

METABOLIC RIFTS

Insect Apocalypse in the Anthropocene, Part 4

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How genetic engineering and weed killers accelerate capitalism's assault on insect life

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“Plants are, of course, the basis of almost every food chain, and by developing methods of farming that almost entirely eradicate weeds from arable fields, such that crops are often close to pure monocultures, we have made much of our landscape inhospitable to most forms of life.” —Dave Goulson [1]



For decades, advocates of genetically engineered (GE) food have been promising miracle crops that would save lives and feed the world. Grains that flourish during droughts. Improved nutrition, including rice that contains eyesight-saving vitamins. Apples that don't rot. Reduced CO₂ emissions. More food from less land.

According to the pro-biotechnology International Service for the Acquisition of Agribiotech Applications (ISAAA), the benefits of genetic modification are so great that the area devoted to GE crops grew from zero in 1996 to 190.4 million hectares (470.5 million acres) in 2019 — “the fastest adopted crop technology” in history. [2]

And yet, if we look at the ISAAA's own statistics, we find that 85 percent of the area devoted to GE crops is in just four countries, USA, Brazil, Argentina, and Canada, and about 99% of all the genetic modifications in commercial crops today fall into just two categories, herbicide tolerance and insect resistance — they have nothing to do with improving food quality. What's more, soybeans and corn, which comprise over 90% of GE crops, are mostly used to make animal feed and biofuel, not to feed hungry people.

The principal results of genetic engineering in agriculture have been expanded monocultures in North and South America, increased use of chemical poisons, and increased profits for the handful of corporations that dominate the production of agricultural chemicals and GE seeds. There is much

debate about the impact of GE crops and the associated pesticides on human health, but this article focuses on their role in creating massive, life-destroying monocultures.

* * * *

As we've seen, two features of industrial agriculture have driven the insect apocalypse : massive use of poisons and habitat destruction. Billions of six-legged animals are killed every year by chemical poisons that supposedly protect crops. And large scale monocultures — single-crop farms fields and farms — deprive them of food and places to live and breed. Both are aspects of what has been called the green revolution, increased production driven by methods that have damaged the environment and reduced biodiversity.

In the 1990s, a second and more destructive phase of industrial agriculture began, a phase that we might call the gene revolution. GE seeds changed the game, dramatically expanding the areas devoted to insect-hostile monocultures. The transition was initiated in 1996 by the St. Louis-based chemical company Monsanto, whose most important product was the weed killer Roundup.

"Weed" is not a scientific category. A weed is an unwanted plant, one that it is growing in the wrong place, competing with more desirable species for space, nutrients, water and sunlight. Traditionally, farmers limited weed growth by using cover crops, mulching, and frequent crop rotation, but physical removal was also required to kill weeds and prevent them from contaminating the harvest. For millennia, hoeing the weeds was a necessary and labor-intensive part of farming, and it still is in much of the world.

In the early 20th century, some farmers in Europe and North America used sulfuric acid and arsenic compounds to kill weeds, but chemical applications didn't become common until the late 1940s, when the plant-killing chemical 2,4-D, developed by the US military as a biological weapon, became generally available. [3] It was soon joined by other synthetic herbicides, including 2,4,5-T, dicamba and triclopyr, as fundamental weapons in what Rachel Carson called "the chemical barrage against the fabric of life." [4] They were widely adopted, Jennifer Clapp writes, because they made farming easier.

"These chemicals were successful in killing unwanted plants over wide areas and were popular because they saved labor. As farm size began to grow with the increasing mechanization of agriculture in the middle of the 20th century, herbicide use expanded dramatically and became the norm for weed control." [5]

Monsanto introduced Roundup In 1976. Its principal ingredient was glyphosate, a chemical that kills plants by blocking their ability to create essential proteins. It was mainly used for clearing fields before planting and for killing weeds on lawns and roadsides, but it would kill growing crops if sprayed on or near them.

In 1996 Monsanto changed that with genetic engineering : instead of changing the poison, it changed the crops. Its two families of genetically modified seeds were highly successful.

- Roundup Ready (RR) seeds were engineered to tolerate glyphosate — Roundup sprayed on fields of RR crops would kill all other plants while leaving the crops intact. It was offered first for soybeans and canola, then corn, alfalfa, cotton, and sorghum.
- Monsanto's corn (maize) and cotton seeds were engineered to contain genes from *Bacteria thuringiensis* (Bt), an organism that is toxic to some caterpillars and beetles that eat those crops. Effectively, crops grown from Bt modified seeds produce their own insecticides.

Monsanto subsequently introduced corn and cotton seeds that contained both genetic traits. According to the ISAAA, 45 percent of GE crops are now devoted to crops that are “stacked” with genes for both herbicide tolerance and insect resistance.

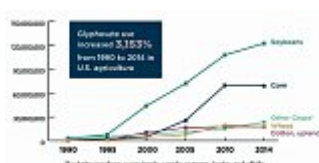


The patented seeds were more expensive, but they simplified production. Glyphosate could now be sprayed during the growing season without harming crops, producing pure monocultures, fields where no competing plants could grow. Farms that grew Roundup Ready crops could be almost entirely mechanized, reducing labor to a minimum. And, as Monsanto emphasized in its advertising, since Roundup was deadly to all non-GE plants, it was “the only weed control you need.” A company website described the combination of glyphosate and glyphosate-resistant seeds as “the system that sets you free.” [6]

At the same time, Monsanto moved to lock up the agricultural input market by acquiring over 30 independent seed companies, becoming the largest seed seller in the world by 2005. Controlling chemicals and seeds and the distribution channels gave the company a huge advantage in the farm inputs industry. “The company bragged to shareholders that it saw an 18 percent rise in the volume of the glyphosate products it was selling just from 1999 to 2000.” Half of its \$5.5 billion revenues in 2000 came from glyphosate. [7]

For over two decades, glyphosate has been the world’s most widely-used herbicide. Glyphosate accounted for 1% of herbicides sprayed on the four biggest US crops in 1982, 4% in 1995, 33% in 2005, and 40% in 2012. [8] “By 2020, 90 percent of all corn, cotton, soybeans and sugar beets planted in the United States [were] genetically modified to tolerate one or more herbicides.” [9]

This graph dramatically illustrates how Monsanto’s GE seeds increased sales and use of Monsanto’s weed killer in the United States.



Agricultural glyphosate use (acres) in the United States, 1990-2014. (Source : Stacy Malken, Merchants of Poison, (Friends of the Earth, 2022), 14.)

Soybeans and corn (maize) are by far the largest crops grown in the United States — together they occupy nearly 190 million acres (77 million hectares), [10] and over 90% of that is planted with genetically engineered seeds. Add smaller areas of GE cotton, sugar beets, alfalfa and canola, and over twelve million acres of GE crops in Canada, and you have an immense area that is profoundly inhospitable to insects.

South America



Declaring “Soy knows no borders,” the agrochemical giant Syngenta called this area the “United Republic of Soyabeans” in a 2003 advertisement.

Monsanto’s sales drive for Roundup Ready Soybeans wasn’t limited to the North America. In the southern cone of South America, where landownership is much more concentrated than in the global north, large landowners adopted the seed/herbicide combination rapidly, beginning in 1996 in Argentina and spreading over the following decade to Paraguay, Uruguay, Brazil and southern Bolivia. Replacing labor with chemicals allowed landowners to expel small tenant farmers by the millions, creating immense soy plantations operated by investment groups. For every agricultural worker employed in GE soy production in Brazil, eleven were displaced. [11]

As early as 2005, two leading ecologists reported on the massive social and environmental dislocation caused by landowners’ adoption of GE soybeans :

“In 1998 there were a total of 422,000 farms in Argentina while in 2002 there were 318,000 farms, a reduction of 24.5%. In one decade soybean acreage increased in 126% at the expense of lands devoted to dairy, maize, wheat and fruit production....

“In Paraguay soybeans are planted on more than 25 % of all agricultural land in the country and in Argentina soybean acreage reached in 2000 almost 15 million hectares producing 38.3 million metric tons. All this expansion is occurring dramatically at the expense of forests and other habitats. In Paraguay much of the Atlantic forest is being cut. In Argentina 118,000 hectares of forests have been cleared to grow soybean, in Salta about 160,000 hectares and in Santiago del Estero a record of 223,000 hectares. In Brazil, the Cerrado and the savannas are falling victim to the plow at a rapid pace.” [12]

At the same time throughout the region, soy producers expanded their holdings by large-scale land clearances and deforestation.

Brazil and the United States are now the largest soybean producers in the world, by a large margin — together they grow more than twice as much soy as the rest of the top ten countries combined.

In 2016, environmental journalist Nazaret Castro found that “Around 60 per cent of Argentina’s arable land, a similar percentage in southern Brazil, and almost 80 per cent in Paraguay, is already planted with soy, which is virtually all genetically modified.” [13]

According to a recent study that used satellite mapping :

“From 2000–2019, the area cultivated with soybean more than doubled from 26.4 million hectares to 55.1 million hectares. Most soybean expansion occurred on pastures originally converted from natural vegetation for cattle production. The most rapid expansion occurred in the Brazilian Amazon

... Across the continent, 9% of forest loss was converted to soybean by 2016. Soy-driven deforestation was concentrated at the active frontiers, nearly half located in the Brazilian Cerrado.” [14]

As in North America, South American soy production is accompanied by massive use of herbicides, particularly glyphosate. In Brazil, GE soybean crops are sprayed with glyphosate an average of three times in each growth cycle — in 2019 alone, Brazilian growers used 218 thousand tons of the weed killer. [15]

Resistance and the Treadmill

In *Silent Spring*, Rachel Carson described how extensive use of pesticides had caused the evolution of insects and weeds that the chemicals couldn't kill.

“Darwin himself could scarcely have found a better example of the operation of natural selection than is provided by the way the mechanism of resistance operates.... Spraying kills off the weaklings. The only survivors are insects that have some inherent quality that allows them to escape harm. ... There results a population consisting entirely of tough, resistant strains” [16]

The result, she wrote, was a “treadmill of chemical control,” that depends on constantly increasing use of ever more deadly poisons. [17] Others have described the consequence of agriculture's chemical-driven evolution as an unwinnable arms race between pesticides and pests.

When Monsanto sought the US Department of Agriculture's approval for Roundup Ready seeds, it seemed to claim that glyphosate was somehow immune to evolution, due to some undefined “biological and chemical properties.” Its petition claimed that, “glyphosate is considered to be a herbicide with low risk for weed resistance,” so “it is highly unlikely that weed resistance to glyphosate will become a problem as a result of the commercialization of glyphosate-tolerant soybeans.” Rather than causing resistance, “total herbicide use may be reduced.” [18]

Few scientists agreed. Ecologist Miguel Altieri, for example, predicted in the socialist magazine *Monthly Review* in 1998 that “these crops are likely to increase the use of pesticides and to accelerate the evolution of ‘superweeds’ and resistant insect pest strains.” [19]

That is exactly what has happened.

Within a few years, weeds that glyphosate can't stop began spreading in North and South America — glyphosate resistance has now been confirmed in about 50 species. Some are particularly destructive : unchecked growth of pigweed (Palmer amaranth), for example, can slash soybean yields by 80 percent and corn yields by 90 percent. As Jennifer Clapp's study of glyphosate adoption shows, glyphosate has become yet another driver of the chemical control treadmill.

“In the face of growing weed resistance, farmers initially sprayed glyphosate in higher amounts on the same crops to control those weeds. As glyphosate-resistant weeds continue to emerge, farmers, encouraged by herbicide companies, are increasingly applying older and more toxic chemicals, such as dicamba and 2,4-D, to control weeds in their fields.” [20]

Similarly, the addition of Bt genes to corn and cotton has increased insect resistance and pesticide use. The 2022 Pesticide Atlas reports :

“In the USA, specimens of the Western corn rootworm are already resistant to more than one Bt

toxin. At the beginning of Bt crop cultivation, the number of pesticides used actually decreased. But only impermanently : Sales of insecticides in corn production in the US have increased significantly. In 2018, Indian farmers spent 37 percent more money per hectare on insecticides than before the introduction of genetically modified cotton in 2002.” [21]

Until recently, GE seeds contained a maximum of three genetic modifications, but Bayer, which acquired Monsanto in 2018, recently upped the ante with eight genetic changes in its Smartstax Pro Corn. These heavily engineered seeds tolerate glyphosate and dicamba weed killers, and produce five different Bt insect-killing toxins, and use new RNA interference technology to block essential protein production in rootworms, the most damaging corn pest.

The arms race continues.

Monocultures and capitalism

In 1859, in the final paragraph of *Origin of Species*, Charles Darwin described the natural world as “a tangled bank, clothed with many plants of many kinds, with birds singing on the bushes, with various insects flitting about, and with worms crawling through the damp earth ... [filled with] elaborately constructed forms, so different from each other, and dependent upon each other in so complex a manner.”

If Darwin could see what capitalist agriculture has done to tangled banks in our time, he would undoubtedly agree with conservation ecologist Ian Appel : “the replacement of wondrous biodiversity with monocultural monotony has become central to capitalism’s socio-ecological metabolism.” [22]

“The ecology that is actively engineered under capitalism is one determined by ruling class aspirations for profit. ...

“Capitalism has only been able to sustain its rejection of nature and its destructive ecological tendency through pulling in artificial ecological commodities from various arms of capitalist industry — for example in agriculture. This creates a dysfunctional ecological tendency towards ecological uniformity and simplicity inevitably resulting in biodiversity loss and extinction.” [23]

Miguel Altieri links the rapid decline of biodiversity to the globalization of capitalist agriculture in the late twentieth century.

“The very nature of the agricultural structure and prevailing policies in a capitalist setting have led to environmental crisis by favoring large farm size, specialized production, crop monocultures and mechanization. Today, as more and more farmers are integrated into international economies, the biological imperative of diversity disappears due to the use of many kinds of pesticides and artificial fertilizers, and specialized farms are rewarded by economies of scale.” [24]

Maximizing production of a few plants that can be sold profitably on world markets has led to the creation of vast monocultures — factory-like farms that poison and starve Darwin’s tangled bank. Maintaining those monocultures requires ever-increasing amounts of chemicals, trapping farmers on a treadmill that is very profitable for the agrochemical industry. It’s estimated that global herbicide sales totaled US\$39 billion in 2021 and are likely to reach \$49 billion by 2027. The equivalent figures for insecticides are US\$19.5 billion and \$28.5 billion. [25]

So long as a handful of agrochemical companies and commodity traders control the inputs and

outputs of global agriculture, capital's drive to impose monocultural monotony will continue — and the insect apocalypse will accelerate.

Ian Angus

- [L'apocalypse des insectes dans l'anthropocène - Partie 1](#)
 - [L'apocalypse des insectes dans l'anthropocène - Partie 2](#)
 - [Insect Apocalypse in the Anthropocene - Part 3](#)
 - [Insect Apocalypse in the Anthropocene, Part 4](#)
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P.-S.

- Climate and capitalism. April 19, 2023 :
<https://climateandcapitalism.com/2023/04/19/insect-apocalypse-in-the-anthropocene-part-4/>
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Notes

- [1] Dave Goulson, *Silent Earth : Averting the Insect Apocalypse* (HarperCollins, 2021), 123.
- [2] ISAAA, "ISAAA Brief 55-2019 : Executive Summary," ISAAA Inc., 2019,
- [3] 2,4-D is short for 2,4-Dichlorophenoxyacetic acid — $C_8H_6Cl_2O_3$
- [4] Rachel Carson, *Silent Spring* (Mariner Books , 2002), 297.
- [5] Jennifer Clapp, "Explaining Growing Glyphosate Use : The Political Economy of Herbicide-Dependent Agriculture," *Global Environmental Change* 67 (February 24, 2021).
- [6] Bartow J. Elmore, *Seed Money : Monsanto's Past and Our Food Future* (W. W. Norton, 2021), 186, 187
- [7] Carey Gullam, *Whitewash : The Story of a Weed Killer, Cancer, and the Corruption of Science* (Island Press, 2017), 46.
- [8] Jennifer Clapp, "Explaining Growing Glyphosate Use," *Global Environmental Change* 67 (February 24, 2021).
- [9] Erica Borg and Amedeo Policante, *Mutant Ecologies : Manufacturing Life in the Age of Genomic Capital* (Pluto Press, 2022), 124.
- [10] *Crop Production Historical Track Records* (United States Department of Agriculture, 2019), 31, 164

- [11] Miguel A. Altieri and Walter A. Pengue, "Roundup Ready Soybean in Latin America : A Machine of Hunger, Deforestation and Socio-Ecological Devastation," Biosafety Information Centre, August 8, 2005.
- [12] Miguel A. Altieri and Walter A. Pengue, "Roundup Ready Soybean in Latin America : A Machine of Hunger, Deforestation and Socio-Ecological Devastation," Biosafety Information Centre, August 8, 2005
- [13] Nazaret Castro, "'United Republic of Soybeans' and the Challenge to Agriculture," Equal Times, December 12, 2016.
- [14] Xiao-Peng Song et al., "Massive Soybean Expansion in South America since 2000 and Implications for Conservation," Nature Sustainability 4, no. 9 (August 7, 2021), 784. A moratorium on new soy farming was imposed in the Brazilian Amazon was imposed in 2006 : development then shifted to even larger-scale production in the tropical Cerrado region in the southeast.
- [15] Aldo Merotto et al., "Herbicide Use History and Perspective in South America," Advances in Weed Science, September 15, 2022, 5.
- [16] Rachel Carson, Silent Spring (Mariner Books , 2002), 273.
- [17] Rachel Carson, Silent Spring (Mariner Books , 2002), 279
- [18] "Petition for Determination of Nonregulated Status : Soybeans with a Roundup Ready™ Gene," (1993) 56, 55
- [19] Miguel A Altieri, "Ecological Impacts of Industrial Agriculture and the Possibilities for Truly Sustainable Farming," in Hungry for Business : The Agribusiness Threat to Farmers, Food, and the Environment, ed. Fred Magdoff (Monthly Review Press, 2000), 86. (Article originally published in Monthly Review, July-August 1998)
- [20] Jennifer Clapp, "Explaining Growing Glyphosate Use : The Political Economy of Herbicide-Dependent Agriculture," Global Environmental Change 67 (March 2021).
- [21] Caspar Shaller, ed., Pesticide Atlas 2022 (Friends of the Earth Europe, 2022), 37.
- [22] Ian Rappel, "The Habitable Earth : Biodiversity, Society and Rewilding," International Socialism, 2021
- [23] Ian Rappel, "Capitalism and Species Extinction," International Socialism, 2015.
- [24] Miguel A Altieri, "Ecological Impacts of Industrial Agriculture and the Possibilities for Truly Sustainable Farming," in Hungry for Business, ed. Fred Magdoff (Monthly Review Press, 2000), 78.
- [25] <https://www.statista.com/statistics/1350387/herbicides-market-size-globally/> ;
<https://www.statista.com/statistics/606103/value-of-the-global-insecticide-market/>