POINT/COUNTERPOINT
FOOD SCIENCE

FOOD BIOTECHNOLOGY: LABELING WILL BENEFIT INDUSTRY AS WELL AS CONSUMERS

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Current evidence indicates that public acceptance of food biotechnology is largely product-specific; people will accept recombinant foods believed beneficial, safe, and consistent with personal value systems. Because values cannot be evaluated scientifically, they are best addressed by permitting consumer choice at the marketplace through product labeling.

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Food biotechnology, the use of recombinant DNA and cell fusion techniques to confer selected characteristics upon food plants, animals, and microorganisms,[1] holds great promise for increasing agricultural productivity, especially in the developing world. In theory—if not yet in practice—these techniques can be used to improve the quantity, quality, and safety of the food supply.[2] Nevertheless, the first genetically engineered products to be marketed in the United States have elicited intense controversy, with reactions ranging from editorial debate to legislative prohibitions and boycotts.

Criticisms of food biotechnology address scientific issues of food safety and environmental impact, but they also involve fundamental questions of values and beliefs. Industry leaders and policymakers, however, have tended to evaluate consumer concerns exclusively on the basis of their scientific merit and to view questions about the societal impact of genetically engineered foods as reflecting antiscientific attitudes and lack of scientific knowledge.[3] The failure to acknowledge broader societal concerns about food biotechnology has contributed to public distrust and has impeded the ability of critics and industry leaders to enter into any meaningful debate on genuine issues.

As I will explain, many—if not most—of the issues raised by consumer advocates concerned about the impact of food biotechnology on health and society have some basis in fact and deserve due consideration. Furthermore, advocates' proposals to label genetically engineered foods, require premarket notification of the Food and Drug Administration (FDA) about new products, and establish management plans for pest resistance[4,5] ultimately would benefit the industry as well as the public. This commentary explains the rationale for these views.

CONSUMER ISSUES

The results of surveys of consumer attitudes toward food biotechnology conducted over the past decade (discussed below), suggest that issues related to public acceptance of recombinant food products can be grouped into three categories: (1) credibility issues related to industry and its government regulators, (2) safety issues relevant to individual consumers as well as the environment, and (3) "ethical" issues—for want of

a better term—that bear on deeply held religious, moral, and philosophical value systems that, for example, prefer nature over science, family businesses and farms over corporations, and animals' over scientists' rights. Among these categories, safety alone can be subjected to scientific measurement and evaluation.

Credibility Issues

Consumer suspicions of food biotechnology stem in large part from the marked disconnection between the benefits to society promised by industry and the products it has actually brought to market. In theory, recombinant techniques can be used to improve the flavor, texture, freshness, and nutrient content of fruits and vegetables, to increase the resistance of crops to damage by insect or microbial pests, to improve the tolerance of crops to frost, heat, salt, or heavy metals, to enable crops to be grown with little or no fertilizer, herbicides, pesticides, or water, and even, perhaps, to enable major crop plants to fix atmospheric nitrogen.[2] Any of these developments could help prevent the large shortfall in world food production expected to occur early in the 21st century.[6] Such possibilities lead industry leaders, policymakers, and scientists to state that biotechnology, and only biotechnology, will be able to solve world food problems.[3]

In the light of such goals, any controversy may be viewed as a barrier to their achievement. Nevertheless, food biotechnology *is* controversial. In the US, the first products to be marketed have elicited public suspicion, hostile press reports, boycotts, and legislative actions.[7] In Europe, the introduction of recombinant soybeans and corn caused a political crisis that has threatened the very structure of the European Union.[8] Such reactions reflect public concerns about the safety and environmental impact of bioengineered foods but also about their impact on society. The reactions also reflect considerable misunderstanding of science along with deep distrust of the biotechnology industry and its government regulators. In the European situation, the controversy additionally reflects distrust of American political and economic goals.

Many biotechnology industry leaders and their supporters tend to view all such concerns, regardless of merit, as irrational. They have described consumers who resist the introduction of recombinant foods as ignorant, hysterical, irresponsible, antiscientific, Luddite, troglodyte, and biotechnophobic. They view "biotechnophobia" as the single most serious threat to the commercialization of new recombinant food products and overcoming it—finding ways to convince an irrational and ignorant public that recombinant foods are not only safe but beneficial—as the most important challenge to industry.[3]

Such rhetoric misses an important point. Although education is always helpful, the need for it is not the greatest problem for industry; instead, the most significant challenge is to create products that will genuinely benefit the public and society. The crux of the credibility issue is that consumers do not view the products that have been approved to date as sufficiently beneficial to outweigh perceived risks.

The difference between industry and public viewpoints is readily explained by an inherent conflict of interest in industry goals for product development. One goal of the food biotechnology industry is to create agricultural products that will solve important food problems; achieving this goal will benefit society. A second goal, however, is to create commercially marketable products; achieving this goal will benefit investors. In theory, products should be able to meet both goals, but food biotechnology is a business, and practical considerations predominate.[9] Thus, industry research necessarily focuses on projects that can be completed in a reasonable amount of time and will generate sales. Such a focus is entirely understandable but does not necessarily address world food problems.

For technical as well as economic reasons, the great promises of food biotechnology have not yet been fulfilled, nor are they likely to be realized in the immediate future.[10] The development of crops that grow under conditions of harsh climate and low input raises scientific challenges of formidable complexity. For example, hundreds of as yet uncharacterized genes are involved in the reproduction of corn,[11] and the more than 350 varieties of cassava seem rather resistant to transgenic manipulations.[12] Technical difficulties do not make genetic problems unsolvable, but overcoming them is likely to take a great deal more time, commitment, and funding than is presently available. To date, therefore, investment of US companies in research on developing nations' agricultural problems has been very limited, with the lack of a viable market considered a major barrier.[13] Furthermore, sources of private and public funding available for biotechnology projects in developing countries tend to be fragmented and poorly coordinated.[14]

Thus, the need to satisfy investors remains the driving force for food product development. This need arises from the context of food product development in the United States. Since early in this century, this country has vastly overproduced food, making our food system fiercely competitive. Today, the US food system supplies an average of 3800 kcal/day per capita (for every man, woman, and child), far more than most people can consume.[15] In such abundance, a choice of any one food means rejection of another. Retail food and beverage generates about $800 billion in sales per year, and food marketers compete for consumer purchases through advertising and new product development. Advertising amounts to about $30 billion per year; $10 billion in direct television and print advertising and an additional

$20 billion in slotting fees and point-of-purchase, coupon, and other campaigns. In 1996, companies introduced about 15,000 new food products.[16] In this highly competitive environment, biotechnology offers a hope for creating new products that will benefit investors as well as the overall food marketing economy. The conflict of interest in industry goals affects credibility.

Federal regulation of food biotechnology also raises credibility issues, as a result of a narrow focus on safety issues that exclude broader societal concerns and of difficulties finding an appropriate balance between oversight of industry and encouragement of new product development. Federal regulation of food biotechnology is dispersed among three major agencies: the Environmental Protection Agency, the US Department of Agriculture, and FDA. Partly because of fragmentation of authority, and also because it can be evaluated scientifically, safety has emerged as the only issue of regulatory relevance. No single federal agency is equipped or mandated to make regulatory decisions based on complex societal issues.[17] Therefore, recombinant foods that appear to pose no currently measurable risk will receive regulatory approval, with primary responsibility for demonstration of safety delegated to industry.[18] In this regulatory environment, federal officials and industry alike view regulations as creating unnecessary barriers to research and development.[3]

Consumer advocacy groups, however, argue that federal regulations should protect the public not only against known safety risks, but also against risks that cannot yet be anticipated by science. They view safety as only one component of a far broader range of concerns about the impact of biotechnology on individuals, society, and the environment, issues that also might be addressed by regulations.[4] Demands that regulation of food biotechnology solely be "science-based" raise credibility issues among consumers who view safety regulations as only one aspect of a much wider range of social values.

Safety Issues

At least some concerns about the safety of genetically engineered products, especially those related to unanticipated consequences, allergenic potential, and environmental impact, deserve more regulatory consideration than they have received to date. By definition, the unanticipated consequences of a technology are difficult to predict; if a problem is unrecognized, it cannot easily be researched or regulated. At least one example of unanticipated consequences—that of tryptophan supplements—raises concerns. These supplements were taken to induce sleep or relieve depression (whether or not they do so is an interesting question but not germane to this discussion). In 1989, health officials linked tryptophan supplements from a single, foreign manufacturer to an eosinophilia-myalgia syndrome of muscle pain, weakness, and increased white blood cell counts.[19] Eventually, this syndrome led to more than 1500 cases of illness and nearly 40 deaths. The manufacturer extracted the tryptophan from a strain of bacteria genetically manipulated to produce especially high levels of this amino acid. Because tryptophan is a normal component of all proteins and is unlikely to be toxic, investigators suspected that some toxic contaminant must have been created or introduced during the manufacturing process. Unfortunately, the cause of the syndrome has not been fully identified.[20] Although it seems highly unlikely that the recombinant processes were at fault, their use created a situation in which toxic products formed, albeit inadvertently.[21] This example suggests that concerns about unknown hazards of biotechnology must be taken seriously, even if we do not yet know how to address them.

Induction of allergenicity appears to be another legitimate concern. Because genes encode proteins, and proteins are allergenic, the introduction of allergenic proteins into previously nonallergenic foods could be an unintended consequence of plant biotechnology. In 1996, researchers did indeed demonstrate that an allergenic protein from Brazil nuts could be transferred to soybeans, and that people who were known to be allergic to Brazil nuts also reacted to soybeans that contained the Brazil nut protein.[22] Food allergies are rare and can be documented in just 2% of adults and 8% of children.[23] The prevalence of allergy, however, depends on the degree of exposure to food proteins; the greater the exposure to a particular protein, the more people become allergic to it. Many more people should be expected to develop food allergies as proteins are increasingly added to commercially prepared foods. Soy proteins, which are known allergens, are widely used already in infant formulas, meat extenders, bread and baked goods, chocolates, candies, meat and other dishes, and dairy replacements. Most biotechnology companies, however, are using microorganisms rather than food plants as gene donors. Although microbial proteins do not appear to share sequence similarities with known food allergens,[24] lack of experience makes their allergenic potential uncertain.

Environmental impact is a third concern. Environmentalists have argued that crop plans genetically engineered to contain the naturally-occurring insect toxin from *Bacillus thuringiensis* (Bt) or to resist herbicides may establish selection pressure for resistant insect and other pests, may pass the genes for herbicide resistance to weeds (creating "superweeds"), and may encourage even more widespread use of herbicides and other chemicals in crop production.[25] Recent events have demonstrated that these seemingly remote possibilities are quite probable. For example, some 1996 plantings of Bt cotton failed to protect against bollworms and other insect pests, suggesting that

widespread use of the Bt gene, particularly at moderate levels, might induce selection for Bt-resistant insects. Such an event would destroy the use of this toxin for sustainable agriculture systems in which it has been a mainstay.[26] Researchers also have reported that recombinant oilseed rape (canola) plants have passed their gene for herbicide resistance to rapidly reproducing weeds.[27] In addition, researchers in Australia are said to have identified weed rye grasses resistant to glyphosate herbicides, raising the uncomfortable possibility that this widely used but relatively benign compound may encounter long-term sustainability problems.

At the moment, these observations are preliminary and pose no immediate threat to industry, but they do suggest the need for caution. Because resistant pests and superweeds harm industry as well as the environment, it is in the best interests of industry to heed advocates' demands for pest resistance management systems to accompany large-scale plantings of any recombinant crop.

Ethical Issues

Because consumer attitudes are important to the economic success of the biotechnology industry, various agencies in the United States, Canada, and Europe have conducted surveys over the past 10 years designed specifically to probe consumer perceptions of this technology and its applications.[29–32] Although the methods used to obtain information have varied, and their results are not strictly comparable, the surveys have yielded remarkably consistent findings over time that reveal an internal logic of considerable value in predicting how the public will react to new products as they come to market.

As might be expected, the surveys have found the public to have only limited knowledge and much misunderstanding of science in general and biotechnology in particular. Nevertheless, respondents were interested in biotechnology, believed that it is capable of producing benefits for them and for society, thought the benefits would outweigh any risks, and favored continued federal funding of food biotechnology research. Taken together, the surveys suggest that scientific ignorance among consumers does not necessarily lead to hostile attitudes toward food biotechnology. Instead, consumers appear to be rather open-minded about the potential benefits of the new technology, even if they do not understand it very well.

The source of public concerns about biotechnology therefore must be sought elsewhere. One clue derives from reports that respondents clearly preferred some bioengineered food products to others. People were more likely to accept products that improved health, benefited society, or saved money or time, and that would do no harm to people, animals, or the environment. Safety was not the primary concern. Instead, respondents appeared most troubled by ethical issues; they were more willing to accept recombinant foods that involved plants rather than animals and did not involve the transfer of animal genes into plants.

The surveys also confirmed substantial public distrust of government credibility in scientific and technical safety matters and of the ability of government to regulate food biotechnology appropriately. People also were skeptical of the ability of the biotechnology industry to make decisions in the public interest. For these reasons, the large majority of survey respondents wanted genetically engineered food products to be labeled as such. International surveys of consumer attitudes have reported similar results.[33]

These reports of public misunderstanding of science, fear of unknown dangers, concern about animal welfare, distaste for transgenic experiments involving animals, and demand for regulation and food labeling can be interpreted in at least two ways. One way is to view such opinions as evidence of public irrationality. If this is the case, the obvious remedy is to develop comprehensive education campaigns to inform consumers about the safety and benefits of biotechnology. Several industry and other spokespersons have suggested the need for precisely such campaigns.[3,33]

An alternative interpretation may be equally valid. Many highly intelligent people and entire civilizations have believed in one or more gods, virgin birth, or an afterlife—all concepts that cannot be validated by scientific methods or held to common standards of scientific proof. Views of food biotechnology as "ethically wrong" may best be categorized as a form of religious belief and best treated with the same level of respect afforded people who hold beliefs other than one's own. Education is unlikely to change such beliefs.

To miss this point is to miss the most strikingly useful conclusion that can be drawn from consumer surveys: in the US, at least, attitudes of most consumers toward food biotechnology are product-specific. The survey results—and actual events—demonstrate that most Americans will readily accept bioengineered foods if they perceive them to meet important needs for public health and welfare. Taken together, the examples that follow suggest that if the food biotechnology industry wants consumers to accept its products, it must market products that are as worthwhile to the public as they are to the industry.

EXAMPLES: APPROVED RECOMBINANT FOODS

This internal logic of consumer attitudes and its predictive value are revealed by the examples of products that have thus far been brought to market. To determine the degree to which a bioengineered food will be acceptable to the majority of consumers, one needs to ask

whether the product is beneficial, safe, and ethical. Will it, for example, increase the availability or nutrient content of a food, improve its taste, decrease its cost, or enable it to grow under conditions of poor soil or difficult climate, or with reduced use of herbicides, pesticides, and fertilizers? Is the food safe for people, animals, and the environment? Will its production have a beneficial impact on small growers, the quality of rural life, or other such societal factors?

If the answers to all of these questions—benefits, safety, and ethics—are positive, the product is likely to be accepted by the great majority of consumers, all but the very small minority who are opposed to any use of biotechnology on principle. To the extent that the answers are negative or equivocal, consumer resistance is likely to increase.

Pharmaceuticals

By the early 1990s, the FDA had approved at least 15 recombinant drugs for use in human subjects. Recombinant insulin, for example, was approved in 1982.[34] This drug is of demonstrable superiority to that obtained from cows or pigs, as it solves problems of scarcity and quality, can be produced in unlimited quantities, and is identical in sequence to that of human insulin. It is safe and raises no ethical issues. Therefore, the drug readily meets all criteria for consumer acceptance and has elicited no noticeable concerns about its recombinant origin.

Chymosin

Recombinant enzymes used in food manufacturing also have been accepted readily. Chymosin, the enzyme that coagulates milk to make cheese, traditionally was obtained from the stomachs of calves and sold as part of a mixture called "rennet." The enzyme was difficult to extract, had to be taken from freshly slaughtered animals, varied in quality, and was scarce and expensive. Recombinant chymosin was approved for food use in 1990 and has elicited little if any complaint.[11] It also meets criteria for consumer acceptance: it is better, does not harm animals, and is just as safe as the product it replaced.

Bovine Somatotropin

Recombinant bovine somatotropin (rBST), or bovine growth hormone, increases milk production in cows by at least 10 to 20%. Its introduction elicited substantial controversy as a result of concerns about its effects on cows, human health, and the economic viability of small dairy farms.[2] It also has raised issues of consumer choice at the marketplace, as the FDA has ruled that milk derived from cows treated with rBST is no different from any other milk and, therefore, cannot be labeled as such.[35]

Public suspicions of rBST relate to the benefits, safety, and ethical status of this product. Milk is already overproduced in this country, and the product would seem to offer no clear benefit to American consumers in availability, price, or quality. Use of rBST is stressful for cows[36] and may well accelerate the long-standing trend toward closure of small dairy farms. These problems, and the fact that rBST affects milk, a product typically advertised as wholesome and pure, made this product an unfortunate choice as the first recombinant product to require regulatory approval under the FDA's new biotechnology policy.[18] Altogether, it appears that rBST was developed because it was possible to do so, not because the product was needed, and that its principal beneficiaries are large dairy farmers and its manufacturer, The Monsanto Company.

The Flavr Savr™ Tomato

The Calgene Company, now owned by Monsanto, originally developed its Flavr Savr tomato to stay ripe longer without spoiling and to taste better.[34] The company intended to market—and label—the tomato as genetically engineered. During the years when Calgene was seeking FDA approval for this product, various groups threatened picket lines, tomato dumpings, boycotts, and legal challenges.[37] Most analysts, however, predicted that people would buy the tomatoes if they tasted better than those otherwise available and did not cost much more. Although approved by FDA in 1995, recombinant tomatoes have not been widely marketed. If they do come to the market, they are likely to encounter some consumer resistance, but not much. Their benefit to the public is restricted to taste, but this value is important to some people. They raise only very remote concerns about safety. If they are marketed successfully, they might drive growers of other tomatoes out of business. Overall, their acceptance is likely to depend much more on taste and cost than on concerns about their recombinant origin.

Soybeans and Corn

The marketing of recombinant soybeans and corn in Europe in 1996 created a controversy that led to bans in several countries, debates in the European Parliament, and regulatory and labeling requirements. These reactions, much more extreme than those observed in the US, were nevertheless related to a similar set of consumer issues. Many Europeans have long-standing traditions of animal welfare, vegetarianism, and other value systems that might affect attitudes toward food biotechnology, as well as long memories of Nazi eugenic experiments during World War II.[38] In addition, the products arrived in Europe soon after the British crisis over "mad cow" disease,[39] which heightened consumer concerns about food safety. European perceptions that American corporations were attempting to control international trade also were an issue.[40]

Biotechnology companies did not help their credibility by insisting that any criticism of their products be "science-based." Press accounts, for example, quoted one

American industry executive as stating that European demands for labeling reflected a social prejudice with no scientific basis, one that sought to reduce risks to zero at the cost of denying food to a hungry world.[41] Such statements only added to consumer suspicions that industry self-interest predominates over other considerations.

In this country, recombinant soybeans and corn have encountered little public opposition, perhaps because they are mainly fed to animals, and their environmental hazards seem remote. Alternatively, the lack of protest may reflect widespread ignorance of their presence in the human food supply; press reports about food crops of any type appear almost exclusively on the business pages. It remains to be seen what will happen when the public recognizes the extent to which recombinant foods already have penetrated the food supply. At that point, calls for labeling are likely to increase.

One early sign of this likelihood is a formal request by Whole Foods, a large company specializing in organic and "natural" foods, that its suppliers verify that their products do not derive from recombinant soybeans, corn, rapeseed, or grains.[42] The company refers suppliers to Genetic ID, a firm in Iowa that markets a test to identify recombinant genes in plant crops. Use of this test will permit segregation of recombinant crops and establish a scientific basis for labeling distinctions.

IMPLICATIONS AND RECOMMENDATIONS

The current debates about food biotechnology offer the industry an opportunity to address consumers' concerns about the credibility, safety, and ethical implications of its products. The industry can improve its credibility by bringing its rhetoric more in line with reality. If industry leaders are going to continue to state that food biotechnology will solve world food problems, they might consider placing substantial resources into research on these problems. One suggestion might be to institute a tithing program that applies 10% of income to research and development projects that will address the food needs of developing countries but are unlikely ever to be profitable. Such a program should convince the public that the industry recognizes its own conflict of interest and distinguishes its societal from its investment goals. The most effective way the industry can achieve credibility is to *be* credible.

FDA regulatory policies delegate responsibility for ensuring the safety of recombinant foods to industry. For its own protection, the industry should voluntarily notify the FDA of new products under development and work with federal agencies to anticipate and prevent adverse consequences. To protect its investment in widely planted recombinant crops and the herbicides to which they are resistant, companies should voluntarily develop, implement, and monitor comprehensive plans for management of pest resistance and support these plans with adequate resources.

Ethical concerns based on grounds other than science can best be addressed by providing an opportunity for consumer choice at the marketplace. It is in industry's best interest to institute voluntary product labeling. The details of labeling may be difficult to construct, but they are not impossible, and labeling is greatly desired by the public. Some industry leaders already have concluded that labeling will do more good than harm, whether or not demands for it are scientifically justifiable. As stated by one industry official, "there is no need for labeling from a scientific and safety standpoint, but if we believe in consumers' right to choose, the industry cannot reasonably argue against labels facilitating the choice."[42] Other companies would do well to follow this lead; if they are producing beneficial, safe, and ethical products, labeling should encourage the public to purchase them. Industry attention to the quality and utility of its products should create a more favorable marketing environment, now and in the future.

REFERENCES

1. Carrol WL. Introduction to recombinant-DNA technology. Am J Clin Nutr 1993;58(Suppl.):249s–58s.
2. US Congress, Office of Technology Assessment. A new technological era for American agriculture. OTA-F-475. Washington, DC: US Government Printing Office.
3. Gaull GE, Goldberg RA. New technologies and the future of food and nutrition. New York: John Wiley & Sons, Inc.; 1991.
4. Mellon M. An environmentalist perspective. In: Davis BD, ed. The genetic revolution: scientific prospects and public perceptions. Baltimore: Johns Hopkins University Press, 1991:60–76.
5. Wadman M. Genetic resistance spreads to consumers. Nature 1996;383:564.
6. Fraley R. Sustaining the food supply. Bio/Technology 1996;10:40–3.
7. Benson S, Arax M, Burstein R. A growing concern: as biotech crops come to market, neither scientists—who take industry money—nor federal regulators are adequately protecting consumers and farmers. Mother Jones 1997;Jan/Feb:36–43, 66, 68, 71.
8. Wolf J. Europe turns up nose at biotech food: lacking EU rules for modified crops, farm sector could suffer. Wall Street J 1997;Jan 2:8.
9. Harlander SK. Biotechnology opportunities for the food industry. In: Rogers PL, Fleet GH, eds. Biotechnology and the food industry. New York: Gordon and Breach; 1989:1–16.
10. Messer E, Heywood P. Trying technology: neither sure nor soon. Food Policy 1990;15:336–45.
11. Kilman S. Growing pains: genetic engineering's biggest impact may eventually be in agriculture. Wall Street J 1994;May 30:R7.
12. Beachy R. Transferring genes. In: Burke WS, ed. Symbol,

substance, science: the societal issues of food biotechnology, conference proceedings. Research Triangle Park, NC: North Carolina Biotech Center; 1993:45–51, 61–2.
13. Hamilton J O'C. Biotech: an industry crowded with players faces an ugly reckoning. Business Week 1994; Sep 26:84–92.
14. Messer E. Sources of institutional funding for agrobiotechnology for developing countries. Adv Technol Assess Systems 1992;9(Winter):371–8.
15. Putnam JJ, Allshouse JE. Food consumption, prices and expenditures, 1970–95. Stat Bull No. 939. Washington, DC: US Department of Agriculture, 1997.
16. Gallo AE. The food marketing system in 1994. Ag Info Bull No. 717. Washington, DC: US Department of Agriculture, 1995.
17. US General Accounting Office. Food safety and quality: innovative strategies may be needed to regulate new food technologies. GAO/RCED-93-142. Washington, DC: US Government Printing Office, 1993.
18. Kessler DA, Taylor MR, Maryanski JH, et al. The safety of foods developed by biotechnology. Science 1992;256: 1747–9, 1832.
19. Centers for Disease Control. Eosinophilia-myalgia syndrome—New Mexico. JAMA 1989;262:3116.
20. Mayeno AN, Gleich GJ. Eosinophilia-myalgia syndrome and tryptophan production: a cautionary tale. Trends Biotechnol 1994;12:346–52.
21. Aldhous P. Yellow light on L-tryptophan. Nature 1991; 353:490.
22. Nordlee JA, Taylor SL, Townsend JA, et al. Identification of a Brazil-nut allergen in transgenic soybeans. N Engl J Med 1996;334:688–92.
23. Sampson HA, Metcalfe DD. Food allergies. JAMA 1992; 268:2840–4.
24. Fuchs RL, Astwood JS. Allergenicity assessment of foods derived from genetically modified plants. Food Technol 1996;50:83–8.
25. Environmental Defense Fund. EDF cautiously praises EPA's proposed genetic engineering rule [press release]. New York: Environmental Defense Fund; 1994: Nov 16.
26. Kaiser J. Pests overwhelm Bt cotton crop. Science 1996; 273:423.
27. Mikkelsen TR, Anderson B, Jorgensen RB. The risk of crop transgene spread. Nature 1996;380:31.
28. Gressel J. Fewer constraints than proclaimed to the evolution of glyphosate-resistant weeds. Resistant Pest Management 1996;8:2–5.
29. US Congress, Office of Technology Assessment. New developments in biotechnology—background paper. public perceptions of biotechnology. OTA-BP-BA-45. Washington, DC: US Government Printing Office, 1987.
30. Hoban TJ, Kendall PA. Consumer attitudes about food biotechnology: project summary. Raleigh, NC: North Carolina State University, 1993.
31. Zimmerman L, Kendall P, Stone M, et al. Consumer knowledge and concern about biotechnology and food safety. Food Technol 1994;48:71–7.
32. Hallman WK, Metcalfe J. Public perceptions of agricultural biotechnology: a survey of New Jersey residents. Rutgers University and the New Jersey Agriculture Experiment Station, 1993.
33. Hoban TJ. Consumer acceptance of biotechnology: an international perspective. Nature Biotechnol 1997;15: 232–4.
34. US Congress, Office of Technology Assessment. Biotechnology in a global economy. OTA-BA-494. Washington, DC: US Government Printing Office, 1991.
35. Food and Drug Administration. Interim guidance on the voluntary labeling of milk and milk products from cows that have not been treated with recombinant bovine somatotropin. Fed Reg 1994;59:6279–80.
36. US General Accounting Office. Recombinant bovine growth hormone. FDA approval should be withheld until the mastitis issue is resolved. GAO/PEMD-92-26. Washington, DC: US Government Printing Office, 1992.
37. Leary W. FDA approves altered tomato that will remain fresh longer. New York Times 1994;May 19:A1, B7.
38. Dickman S. Germany joins the biotech race. Science 1996;274:1454–5.
39. Smith PG, Cousens SN. Is the new varient of Creutzfeldt-Jakob disease from mad cows? Science 1996; 273:748.
40. Ibrahim YM. Genetic soybeans alarm Europeans. New York Times 1996;Nov 7:D1, D24.
41. Feder BJ. Biotechnology company to join those urging labels on genetically altered products. New York Times 1997;Feb 24:B8.
42. Burros M. Trying to get labels on genetically altered food. New York Times 1997;May 21:C3.