



CLOSED-SOURCE  
**CROPS**  
 BY PAUL SALOPEK

A HANDFUL OF GIANT CORPORATIONS ARE LAYING CLAIM TO THE GERM PLASM OF THE WORLD'S MAJOR FOOD CROPS. AND WHEN YIELD IS THE GRAIL OF PROFIT, BIODIVERSITY ISN'T A PRIORITY

## LOOK AT THE SEED. IT IS OBLONG,

tapered like a bowling pin, ashy black, smaller than a peppercorn. “You can see it’s not really domesticated,” Chris Schmidt says.

Schmidt, who is prematurely bald, soft-spoken, a bit monastic, a noticer of small things, looks exactly like an entomologist from the moment you meet him—long before he actually tells you that’s his specialty. He curates a community seed bank in Tucson, Arizona. Right now, he is abrading a seed’s tough skin with his gardener’s battered thumbnail before placing it on a moist paper towel to sprout. “Most modern food crops are bred for thinner seed coats,” he explains. “It speeds up germination. But if you breed the coat too thin, you’re susceptible to disease.”

The seed in question is a pip of *Proboscida sp.*, devil’s claw, an annual of the desert Southwest whose extravagantly hooked fruit was once dispersed on the woolly fetlocks of bison. (Ranch cattle now do the honors.) It was indifferently cultivated by Arizona’s Tohono O’odham people for centuries as a source of food and basketry pigment. They never quite slimmed down that coat.

Humankind’s tinkering with seed coats—“testae” to botanists—is just one small step in a saga of plant husbandry that began perhaps 11,000 years ago, when a hungry genius in what is now Syria first tried cultivating wild rye grass. His experiment unwittingly launched an agricultural revolution that arrested our species’ nomadic impulses, built towns and empires, and ultimately spawned monotheism, organized warfare, and the Food Network—not to mention specialized jobs such as “seed bank curator” and “journalist.”

Yet the latest epic change in our long journey with seeds remains nearly as invisible to the public eye as a grain of wheat lodged in a pants cuff.

An unprecedented monopoly on food seeds is taking root, particularly in developed countries, that may decide farming’s success or failure in an era of wrenching climate change. And a debate is growing in food-security circles regarding the wisdom of concentrating our crops’ germ plasm, or genetic inheritance,



within the board rooms of a shrinking number of Big Ag corporations.

Schmidt’s nonprofit conservation group, Native Seeds/SEARCH, is a small but strategic player in this veiled controversy. A walk-in freezer in his lab holds more than 1,800 jars of heirloom seeds. The varieties have been collected over decades from the surrounding U.S.-Mexico

borderlands. “White Sonora Wheat,” “Acoma Squash,” “Tarahumara Goat-eye Beans”—the exotic names on the jars are somehow comforting. The antique seeds suggest that, regardless of the furies unleashed by looming weather shifts, by a population spiking to 9 billion by 2050, and by rapidly degrading farmland, our deep legacy of plant breeding offers us a safety net—a genetic trove from which to mine adaptable new crops. Like a lot of things in life, this may be wishful thinking.

Ancient humans utilized roughly 7,000 different plants to meet their food needs. Today, by and large, our agricultural diet has been whittled to perhaps 150 species. True, there are 4,000 corn hybrids available to grow in the U.S., but they’re kissing cousins teased from a handful of races. And only four multinational chemical and pesticide companies now control most of that crop’s germ plasm—as well as 56 percent of the planet’s multibillion-dollar commercial seed trade. When yield is the grail of profit, biodiversity isn’t a priority.

“Monopolies reduce choice,” Schmidt says. “We’re living at a time when we need choices more than ever.”

Schmidt’s cooler is chilled to 45 degrees Fahrenheit. He hunches inside, hands tucked under his armpits, bare feet strapped into sandals, staring at the myriad seeds. His two assistants were recently laid off due to budget cuts—a common-enough fate befalling today’s struggling community seed banks. The seeds sit there, and he looks at them. They appear to be communing. He regards them doubtfully, with a knowing exhaustion, the way couples do on the brink of divorce. Then he pushes the big steel door to leave.

Civilization hangs on the thickness of a seed coat.

**The four big corporations** are Monsanto, DuPont, Syngenta, and Bayer. Together, they represent that truly rare thing, a visible corner being turned in human history: the rise of the first global, seed-based food oligopoly since the dawn of agriculture.

Most Americans are probably vaguely aware that the bulk of seeds growing the bounty for their tables—and the cotton they wear, the ethanol burned in their cars, and the fodder that fattens their broiler chickens and beef cattle—is controlled by a startlingly small club of conglomerates. And many may not care. After all, industrial monoculture is phenomenally productive. Since 1930, mechanization, chemical fertilizers, pesticides, and genetically modified seeds have all propelled corn yield in the U.S. from 20 to more than 140 bushels per acre. Soybean production has more than doubled. Factory farms feed not only the U.S. public but much of the world.

Yet there are some hidden casualties within the efficiencies of this “seed-industry consolidation.” The first appears to be a competitive marketplace.

With the introduction of genetically modified seeds—that is, seeds with alien genes implanted to resist insects or herbicides—in the 1990s, hundreds of smaller, “conventional” seed firms in the U.S. simply got winnowed out of the business. They couldn’t afford the biotech R&D. After a frenzy of acquisitions and mergers—one Midwest trade group, the Independent Professional Seed Association, has lost two-thirds of its 300 members—the top ten seed giants have walked away with 67 percent of the world’s branded-seed market, according to the calculations of one sustainability watchdog. (1) By most economists’ definition, this is a monopoly. Yet food crops are such a vital human resource—apologies to Microsoft and Google—that the U.S. government started probing the industry for price-gouging and other antitrust abuses only two years ago.

Consider the case of Monsanto. Any corporation whose Wikipedia page contains subheadings such as “Child labor,” “Farmer suicides,” and “Indonesian bribing convictions” might fairly be said to have an image problem. Yet St. Louis-based Monsanto, the favorite bogeyman of the renewable farming movement, seems inured to controversy.

That’s partly because its technicians have invented the most popular genetically altered seeds on the market. The firm’s bestselling Roundup Ready system produces crops that stand up to the powerful herbicide glyphosate, which allows farmers to clear weeds without costly labor. Monsanto seeds implanted

with toxic bacterial DNA germinate plants that kill boring insects without resorting to pesticides. But the company’s most important product by far is a piece of paper.

Monsanto, like other transgenic seed sellers, requires farmers to sign a “technology stewardship” agreement that forbids customers from replanting the seed. This is understandable. The contract ensures returns on the firm’s investments in biotechnology, which can run to tens of millions of dollars per seed variety in research and regulatory costs. But it also shatters a hallowed farming practice of saving local, perhaps more biodiverse seed stock for future use.

Today, this seed-saving tradition, a rite of genetic sovereignty dating back to the Neolithic, is fading away. That’s because, in a perverse sense, farmers don’t own their new hi-tech germ plasm.

Monsanto and the other corporations do. And Monsanto’s enormous market share—roughly one-third of the corn and soybean seeds grown in the U.S.—means that when the company jacks up its seed prices 50 percent, as it did between 2005 and 2008, farmers grumble quietly. Because they don’t want to be cut off.

Cheaters attempting to replant modified seeds, meanwhile, can be reported anonymously on a Monsanto toll-free hotline. The biggest purveyor of proprietary seed on the globe even dispatches private investigators to stalk suspected “patent infringers.” When necessary, it sues them—including some farmers

who claim their fields were accidentally infected by wind-blown seed. Bare-knuckle tactics such as these have earned the firm some uncharitable epithets, among them “Gestapo.”

Monsanto customers “are afraid to speak in public, worried that they will become victims of retaliation,” a DuPont executive complained. DuPont filed an anti-monopoly suit against Monsanto in 2009. (DuPont controls its own third of the country’s seed-corn market.)

“We believe that competition in the seed industry is quite robust, and we have full confidence in the integrity of the Department of Justice’s review process,” Tom Helscher, a Monsanto spokesman, wrote me. He stated that farmers can choose from dozens of companies’ genetic technologies. “The fight to win the farmer’s business is intense.”

I think about all this while I take Chris Schmidt, the Tucson seed-bank curator, to lunch at his favorite Mexican restaurant. At the table, over chips and salsa, I ponder what Jim Orf, a soybean breeder at the University of Minnesota, told me about the erosion of our folk intimacy with seeds.



**The biological bottleneck** of corporate seeds is changing not just how we eat, but who gets to think our way out of hunger.



In 1900, roughly **7,100 TYPES OF APPLE TREES** were grown in the U.S., of which 6,100 are now extinct

In 1949, Chinese farmers grew nearly **10,000 WHEAT VARIETIES**  
By the 1970s, only about 1,000 varieties remained in cultivation

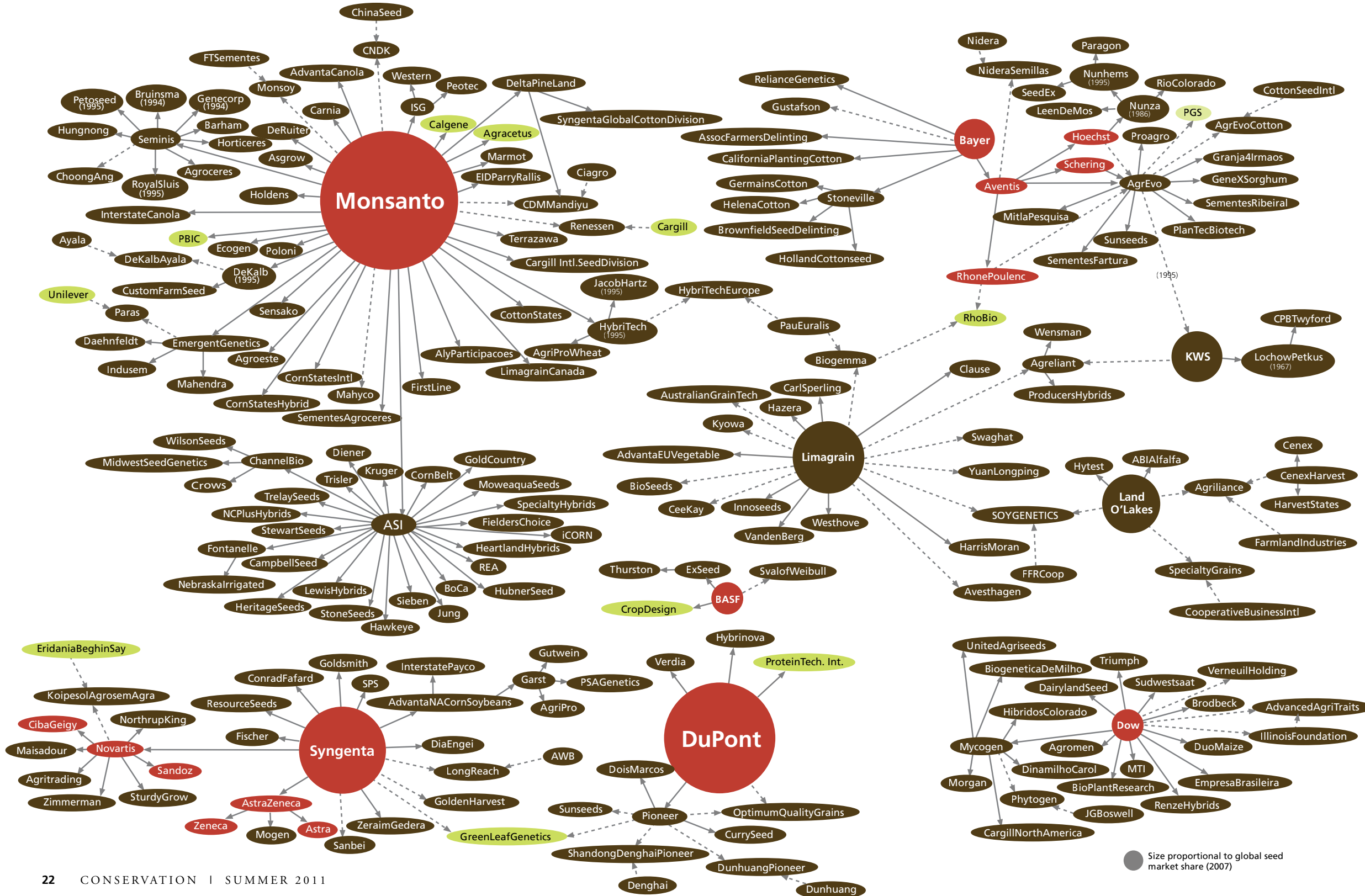


Sources: FAO and Worldwatch Institute

# SEED INDUSTRY STRUCTURE (Acquisitions 1996–2008)

● Seed Company ● Pharmaceutical/Chemical Company ● Other Company

→ Full Ownership → Partial Ownership



“When I ask farmers what seeds they used last year, or the year before, they’re not even sure,” he said. “They say ‘Syngenta’ or ‘Monsanto.’ Or they wait ‘til I suggest something. They’re paying closer attention to the price than to what they’re planting.”

Orf is convinced that genetic diversity is declining in America’s crops but says nobody really knows by how much. He says that our thousands of soybean varieties look impressive in catalogues, but many are the same varieties—multiply branded by agribusiness. It is all so complex. So murky. So unprecedented. Few can keep up with it. No one can predict where the loss of our collective seed memory will ultimately take us.

I stare into my plate of enchiladas. I imagine Monsanto gazing back. Its proprietary seeds and franchised genes are there, re-incarnated inside at least 80 percent of the corn in my tortillas.

**When I was dating my wife,** I offered to take her camping. I hauled my surplus U.S. Forest Service pack over to her apartment and yanked a sleeping bag nicknamed Old Greasy from its main compartment; out tumbled two forgotten, rotting potatoes that had sprouted etiolated stalks and leaves. She laughed. A seed was planted.

**The biological bottleneck** of corporate seeds. It’s changing not just how we eat, but who gets to think our way out of hunger.

Stewardship agreements that farmers must sign with seed companies don’t simply bar replanting. They prohibit virtually all outside experimentation with corporate DNA. Until recently, this even precluded most independent product testing of transgenic seeds. Any farmer or college teacher who attempted it could face patent-infringement suits. Here is part of an open letter sent to the Environmental Protection Agency in February 2009 by a group of 26 public-sector corn crop scientists:

*Technology/stewardship agreements required for the purchase of genetically modified seed explicitly prohibit research. These agreements inhibit public scientists from pursuing their mandated role on behalf of the public good unless the research is approved by industry. As a result of restricted access, no truly independent research can be legally conducted on many critical questions regarding the technology, its performance [and] management implications . . .*

◀ **SHIFTING ORBITS** In 1998, seed companies were largely independent. A decade later, more than 200 had been acquired or had formed joint ventures with large pharmaceutical or chemical companies. Watch an animation of this graphic on YouTube: [www.youtube.com/watch?v=nBBXLZWyXBQ](http://www.youtube.com/watch?v=nBBXLZWyXBQ).

**Source: Philip H. Howard, Michigan State University**  
Howard, P.H. 2009. Visualizing consolidation in the global seed industry: 1996–2008. *Sustainability* doi:10.3390/su1041266.

Such frustrations have been building in public research circles for years. Agro-industry's highly restrictive and—critics say—overly broad gene and technology patents have essentially allowed the new seed oligarchy to rebuff scrutiny. What's striking, though, is that all but one of the letter's authors—college professors, government entomologists—chose to remain anonymous. Pinched by vanishing public funding, they feared losing grant money from Big Seed.

And so there it is, that lone ship that Joseph Conrad describes in *Heart of Darkness*—firing cannonballs, almost absurdly, into the immense jungled coastline of Africa. The missive is a salvo from another time, when seeds were a public legacy—when the improvement of our food supply involved individual farmers, garden clubs, county extension agents, academics. That era is largely gone. The initiative in seed research has slipped decisively into corporate hands. The green revolution, the oldest one, once open to all, is being narrowly privatized.

**Look at the seeds.** Then look at the numbers. The U.S. Department of Agriculture says industry spending on crop research exploded 14-fold, to about \$600 million a year, between 1960 and 1996. Though more recent figures are sketchy, it's believed to be many times higher now. Monsanto alone poured \$1.5 billion into its Roundup Ready research. Public-sector expenditures have stagnated at about \$200 million a year for decades.

"You used to see ag professors driving old clunkers on campus," Philip Howard, a seed-industry analyst at Michigan State University, says. "Suddenly they're driving Mercedes. That tells you where the research is going."

Good for long-suffering university ag professors. They need incentives, too. Except that, like everything else in the brave new world of manufactured seeds, there remain thorny questions with ambiguous answers.

There is the question of the Bayh-Dole Act of 1980, a law that allows public research institutions to commercialize their inventions. Thus, according to one survey published in *Science* magazine, up to a quarter of all the patented biotech discoveries now padding seed companies' bank accounts have been made by taxpayer-funded universities. The value of this transferred intellectual capital easily runs to billions of dollars. There is the

question of industry's zealous control of information, which blocks scientific innovation and the knowledge of how to feed ourselves. Many researchers complain that patent rights hinder their ability to compare gene-modified crops to conventional crops grown using organic or sustainable farming methods. (Syngenta flatly prohibits independent labs from testing its seeds against any competitors.)

And then there's the blue-sky question: who owns a seed? Should the whole life form be patentable? Does a seed belong to the company that inserts a single gene imbuing it with disease

resistance? Or is it the property of generations of ordinary farmers and public-sector plant breeders who notched up the seed's yield or perhaps perfected its testa—that all-important coat?

"It is challenging on the tech side," allows Andy La Vigne, president and CEO of the American Seed Trade Association. "There are communications issues. Scientists. Industry. Two ships passing in the night."

La Vigne runs what is possibly the biggest commercial seed lobby in the world (consolidation's toll since 2000: a drop from 584 members to 428). His group has helped negotiate more transparent science protocols between seed companies and nonindustry researchers. But he sees the eclipse of public seed science as a long-term societal challenge. Fewer than two percent of Americans now live on farms. Seed development, a foundation of our high-caloric lives, has a dwindling public constituency in the developed world. "Where's the support for land-grant colleges?" La Vigne asks plaintively. "How do we sustain that?"

Aliens landing on our climatically volatile planet would take one glance at our modern approach to seeds, a bedrock food source, and fly away scratching their heads.

For instance, an international seed bank operating a "doomsday" vault on the Arctic island of Spitsbergen has had difficulties scraping together even a quarter of its \$250-million budget to assemble a global collection of crop seeds—the ultimate nest egg of plant genetic capital stored away against potential agricultural collapse due to climate change.

Meanwhile, the consolidated seed industry has developed a so-called "terminator seed." This Monsanto novelty, also dubbed a "suicide seed," is genetically engineered to go sterile after one



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generation of growth. Farmers would need to buy new stock every year. The technology is on hold; there's been an outcry from developing countries. But it may be unnecessary, anyway. With stewardship contracts, the seed lords do fine with human terminators called lawyers.

**In a 1957 essay titled** "How Flowers Changed the World," the naturalist Loren Eiseley imagines the first humans to pluck "a handful of grass seed and hold it contemplatively":

*In that moment, the golden towers of man, his swarming millions, his turning wheels, the vast learning of his packed libraries, would glimmer dimly there in the ancestor of wheat, a few seeds held in a muddy hand.*

But just as industrial farming gives, so it takes away. Of the roughly 7,000 varieties of apple that grew in the U.S. at the turn of the last century, more than 86 percent no longer exist.

**Chris Schmidt, the taciturn** seed banker, drives me an hour south of Tucson to his organization's test farm.

There are border-patrol checkpoints on a curving desert road and then high, yellow grasslands. Devil's claw probably grows out there somewhere, wondering where all the buffalo went. At the farm, an experimental heirloom crop is sprouting—White Sonoran wheat, introduced to northern Mexico by Spanish missionaries in 1770. Schmidt says it shows commercial promise for baked goods. Its leaves feel like silk.

One of the founders of Native Seeds/SEARCH, Gary Paul Nabhan, lives in an isolated house above the farm.

Nabhan is a MacArthur "genius" Fellow and a prolific writer on food-crop diversity. He says Big Seed's days are numbered. This is news to me. But he insists. Choking thickets of technology patents, proliferating antitrust lawsuits, hugely expensive gene research and regulation—the Goliaths are losing their nimbleness in a swiftly changing agricultural environment, he says. (Monsanto's stock did take a knock last year, partly because its latest, heavily "trait-stacked" seeds proved disappointing on yield.)

"With rapid climate change bringing new pests and viruses every year, farmers aren't going to wait around for Monsanto to come up with another patented seed," says Nabhan, an energetic man in an unruly prophet's beard. "The corporations' heavy-footedness actually favors us—a resurgence of local experiments with tons of open-source seeds."

There is evidence for this rebellion. A guerrilla food movement, albeit limited mostly to richer countries, is pushing back against the rule of King Seed. In the U.S., the rising popularity of locally produced vegetables and meats ("locavore" diets)

has encouraged some mass-market stores such as Wal-Mart to embrace heirloom varieties. But the market share of these older, biodiverse crops remains tiny. And the intense backbone labor required to grow them without gene-splicing technologies and herbicides—Nabhan's preference—will be a serious hurdle for a post-industrial society long unaccustomed to fieldwork.

In the meantime, the world's powerful seed merchants are already pivoting aggressively to where the money is.

A report issued by the ETC Group, a sustainability think tank, showed how just eight companies—the usual suspects among them—have cornered patents on 77 percent of 262 known gene-family traits that boost plant adaptability to extreme climate change conditions: drought, salinity, cold, and flooding. (1) And like Big Pharma, which shuns unprofitable drugs, the seed oligopolists will likely cater their bottom lines to affluent customers in the global North. In the poorer South, where scientists say far more people are at risk of climate-warped famines, farmers will have to rely on Nabhan's age-old methods of seed husbandry.

Which seeds, then, will rescue us?

Whatever the balance—traditional or technological—the ultimate answer rests squarely on our tongues. In essence, we have to learn how to eat all over again. The United Nations Food and Agriculture Organization says that modern-day humans consume, on average, just 12 different plants in our diet—a ghostly remnant of an agricultural cornucopia that's been whittled for yield by generations of industrial farming and now, even more drastically, by seed market consolidation.

"Wait," Nabhan says. He springs up from a living-room chair. "I want to show you something."

He wanders off in search of the winning entry in a recent chili-judging contest in Mexico. Local campesinos' seeds handily beat out a transgenic seed giant, Siemens, in taste, yield, and disease resistance.

A lovely elderly woman, perhaps Nabhan's mother, returns a few moments later, bearing a jar of the triumphant peppers. Their seeds float like pale sequins in vinegar. I ask her if she likes them.

"Oh," she says, smiling warmly. "I can't eat that." 🍌

1. Who Owns Nature? Corporate Power and the Final Frontier in the Commodification of Life. ETC Group, November 2008. [www.etcgroup.org](http://www.etcgroup.org)

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