

Commentaries

Genetically Modified Crops: The Real Issues Hindering Public Acceptance*

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I'm a risk assessor. That's my job, but I'm also a toxicologist, an agriculturist, and a food enthusiast! More germane to this subject, I have been involved in the development of agricultural biotechnology for more than a decade. In 1987, I was appointed the Directorship of the Office of Agricultural Biotechnology, with the United States Department of Agriculture [USDA] in Washington, DC. What an exciting opportunity – a technology was emerging and its impact on world agriculture would be profound. My experiences with such controversial issues as Agent Orange, dioxins, and food irradiation, cautioned me that this emerging technology would likely encounter public resistance before adoption was internationally accepted.

As we began to support development of the research, laboratory evaluation, and finally field testing, we also established a regulatory pathway, coordinating with the White House Office of Science and Technology Policy, the Environmental Protection Agency [EPA], and the Food and Drug Administration [FDA]. At USDA, the Animal and Plant Health Inspection Service [APHIS] took the lead responsibility for ensuring regulatory compliance. The Office of Agricultural Biotechnology took the tasks of evaluating and promoting the science agenda, developing public outreach and education programs, and being responsible for the Agricultural Biotechnology Research Advisory Committee [ABRAC]. The ABRAC was a Federal Advisory Committee that reported to the Secretary of Agriculture. It included plant and animal molecular biologists, ecologists, entomologists, food scientists, plant pathologists, and specialists in law, ethics, and public policy. The members of ABRAC were selected so as to represent industry, university, and public interest group constituencies.

Realizing the importance of public outreach, the Office established *Biotechnology Notes*, a publication that received national and international distribution, and one of the first biotechnology publications to be placed on the Internet. In the fall of 1989 and through 1990, the Office co-sponsored regional meetings with the public called "Agricultural Biotechnology and the Public". These meetings were held in Nevada, North Carolina, Minnesota, and New Jersey. Hundreds of reporters, scientists, environmentalists, farmers, and members of the general public attended these very popular meetings. Presentations included visions of the science [the possibilities], potential environmental impacts, and ethical

discussions. Panels comprised of representatives from the major regulatory agencies, public interest groups, and of media specialists, often engaged in heated debate on the issues important to the adoption of the technology. Members of the ABRAC were always key participants in these meetings.

By late 1995, USDA's funding for biotechnology approached \$300 million as an annual investment, with both universities and Federal laboratories engaged in the research. A vital component of this research program was a commitment to fund research into the potential risks of the technology, including food safety. Dozens of national and international conferences had been held, and the field-testing was proving to be incredibly successful, with thousands of tests safely conducted. Hundreds of publications were being written and distributed by university and government researchers, and by the emerging biotechnology industry. The success of the overall program in moving the adoption of the technology forward was viewed by the leadership of the Department of Agriculture as justification to abolish the Office of Agricultural Biotechnology, the publication *Biotechnology Notes*, and the ABRAC [1]. Indeed, the Under Secretary for Research, Education, and Economics noted that they had "completed" their business, and other budgetary matters took priority [2].

By all accounts adoption of the technology should have occurred. So where did we go wrong? Why do we see a rising tide of discontent, suspicion, and opposition to the adoption of a technology that was clearly intended to be a win-win situation for everyone? Did we fail to adequately evaluate the risks or understand the science? Or were we so arrogant that we believed that the positive benefits of science and technology were so obvious that they alone could sway the public's acceptance? Or perhaps we failed to realize that there maybe a more fundamental "link" between technology, and the understanding and acceptance of the products of that technology, by a society.

1 The Right Start but the Wrong Ending

The value of an appropriately constituted Federal Advisory Committee is in its expertise, diversity of views, and independence. The ABRAC was viewed by many individuals and groups as successful [1,2]. As an advisory body, ABRAC had the potential to surface any or all of the difficult and unresolved issues in a forum that was open, yet focused, and the committee structure give the opportunity to direct inquiry and debate along the directions that the members

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deemed most relevant. As early as 1988, ABRAC began to evaluate both the potential benefits and the potential risks of genetically engineered organisms. The benefits were obvious: the addition of a few genes to a crop plant could make it more productive, more nutritious, more tolerant to environmental stresses such as cold, drought, and salinity, and more resistant to diseases and pests. Indeed, the benefits could be observed in the laboratory and evaluated in field tests. But to document the risks, the genetically engineered crops would likely need to be assessed for both long-term and unintended effects. Accordingly, the ABRAC developed bio-safety guidelines for rDNA-manipulated organisms for USDA's research and regulatory agencies. It also supported the need to invest in risk-related research, and to seek a better understanding of the risks associated with traditional plant breeding. It also stressed the importance of finding methods to evaluate potential impacts on human health.

Like a large ball rolling down a hill, the momentum for regulatory agencies to approve field tests increased. APHIS initially required lengthy applications, but as more and more of their determinations indicated "non significant risks", the notification process was amended. The roster of hundreds of field tests became a roster of thousands of tests. Companies, universities, foundations, and government laboratories were conducting tests with dozens of species and hundreds of genes. Critics were skeptical of the results, and demanded that the agency take greater care in the assessments of risks. Their concerns were heard but essentially ignored. At a conference in Monterey, California, I chaired a meeting in which a critic of the technology was booed when she cautioned the audience about the studies being conducted and the rising tide of European opposition. The ABRAC was present and recognized both the need for caution and the need for more public involvement.

During their final years (1995-96), ABRAC and the Office of Agricultural Biotechnology became the object of extended attacks by some individuals from the private sector, and from Henry Miller [2,3,4]. Miller had formerly been the Director for the Biotechnology Section at FDA. With his departure from FDA, he subsequently became a fellow of the Hoover Institution at Stanford University. But Miller's influence was magnified by his connections within the Clinton Administration and the Congress. Miller argued that there was no evidence for the belief that human health or environmental risks associated with genetically engineered organisms differed either qualitatively or quantitatively from risks associated with organisms produced through breeding or by natural mutations in the wild. As such, he concluded that there was no basis for special regulations or special considerations of products from biotechnology [4]. Hence, ABRAC's caution that there was still research needed to finally substantiate whether there are unique risks conferred by the use of rDNA techniques, placed it at odds with Miller, and the prevailing views of government and the biotechnology industry. As Thompson [2] noted, had ABRAC continued it might have reviewed the need for consumer education tools for genetically modified foods. It might have become a vehicle for collecting and disseminating information on the pros and cons of labels, and on the cost and scientific possibility of

monitoring the use of genetically modified food products, especially in processed foods. It could even have been a forum for taking up the thorny issue of how research is and is not linked to social consequences for farmers and rural communities. Had these issues been explored by ABRAC, and the results widely disseminated, would the critics of the technology still have an agenda and the media support they have today?

2 Finding the Middle Ground Will be Difficult

Science cannot answer all the questions that have been asked about biotechnology. And scientists are always cautious about giving definitive answers. In the final analysis, it is the public that will decide the fate of genetically modified crops. The scientific community, the regulatory agencies of governments, and even many of the public interest groups generally concur that the risks both to public health and the environment from genetically modified crops are minimal. The appearance of superweeds, undetected and unsuspected allergens, and the impacts on non-target insects and other species, are the common risk issues that we read about in our newspapers, magazines, or hear on the evening news. But the reality is that these can be detected, monitored, and regulated by government agencies should or if they occur. Strategies for managing these risks exist, and, in general, are acceptable to the farming community, the industry, and regulatory agencies. Despite the efforts of the scientific community to allay these fears, controversies continue to rage.

I can only conclude that we are engaged in a battle not for minds, but the hearts of the public. Greenpeace and other activists groups win not because of their stellar science, but because they appeal to the emotions of the public. Do they honestly believe that the risks are greater than the menaces of cigarettes, alcohol, junk food, or even unregulated herbal dietary supplements? How about the risks associated with pest-infested foods or poor diets? Is it possible that the issues with biotechnology and genetically modified crops are not really about food and choice but are symbols of something much more sinister? Are the extremists hiding their real agenda by playing on consumer fears, nationalistic pride, and hate for large multi-national corporations?

Schatz [5] recently argued that the European public brands transgenic crops as "obscene and dangerous follies foisted on consumers by profit hungry corporations". He notes that many people in Switzerland view the large multinational agricultural biotechnology companies as "heartless giants" that threaten the ability of democratically elected representatives to decide a country's fate to accept or reject genetically modified crops.

Echoing the same theme, Koch [6] in responding to the charge of hysteria by the European public and the demand for labeling of genetically modified food stated: "If we respect the independence of nations, each should be free to make its own choice". He argues that we are living in a time when the public trust in science and scientists is at its lowest. He concludes "We do nothing to better this situation by allowing prestige and money to drive decisions rather than true insight and a striving toward a better future for this planet".

An advertisement in the January/February 2000 issue of *Mother Jones* magazine [7] announced a major conference on "Technology and Globalization in the New Millennium" with the question "Do we know where we're going? The interface between the new technologies (including biotechnology), economic globalization and centralized corporate power is arguably leading the earth toward the brink of environmental, political, and social traumas unprecedented in history" ... "What are the appropriate technological choices for an environmentally and socially sustainable future?" I would suggest that these statements were not directed at our lack of understanding the science or the safety of biotechnology, but rather the fear that technology is out of control, and that individuals and nations may no longer determine their destiny.

Another advertisement in *Mother Jones* is instructive [8]. It is by the company Nature's Path, the "Organic Cereal People", and is titled "Just Say No to GMOs (Genetically Modified Organisms)". The advertisement informs the reader that "Nature's Path agrees with the leaders of all the major religious faiths who have called for a prohibition of this kind of genetic violation of the laws of nature...it is clear that we humans are unleashing a potential disaster for the natural balance of all life forms on this planet". How does a rational person who favors the adoption of the technology respond to such charges, or provide an acceptable counterpoint? Perhaps Gaull [9] has provided some clarity for such a position in his article on viewing biotechnology in a cultural perspective. Gaull suggested that such views arise from a cultural background [in Europe] that romanticized those individuals who live in harmony with the natural world. He further suggested that the Christian Revolution freed the American spirit to exploit nature in a mood of indifference. This predisposed those under the aegis of the Christian west to develop a more imperial relationship with the natural world, one in which capitalism, industry, and science could flourish. Indeed, Gaull argued that such philosophical differences underlying public acceptance of biotechnology have already exerted dramatic effects on the globalization of biotechnological innovation.

Miller [10] was not so kind to those individuals who present non-scientific arguments against biotechnology. Miller describes these criticisms of biotechnology as "the emotional dimension", or romantic naivete. He suggested that those individuals who would use emotion or anti-technology are seldom either educable or misinformed.

"They are waging a calculated campaign against the new technology, for reasons that are naïve, self-serving, or both. And no strategy is out of bounds to them...they threaten, misrepresent, and litigate".

Repeatedly we are told that "labeling" of genetically modified crops will give the public the tool to make choices. Haslberger [11] proposes a scheme for monitoring and labeling for genetically modified products. He concludes that the only way to address the significant opposition to the use of GMOs and obtain worldwide markets, is by addressing environmental concerns and consumer demands with improved risk management [specifically monitoring] and appropriate labeling. I believe that an appropriate label intended to in-

form, but not to scare would be acceptable to most parties. However, as Schatz [5] observed, the critics of the technology want more than just a label. The Gene Protection Initiative in Switzerland demanded that government outlaw

- [i] the generation, purchase, or distribution of transgenic animals;
- [ii] the release of genetically altered organisms into the environment; and
- [iii] the patenting of transgenic animals and plants, of their components, and of the relevant processes.

The Initiative also demanded that experiments with all genetically modified organisms require proof of benefit and safety, proof of lack of alternatives, and a statement of ethical responsibility. I believe that the message buried in the Gene Protection Initiative is that the power of gene technology is so great that scientists will give in to temptation and will try whatever is possible, inevitably leading to global disaster. And, although the Swiss voted to defeat the Initiative, Greenpeace and other activists continue to seek the emotional impetus from the public to stop the adoption of biotechnology, for it is not "save the whales", but "save the genetic purity of the planet". With such a philosophy and demand, can there be a way for all parties to seek and find a middle ground?

3 So what is the Future of Genetically Modified Foods and Biotechnology?

The potential crises facing mankind are real. The number of humans reached 6 billion in 1999, and if unchecked another billion will be added to the global population in 12 years.

This unchecked population growth and the need for habitable land, food, and water portend doom. Vast regions of the earth are much too salty to support agriculture. Freshwater will be the most crucial and limiting natural resource in the twenty-first century. Unless agriculture can develop new solutions, wars will be fought over this resource. Deforestation and loss of genetic diversity will be unrelenting if current agricultural lands cannot be made productive. Nor can we ignore the growing divide between rich and poor, the feminization of poverty, or the dearth of jobs. But it is new technologies, including biotechnology, supported by appropriate services and public policies that will be the tools to forestall or prevent these crises. And unless nations are willing to invest in these tools and promote their acceptance, our children will have a very uncertain future.

It is anticipated that the molecular revolution will occur in three generations. The first generation, which is represented by the current transgenic crops, is intended to profit the producer. The second generation will benefit the consumer, while the third generation will benefit mankind and the global ecosystem [12]. What are the challenges and goals for each advancement in this technology?

In an era of great regulatory uncertainty and government oversight, farmers are in a very risky business. There is a vocal segment of the public that demands food grown without fertilizers or the use of pesticides. They want their animal products free of hormones, from "free-ranging" animals, raised under non-stress environments, and nurtured with the purity

of bottled water. Yet, they demand all of this at a price that allows them to commit less than 15 percent of their income for food. Farmers know that to stay in business, feed their families, and plan for their future, they must maximize profits. That means keeping the cost of inputs such as fertilizers, pesticides, and tillage low to produce the largest yields that meet the highest standards of food quality for marketing. Farmers also know that to compete successfully, they need every opportunity and advantage that science and technology can offer. Increasingly farmers are being forced to raise crops on marginal lands (the impact of urban sprawl). They must compete for water rights with large cities and find more efficient ways to harvest, process, and transport produce and livestock to global markets. This is the setting in which we now find the first "fruits" of molecular biology. And these are the reasons why farmers in North America have been so attracted to insect resistant, virus resistant, and herbicide resistant crops. Crops that produce higher yields, require less pesticide, and reduce tillage. In the pipeline are crops that tolerate salt, resist drought, and survive in cold temperatures.

The second generation is now being commercialized. These are the genes that enhance the quality, nutrition, or cash value of a crop. For example, modifying the genes in canola, sunflower, or soybeans to produce oils high in unsaturated fatty acids and thus enhancing the cash value of the crop. However, as Guerinot [13] has noted, the crops that will make the biggest difference for the largest number of people in the world are those that would serve as better sources of essential nutrients. Indeed, she described the new engineered rice that produces provitamin A. Although half of the world's population eats rice daily and depends on it as their staple food, rice is a poor source of many essential micronutrients and vitamins. If the new transgenic "gold" rice performs in field trials, it has the potential to prevent 1 to 2 million deaths each year among Southeast Asian children aged 1 to 4 years.

The third generation will represent a new way to solve some of the extremely difficult problems facing mankind. We are now seeing significant increases in mass mortalities due to disease outbreaks, and a tidal wave of exotic species is transforming ecosystems worldwide. Increased human mobility, the shipping and entry of infected cargo, and impact of climate variability all promoted these outbreaks and invasions. Using biocides and introducing natural predators cannot be the only answers. Understanding the molecular basis for infection, invasion, and predation will allow ecologists to use the genes that nature provides to reestablish the balance. Farfetched? I don't think so.

In a hundred years, we will look back over the twenty-first century and marvel at the impact that biotechnology had. But this scenario and the opportunities that biotechnology may bring to our society and our environment are now threatened by a campaign to spread fear of the products, disfavor of science and scientists, and hatred of the commercial sector involved.

Quoting from Gaull [9]: "In the end, economic and practical advantage is likely to prevail in agricultural biotechnology as it did in fluoridation of water and pasteurization of milk (for public health). I am persuaded that further devel-

opment of biotechnology in the European Union will be concurrent with the ultimate realization that prioritizing the present public fear of biotechnology has negative implications for European economic well-being." Gaull made his statement in 1997 before much of the present furor. In the 4 February 2000 issue of *Science*, Frank [14] commenting about the decreased support for funding plant biotechnology [and the loss of scientists] in Europe wrote: "Most researchers believe the public will come to embrace transgenic crops, especially after future varieties show traits that genuinely benefit consumers, such as increased nutritional value or the elimination of natural allergens. But by then it may be too late for European researchers...By not concentrating on this research now we risk having to import the future products of plant biotechnology from elsewhere".

I am encouraged that the day is dawning when the public realizes the messages of doom and gloom are intended to deny them access to a technology that will benefit both mankind and mankind's planet.

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