments.^{21,22,23,24,25,26,27,28}

3. GM crops have created “superweeds”

The major cause of the increase in herbicide use on GM crops is the rapid spread of glyphosate-resistant superweeds.⁵ Over-use of Roundup and other glyphosate-based herbicides on GM herbicide-tolerant crops^{4,29} has caused selection pressure, meaning that only those weeds that are resistant to the herbicide survive spraying and pass on their resistant genes to the next generation of weeds. Farmers have to spray more herbicide, or mixtures of herbicides, to try to control the weeds.

The area of US cropland infested with glyphosate-resistant weeds expanded to a massive 61.2 million acres in 2012, according to an industry survey. Nearly half of all US farmers interviewed reported that glyphosate-resistant weeds were present on their farm in 2012, up from 34% of farmers in 2011. The survey also showed that the rate at which glyphosate-resistant weeds are spreading is gaining momentum, increasing 25% in 2011 and 51% in 2012.^{30,31}

When resistant weeds first appear, farmers often use more glyphosate herbicide to try to control them. But as time passes, no amount of glyphosate herbicide is effective.^{29,32} Farmers are forced to resort to potentially even more toxic herbicides and mixtures of herbicides, including 2,4-D (an ingredient of the Vietnam War toxic defoliant Agent Orange) and dicamba.^{4,33,34,35,36,37,38,39}

Some US farmers are going back to more labour-intensive methods like ploughing – and even pulling weeds by hand.⁴⁰ In Georgia in 2007, 10,000 acres of farmland were abandoned after being overrun by glyphosate-resistant pigweed.⁴¹ One report said the resistant pigweed in the Southern United States was so tough that it broke farm machinery.⁴²

4. GM crops have toxic or allergenic effects on laboratory animals

Feeding studies on laboratory animals and farm livestock have found that some GM crops, including those already commercialized, have toxic or allergenic effects. Effects, which may arise from the GM crop itself or from residues of the pesticides used on them, include:

- Liver and kidney toxicity^{12,22,21,28}
- Enlarged liver⁴³
- Disturbed liver, pancreas and testes function^{44,45,46}
- Accelerated liver ageing⁴⁷
- Disturbances in the functioning of the digestive system and cellular changes in liver and pancreas²³
- Less efficient feed utilization and digestive disturbance⁴⁸
- Altered gut bacteria^{49,50}
- Intestinal abnormalities²⁴
- Excessive growth in the lining of the gut, similar to a pre-cancerous condition^{51,52}
- Altered blood biochemistry, multiple organ damage, and potential effects on male fertility^{26,25}
- Immune disturbances,^{27,53,54} immune responses,^{53,49} and allergic reactions⁵⁵
- Enzyme function disturbances in kidney and heart⁵⁶
- Stomach lesions and unexplained deaths^{57,58,59,60}

- Higher density of uterine lining⁶¹
- Severe stomach inflammation and heavier uterus⁶²
- Differences in organ weights,⁵⁰ which is a common sign of toxicity or disease.

Further details of these studies can be found in *GMO Myths and Truths* (Myth 3.1).

In the most detailed feeding study ever carried out on a GM food, severe damage to the liver, kidney, and pituitary gland was found in rats fed a commercialized GM maize and tiny amounts of the Roundup herbicide it is grown with over a long-term period. Additional observations were increased rates of large tumours and mortality in the rats fed GM maize and/or Roundup.⁶³ GM maize that had not been treated with Roundup had similar toxic effects to the GM maize sprayed with Roundup and to Roundup on its own, indicating that the GM crop itself was toxic.

This study came under heavy attack by pro-GM critics and was retracted by the journal that published it, over a year after it had passed peer review and appeared in print. However, the retraction was condemned as invalid by hundreds of scientists worldwide.^{64,65} A full discussion of the study and its retraction is in *GMO Myths and Truths* 3.2).⁶⁶

The argument that trillions of GM meals have been eaten with no ill effects is disingenuous. No epidemiological studies have been carried out to track consumption of GM foods and to assess whether there are ill effects that correlate with consumption. What is more, such studies are not even possible on the continent where most GM meals are consumed – North America – as GM foods are not labeled there. Unless consumption caused an acute and obvious reaction that could be immediately traced back to a GM food, the link could not be made. An increase in incidence of a common, slow-developing disease like cancer, allergies, or kidney or liver damage would be difficult or impossible to link to GM foods.

5. GM and non-GM crops cannot “coexist”

GM genes cannot be controlled, contained, or recalled. Once released into the environment, they can persist and proliferate through cross-pollination and self-seeding. In addition, GM crops can be mixed with non-GM crops during harvesting, in storage, or in transport.

For these reasons, “coexistence” of GM with non-GM and organic crops inevitably results in GM contamination of the non-GM and organic crops. This removes choice from farmers and consumers, forcing everyone to produce and consume crops that are potentially GM-contaminated into the indefinite future.

GM contamination incidents have cost the food and GMO industry and the US government millions of dollars in lost markets, legal damages and compensation to producers, and product recalls. Examples include:

- In 2011 an unauthorized GM Bt pesticidal rice, Bt63, was found in baby formula

and rice noodles on sale in China.⁶⁷ Contaminated rice products were also found in Germany,⁶⁸ Sweden,⁶⁹ and New Zealand, where it led to product recalls.⁷⁰ GM Bt rice has not been shown to be safe for human consumption. Bt63 contamination of rice imports into the EU was still being reported in 2012.⁷¹

- In 2006 an unapproved experimental GM rice, grown for only one year in experimental plots, was found to have contaminated the US rice supply and seed stocks.⁷² Contaminated rice was found as far away as Africa, Europe, and Central America. In 2007 US rice exports decreased 20% from the previous year as a result of the GM contamination.⁷³ In 2011 the company that developed the GM rice, Bayer, agreed to pay \$750 million to settle lawsuits brought by 11,000 US farmers whose rice crops were contaminated.⁷⁴ A court also ordered Bayer to pay \$137 million in damages to Riceland, a rice export company, for loss of sales to the EU.⁷⁵
- In 2009 an unauthorized GM flax called CDC Triffid contaminated Canadian flax seed supplies, resulting in the collapse of Canada's flax export market to Europe.^{76,77}
- In Canada, contamination from GM oilseed rape has made it virtually impossible to cultivate organic non-GM oilseed rape.⁷⁸
- Organic maize production in Spain has dropped as the acreage of GM maize production has increased, due to contamination by cross-pollination with GM maize.⁷⁹
- In 2000 GM StarLink maize, produced by Aventis (now Bayer CropScience), was found to have contaminated the US maize supply. StarLink had been approved for animal feed but not for human consumption. The discovery led to recalls of StarLink-contaminated food products worldwide. Costs to the food industry are estimated to have been around \$1 billion.⁸⁰ One study estimated that the StarLink incident resulted in \$26 million to \$288 million in lost revenue for producers in 2000–2001.⁸¹

Claims that farmers should have the “choice” to plant GM crops ring hollow when it is considered that the choice to plant GM crops removes the choice to eat GM-free and organic crops, a far more popular choice. Even one farmer’s “choice” to plant GMOs can create tremendous financial risk for growers and food manufacturers who wish to produce organic and non-GMO products. Also, research⁸² and on-the-ground experience⁸³ shows that once GM crops are adopted by a country, seed choice decreases as non-GM varieties are withdrawn from the market. This situation is possible because of the monopolistic control of the seed market by a few large companies, which are heavily invested in GM and their accompanying agrochemicals.⁸⁴

6. GM is not needed for good nutrition

GM proponents have long claimed that genetic engineering will deliver healthier and more nutritious “biofortified” crops. However, no such nutritionally enhanced GM foods are available in the marketplace. Some GM foods have been found to be less

nutritious than their non-GM counterparts, due to unexpected effects of the genetic engineering process.^{85,86}

The best-known attempt to nutritionally improve a crop by genetic engineering is beta-carotene-enriched GM “golden rice”.^{87,88} Beta-carotene can be converted by the human body to vitamin A. The crop is intended for use in poor countries in the Global South, where vitamin A deficiency causes blindness, illness, and death. However, despite over a decade’s worth of headlines hyping golden rice as a miracle crop, it is still not available in the marketplace.

GM proponents blame excessive regulation and anti-GM activists for delaying the commercialization of golden rice.⁸⁹ But the real reasons for the delay in deploying golden rice are basic research and development problems. The first golden rice variety had insufficient beta-carotene content and would have had to be consumed in kilogram quantities per day to provide the required daily vitamin A intake.⁸⁷ As a result, a new GM rice variety had to be developed with higher beta-carotene content.⁸⁸

Also, the process of backcrossing golden rice with varieties that perform well in farmers’ fields has taken many years.^{90,91} A 2008 article in the journal *Science* said that there was still a “long way to go” in the process of backcrossing golden rice lines into the Indica varieties favoured in Asia.⁹⁰

After the publication of articles that once again blamed excessive regulation and anti-GM activists for the delays in deploying GM golden rice,^{89,92} in February 2013 the International Rice Research Institute (IRRI), the body responsible for the rollout of GM golden rice, issued a statement contradicting the claims that golden rice was (a) already available and (b) proven effective. On the latter the IRRI said: “It has not yet been determined whether daily consumption of Golden Rice does improve the vitamin A status of people who are vitamin A deficient and could therefore reduce related conditions such as night blindness”, adding that studies still had to be carried out before this could be known.⁹³

At this time, the IRRI expected that it “may take another two years or more” for GM golden rice to be available to farmers.⁹³ But in early 2014 even this estimate was rolled back indefinitely, when field trials in the Philippines found that GM golden rice failed to produce the yields and agronomic performance necessary for farmers to adopt it. IRRI noted, “average yield [of GM golden rice] was unfortunately lower than that from comparable local varieties already preferred by farmers”.⁹⁴

Inexpensive and effective methods of combating vitamin A deficiency (VAD) have long been available and only require modest funding to roll out more widely. The World Health Organization’s (WHO) long-standing VAD programme gives supplements where needed but also encourages mothers to breastfeed and teaches people how to grow carrots and leafy vegetables in home gardens – two inexpensive, effective, and widely available solutions.^{95,90}

Programmes using supplementation and educational approaches have already

successfully addressed the VAD problem in the Philippines, the country targeted for the introduction of GM golden rice. Only a decade ago, the Philippines was severely affected by VAD. The data for VAD in children under 5 in 1993, 1998 and 2003 were 35%, 38% and 40.1%, respectively. But the data on VAD levels in 2008 show a remarkable decline. For children aged five or younger, only 15.2% had VAD, while the figures for pregnant and lactating women were 9.5% and 6.4%, respectively. In other words, dramatic declines occurred in VAD over a five-year period, to the point where it was just above the threshold of what would be considered of public health significance.^{96,97}

These data show that basic public health programmes have succeeded in saving lives, while GM golden rice, despite having swallowed millions of dollars in investment funds, is still not available. Far from people's lives being lost because of being denied GM golden rice, the truth is that lives are being lost due to money being wasted on expensive and failed GM technology instead of proven successful programmes.

Beta-carotene is one of the commonest molecules in nature, being found in abundance in green leafy plants and fruits. There is no need to engineer beta-carotene into rice. If biofortified crops are considered desirable, non-GM beta-carotene-enriched orange maize is already available.^{98,99}

7. There are better ways to feed the world

The notion that GM crops are needed to feed the world's growing population is repeated everywhere. But it is difficult to see how GM can contribute to solving world hunger when GM crops do not have higher intrinsic yields (see point 1, above). Nor are there any GM crops that are better than non-GM crops at tolerating poor soils or challenging climate conditions. This is because, like high yield, tolerance to poor soils and extremes of weather are complex genetic traits involving many genes working together in ways that are not fully understood. Complex traits such as these cannot be genetically engineered into a crop.

Virtually all of the currently available GM crops are engineered for herbicide tolerance or to contain a pesticide, or both.³ The two major GM crops, soy and maize, mostly go into animal feed for intensive livestock operations, biofuels to power cars, and processed human food – products for wealthy nations that have nothing to do with meeting the basic food needs of the poor and hungry. GM corporations are answerable to their shareholders and are interested in profitable commodity markets, not in feeding the world.

A major UN/World Bank-sponsored report on the future of agriculture compiled by 400 scientists and endorsed by 58 countries did not endorse GM crops as a solution to the challenges of poverty, hunger, and climate change, noting "variable" yields, safety concerns, and restrictive patents on seeds that could undermine food security in poorer countries. Instead the report called for a shift to "agroecological" methods of farming.¹⁰⁰

Sustainable agriculture projects in the Global South and other developing regions have produced dramatic increases in yields and food security.^{101,102,103,104,105,106}

A 2008 United Nations report looked at 114 farming projects in 24 African countries and found that adoption of organic or near-organic practices resulted in yield increases averaging over 100%. In East Africa, a yield increase of 128% was found. The report concluded that organic agriculture can be more conducive to food security in Africa than chemically-based production systems, and that it is more likely to be sustainable in the long term.¹⁰⁴

The System of Rice Intensification (SRI) is an agroecological method of increasing the productivity of irrigated rice by changing the management of plants, soil, water and nutrients. SRI is based on the cropping principles of reducing plant population, improving soil conditions and irrigation methods for root and plant development, and improving plant establishment methods. According to the SRI International Network and Resources Center (SRI-Rice) at Cornell University, the benefits of SRI have been demonstrated in over 50 countries. They include 20%–100% or more increased yields, up to a 90% reduction in required seed, and up to 50% water savings.¹⁰⁷

These results serve as a reminder that plant genetics are only one part of the answer to food security. The other part is how crops are grown. Sustainable farming methods that preserve soil and water and minimize external inputs not only ensure that there is enough food for the current population, but that the land stays productive for future generations.

8. Conventional breeding is better than GM at producing crops with useful traits

Conventional plant breeding continues to outperform GM in producing crops with useful traits such as tolerance to extreme weather conditions and poor soils, improved nutrient utilization, complex-trait disease resistance, and enhanced nutritional value (biofortification). In some cases, marker assisted selection (MAS) is used to speed up conventional breeding by guiding the process of natural, conventional breeding, quickly bringing together in one plant genes linked to the desired important traits. MAS does not involve inserting foreign genes into the DNA of a host plant and avoids the risks and uncertainties of genetic engineering. It is widely supported by environmentalists and organic farming bodies. Any concerns focus on patent ownership of seeds developed in this way.

Conventional breeding and MAS use the many existing varieties of crops to create a diverse, flexible, and resilient crop base. GM technology offers the opposite – a narrowing of crop diversity and an inflexible technology that requires years and millions of dollars of investment for each new trait.^{108,109}

The following are just a few examples of conventionally bred crops with the types of traits that GMO proponents claim can only be achieved through genetic engineering. Many are already commercially available and making a difference in farmers' fields. A

more complete database is on the GMWatch website.¹¹⁰

High-yield, pest-resistant, and disease-resistant

- High-yield, multi-disease-resistant beans for farmers in Africa¹¹¹
- High-yield, disease-resistant cassava for Africa¹¹²
- Australian high-yield maize varieties targeted at non-GM Asian markets¹¹³
- Maize that resists the parasitic weed pest Striga and tolerates drought and low soil nitrogen, for African farmers¹¹⁴
- Maize that resists the grain borer pest¹¹⁵
- “Green super-rice” bred for high yield and disease resistance¹¹⁶
- High-yield soybeans that resist the cyst nematode pest¹¹⁷
- Aphid-resistant soybeans^{118,119,120,121}
- High-yield tomato with sweeter fruit¹²²
- High-yield, pest-resistant chickpeas¹²³
- Sweet potato resistant to nematodes, insect pests, and Fusarium wilt, a fungal disease¹²⁴
- High-yield, high-nutrition, and pest-resistant “superwheat”¹²⁵
- Potatoes that resist late blight and other diseases^{126,127,128,129,130,131,132}
- Potato that resists root-knot nematodes¹³³
- Papayas that resist ringspot virus.¹³⁴ There is also a GM virus-resistant papaya,¹³⁵ which is claimed by GMO proponents to have saved Hawaii’s papaya industry.¹³⁶ However, this claim is questionable. Though the GM papaya has dominated Hawaiian papaya production since the late 1990s, Hawaii’s Department of Agriculture reportedly said that the annual yield of papayas in 2009 was lower than when the ringspot virus was at its peak.¹³⁷ An article in the Hawaiian press said that GM has not saved Hawaii’s papaya industry, which has been in decline since 2002. The article cites as a possible reason for the decline the market rejection that has plagued GM papayas from the beginning.¹³⁸

Salt-tolerant

- Rice varieties that tolerate saline soils¹¹⁶
- Durum wheat that yields 25% more in saline soils than a commonly used variety^{139,140}
- Indigenous crop varieties from India that tolerate saline soils, stored by the Indian seed-keeping NGO, Navdanya. Navdanya reported that it gave some of these seeds to farmers in the wake of the 2004 tsunami, enabling them to continue farming in salt-saturated soils in spite of scientists’ warnings that they would have to abandon the land temporarily.¹⁴¹

Nutritionally fortified and health-promoting

- Soybeans containing high levels of oleic acid, reducing the need for hydrogenation, a process that leads to the formation of unhealthy trans fats¹⁴²
- Beta-carotene-enriched orange maize, aimed at people suffering from vitamin A deficiency^{98,99}
- Millet rich in iron, wheat abundant in zinc, and beta-carotene-enriched cassava¹⁴³
- Purple potatoes containing high levels of the cancer-fighting antioxidants, anthocyanins^{144,145}
- A tomato containing high levels of the antioxidant lycopene, which has been found in studies to have the potential to combat heart attacks, stroke, and cancer¹⁴⁶
- A purple tomato containing high levels of anthocyanins and vitamin C¹⁴⁷ (this story attracted only a fraction of the publicity gained by the John Innes Centre's GM purple "cancer-fighting" tomato^{148,149,150})
- Low-allergy peanuts.¹⁵¹

9. GM is an imprecise technology that will continue to deliver unpleasant surprises

GM proponents claim that GM is a precise technique that allows genes coding for the desired trait to be inserted into the host plant with predictable outcomes and no unexpected effects. But the genetic engineering process is crude, imprecise and highly mutagenic (see GMO Myths and Truths, Myth 1.2).⁶⁶ It causes unpredictable changes in the DNA, proteins, and biochemical composition of the resulting GM crop,¹⁵² which can result in unexpected toxic or allergenic effects (see point 4 above) and nutritional disturbances (see point 6 above),¹⁵³ as well as crop failure in the field and unpredictable effects on the environment (see point 2 above).¹⁵⁴

Claims that new genetic engineering techniques are making GM technology more precise and predictable are not supported by evidence. For example, with regard to zinc finger nuclease (ZFN) technology, two studies found that ZFNs caused unintended off-target effects in human cell lines,^{155,156} potentially causing a range of harmful side-effects. Another new technology, Clustered Regularly Interspaced Short Palindromic Repeats (CRISPR-Cas9), was found to cause unintended mutations in many regions of the genome of human cells.¹⁵⁷

Cisgenesis (sometimes called intragenesis) is a type of genetic engineering involving artificially transferring genes between organisms from the same species or between closely related organisms that could otherwise be conventionally bred. Cisgenesis is presented as safer and more publicly acceptable than transgenic genetic engineering, in which GM gene cassettes containing genes from unrelated organisms are introduced into the host organism's genome. However, in cisgenesis, the GM gene cassette will still contain DNA elements from other unrelated organisms like bacteria and viruses.

Cisgenesis is as mutagenic as transgenesis, and cisgenes can have the same disruptive effects as transgenes on the genome, gene expression, and a range of processes operating at the level of cells, tissues and the whole organism. Studies show that a cisgene can introduce important unanticipated changes into a plant.^{158,159,160}

10. GM crops are not about feeding the world but about patented ownership of the food supply

While non-GM seeds are also increasingly being patented, GM seeds are far easier to patent because the “inventive step” necessary to satisfy patent offices is clearer. From the beginning, the introduction of GM seeds was strongly connected with the idea of consolidation and patented ownership of the food supply.¹⁶¹ For example, a 1992 OECD publication¹⁶² stated that within the seeds sector, the main company focus should be on the reorganisation of the seed market, leading to a greater integration and dependency with the agrochemicals sector. According to the expert group ETC, just ten companies control two thirds of global seed sales.

Genetic engineering and patents served as a major tool in this context. The patent granted on a GM gene sequence introduced into plant material extends to seeds, plants and any plants that are bred or otherwise derived (for example, by propagation) from those GM plants, all along the chain of farm and food production up to markets such as food and biofuels.¹⁶¹

Thus patents became an important driving factor in the consolidation process. They made it possible to hamper or even block access of other breeders to the biological material. In comparison, the traditional plant variety protection (PVP) system that has long applied to non-GM seeds allows free access to commercially traded seed for the purpose of further breeding (“breeders’ exemption”). Thus PVP works as an open source system for other breeders.¹⁶¹

Patents do not only block access to genetic material of a certain variety. The monopoly rights of patents apply as long as the patented genetic sequences can be found in any progeny. Thus even after plants are cross-bred, the patented gene sequences can accumulate in the subsequent generations. So contrary to the principle of breeders’ exemption in the PVP system, no other breeder can use patented seeds for further development of new varieties if the patent holder does not issue a licence. The main objective of these patents is the monopolisation of resources rather than the protection of inventions.¹⁶¹

Within this context, the fact that GM fails to increase crop yields, reduce pesticide use, or deliver useful traits does not matter in the least to the companies that own the patents. As a report by the expert organization ETC Group said, “The new technologies don’t need to be socially useful or technically superior (i.e., they don’t have to work) in order to be profitable. All they have to do is chase away the competition and coerce governments into surrendering control. Once the market is monopolized, how the technology performs is irrelevant.”¹⁶³

References

1. Gurian-Sherman D. Failure to yield: Evaluating the performance of genetically engineered crops. Cambridge, MA: Union of Concerned Scientists; 2009. Available at: http://www.ucsusa.org/assets/documents/food_and_agriculture/failure-to-yeild.pdf.
2. Heinemann JA, Massaro M, Coray DS, Agapito-Tenfen SZ, Wen JD. Sustainability and innovation in staple crop production in the US Midwest. *Int J Agric Sustain*. 2013;1–18.
3. James C. Global status of commercialized biotech/GM crops: 2012. ISAAA; 2012. Available at: <http://www.isaaa.org/resources/publications/briefs/44/download/isaaa-brief-44-2012.pdf>.
4. Mortensen DA, Egan JF, Maxwell BD, Ryan MR, Smith RG. Navigating a critical juncture for sustainable weed management. *BioScience*. 2012;62(1):75-84.
5. Benbrook C. Impacts of genetically engineered crops on pesticide use in the US – The first sixteen years. *Environ Sci Eur*. 2012;24. doi:10.1186/2190-4715-24-24.
6. Benbrook CM. Rust, resistance, run down soils, and rising costs – Problems facing soybean producers in Argentina. Technical Paper No 8. AgBioTech InfoNet; 2005. Available at: <http://www.greenpeace.org/raw/content/international/press/reports/rust-resistence-run-down-soi.pdf>.
7. Pengue W. El glifosato y la dominación del ambiente. *Biodiversidad*. 2003;37. Available at: <http://www.grain.org/biodiversidad/?id=208>.
8. MECON (Ministerio de Economía Argentina). Mercado argentino de fitosanitarios – Año 2001. 2001. Available at: <http://bit.ly/1eqMudL>.
9. CASAFE. Mercado Argentino de productos fitosanitarios 2012. 2012. Available at: <http://www.casafe.org/pdf/estadisticas/Informe%20Mercado%20Fitosanitario%202012.pdf>.
10. Jacquet F, Butault JP, Guichard L. An economic analysis of the possibility of reducing pesticides in French field crops. *Ecol Econ*. 2011;70(9):1638–1648.
11. Székács A, Darvas B. Comparative aspects of Cry toxin usage in insect control. In: Ishaaya I, Palli SR, Horowitz AR, eds. *Advanced Technologies for Managing Insect Pests*. Dordrecht, Netherlands: Springer; 2012:195–230.
12. Séralini GE, Mesnage R, Clair E, Gress S, de Vendômois JS, Cellier D. Genetically modified crops safety assessments: Present limits and possible improvements. *Environ Sci Eur*. 2011;23. doi:10.1186/2190-4715-23-10.
13. Freese W, Schubert D. Safety testing and regulation of genetically engineered foods. *Biotechnol Genet Eng Rev*. 2004;299-324.
14. Losey JE, Rayor LS, Carter ME. Transgenic pollen harms monarch larvae. *Nature*. 1999;399:214. doi:10.1038/20338.
15. Jesse LCH, Obrycki JJ. Field deposition of Bt transgenic corn pollen: Lethal effects on the monarch butterfly. *J Oecologia*. 2000;125:241–248.
16. Lang A, Vojtech E. The effects of pollen consumption of transgenic Bt maize on the common swallowtail, *Papilio machaon* L. (Lepidoptera, Papilionidae). *Basic Appl Ecol*. 2006;7:296–306.
17. Hilbeck A, McMillan JM, Meier M, Humbel A, Schlaepfer-Miller J, Trtikova M. A controversy re-visited: Is the coccinellid *Adalia bipunctata* adversely affected by Bt toxins? *Environ Sci Eur*. 2012;24(10). doi:10.1186/2190-4715-24-10.
18. Hilbeck A, Meier M, Trtikova M. Underlying reasons of the controversy over adverse effects of Bt toxins on lady beetle and lacewing larvae. *Environ Sci Eur*. 2012;24(9). doi:10.1186/2190-4715-24-9.
19. Hilbeck A, Baumgartner M, Fried PM, Bigler F. Effects of transgenic Bt corn-fed prey on immature development of *Chrysoperla carnea* (Neuroptera: Chrysopidae). *Environ Entomol*. 1998;27(2):480–487.
20. Hilbeck A, Moar WJ, Pusztai-Carey M, Filippini A, Bigler F. Prey-mediated effects of Cry1Ab toxin and protoxin and Cry2A protoxin on the predator *Chrysoperla carnea*. *Entomol Exp Appl*. 1999;91:305–316.
21. Séralini GE, Cellier D, Spiroux de Vendomois J. New analysis of a rat feeding study with a genetically modified maize reveals signs of hepatorenal toxicity. *Arch Environ Contam Toxicol*. 2007;52:596–602.
22. De Vendomois JS, Roullier F, Cellier D, Séralini GE. A comparison of the effects of three GM corn varieties on mammalian health. *Int J Biol Sci*. 2009;5:706–26.
23. Trabalza-Marinucci M, Brandi G, Rondini C, et al. A three-year longitudinal study on the effects of a diet containing genetically modified Bt176 maize on the health status and performance of sheep. *Livest Sci*. 2008;113:178–190. doi:10.1016/j.livsci.2007.03.009.
24. Fares NH, El-Sayed AK. Fine structural changes in the ileum of mice fed on delta-endotoxin-treated potatoes and transgenic potatoes. *Nat Toxins*. 1998;6(6):219-33.
25. El-Shamei ZS, Gab-Alla AA, Shatta AA, Moussa EA, Rayan AM. Histopathological changes in some organs of male rats fed on genetically modified corn (Ajeeb YG). *J Am Sci*. 2012;8(10):684–696.
26. Gab-Alla AA, El-Shamei ZS, Shatta AA, Moussa EA, Rayan AM. Morphological and biochemical changes in male rats fed on genetically modified corn (Ajeeb YG). *J Am Sci*. 2012;8(9):1117–1123.
27. Finamore A, Roselli M, Britti S, et al. Intestinal and peripheral immune response to MON810 maize ingestion in weaning and old mice. *J Agric Food Chem*. 2008;56:11533–39. doi:10.1021/jf802059w.
28. Kilic A, Akay MT. A three generation study with genetically modified Bt corn in rats: Biochemical and histopathological investigation. *Food Chem Toxicol*. 2008;46:1164–70. doi:10.1016/j.fct.2007.11.016.
29. Nandula VK, Reddy KN, Duke SO, Poston DH. Glyphosate-resistant weeds: Current status and future outlook. *Outlooks Pest Manag*. 2005;16:183–187.
30. Fraser K. Glyphosate resistant weeds – intensifying. Guelph, Ontario, Canada: Stratus Ag Research; 2013. Available at: <http://stratusresearch.com/blog/glyphosate-resistant-weeds-intensifying/>.
31. Farm Industry News. Glyphosate-resistant weed problem extends to more species, more farms. <http://farministrynews.com/ag-technology-solution-center/glyphosate-resistant-weed-problem-extends-more-species-more-farms>. Published January 29, 2013.
32. Syngenta. Syngenta module helps manage glyphosate-resistant weeds. Delta Farm Press. <http://deltafarmpress.com/syngenta-module-helps-manage-glyphosate-resistant-weeds>. Published May 30, 2008.
33. Robinson R. Resistant ryegrass populations rise in Mississippi. Delta Farm Press. 2008. Available at: <http://deltafarmpress.com/resistant-ryegrass-populations-rise-mississippi>.

34. Johnson B, Davis V. Glyphosate resistant horseweed (marestail) found in 9 more Indiana counties. *Pest Crop*. 2005. Available at: <http://extension.entm.purdue.edu/pestcrop/2005/issue8/index.html>.
35. Nice G, Johnson B, Bauman T. A little burndown madness. *Pest & Crop*. <http://extension.entm.purdue.edu/pestcrop/2008/issue1/index.html>. Published March 7, 2008.
36. Nice G, Johnson B. Fall applied programs labeled in Indiana. *Pest Crop*. 2006;(23). Available at: <http://extension.entm.purdue.edu/pestcrop/2006/issue23/table1.html>.
37. Randerson J. Genetically-modified superweeds "not uncommon." *New Sci*. 2002. Available at: <http://www.newscientist.com/article/dn1882-geneticallymodified-superweeds-not-uncommon.html>.
38. Kilman S. Superweed outbreak triggers arms race. *Wall Street Journal*. <http://biolargo.blogspot.com/2010/06/round-up-weed-killer-and-acquired.html>. Published June 4, 2010.
39. Brasher P. Monsanto paying farmers to increase herbicide use. *Des Moines Register*. <http://bit.ly/az3fSo>. Published October 19, 2010.
40. Neuman W, Pollack A. US farmers cope with Roundup-resistant weeds. *New York Times*. <http://www.nytimes.com/2010/05/04/business/energy-environment/04weed.html?pagewanted=1&hp>. Published May 3, 2010.
41. Caulcutt C. "Superweed" explosion threatens Monsanto heartlands. *France 24*. <http://www.gmwatch.org/index.php/news/archive/2009/10923>. Published April 19, 2009.
42. Osunsami S. Killer pig weeds threaten crops in the South. <http://abcnews.go.com/WN/pig-weed-threatens-agricultureindustryovertaking-fields-crops/story?id=8766404&page=1>. Published October 6, 2009.
43. US Food and Drug Administration (FDA). Biotechnology consultation note to the file BNF No 00077. Office of Food Additive Safety, Center for Food Safety and Applied Nutrition; 2002. Available at: <http://bit.ly/ZUmiAF>.
44. Malatesta M, Biggiogera M, Manuali E, Rocchi MBL, Baldelli B, Gazzanelli G. Fine structural analyses of pancreatic acinar cell nuclei from mice fed on genetically modified soybean. *Eur J Histochem*. 2003;47:385–388.
45. Malatesta M, Caporaloni C, Gavaudan S, et al. Ultrastructural morphometrical and immunocytochemical analyses of hepatocyte nuclei from mice fed on genetically modified soybean. *Cell Struct Funct*. 2002;27:173–80.
46. Vecchio L, Cisterna B, Malatesta M, Martin TE, Biggiogera M. Ultrastructural analysis of testes from mice fed on genetically modified soybean. *Eur J Histochem*. 2004;48:448–54.
47. Malatesta M, Boraldi F, Annovi G, et al. A long-term study on female mice fed on a genetically modified soybean: effects on liver ageing. *Histochem Cell Biol*. 2008;130:967–977.
48. Gu J, Krogdahl A, Sissener NH, et al. Effects of oral Bt-maize (MON810) exposure on growth and health parameters in normal and sensitised Atlantic salmon, *Salmo salar* L. *Br J Nutr*. 2013;109:1408–23. doi:10.1017/S000711451200325X.
49. Poulsen M, Kroghsbo S, Schroder M, et al. A 90-day safety study in Wistar rats fed genetically modified rice expressing snowdrop lectin *Galanthus nivalis* (GNA). *Food Chem Toxicol*. 2007;45:350–63. doi:10.1016/j.fct.2006.09.002.
50. Schröder M, Poulsen M, Wilcks A, et al. A 90-day safety study of genetically modified rice expressing Cry1Ab protein (*Bacillus thuringiensis* toxin) in Wistar rats. *Food Chem Toxicol*. 2007;45:339–49. doi:10.1016/j.fct.2006.09.001.
51. Ewen SW, Pusztai A. Effect of diets containing genetically modified potatoes expressing *Galanthus nivalis* lectin on rat small intestine. *Lancet*. 1999;354:1353–4. doi:10.1016/S0140-6736(98)05860-7.
52. Pusztai A, Bardocz S. GMO in animal nutrition: Potential benefits and risks. In: Mosenthin R, Zentek J, Zebrowska T, eds. *Biology of Nutrition in Growing Animals*. Vol 4. Elsevier Limited; 2006:513–540. Available at: <http://www.sciencedirect.com/science/article/pii/S1877182309701043>.
53. Kroghsbo S, Madsen C, Poulsen M, et al. Immunotoxicological studies of genetically modified rice expressing PHA-E lectin or Bt toxin in Wistar rats. *Toxicology*. 2008;245:24–34. doi:10.1016/j.tox.2007.12.005.
54. Krzyzowska M, Wincenciak M, Winnicka A, et al. The effect of multigenerational diet containing genetically modified triticale on immune system in mice. *Pol J Vet Sci*. 2010;13:423–30.
55. Prescott VE, Campbell PM, Moore A, et al. Transgenic expression of bean alpha-amylase inhibitor in peas results in altered structure and immunogenicity. *J Agric Food Chem*. 2005;53:9023–30. doi:10.1021/jf050594v.
56. Tudisco R, Lombardi P, Bovera F, et al. Genetically modified soya bean in rabbit feeding: Detection of DNA fragments and evaluation of metabolic effects by enzymatic analysis. *Anim Sci*. 2006;82:193–199. doi:10.1079/ASC200530.
57. Hines FA. Memorandum to Linda Kahl on the Flavr Savr tomato (Pathology Review PR–152; FDA Number FMF–000526): Pathology Branch's evaluation of rats with stomach lesions from three four-week oral (gavage) toxicity studies (IRDC Study Nos. 677–002, 677–004, and 677–005) and an Expert Panel's report. US Department of Health & Human Services; 1993. Available at: <http://www.biointegrity.org/FDAdocs/17/view1.html>.
58. Pusztai A. Witness Brief – Flavr Savr tomato study in Final Report (IIT Research Institute, Chicago, IL 60616 USA) cited by Dr Arpad Pusztai before the New Zealand Royal Commission on Genetic Modification. 2000. Available at: <http://www.gmcommission.govt.nz/>.
59. Pusztai A. Can science give us the tools for recognizing possible health risks of GM food? *Nutr Health*. 2002;16:73–84.
60. Pusztai A, Bardocz S, Ewen SWB. Genetically modified foods: Potential human health effects. In: D'Mello JPF, ed. *Food Safety: Contaminants and Toxins*. Wallingford, Oxon: CABI Publishing; 2003:347–372. Available at: <http://www.leopold.iastate.edu/sites/default/files/events/Chapter16.pdf>.
61. Brasil FB, Soares LL, Faria TS, Boaventura GT, Sampaio FJ, Ramos CF. The impact of dietary organic and transgenic soy on the reproductive system of female adult rat. *Anat Rec Hoboken*. 2009;292:587–94. doi:10.1002/ar.20878.
62. Carman JA, Vliieger HR, Ver Steeg LJ, et al. A long-term toxicology study on pigs fed a combined genetically modified (GM) soy and GM maize diet. *J Org Syst*. 2013;8:38–54.
63. Séralini GE, Clair E, Mesnage R, et al. [RETRACTED:] Long term toxicity of a Roundup herbicide and a Roundup-tolerant genetically modified maize. *Food Chem Toxicol*. 2012;50:4221–4231.
64. EndScienceCensorship.org. Statement: Journal retraction of Séralini GMO study is invalid and an attack on scientific integrity. 2014. Available at: <http://www.endsciencencensorship.org/en/page/Statement#.UwUSP14vFY4>. Accessed February 19, 2014.
65. Institute of Science in Society. Open letter on retraction and pledge to boycott Elsevier. 2013. Available at: http://www.i-sis.org.uk/Open_letter_to_FCT_and_Elsevier.php#form. Accessed February 19, 2014.
66. Fagan J, Antoniou M, Robinson C. *GMO myths and truths: An evidence-based examination of the claims made for the safety and efficacy of genetically modified crops and foods*. London, UK: Earth Open Source; 2014.
67. Greenpeace. Children and infants in China at risk of eating food contaminated by illegal GE rice. <http://www.greenpeace.org>.

- org/eastasia/press/releases/food-agriculture/2011/ge-rice-baby-food/. Published April 20, 2011.
68. Greenpeace and GeneWatch UK. Germany finds unauthorised genetically modified (Bt63) rice noodles. GM Contamination Register. <http://bit.ly/1nEKmEO>. Published June 15, 2011.
 69. Greenpeace and GeneWatch UK. Sweden finds unauthorised genetically modified (Bt63) rice. GM Contamination Register. <http://bit.ly/1kXDCSP>. Published June 27, 2011.
 70. New Zealand Food Safety Authority (NZFSA). Unauthorised GM rice product found and withdrawn. http://www.foodsafety.govt.nz/elibrary/industry/Unauthorised_Rice-Zealand_Food.htm. Published July 30, 2008.
 71. Eurofins. New regulations concerning GMO rice from China. Eurofins Food Testing Newsletter No. 38. <http://www.eurofins.de/food-analysis/information/food-testing-newsletter/food-newsletter-38/gmo-rice-from-china.aspx>. Published March 2012.
 72. Blue EN. Risky business: Economic and regulatory impacts from the unintended release of genetically engineered rice varieties into the rice merchandising system of the US. Greenpeace; 2007. Available at: <http://www.greenpeace.org/raw/content/international/press/reports/risky-business.pdf>.
 73. Reuters. Mexico halts US rice over GMO certification. <http://www.gmwatch.org/latest-listing/1-news-items/3625>. Published March 16, 2007.
 74. Harris A, Beasley D. Bayer agrees to pay \$750 million to end lawsuits over gene-modified rice. Bloomberg. <http://www.bloomberg.com/news/2011-07-01/bayer-to-pay-750-million-to-end-lawsuits-over-genetically-modified-rice.html>. Published July 2, 2011.
 75. Fox JL. Bayer's GM rice defeat. *Nat Biotechnol*. 2011;29(473). Available at: <http://www.nature.com/nbt/journal/v29/n6/full/nbt0611-473c.html>.
 76. Dawson A. CDC Triffid flax scare threatens access to no. 1 EU market. Manitoba Cooperator. <http://www.manitobacooperator.ca/2009/09/17/cdc-triffid-flax-scare-threatens-access-to-no-1-eu-market/>. Published September 17, 2009.
 77. Dawson A. Changes likely for flax industry. Manitoba Cooperator. <http://www.gmwatch.org/component/content/article/11541>. Published September 24, 2009.
 78. Organic Agriculture Protection Fund Committee. Organic farmers seek Supreme Court hearing. 2007. Available at: <http://bit.ly/1iGdQla>.
 79. Binimelis R. Coexistence of plants and coexistence of farmers: Is an individual choice possible? *J Agric Environ Ethics*. 2008;21:437–457.
 80. Macilwain C. US launches probe into sales of unapproved transgenic corn. *Nature*. 2005;434(423). Available at: <http://www.nature.com/nature/journal/v434/n7032/full/nature03570.html>.
 81. Schmitz TG, Schmitz A, Moss CB. The economic impact of StarLink corn. *Agribusiness*. 2005;21(3):391–407.
 82. Hilbeck A, Lebrecht T, Vogel R, Heinemann JA, Binimelis R. Farmer's choice of seeds in four EU countries under different levels of GM crop adoption. *Environ Sci Eur*. 2013;25(1):12. doi:10.1186/2190-4715-25-12.
 83. Patriat P. Speech delivered at the association of seed producers of Mato Grosso, on May 11, 2011 at the soy industry conference SEMEAR 2011 in Sao Paulo, Brazil. GMWatch. 2012. Available at: <http://www.gmwatch.org/latest-listing/1-news-items/14092>.
 84. Howard P. Visualizing consolidation in the global seed industry: 1996–2008. *Sustainability*. 2009;1:1266–1287.
 85. Jiao Z, Si XX, Li GK, Zhang ZM, Xu XP. Unintended compositional changes in transgenic rice seeds (*Oryza sativa* L.) studied by spectral and chromatographic analysis coupled with chemometrics methods. *J Agric Food Chem*. 2010;58:1746–54. doi:10.1021/jf902676y.
 86. Lappé M, Bailey B, Childress C, Setchell KDR. Alterations in clinically important phytoestrogens in genetically modified herbicide-tolerant soybean. *J Med Food*. 1999;1:241–245.
 87. Ye X, Al-Babili S, Klott A, et al. Engineering the provitamin A (beta-carotene) biosynthetic pathway into (carotenoid-free) rice endosperm. *Science*. 2000;287:303–5.
 88. Paine JA, Shipton CA, Chaggar S, et al. Improving the nutritional value of Golden Rice through increased pro-vitamin A content. *Nat Biotechnol*. 2005;23:482–7. doi:10.1038/nbt1082.
 89. Lomborg B. The deadly opposition to genetically modified food. *Slate*. <http://slate.me/ZUgOWB>. Published February 17, 2013.
 90. Enserink M. Tough lessons from Golden Rice. *Science*. 2008;230:468–471.
 91. Sharma A. Golden Rice still at development stage. *The Financial Express (India)*. <http://bit.ly/10Jsfqw>. Published November 23, 2006.
 92. McKie R. After 30 years, is a GM food breakthrough finally here? *The Observer*. <http://bit.ly/10k62lf>. Published February 2, 2013.
 93. International Rice Research Institute (IRRI). Clarifying recent news about Golden Rice. <http://bit.ly/Z6ohSq>. Published February 21, 2013. Accessed March 3, 2014.
 94. International Rice Research Institute (IRRI). What is the status of the Golden Rice project coordinated by IRRI? 2014. Available at: <http://irri.org/golden-rice/faqs/what-is-the-status-of-the-golden-rice-project-coordinated-by-irri>.
 95. World Health Organization (WHO). Micronutrient deficiencies: Vitamin A deficiency. 2011. Available at: <http://www.who.int/nutrition/topics/vad/en/index.html>. Accessed January 1, 1915.
 96. Food and Nutrition Research Institute/Dept of Science and Technology (Philippines). 7th National Nutrition Survey: 2008: Biochemical survey component. Manila, Philippines; 2010. Available at: http://www.fnri.dost.gov.ph/images/stories/7thNNS/biochemical/biochemical_vad.pdf.
 97. Hansen M. Golden rice myths. *PermacultureNews.org*. <http://permaculturenews.org/2014/03/27/golden-rice-myths/>. Published March 27, 2014.
 98. Li S, Nugroho A, Rocheford T, White WS. Vitamin A equivalence of the β -carotene in β -carotene–biofortified maize porridge consumed by women? *Am J Clin Nutr*. 2010;92(5):1105–1112. doi:10.3945/ajcn.2010.29802.
 99. HarvestPlus. Scientists find that "orange" maize is a good source of vitamin A. *HarvestPlus.org*. <http://bit.ly/L2PxNV>. Published September 7, 2010.
 100. International Assessment of Agricultural Knowledge, Science and Technology for Development (IAASTD). *Agriculture at a crossroads: Synthesis report of the International Assessment of Agricultural Knowledge, Science and Technology for Development: A Synthesis of the Global and Sub-Global IAASTD Reports*. Washington, DC, USA: Island Press; 2009.

Available at: http://www.unep.org/dewa/agassessment/reports/IAASTD/EN/Agriculture%20at%20a%20Crossroads_Synthesis%20Report%20%28English%29.pdf.

101. Altieri MA. Applying agroecology to enhance the productivity of peasant farming systems in Latin America. *Environ Dev Sustain*. 1999;1:197–217.
102. Bunch R. More productivity with fewer external inputs: Central American case studies of agroecological development and their broader implications. *Environ Dev Sustain*. 1999;1:219–233.
103. Pretty J. Can sustainable agriculture feed Africa? New evidence on progress, processes and impacts. *J Environ Dev Sustain*. 1999;1:253–274. doi:10.1023/A:1010039224868.
104. Hine R, Pretty J, Twarog S. Organic agriculture and food security in Africa. New York and Geneva: UNEP-UNCTAD Capacity-Building Task Force on Trade, Environment and Development; 2008. Available at: <http://bit.ly/KBCgY0>.
105. Barzman M, Das L. Ecologising rice-based systems in Bangladesh. *LEISA Mag*. 2000;16. Available at: <http://bit.ly/L2N71R>.
106. Zhu Y, Chen H, Fan J, et al. Genetic diversity and disease control in rice. *Nature*. 17;406:718–722.
107. SRI International Network and Resources Center (SRI-Rice)/Cornell University College of Agriculture and Life Sciences. Home page. 2014. Available at: <http://sri.ciifad.cornell.edu/>.
108. Goodman MM. New sources of germplasm: Lines, transgenes, and breeders. In: Martinez JM, ed. *Memoria Congreso Nacional de Fitogenetica*. Univ Autonimo Agr Antonio Narro, Saltillo, Coah, Mexico; 2002:28–41. Available at: <http://www.cropsci.ncsu.edu/maize/publications/NewSources.pdf>.
109. Mellon M, Gurian-Sherman D. The cost-effective way to feed the world. *The Bellingham Herald*. <http://bit.ly/NvQoZd>. Published June 20, 2011.
110. GMWatch. Non-GM successes. 2014. Available at: <http://www.gmwatch.org/index.php/articles/non-gm-successes>.
111. Ogodo O. Beans climb to new heights in Rwanda. *SciDevNet*. 2010. Available at: <http://www.scidev.net/en/news/beans-climb-to-new-heights-in-rwanda.html>.
112. AFP. "Rooting" out hunger in Africa – and making Darwin proud. *Indep UK*. 2010. Available at: <http://www.independent.co.uk/life-style/health-and-families/rooting-out-hunger-in-africa--and-making-darwin-proud-2076547.html>.
113. Queensland Country Life. New maize hybrids to target niche Asian markets. <http://bit.ly/LZr89P>. Published April 5, 2011.
114. Atser G. Ghanaian farmers get quality protein, drought-tolerant, and Striga-resistant maize varieties to boost production. *Modern Ghana*. <http://bit.ly/LZolNL>. Published April 2, 2010.
115. CIMMYT. Body blow to grain borer. *CIMMYT E-News*. 2007;14 May 2012. Available at: <http://www.cimmyt.org/en/news-and-updates/item/body-blow-to-grain-borer>.
116. Berthelsen J. A new rice revolution on the way? *AsiaSentinel*. <http://bit.ly/Lzthdi>. Published January 17, 2011.
117. Swoboda R. Cho[ol]se high-yielding, SCN-resistant soybeans. *Wallace's Farmer* (Iowa, USA). <http://bit.ly/1fCi7H2>. Published November 7, 2007.
118. Diers B. Discovering soybean plants resistant to aphids and a new aphid. University of Illinois Extension. <http://web.extension.illinois.edu/state/newsdetail.cfm?NewsID=15202>. Published February 20, 2010.
119. Li Y, Hill CB, Carlson SR, Diers BW, Hartman GL. Soybean aphid resistance genes in the soybean cultivars Dowling and Jackson map to linkage group M. *Mol Breed*. 2007;19(1):25–34. doi:10.1007/s11032-006-9039-9.
120. Kim K-S, Hill CB, Hartman GL, Mian MAR, Diers BW. Discovery of soybean aphid biotypes. *Crop Sci*. 2008;48(3):923. doi:10.2135/cropsci2007.08.0447.
121. Hill CB, Kim K-S, Crull L, Diers BW, Hartman GL. Inheritance of resistance to the soybean aphid in soybean PI 200538. *Crop Sci*. 2009;49(4):1193. doi:10.2135/cropsci2008.09.0561.
122. Allen J. Single gene powers hybrid tomato plants. *PlanetArk*. <http://www.planetark.com/enviro-news/item/57360>. Published March 30, 2010.
123. Suszkiw J. Experimental chickpeas fend off caterpillar pest. *USDA Agricultural Research Service News & Events*. <http://www.ars.usda.gov/is/pr/2009/090825.htm>. Published August 25, 2009.
124. Clemson University. New not-so-sweet potato resists pests and disease. *Bioscience Technology*. <http://bit.ly/LGHVlo>. Published June 22, 2011.
125. Kloosterman K. Pest-resistant super wheat "Al Israeliano." *greenprophet.com*. <http://www.greenprophet.com/2010/08/israel-super-wheat/>. Published August 17, 2010.
126. Clarke A. Conventional potato varieties resist PCN and blight. *Farmers Wkly*. 2014. Available at: <http://www.fwi.co.uk/articles/09/04/2014/144089/conventional-potato-varieties-resist-pcn-and-blight.htm>.
127. Potato Council (UK). Toluca. *Br Potato Var Database*. 2014. Available at: http://varieties.potato.org.uk/display_description.php?variety_name=Toluca.
128. Wragg S. Elm Farm 2010: Blight-resistant spuds could lower carbon levels. *Farmers Weekly Interactive*. <http://bit.ly/LsRjb2>. Published January 11, 2010.
129. Suszkiw J. ARS scientists seek blight-resistant spuds. *USDA Agricultural Research Service*. <http://www.ars.usda.gov/is/pr/2010/100603.htm>. Published June 3, 2010.
130. Shackford S. Cornell releases two new potato varieties, ideal for chips. *Chronicle Online*. <http://www.news.cornell.edu/stories/Feb11/NewPotatoes.html>. Published February 21, 2011.
131. Fowler A. Sárpo potatoes. *The Guardian*. <http://www.theguardian.com/lifeandstyle/2012/jan/13/aly-fowler-sarpo-potatoes>. Published January 13, 2012.
132. White S, Shaw D. The usefulness of late-blight resistant Sárpo cultivars – A case study. *ISHS Acta Hort*. 2009;834. Available at: http://www.actahort.org/members/showpdf?booknrnmr=834_17.
133. Suszkiw J. Scientists use old, new tools to develop pest-resistant potato. *USDA Agricultural Research Service*. <http://www.ars.usda.gov/is/ar/archive/apr09/potato0409.htm>. Published March 31, 2009.
134. Siar SV, Beligan GA, Sajise AJC, Villegas VN, Drew RA. Papaya ringspot virus resistance in *Carica papaya* via introgression from *Vasconcellea quercifolia*. *Euphytica*. 2011;181(2):159–168.
135. Gonsalves D. Transgenic papaya in Hawaii and beyond. *AgBioForum*. 2004;7(1 & 2):36–40.
136. Summers J. GM halo effect: Can GM crops protect conventional and organic farming? *Genetic Literacy Project*. <http://www.geneticliteracyproject.org/2014/01/09/gm-papaya-halo-effect/#.U2Kp3ccowsk>. Published January 9, 2014.
137. Chan K. War of the papayas. *ChinaDaily.com*. <http://bit.ly/LQT67d>. Published September 8, 2011.
138. Hao S. Papaya production taking a tumble. *The Honolulu Advertiser*. <http://bit.ly/LzDZRb>. Published March 19, 2006.

139. Sawahel W. Wheat variety thrives on saltier soils. SciDevNet. 2010. Available at: <http://www.scidev.net/en/news/wheat-variety-thrives-on-saltier-soils.html>.
140. Dean T. Salt tolerant wheat could boost yields by 25%. LifeScientist. <http://lifescientist.com.au/content/biotechnology/news/salt-tolerant-wheat-could-boost-yields-by-25--583063808>. Published March 12, 2012.
141. Davis R. Interview with Vandana Shiva. New Int. 2008. Available at: <http://bit.ly/L3yhca>.
142. Suszkiw J. New soybeans bred for oil that's more heart-healthy. USDA Agricultural Research Service News & Events. <http://www.ars.usda.gov/is/pr/2010/100916.htm>. Published September 16, 2010.
143. Anderson T. Biofortified crops ready for developing world debut. SciDev.Net. <http://bit.ly/MAkMg7>. Published November 17, 2010.
144. BBC News. "Healthy" purple potato goes on sale in UK supermarkets.<http://www.bbc.co.uk/news/uk-scotland-11477327>. Published October 6, 2010.
145. Watson J. Purple spud will put you in the pink. Scotland on Sunday. <http://scotlandonsunday.scotsman.com/uk/Purple-spud-will-put-you.4841710.jp>. Published January 3, 2009.
146. Knowles M. Italian producers unveil "supertomato." Fruitnet.com. <http://bit.ly/1oLKL7t>. Published July 5, 2010.
147. CBS News. Purple tomatoes may fight cancer, other diseases.<http://archive.digtriad.com/news/health/article/202115/8/Purple-Tomatoes-May-Fight-Cancer-Other-Diseases>. Published December 3, 2011.
148. John Innes Centre. Purple tomatoes may keep cancer at bay.<http://bit.ly/NAwtZ6>. Published October 26, 2008.
149. Martin C. How my purple tomato could save your life. Mail Online. <http://bit.ly/10JsmIO>. Published November 8, 2008.
150. Derbyshire D. Purple "super tomato" that can fight against cancer. Daily Mail. http://www.athena-flora.eu/florapress/4-Purple_Tomatoes_International_press_clip/UK/daily%20mail_UK.pdf. Published October 27, 2008.
151. Asian News International. Low-allergy peanuts on the anvil. OneIndiaNews. <http://bit.ly/Li7xIV>. Published June 8, 2010.
152. Latham JR, Wilson AK, Steinbrecher RA. The mutational consequences of plant transformation. J Biomed Biotechnol. 2006;2006:1-7. doi:10.1155/JBB/2006/25376.
153. Schubert D. A different perspective on GM food. Nat Biotechnol. 2002;20:969. doi:10.1038/nbt1002-969.
154. Wilson AK, Latham JR, Steinbrecher RA. Transformation-induced mutations in transgenic plants: Analysis and biosafety implications. Biotechnol Genet Eng Rev. 2006;23:209-238.
155. Pattanayak V, Ramirez CL, Joung JK, Liu DR. Revealing off-target cleavage specificities of zinc-finger nucleases by in vitro selection. Nat Methods. 2011;8(9):765-770. doi:10.1038/nmeth.1670.
156. Gabriel R, Lombardo A, Arens A, et al. An unbiased genome-wide analysis of zinc-finger nuclease specificity. Nat Biotechnol. 2011;29(9):816-823. doi:10.1038/nbt.1948.
157. Fu Y, Foden JA, Khayter C, et al. High-frequency off-target mutagenesis induced by CRISPR-Cas nucleases in human cells. Nat Biotechnol. 2013;31(9):822-826. doi:10.1038/nbt.2623.
158. Bergelson J, Purrington CB, Palm CJ, Lopez-Gutierrez JC. Costs of resistance: A test using transgenic Arabidopsis thaliana. Proc Biol Sci. 1996;263:1659-63. doi:10.1098/rspb.1996.0242.
159. Purrington CB, Bergelson J. Fitness consequences of genetically engineered herbicide and antibiotic resistance in Arabidopsis thaliana. Genetics. 1997;145(3):807-814.
160. Bergelson J, Purrington CB, Wichmann G. Promiscuity in transgenic plants. Nature. 1998;395:25. doi:10.1038/25626.
161. Tippe R, Then C. Patents on melon, broccoli and ham? ELNI Rev. 2011;2:53-57.
162. Organisation for Economic Cooperation and Development (OECD). Biotechnology, Agriculture and Food. Paris, France: OECD Publishing; 1992.
163. ETC Group. Who owns nature? Corporate power and the final frontier in the commodification of life. Ottawa, Canada; 2008. Available at: http://www.etcgroup.org/sites/www.etcgroup.org/files/publication/707/01/etc_won_report_final_color.pdf.



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