Introduction:
Beyond Precaution

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The debate over food and genes has degenerated in recent years into a cartoon discourse. Common sense, science, and the needs of the poor and malnourished are now regularly sacrificed to political calculations.

Consider the contretemps over "Golden Rice," the genetically modified, vitamin-enhanced version of the world's most popular staple. White rice makes up 72 percent of the diet of the people of Bangladesh, and nearly as much in Laos and Indonesia; more than 40 percent in Madagascar and Sierra Leone; and around 40 percent in Guyana and Suriname. While it is a filling food that can be grown in abundance, it has a major drawback: It lacks vitamin A. Vitamin A deficiency (VAD) weakens the immune system, increasing the risk of infections such as measles and malaria. Severe deficiencies can lead to blindness. Children and pregnant women are particularly vulnerable to VAD. According to the World Health Organization, there are more than 100 million VAD children around the world. Some 250,000 to 500,000 of these children become blind every year; half of them die. In Asia and Africa, nearly 600,000 women with vitamin A deficiencies die from childbirth-related causes (World Health Organization 2004).

How should we as a society respond to a crisis of such malignant proportions?

In the 1960s, the developed world began reaping enormous benefits from the "Green Revolution," with the widespread use of pesticides, fertilizers, sophisticated irrigation, mechanization, and the use of new crop cultivars that

dramatically improved yields and the nutritional content of crops. Norman Borlaug won the Nobel Peace Prize for his development of high-yielding wheat varieties that helped feed people in developing countries. Now, with the advent of agricultural biotechnology, we have an opportunity to extend those gains with the development of new grains, fruits, vegetables, and other nutritionally enhanced foods developed using far fewer pesticides.

The engineering of so-called Golden Rice stands as the most powerful example of the potential of this remarkable technology. In 1999, Swiss and German scientists developed this unique gold-colored rice, the first major genetically enhanced food. Until this point, bioengineers had focused on developing new strains of crops and grains, such as cotton, wheat, and soybeans; this was the first time this technology was used to develop a food that people eat directly, rather than a crop that needed to be processed. The new variety was produced by splicing into white rice two genes from the daffodil, which give the rice a golden color, and one from a bacterium. The added genes cause the new rice strain to produce beta carotene, which the body can convert to vitamin A. Newer varieties have been created to add iron and to make the iron already in the white rice more readily absorbed into the body. Yet, despite the enormous promise of Golden Rice and other remarkable new crops and foods, the biotech phase of the Green Revolution became mired in controversy.

The central opposition comes from organized antibiotechnology activists. They include well-known environmental groups such as Greenpeace, Friends of the Earth, and organic advocates; religious groups such as Christian Aid; and a small but media-savvy sector of the investment community known as "socially responsible investors," which includes groups such as Co-Op America; the Interfaith Center on Corporate Responsibility (ICCR), a religious-based advocacy group; and the Social Investment Forum, the trade group for liberal social investors. This loosely organized coalition attacks vitamin-packed rice seed and other biotech products on two grounds.

First, they contend that genetic technology is inherently unpredictable, conjuring up images of a genetic Godzilla that could cause irreparable environmental and health damage. They argue that genes not subject to checks and balances in nature could be released into the environment, causing untold havoc, although scientists believe this scenario is unlikely outside of doomsday scenarios that could apply just as well to conventional agriculture.

And as the authors of the chapters in this volume make clear, agricultural biotechnology has proven to be even less risky than conventional gene transfer techniques developed before the advent of genetic modification, including radiation and selective breeding, to produce new varieties with enhanced nutritional qualities or disease resistance.

Second, they argue that biotechnology crops and foods will ultimately result in higher food prices and less variety because private companies patent many of the new seeds and food genes. Some have even gone so far as to dismiss Golden Rice as bad science and a "gift horse for the poor" (Institute of Science in Society 2005). Other critics imply that Golden Rice amounts to a "Trojan Horse"—as Genewatch, one British-based antibiotech group, characterizes it—designed to soften opposition to agricultural biotech (Fumento 2003).

"At the end of the day," concludes a briefing on Grain.org, a popular antibiotechnology Web site, "the main agenda for golden rice is not malnutrition but garnering greater support and acceptance for genetic engineering amongst the public, the scientific community and funding agencies" (Grain.org 2001).

In fact, Golden Rice was developed over ten years at a total cost of $2.6 million, using funds donated by the Rockefeller Foundation, the Swiss Federation, the National Science Foundation, and the European Union. Numerous corporations have contributed to its development, donating their expertise in what is called "open source" drug discovery, modeled after the open source technology that was used in computing to develop the Linux operating system (Pollack 2005). In May 2004, the biochemical firm AstraZeneca announced it would be distributing one type of genetically modified rice, developed by two European scientists, to Asian countries free of charge because of the crop's health benefits. Three months later, biotech giant Monsanto announced it would be providing royalty-free licenses for all of its patented technologies that might help further the development of this particular crop. Still, because of the intense opposition to biotechnology, it may take four years or more before the new crop can wind its way through the Byzantine regulatory system and go into production.

Increasingly, nongovernmental organizations (NGOs) and religious groups that often align themselves on other issues with Greenpeace and other more radical environmental groups have come out in favor of agricultural biotechnology.

"I think [Golden Rice] has tremendous potential," said Alan McHughen, a senior research scientist at the University of Saskatchewan in Canada and author of *Pandora's Picnic Basket: The Potential and Hazards of Genetically Modified Foods*. "Many expert ethicists, including the Nuffield Foundation, the Church of England and even the Vatican have given their seal of approval for genetically modified food that is used to provide more food or more nutritious food" (Orfinger 2004).

Agricultural Biotechnology on Hold

The worldwide $46.6 million commercial biotechnology industry rests on four crops: cotton, used to make clothing, and soybeans, corn, and canola, used primarily for animal feed or to make oil and other ingredients for processed food. These four products increase yields by programming plants for two new qualities: to generate "natural" insecticides to ward off killer pests, or to be herbicide resistant, so farmers can spray insecticides without killing the plants. These innovations reduce the overall need for costly and potentially harmful chemicals, a dramatic environmental achievement in its own right.

Although the first generation of biotech crops increased yields and reduced the use of costly pesticides, they came under heavy criticism from antibiotech activists because they were developed by private corporations and used mostly by corporate farmers. The new round of innovations, however, is specifically designed to target malnutrition and the needs of poor farmers, and to attack broader environmental concerns. These new products include drugs, known as functional foods and nutraceuticals, made from genetically modified plants, as well as crops that are more pest and drought resistant, nutritionally enhanced crops and foods, and even forest trees that are being tweaked to extract toxins from the soil, resist disease, and absorb carbon to help reduce global warming.

None of these innovations has yet appeased antibiotech protestors. The controversy is frozen over the issue of whether the process of producing the products or the products themselves might result in unacceptable environmental or health hazards. Critics and defenders cannot even agree on whether this new technology is evolutionary or revolutionary. Farmers and

plant breeders have relied for centuries on crossbreeding, hybridization, and other forms of genetic modification to improve the yield, quality, and disease resistance of crops. Today, virtually every plant grown commercially for food or fiber is a product of crossbreeding, hybridization, or both. Many of the same techniques have been used in modifying animal breeds and developing new pharmaceuticals.

Most geneticists and government regulators believe agricultural biotechnology is benign and at least as safe as traditional breeding techniques. There is absolutely no evidence that genetic modification poses greater risks than crossbreeding and gene-splicing, which have given us such products as the tangelo and seedless grapes. Using such traditional methods (including the radioactive bombardment of plants to create mutations, a scattershot process embraced by antibiotech groups as a "safe" alternative to biotechnology), thousands of genes, often of unknown function, are moved into crops. The new tools of biotechnology allow breeders to more precisely select single genes that produce desired traits and move them from one plant or animal to another. Researchers have been able to supercharge an organism's natural defenses using genetic material already in place or by introducing genes from other plants or animals.

Even the decision in May 2004 by the United Nations food agency, the Food and Agriculture Organization, endorsing the safety and health benefits of biotechnology in crops and food and urging its extension to the developing world, has not allayed the concerns of protesting NGOs. Consequently, while agricultural biotechnology continues to spread, it remains limited to but a select few countries: the United States, Argentina, Canada, Brazil, China, and South Africa. Almost all of the acreage remains devoted to only the four first-generation biotech crops: cotton, soybeans, corn, and canola.

There are serious issues about biotechnology and public policy that deserve vigorous public discussion. Legitimate questions have been raised about the degree to which corporations should be allowed to patent and therefore control beneficial biotech seeds or products they develop. Patents on human genes are the new stock in trade for biotechnology companies. The number of agriculture-related patents soared from next to nothing in 1986 to more than seven hundred annually by the year 2000.

While genetically modified (GM) crops offer many benefits, farmers who utilize these seeds can do so only after agreeing to certain licensing agreements. Universities, the federal government, and various public entities control many of the key technologies necessary for agricultural biotech (approximately 24 percent), but private companies own three-quarters of U.S. patents, including the most relevant genes. Monsanto (which controls 14 percent), Dupont (13 percent), Syngenta (7 percent), Bayer (4 percent), Dow (3 percent), and myriad other firms take the position that they need to recoup their research costs (Hayden 2004).

Unfortunately, reasonable concerns over patent rights, which should be part of the public debate, have been obscured by sensational and often misleading allegations. Critics claim that while the process of genetic modification might appear to be more precise than conventional breeding techniques, it is dangerous because of what they say is a limited understanding of potential hidden problems from allergens or antibiotic resistance. They often invoke the so-called precautionary principle to sow doubt about the long-range impact of this technology.

The Alice-in-Wonderland World of the "Precautionary Principle"

The precautionary principle, first used as a legal principle in Sweden in the late 1960s and Germany in the 1970s during environmental protests, has gradually become the weapon of choice for groups dedicated to scuttling technology they believe entails some risk—any risk. Although its adherents claim it asserts nothing more revolutionary than the maxim "Better safe than sorry," this innocent ring of moderation is deceptive in practice.

Precaution can be a prescription for paralysis. After all, innovation by definition entails unknown risks. Rather than encouraging a calm assessment of a complicated technology, the precautionary principle ends up firing hysteria. It exploits the public's inability to balance health and environmental benefits against a reasonable assessment of environmental risk. It also does not take into account the potential human cost of not innovating. That's one reason the World Trade Organization (WTO) forbids any nation from banning imports unless it can be proved to a "scientific certainty" that products are unsafe (World Trade Organization 1999).

Slavish adherence to an ultraconservative precautionary principle merely shifts risk to some current practices that would be banned if the principle were actively enforced. While there have been no documented health problems, deaths, or injuries linked to bioengineering, dozens of people die every year from eating organic and "natural" products contaminated as the result of poor quality control. Recall the dozens of serious injuries and the death of a Seattle girl in 1997 from drinking unpasteurized juice contaminated with *E. coli*, made by the Odwalla company from apples that had fallen in bacteria-laden "natural" fertilizer—that is, dung (Entine 1999). If the precautionary principle were applied to "natural" foods, they would be stripped from the grocery shelves overnight.

Claiming to be acting on behalf of innocent but unaware consumers and the "natural environment," determined protestors attempt to co-opt the debate by invoking the precautionary principle and using incendiary pejoratives like "pollution" and "contamination" to describe anything that contains genetically modified seeds or ingredients. That's exactly what has happened in an ongoing protest against farmers using a bioengineered treatment to increase milk yields. More than a decade ago, farmers discovered that cows given recombinant bovine somatotropin—rBST—produce more milk for a longer time. That means less feed and fuel are used compared with lower-producing herds, resulting in a host of environmental benefits. But the biofermentation production process, which is similar to making beer and wine and doesn't change the milk, involves biotechnology; and so organic and antibiotech activists allege that 90 percent of our milk supply is hopelessly "contaminated" by being mixed with milk from cows treated with a protein supplement.

Are milk drinkers endangered? Not according to independent studies in the United States and Europe. *Consumer Reports*, which summarized the scientific consensus, concluded "milk from hormone-treated cows poses no appreciable risk to humans" (*Consumer Reports* 2000).

Time and again, dire antibiotech warnings have proved feckless. In one well-known episode in 1999, an international firestorm flared when a letter was published in the magazine *Nature* suggesting that the monarch butterfly might face *some* danger from exposure to Bt corn pollen. This was not a peer-reviewed article or a state-of-the-art study, but a short summary of a four-day laboratory test. Its author, John E. Losey, carefully wrote: "It would be inappropriate to draw any conclusions about the risk to monarch populations

in the field based solely on these initial results" (Losey, Rayor, and Carter 1999). In the hands of those claiming to be environmentalists, these modest concerns mutated into near hysteria. Activists outfitted with wings were dispatched to protests to die on cue to illustrate the fate facing humanity if scientists were not restrained and our dalliance with agricultural biotechnology not abandoned.

Backed into a corner by public concern, the National Academy of Sciences launched a two-year study of the monarch butterfly "crisis" (Sears et al. 2001). The detailed—and costly—report concluded that "the portion of the monarch population that is potentially exposed to toxic levels of *Bt* corn pollen is negligible" and therefore the risks to the butterfly from GM corn "should remain very low." But while the antibiotech smoking gun proved to have no bullets in this and similar cases, the damage to public discourse was already done. Years of exaggeration and misinformation have taken an enormous toll, undermining public confidence in science and genetics, profoundly altering the trajectory of biotechnology applications, and damaging the financial wherewithal of dozens of companies and university research projects.

The potentially devastating effect of the precautionary principle can be seen in the Philippines, where 42 percent of the diet comes from white rice. Scientists and UN food experts estimate that a broad acceptance of Golden Rice could avert 879 deaths, 1,925 corneal ulcers, and 15,398 cases of night blindness each year (Hayden 2004). Yet a Philippine-based antibiotechnology group, Masipag, with ties to Greenpeace and other international antibiotech campaigners, has aggressively lobbied against Golden Rice on the grounds that the benefits from beta-carotene are minimal and that Philippine farmers do not want to grow genetically modified crops.

Belying claims by the rice's ideological opponents, a survey of Philippine farmers reported in *Nature Biotechnology* found that most are not opposed to Golden Rice. "There is a huge disparity from what the anti-GMO groups are saying and what the farmers really have said in my research," says Mark Chong of Cornell University. "Most of the farmers know next to nothing about agricultural technology" (Chong 2003).

Farmers are mainly concerned with producing enough rice to meet immediate needs and would welcome the enhanced rice, says Chong. It is significant, he notes, that not a single barrio leader mentioned antibiotech nongovernmental organizations as a trusted information source, even though

Masipag operates programs in the heart of the rice-growing region. This casts doubt on the legitimacy of claims by antibiotech groups that they represent the broad concerns of Philippine farmers (Chong 2003). How farmers will react years from now when these new grains actually are cleared for planting remains an open question.

As is so common in this debate, the most heated claims by those challenging the science are often the ones least supported by scientists. "Greenpeace has a strategy to convince people that Golden Rice provides so little beta-carotene that it is useless," notes Ingo Potrykus, the Zurich-based researcher who helped developed the rice. "This group and its allies base their argument on 100 percent of the recommended daily allowance [RDA], thus hiding the fact that far lower values are effective against mortality, morbidity, and blindness. The Golden Rice . . . provide[s] true benefits at just 300 grams [10.5 ounces] per day" (Potrykus 2001).

Enviromanticism

In case after case, activist groups have demonized biotechnology by exploiting a general wariness about science. The 2004 National Science Foundation study of science and engineering indicators shows that, although Americans express strong support for science in the abstract, public knowledge about science issues and the process of science remains low and the public is increasingly turning to the Internet as a major source of information (National Science Foundation). Echoing the views of other antibiotech crusaders, Amory Lovins, founder of the Rocky Mountain Institute, waxes about the dangers of "replacing nature's wisdom with people's cleverness" (Lovins and Lovins 1999). For many biotech critics, this is not a scientific dispute but an ideological and religious one, driven by a simple—and dangerously simplistic—principle: Don't tamper with nature. It is a romantic and superficially seductive message, but a blanket insinuation that nature's products are always benign or better is obviously nonsense.

Some mainstream environmental groups, such as the Sierra Club, and social investors, who could have taken the high road on a complex issue, instead stand with antiscience hardliners. They often portray themselves as advocates of consumer choice by arguing for mandatory labeling of products

made with genetically modified ingredients. At first blush, more disclosure seems reasonable and moderate. But will it provide any tangible benefit to consumers? As recently as July 2004, an independent panel of the National Academy of Sciences concluded without equivocation that genetically engineered crops do not pose any health risks that are not also present in conventionally produced crops.

"The most important message from this report is that 'It's the product that matters, not the system you are using to produce it,'" said Jennifer Hillard, a consumer advocate from Canada and one of the co-writers of the report *Safety of Genetically Engineered Foods* (Pollack 2004).

The labeling argument is a disingenuous ploy, as even its proponents acknowledge. A spokesperson for the Interfaith Center on Corporate Responsibility told me that mandatory labeling would be akin to slapping "a skull and crossbones" on GM products. And Michael Passoff of As You Sow, another antibiotech group, predicted to me that if the mandatory labeling campaign succeeds, "We expect that [the food industry] won't want to risk alienating their customers with labeling, so they'll eventually decide not to use any bio-stuff at all" (Entine 2002). In other words, GM products with absolutely no evidence of posing any danger, but with proven health and environmental benefits, would be vaporized from the marketplace.

While not a panacea, GM technology offers unique tools to address international food needs, especially in countries with increasing populations and widespread poverty. There are certainly valid concerns that need to be addressed if genetic modification is to get a fair shot in the marketplace. However, in the current atmosphere, rational policy initiatives and coordinated international trade policies are extremely difficult to undertake.

The unfulfilled potential of biotechnology might well rest on how it comes to be perceived by the greater world community. Public perceptions about bioengineering have dogged the research and commercialization strategies of the biotech industry since the first commercial products were introduced more than a decade ago. The often-politicized process has prompted firms to formulate what are known as "freedom to operate" strategies, which allow otherwise competing companies to cooperate in research without infringing on the patent rights of their research partners. In response, an international advocacy industry has coalesced, seeking to limit this freedom to operate in the name of social, environmental, and health responsibility.

This coalition includes traditional activists, such as public interest research groups, self-defined environmentalists, religious groups, social investment organizations, and umbrella antibiotech groups, like the GE Food Alert Coalition. They seek to apply public relations and, by proxy, financial pressures to influence the debate and public policy; many are determined to scale back radically or even kill the introduction of bioengineered products and processes. Also highly involved are the media, who have acted as a filter and sometime mouthpiece and advocate for the antibiotech perspective.

What appears to be lacking in the public debate in Europe and, increasingly, in the United States is a candid discussion about the current and potential benefits that these technologies can provide. That's where *Let Them Eat Precaution* has a role to play. The chapters in this book deconstruct the politics of the biotechnology debate and examine the extremely well-funded antibiotech industry; they also renew the promise of GM technology. Largely segregated to industrial crops in the developed world, there is now hope that the next generation of products—foods and crops that enhance nutrition or help in the development of critical new drugs—will break the public perception gridlock.

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