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Part III

GENETICALLY ENGINEERED FOOD

"All people have the right to a food supply that has not been genetically engineered."

Article 3 of the Genetic Bill of Rights

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Food Free of Genetic Engineering: More Than a Right

Martha R. Herbert

What should we do when two conflicting assertions of rights are in whole or in part mutually exclusive? Can the "right to modify food genetically"—a right asserted mainly by producers of genetically modified foods and producer-friendly policymakers—coexist with the "right to have access to food that is not engineered"? This chapter argues that the new technology of genetic engineering should not be preemptive of traditional food. If genetically engineered (GE) food can displace and eliminate cultivation of food that has not been genetically engineered, then the insistence on access to food free of genetic engineering is at the same time a call to restrict GE food, and if necessary to curtail it severely or entirely.[1] The right to food free of genetic engineering simply cannot be compromised.

Objections to genetic engineering of food are fundamental. Given the deeply questionable premises of genetically modifying food, it is not surprising that the technology has not delivered on its promises.[2] The tables need to be turned. For reasons that I will spell out on multiple levels, we cannot rest on insisting that food free of genetic engineering be merely preserved as an option. Instead, we need to be arguing that agribusiness should not have the right to implement the genetic engineering of food at all, given the inherent unpredictability of the technology and its many risks, the poor prioritizing it represents, and everything valuable that it displaces.

CULTIVATION VS. PRODUCTION

To insist on access to non-GE food is a good start, but it is not sufficient for dealing with the broad ramifications of genetically modifying the food supply. The issues here go far beyond health and the testing and labeling of new food products, and very far beyond choice in the supermarket aisles. They reach into fundamental questions about how we evaluate technologies. Demonstrating that a technology appears to "work" is short sighted if the longer-term consequences and ripple effects of the technology are ignored. The issues also reach into questions about how we organize agriculture and how we keep ourselves and our fellow living beings alive. Industrial farming, of which GE food is only the most recent example, has forced a transition from food *cultivation* to food *production*.[3] The emphasis on *production* dismisses an enormous range of ecological and cultural considerations related to food.[4] Proponents of GE food promise that genetic engineering will increase food productivity. But they ignore a host of other relevant domains—including not only ecological and health concerns, but also the communities and cultures of farming, the cultural resonance of cuisine, and the historically contingent and problematic urban-rural split.

Even in its own narrow productivist terms, genetic engineering is likely to yield not productivity but its opposite—crop failures, diseases, or blights from unforeseen vulnerability of genetically manipulated strains cultivated as widespread monocultures. Moreover, a serious analysis of the causes of world hunger reveals that, for many social and economic reasons (including maldistribution of ample food stocks), productivity is not the issue.[5] Fundamentally, insistence that food be free of genetic engineering is a critically important issue because ecological and cultural sustainability are at stake. Science is now able to develop "gentle, thought-intensive technologies,"[6] to advance beyond the industrial and engineered monocultures, including insertion of gene sequences, that may be characterized as aggressive, energy and input laden, and hype intensive. What we need for both physical survival and for a future worth living is a scientifically sophisticated but context-sensitive and culturally rich recovery of *cultivation*. Genetic engineering of food, and the vested interests that obstruct balanced debate about it, are obstacles to this deeply needed advance.

KEEP THE DEBATE BROAD, FULL, AND TRANSPARENT

Keeping the food supply free of genetic engineering should be guaranteed not only as a right but as a necessity. This right and indeed necessity can be defended on many grounds—including views about molecular genetics, cell biology, plant

and animal physiology, ecology, economics, health, culture, even aesthetics. GE food proponents often call for arbitration of controversy over this technology through what they call "sound science," which at present consists of hastily conducted, short-term studies of this technology. Such "studies" do not begin to carry sufficient weight to satisfy even scientific issues, let alone concerns at many other levels. Proponents sometimes attempt to restrict debate to health issues, and then to foreclose discussion on the grounds that studies to date show no health risks. But this gambit ignores, indeed denies, many other concerns beyond human health. Attempts to restrict the debate to human health and to ignore the many plausible scientific questions as well as other types of concerns are as objectionable as the technology itself. Both the technology and the controversy over it are so new and so many sided that any call for hurried approval of GE food, particularly without protecting the availability of food free of this kind of manipulation, can only result from ideological zeal or financial interest.

To its opponents, the genetic engineering of food is a technology based on limited and parochial assumptions,[7] deplorably naive about organisms, oblivious to ecology, economically motivated, and blind (at least in part deceitfully so) to the real causes of hunger in the world. Yet genetically engineered crops and animals have been rushed into large-scale production with inadequate scientific evaluation and public discussion. Why? The reasons are of two kinds: belief systems and economics.

Proponents of genetically engineered food have consistently resisted engaging opposing perspectives. Regulators welcome favorable assessments, even if they are of poor quality, but give critical assessments a hard time even if they meet rigorous standards and are peer reviewed.[8] In addition, while there has been abundant funding for genetic engineering research, little money is available for context-sensitive agroecological approaches.[9] One reason is that genetic engineering can easily lead to patentable products and the promise of profit, while agroecology, though more sustainable, generally cannot lead to such prospects of economic gain. These biases have been incorporated into national policy; for example, international trade legislation includes funds for promoting agricultural biotechnology but not for seriously assessing it or developing agroecological, non-engineered approaches.[10] Thus, it is important for the public to understand that we do not see "equal time" or the operation of "unbiased science" in allocation of research resources. Serious conflicts of interest have dogged government- and industry-sponsored inquiry, with commissions composed predominantly of members with industry ties and funding empowered to consider the merits of GE food.[11]

Proponents of GE foods do not appear willing to engage in open and transparent debate. We may attribute some of this to vested interests, but that does not fully explain the problem. Many GE food proponents not only fail to address the

concerns of GE food critics but appear unable even to comprehend the criticisms. They frequently claim that they themselves (the proponents) are uniquely "scientific" and their critics merely "emotional." Sometimes this rhetorical strategy is a disingenuous public relations maneuver. But it also reflects genuine naivete. Arguments about GE food's threats to organismic, ecological, and cultural complexity and diversity may simply be incomprehensible to many GE enthusiasts. They appear to see molecular genetics as the definitive universal code of life, whose encompassing truth must override all prior frameworks. Because the DNA code translates into amino acids in fundamentally the same way across species, the particularities of species differences seem incidental. GE thus rests on a purported universalism that particularities and local details have a lesser importance than the general abstractions that can be distilled out of them. It involves a belief (and only a belief, though its adherents seem to think it is "fact") that all analogical processes at every level, including organismic processes, lived experience, and more, can be digitized into code (like the genetic code) without loss of nuance.

One also sees an emboldened triumphalism, a sense of mission to improve the world on the basis of what are seen as "truths" revealed by molecular genetics. All human and other organic frailties are seen as susceptible to remediation by engineering or genetic recoding. Calls by doubters to consider problems that arise where recoding cannot be directly applied are considered naive and irritating distractions, willful obstacles to the "incredible potential" of genetic modification. Yet ironically this investment in the "universalism" of the genetic code has even interfered with genetic science itself, because while a growing number of studies have identified ways, sometimes species specific, that non-coding DNA as well as non-DNA proteins modulate gene expression—and moreover may do so in ways that differ among species—these findings cannot comfortably be incorporated into an ideological framework of genetic universalism and gene dominance.

GENETIC ENGINEERING AS TECHNOLOGICAL MESSIANISM

Technological messianism dovetails elegantly with the economic forces driving genetic modification. Inserting a specifically characterized gene sequence into an organism has been considered adequate justification for patenting the organism.[12] This patented seed offers numerous benefits to the patent-holding proprietor. It allows a new kind of ownership of organisms. Contractual relations can apply, allowing the revenue stream to be assured with new mechanisms not available to non-engineered varieties of agricultural organisms. This patenting and turning of living beings into intellectual property occurs in a market system where the goal is accumulation of profit. It is worth reflecting that getting rich

means having more money, and "money" itself is an abstraction that is dissociated from the particular qualities of the commodities that are produced and sold. One can get rich from selling corn flakes or nerve gas—it doesn't really matter to the "bottom line." In this setting, the compulsion to implement a more efficient means of capital accumulation overwhelms all other considerations. Thus, the mission to improve the world by redesigning it according to "genetic universals" complements the economic drive to control the market—and the world—according to the "universal money abstraction." Both the money abstraction and the genetic abstraction are divorced from any commonsense reality checks because they are divorced from any particular loyalties to specific context, whether it be place, species, person, or culture. Those who pursue the "money abstraction" and the "genetic abstraction" are, in terms of the "logic" of their activities, impervious to arguments coming from any domain of particularity that is outside their frame of reference. Such particular concerns may simply not register in the mind of anyone staying within this abstract framework.

The technological messianism of GE food advocates thus coexists poorly with other belief systems. Certainly this inability to coexist with other frames of reference characterizes messianisms of many kinds. The problem is that the genetic engineering of food is more than a belief system; it is a technology—and moreover, a technology which utilizes living organisms as its substrate and transforms them in unprecedented ways. GE foods do not merely represent a belief system; they *embody* it. GE foods incorporate the belief system that conceived them in their very tissues, their very flesh, indeed their genes, in a manner that goes beyond previous breeding techniques of industrial agriculture. They thus do not assert themselves merely as ideology or dogma, but even more as material—and organismic—force. And as a material, living force enlisted in a messianic mission, they not only ideologically oppose but, even more, materially—and reproductively—displace non-genetically engineered organisms. Once an organism is genetically modified, there is no going back. And once genetically engineered organisms are in the environment, gene-sharing with non-genetically engineered wild species cannot be controlled.[13]

This aggressive, intrusive character of GE food is not due just to the nature of the technology and its ecological risks. It also appears to be an explicit market strategy. In the words of one industry spokesperson: "The hope of the industry is that over time the market is so flooded [with GE food] that there's nothing you can do about it. You just sort of surrender."[14] A U.S. government official said, without distress: "In four years, enough GE crops will have been planted in South Africa that the pollen will have contaminated the entire continent."[15] From this point of view, the biotech industry might privately perceive the genetic contamination of maize by transgenic DNA in its center of origin in Oaxaca, Mexico, as a welcome development.[16]

Thus, the perception of genetic engineering of food as an intrusive and self-propagating biological colonialism cannot be refuted by recourse to scientific studies finding no evidence of hazard, because hazard, while an issue, is not the *only* issue. But the dominant attempt to keep the discussion narrow, the dismissal of the value of many other levels of concern, and the aggressive attempts to restructure and gain control of global agriculture all reinforce the perception that GE food advocates are perpetrators of a new level of colonialism. The right to food free of genetic engineering—and indeed strong opposition to the right to pursue this questionable technology—are both thus critical bulwarks against being engulfed and devoured by an insensitive, greed-driven ideological monolith.

THE MULTILEVEL OBJECTIONS TO GENETICALLY ENGINEERED FOOD

Critics of genetically engineered food have not shared the conversion experience of the enthusiasts. GE food proponents may allege that ignorance is the reason for the critics' failure—or more accurately, their *refusal*—to see the genetic code as a comprehensive universalism. But the reasons for rejecting GE food are substantive and span multiple levels, from molecular genetics all the way to ecology and culture. Insistence on the right to—and need for—food free of genetic engineering is grounded in all these levels. It is unlikely that all of these arguments could ever be refuted by GE food proponents, which is presumably why most of these levels are so often excluded from official, industry-influenced debate.

At the level of genetics, there is abundant evidence that the genetic code is not uniquely determinative.[17] No one has ever created an organism out of raw DNA. Even if this creation should come to pass, which may be conceivable for very "simple" organisms but much more remote for multicellular organisms, other parts of the cell participate in reproduction and development, and significantly modulate the role of the DNA in ways that are not DNA controlled.[18]

There is also abundant evidence that genes do not act in isolation but in systems.[19] It is not unreasonable to think of a cell as a "little ecosystem." Insertion of foreign genetic sequences does not merely add new function, nor does it leave the cell otherwise undisturbed. Instead, this genetic modification has the potential to create widespread alterations in gene expression patterns.[20] Mere knowledge of the genetic code does not even begin to give scientists the capacity to predict these types of systemic changes.[21] It is therefore the case that genetic modification has the potential to alter cellular metabolism in ways

that we can neither understand, predict, nor control.[22] This unpredictability is not simply due to the complex interconnections within the genome. It is also due to the essentially random fashion in which genetic material is introduced. From this vantage point genetic engineering is not so much a technology as a gamble. And just as in Las Vegas, most of the wagers fail. Very few attempts to engineer organisms produce viable outcomes; the few that do survive often have significant problems emerge during the organism's life course or after reproduction.

The transfer of genes that are supposed to "code for" specific traits fails to account for the fact that genes and gene products are modified in ways that are specific not only to individual species, but also to particular tissue types within species.[23] Genes may play different roles when they are transferred into novel organisms than they play in the species from which they came. Thus, particularities of species and even tissues haunt and constrain genetic universalism. We can thus conclude that knowledge of the genetic code, while it provides new ways to manipulate organisms, does not go very far in helping us understand how organisms are affected by these manipulations.

This lack of knowledge, understanding, and control at the molecular and cellular level has ramifications when these techniques are applied to agricultural crops. Inserting a gene to add a desired characteristic—such as herbicide tolerance, frost tolerance, or salt tolerance—may have results other than the ones desired. First, the inserted genes may not function as intended, or may function optimally in only a narrow range of environmental conditions.[24] Beyond this, the organism may have unexpected additional metabolic alterations, some of which may lead to health risks such as allergenicity or toxicity in food products, or to detrimental effects on other organisms. These possibilities have finally been acknowledged even by the U.S. Food and Drug Administration,[25] after years of its insistence that genetically engineered foods were "substantially equivalent."[26] The significant likelihood of these complications contributes greatly to the enormous cost of developing viable genetically engineered varieties. This huge cost further belies public relations claims that genetic engineering of food is a practical, economical, people-oriented solution to world hunger.

Another difference from traditionally bred organisms has to do with gene silencing. The inserted genes may be modified or silenced by the organism. This can occur variably in different parts of the plant, and among different plants, and can worsen over the course of the growing season.[27] Such erratic gene expression deviates strikingly from that of traditionally bred organisms and their native genes. It indicates a potential serious intrinsic instability in genetically modified organisms. Such instability forebodes worrisome potential complications, particularly insofar as we allow our food supply to become dependent on these crops.

While some studies have demonstrated that these possibilities may occur, independent researchers are not generally funded to do these kinds of studies. Contrary to the complacent popular belief (in the United States at any rate) that our foods are well-regulated, genetically engineered organisms are generally only tested by the companies that produce them, and these tests are reviewed fairly uncritically by regulators. We must ask whether we can entrust industry-sponsored or even industry-influenced science to seek evidence of such problems, let alone publicize such evidence if they find it.[28] Such results would be bad news for the bottom line; thus, between obedient/intimidated company employees and growing corporate influence on public research, the likelihood is minimized that such results, if obtained, will see the light of day.

The recourse to genetic modification of food crops to solve agricultural problems is yet another attempt to solve complex problems with a simple "magic bullet." Agriculture itself is a peculiar modification of growing patterns in the wild. In its currently dominant "industrial" forms, it tends toward monoculture, or at least toward a reduced number of coexisting organisms.[29] Many traditional agricultural systems, as well as contemporary organic and agroecological methods,[30] address not only the characteristics of individual species but also effects of intercropping on agricultural problems like pests and weeds. Industrial agriculture may attempt to fight infestations by applying or (in the case of GE food) inserting pesticides, but the efficacy is often at best modest, short lived, and rife with side effects such as toxicity and the emergence of resistance. In any event, organismic resourcefulness in getting around, adapting to, and defeating magic bullets is well established.[31] An agroecological approach to integrated pest management, on the other hand, which draws on intercropping and other inter-species interactions, can be safer, more effective, and more stable.[32] While some agricultural scientists see genetic modification as one tool in a larger agroecological armamentarium, the fact remains that genetic engineering techniques on their own are incapable of taking advantage of beneficial synergies in inter-species relationships. This is yet another way that interventions based in knowledge of gene code cannot in themselves provide a comprehensive basis for flexible agricultural practices. Thus, it is all the more disturbing that some advocates of genetic engineering in the developing world are a party to the dismantling of agricultural research stations that are not oriented toward genetic engineering.[33]

When one broadens the context even further to include ecology, the gene-based approach to crop organisms seems even more limited and short sighted. Genetic engineering is quite prone to creating ecological problems such as pollen flow to wild relatives, bioinvasion, and harm to other organisms through various direct and indirect pathways,[34] but it is incapable of solving or preventing these problems. Regarding biodiversity, the mode of operation of

development of new genetically modified organisms tends to ignore rather than relate to local organism and ecology variants. Biotechnologists don't generally use scientific models that involve the interaction of organisms with specific ecological or cultural contexts. They tend to see biological features in a more general, context-independent way, rather than in relation to particular plants or animals that live in specific places with specific people. In addition, it is enormously expensive to produce GE food products, for one thing because it takes many thousands of laboratory failures before arriving at viable genetically modified varieties. There are thus multiple imperatives to market the seeds or animals that finally succeed in the lab in many widely differing ecological and cultural locales. Locally adapted varieties are displaced, in favor of GE varieties ~~adapted to~~ ecologically unwise agriculture.

If we broaden the context still further and consider the diversity and cognitive richness of local cultures, we find that genetic engineering and industrial agriculture are blind to their integrity and value.[35] For industrial agriculture, the imperative of production predominates, and considerations such as the stabilizing and nurturing effects of relationships, community, and traditions have no meaning. These human and cultural structures appear as primitive obstacles to progress, which is defined by genetic engineers as a technologically facilitated bountiful harvest. But aside from the fact that genetic engineering's promise of improved yields is often not fulfilled,[36] there are further catastrophic impacts: farming communities are disrupted (particularly through the bankruptcy of smaller farms that cannot afford these technologies), and the accumulation of detailed local knowledge is lost.[37] Neither bounty nor genetic manipulation can substitute for what is destroyed. What remains is a homogenized and degraded countryside, cultural and material impoverishment, psychological devastation that passes from one generation to the next, and an abject dependency on multinational corporations.

THERE ARE OTHER POSSIBILITIES

Biotechnology, industrial agriculture, and genetic engineering of food are promoted as the only scientific options, but this is simply not true.[38] The science underlying these industrial approaches is actually primitive, outdated, and already surpassed.[39] Beyond the universalism of abstractions—here, GE's claim that there are no qualifications to the universality of the genetic code, and that context doesn't matter—there is a kind of science that is capable of incorporating what is known generally into an approach that is grounded locally.[40] Thus, opposition to genetic manipulation of food is not anti-science. Instead,

the relentless press of genetic modification, shielded from critics, is retarding genuine scientific progress. This relentless press throws good money after bad in an attempt to recoup an investment that should not have been made in the first place, and marks a failure to be able to admit a mistake of this scale.

The right to food that is not genetically engineered is thus also a right to maintain allegiance to a different frame of reference from the productivist mentality and instrumentalist reductionism that genetic modification represents. The assertion of this right is much more than a meek demand for little preserves or reservations of organic farming in the midst of vast spreads of GE crops, or a tame request for GE-free labels on our food and GE-free aisles in our supermarkets. Certainly, demands for protecting organic farming and for food labeling have tactical importance. But they are not enough. (In any case, pollen spread appears to make it impossible to maintain crops that are organic and GE free in close proximity to the cultivation of genetically modified varieties.) The right to GE-free food is also important because the technology and its ideology are both immature and misguided. This makes it important that we not turn over the world's food supply to a poorly thought out technological impulse. This right involves an insistence that there is a profound value to the panoply of particular, unique qualities of organisms, cultures, and ecosystems, and that they need to be protected from an inexorably destructive competitor. It also means we need to insist that this destructive competitor and interloper be stopped.

It does not appear, for the moment at least, that either the right to food free of genetic engineering or opposition to the right to pursue this questionable technology will be aggressively protected by governments or by international organizations such as the United Nations. These bodies are either in partnership with biotechnology corporations or have naively accepted biotechnology's claims that GE food is the best way to feed the world's hungry. Continuing grassroots pressure, an emerging awareness of agroecology as a scientifically informed rational approach that is more sophisticated than genetic engineering and industrial agriculture, and exposure of the hidden economic agendas of genetic engineering may help bring them around. GE crop failures or other disasters, should they occur and make it into the press, may contribute to this change of heart as well. Meanwhile the protection of the right to food free of genetic engineering remains for the most part a continual uphill battle against entrenched, unsympathetic, and incomprehending institutions.

The question remains whether in the long run genetic modification of food crops will find a more humble role in a truly ecologically and culturally friendly agricultural strategy. I would argue that the current technologies are intrinsically incapable of maturing in this fashion. While idealistic scientific agronomists may wish to incorporate genetic engineering into sustainable

agriculture, they are unlikely to have grappled with the full range of objections to genetic engineering, and also are probably quite naive about the economic imperatives driving the biotech industry's commitment to this approach—imperatives that will hijack the good will of those who see positive applications of biotechnology. The prudent thing to do at this time, therefore, is to strengthen our opposition and to fight to preserve the knowledge bases and the biological and cultural diversity that we deeply need, given the unlikelihood that agricultural biotechnology will be transformed into a more modest, context-sensitive, and gentle technology.

The insistence on the right to food that is free of genetic engineering is both a plea and a struggle for human, organismic, cultural, and ecological viability. It rests on an understanding that the current generation of agricultural biotechnology was designed not with an appreciation of ecology and sustainability, but more with the aim of maximization of profits and production. Contemporary agricultural biotechnology unconstrained is gobbling everything in its path. Even worse, it may lead to major crop failures, because of the vulnerabilities arising from potentially unstable GE organisms applied as monocultures. Genetic engineering of food may thus create urgent needs for the very biological and cultural lifelines it is destroying. Protecting our right to food that is not genetically engineered will preserve some of these lifelines, and we may well need them.

NOTES

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1. Ivan Illich, *Tools for Conviviality* (New York: Harper, 1980).

2. Margaret Mellon, "The Wages of Hype: Agricultural Biotechnology After 25 Years," Arthur Miller Lecture presented at MIT (October 3, 2003); Marc Lappé and Britt Bailey, *Against the Grain* (Monroe, ME: Common Courage Press, 1998); Mae-Won Ho, *Genetic Engineering: Dream or Nightmare* (Bath, UK: Gateway Books, 1998).

3. Andrew Kimbrell (ed.), *Fatal Harvest: The Tragedy of Industrial Agriculture* (Covelo, CA: Island Press, 2002).

4. M. S. Prakash and Gustavo Esteva, *Grassroots Post-Modernism: Remaking the Soil of Culture* (London: Zed Books, 1998); Gustavo Esteva, "Re-Embedding Food in Agriculture," *Culture & Agriculture* (Winter 1994): 2–12.

5. Frances Moore Lappe, Joseph Collins, and Peter Rossett, with Luis Esparza, *World Hunger: 12 Myths* (London: Earthscan, 1998). Miguel A. Altieri and Peter Rosset, "Ten

Reasons Why Biotechnology Will Not Ensure Food Security, Protect the Environment and Reduce Poverty in the Developing World," *AgBioForum* 2 (1999): 155–62, www.agroeco.org/doc/10reasonsbiotech1.pdf.

6. Richard Levins, "When Science Fails Us," www-trees.slu.se/newsl/32/32levin.htm (1996).

7. Barry Commoner, "Unraveling the DNA Myth: The Spurious Foundation of Genetic Engineering," *Harper's* (February 2002): 39–47.

8. Les Levidow and Susan Carr, "Unsound Science? Trans-Atlantic Regulatory Disputes over GM Crops," *International Journal of Biotechnology* 2(2000): 257–73; B. Vogel and B. Tappeser, Der Einfluss der Sicherheitsforschung und Risikoabschätzung bei der Genehmigung von Inverkehrbringung und Sortenzulassung transgener Pflanzen, Öko-Institut e.V., study commissioned by the German Technology Assessment Bureau Auftrag, Berlin, 2000, available as pdf-file under www.oeko.de (only german). Also, see Jane Anne Morris, "Sheep in Wolf's Clothing," *By What Authority* (Fall 1998), www.poclad.org/bwa/fall98.htm.

9. Miguel Altieri, "Agroecology: The Science of Natural Resource Management for Poor Farmers in Marginal Environments," *Agriculture, Ecosystems and Environment* 93 (December 2002): 1–24, www.agroeco.org/doc/NRMfinal.pdf.

10. See USAID bilateral assistance programs, for example. Alan P. Larson, "The Future of Agricultural Biotechnology in World Trade," remarks at the Agricultural Outlook Forum 2002, www.state.gov/e/rls/rm/2002/8447.htm.

11. See Ian Sample, "Naïve, Narrow, and Biased," *The Guardian*, Op-Ed, July 24, 2003; Sujatha Byravan, "Genetically Engineered Plants: Worth the Risk?" plenary lecture at Viterbo University, February 3, 2004.

12. See, for example, the "oncomouse" decision of the U.S. Patent and Trademark Office, U.S. patent No. 4,736,866 (1988).

13. L. LaReesa Wolfenbarger and Paul R. Phifer, "The Ecological Risks and Benefits of Genetically Engineered Plants," *Science* 290 (2000): 2088–93.

14. Don Westfall, food industry marketing strategies consultant formerly with Promar International, quoted in Stuart Laidlaw, "Starlink Fallout Could Cost Billions," *Toronto Star* (January 9, 2001).

15. Emmy Simmons, assistant administrator, USAID, quoted in Philip Bereano, "Engineered Food Claims Are Hard to Swallow," *Seattle Times* (November 19, 2001).

16. See, for example, www.agroeco.org/doc/alt.maize-contam.pdf.

17. Evelyn Fox Keller, *The Century of the Gene* (Cambridge, MA: Harvard University Press, 2000).

18. Richard Lewontin, *Triple Helix: Gene, Organism, and Environment* (Cambridge, MA: Harvard University Press, 2000); Richard Lewontin, *It Ain't Necessarily So* (New York: New York Review Books, 2000).

19. Commoner, "Unraveling the DNA Myth"; Ruth Hubbard and Elijah Wald, *Exploding the Gene Myth* (Boston: Beacon Press, 1993).

20. See Michael Hansen, "Genetic Engineering Is not an Extension of Conventional Breeding," Consumers Union Discussion Paper (2000), www.consumersunion.org/food/widecpi200.htm. Also see David Schubert, "A Different Perspective on GM Food," *Nature Biotechnology* 20 (October 2002): 969.

21. Richard C. Strohman, "Organization Becomes Cause in the Matter," *Nature Biotechnology* 18 (June 2000): 575–6; Richard C. Strohman, "Five Stages of the Human Genome Project," *Nature Biotechnology* 17 (February 1999): 112.

22. Sui Huang, "The Practical Problems of Post-Genomic Biology," *Nature Biotechnology* 18 (May 2000): 471–2.

23. See G. Riddihough and E. Pennisi, "The Evolution of Epigenetics," *Science* 293 (2001): 1063.

24. See, for example, P. Meyer, F. Linn, I. Heidmann, H. Meyer, I. Niedenhof, and H. Saedler, "Endogenous and Environmental Factors Influence 35S Promoter Methylation of a Maize A1 Gene Construct in Transgenic Petunia and Its Colour Phenotype," *Molecular Genes and Genetics* 231 (1992): 345–52.

25. Sheldon Krimsky, "Biotechnology at the Dinner Table: FDA Oversight of Transgenic Food," *Annals of the American Academy of Political and Social Science* 584 (November 2002): 80–96.

26. Erik Millsone, Eric Brunner, and Sue Mayer, "Beyond Substantial Equivalence," *Nature* 401 (October 7, 1999): 525–6.

27. Hansen, "Genetic Engineering Is not an Extension of Conventional Breeding." Also see Meyer et al., "Endogenous and Environmental Factors Influence 35S Promoter Methylation"; and A N. E. Birch, I. E. Geoghegan, D. W. Griffiths, and J. W. McNichol, "The Effect of Genetic Transformations for Pest Resistance on Foliar Solandine-based Glycoalkaloids of Potato (*Solanum tuberosum*)," *Annals of Applied Biology* 140 (2002): 134–49.

28. Sheldon Krimsky, *Science in the Private Interest* (New York: Rowman & Littlefield, 2003).

29. Kimbrell, *Fatal Harvest*; Wes Jackson and Wendell Berry, *New Roots for Agriculture* (Lincoln: University of Nebraska Press, 1985).

30. Miguel A. Altieri, *Agroecology: The Science of Sustainable Agriculture* (Boulder, CO: Westview Press, 1995).

31. See Pesticide Action Network North America, www.panna.org.

32. Altieri, *Agroecology*.

33. Fred Pearce, "Cashing in on Hunger: Biotechnology's Bid to Feed the World Is Leaving Less Profitable Techniques Starved for Funds," *New Scientist* (October 10, 1998).

34. Jane Rissler and Margaret Mellon, *The Ecological Risks of Genetically Engineered Crops* (Cambridge, MA: MIT Press, 1996).

35. Wendell Berry, *The Unsettling of America: Culture and Agriculture* (San Francisco: Sierra Club Books 1977).

36. Margaret Mellon, "The Wages of Hype."

37. Stephen B. Brush and Doreen Stabinsky (eds.), *Valuing Local Knowledge* (Covelo, CA: Island Press, 1996); Vandana Shiva, *Biopiracy* (Boston: South End Press, 1996).

38. Amory B. Lovins and L. Hunter Lovins, "A Tale of Two Botanies," *St. Louis Dispatch* (August 1, 1999), www.global-vision.org/misc/twobotanies.htm.

39. Lovins and Lovins, "A Tale of Two Botanies"; Commoner, "Unraveling the DNA Myth"; Martha Herbert, "Genetics Finding Its Place in Larger Living Schemes," *Critical Public Health* 12 (2002): 221–36.

40. Levins, "When Science Fails Us"; Steve Lerner, *Eco-Pioneers: Practional Visionaries Solving Today's Environmental Problems* (Cambridge, MA: MIT Press, 1997); Kenny Ausubel, *The Bioneers: Declarations of Interdependence* (South Burlington, VT: Chelsea Green, 2001); Alan Weisman, *Gaviotas: A Village to Reinvent the World* (South Burlington, VT: Chelsea Green, 1995).