DEFYING NATURE: THE ETHICAL IMPLICATIONS OF GENETICALLY MODIFIED PLANTS

Debra M. Strauss[*]

I. INTRODUCTION

> *Genetic engineering is changing the semantics, the meaning of life itself. We're trying to usurp the plant's choice. To force alien words into the plant's poem, but we [have] a problem. We barely know the root language. Genetic grammar's a mystery . . . . We've learned a lot about the letters—maybe our ability to read and spell words now sits halfway between accident and design—*

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* Debra Strauss is an Assistant Professor of Business Law at Fairfield University, Charles F. Dolan School of Business. She received her B.A. from Cornell University and her J.D. from Yale Law School. Professor Strauss, a former Food and Drug Law Institute Scholar, currently teaches the legal environment of business, international law, and law and ethics.

> *but our syntax is still haphazard. Scrambled. It's a semiotic nightmare.*[1]

> *Man alone of all Nature's children thinks of himself as the center about which his world, little or large, revolves, but if he persists in this hallucination he is certain to receive a shock that will waken him or else he will come to grief in the end.*[2]

One of the essential functions of life is the ability to reproduce for the survival of future generations. The biotechnology industry is taking this ability away in order to turn a profit for no other reason than because they can – man has figured out the essence of life.

Genetically Modified Organisms (GMOs) are created when the genes of one organism are inserted into the DNA of another organism, causing the target trait to be expressed in that non-related species.[3] The genetically modified (GM) plants then produce GM foods and ingredients, which now occupy a vast majority of food products on U.S. grocery store shelves.[4] Glyphosate-tolerant soybeans (e.g., Roundup Ready® by Monsanto) contain a gene that protects them from the herbicide glyphosate, allowing the fields to be sprayed with the herbicide to kill the weeds while leaving the soybeans standing.[5] Herbicide-resistant varieties of canola, cotton, corn, radicchio, rice, and sugar beet are also on the market.[6] Genes derived from a bacterium in the soil used as an insecticide, *Bacillus thuringiensis* (Bt), have been inserted into crops to induce the plant to produce a toxin against certain insects, producing Bt-corn, Bt-cotton, Bt-potatoes, Bt-rice, and Bt-tomatoes.[7] The United States has approved virus-

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1. RUTH OZEKI, ALL OVER CREATION 124-25 (Penguin Books 2003).

1. *Id.* at 243 (quoting LUTHER BURBANK & WILBUR HALL, THE HARVEST OF THE YEARS (1927); Luther Burbank was a pioneer of agricultural science who, among other things, developed the Burbank potato).

2. *See* Associated Press, *Americans Clueless About Gene-Altered Foods* (Mar. 24, 2005),*available at* http://pewagbiotech.org/newsroom/summaries/dis-play.php3?NewsID=857.

2. The Grocery Manufacturers of America estimates that seventy-five percent of
all processed foods in the United States contain a GM ingredient, including almost every product with a corn or soy ingredient and some containing canola or cottonseed oil. *See id*. (statement of Stephanie Childs, Grocery Manufacturers of America).

3. *See* Food & Drug Administration (FDA), Center for Food Safety & Applied Nutrition (CFSAN), *List of Completed Consultations on Bioengineered Foods* (Nov. 2005), *available at* http://www.cfsan.fda.gov//~lrd/biocon.html.

4. *See id.*

5. *See id*. "*Bacillus thuringiensis* (*Bt*) is a naturally occurring soil bacterium that produces proteins active against certain insects." Mike Mendelsohn et al., *Are Bt Crops Safe?*, 21 NATURE BIOTECHNOLOGY 1003 (Sept. 2003).

resistant varieties of papaya, potato, and squash, along with tomato and cantaloupe varieties containing a gene that slows the ripening process to allow fruit to ripen longer on the vine.[8] There is even an invention called "Terminator" technology, also known as Genetic Use Restriction Technologies (GURTs), which refers to plants that have been genetically modified to render sterile seeds at harvest, eliminating the possibility of future generations from a plant's seeds.[9] Terminator technology was developed by the multinational seed/agrochemical industry and the United States Department of Agriculture (USDA) to prevent farmers from saving and replanting harvested seed.[10] Terminator technology has not yet been commercialized or field-tested, but tests are currently being conducted in greenhouses in the United States.[11]

Unlike the strict regulatory approach of European and international law, the United States does not treat genetically modified foods differently than other foods.[12] Since the development of GM foods, no federal legislation has been enacted, nor have regulatory agencies required any labeling or special approval of these substances.[13] The legal system in the United States appears to be ill-equipped or unwilling to recognize the risks (i.e., the Food and Drug Administration (FDA) does not consider genetically engi-

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8. *See id.*

9. Ban Terminator, *Genetic Use Restriction Technologies (GURTs)*, http://www.banterminator.org/glossary/genetic_use_restriction_technologies_gurts (last visited Aug. 18, 2007).

10. CANADIAN INST. FOR ENVTL. L. & POL'Y, FACT SHEET SERIES ON INNOVATIVE TECHNOLOGIES—2006: GENETIC USE RESTRICTION TECHNOLOGIES (GURTS) OR TERMINATOR TECHNOLOGY, at 3 (2006), *available at* http://www.cielap.org/pdf/TerminatorTechnologyFactsheet.pdf.

11. "Genetic Use Restriction Technologies (GURTs) is the 'official' name for Terminator technology that is used at the United Nations and by scientists. It refers to ...technologies that, in their design, provide a mechanism to switch introduced genes on or off, using external inducers like chemicals or physical stimuli (e.g., heat shock). This mechanism allows for restricted use or performance of transgenes." *See* Ban Terminator, *supra* note 9. Two types of GURTs rely on the same mechanism: variety-related (V-GURTs) and trait-related (T-GURTs). V-GURTs control reproductive processes to result in seed sterility, thus affecting the viability of the whole variety. T-GURTs control the use of traits such as insect resistance, stress tolerance or production of nutrients. *See id*.

12. *See* Debra M. Strauss, *The International Regulation of Genetically Modified Organisms: Importing Caution into the U.S. Food Supply*, 61 FOOD & DRUG L.J. 167, 168 (2006) [hereinafter *International Regulation of Genetically Modified Organisms*] (discussing the legal issues associated with the regulation of GMOs, including a comparison of European and international law to the U.S. approach and a proposal for labeling and monitoring).

13. *Id.* at 182.

neered foods to be a "substantially different" product or a "material" change from other hybrid methods)[14] and regulate this area.[15] Perhaps this is another area where an examination of the ethical issues can lead to developments in the law—the arguments have to be raised for the community to address the concerns and resolve these issues.

Meanwhile, the proliferation of GM crops continues. "Global biotech crop acreage grew to 252 million acres in 2006, according to the International Service for the Acquisition of Agri-biotech Applications (ISAAA)."[16] Since biotech crops were first commercialized in 1996, the global biotech crop area has increased more than fifty-fold; most astonishingly, the one-billionth cumulative acre of biotech crops was planted in 2005.[17] These GM crops were planted in twenty-two countries by 10.3 million farmers.[18] Of the 10.3 million farmers, ninety percent are resource-poor farmers in developing countries, and developing countries comprise more than one-third of the global biotech crop acreage.[19] However, the United States leads in total crop acreage—49.8 million hectares (fifty-five percent of the global biotech area)—with the biotech crops of soybean, maize, cotton, canola, squash, and papaya.[20] Biotech soybean was the principal biotech crop in 2005, occupying 54.4 million hectares (sixty percent of global biotech area), followed by maize (21.2 million hectares at twenty-four percent), cotton (9.8 million hectares at eleven percent) and canola (4.6 million hectares at five percent).[21] Between 1996 and 2005, the first decade of commercialization of GM crops, the dominant trait introduced into crops was herbicide

14. *Id.* at 183.

15. *Id.* at 168.

16. Biotechnology Industry Organization (BIO), *2006 Global Biotech Crop Acreage Increases by 13 Percent Over 2005*, http://www.bio.org/news/features/20060210.asp?p=yes (last visited Aug. 18, 2007).

17. *See* Truth About Trade & Technology, *One Billionth Acre of Biotech Crops Has Been Planted*, http://www.truthabouttrade.org/article.asp?id=3833 (last visited Aug. 18, 2007).

18. *See* BIO, *supra* note 16.

19. *See id*. *See also* Truth About Trade & Technology, *supra* note 17.

20. CLIVE JAMES, INT'L SERV. FOR THE ACQUISITION OF AGRI-BIOTECH APPLICATIONS (ISAAA), ISAAA BRIEFS NO. 34-2005: EXECUTIVE SUMMARY: GLOBAL STATUS OF COMMERCIALIZED BIOTECH/GM CROPS: 2005, at iii, *available at* http://www.isaaa.org/Resources/publications/briefs/34/download/isaaa-brief-34-2005.pdf.

21. *Id.* at iv.

tolerance, followed by insect resistance and stacked genes for the two traits.[22]

This growth has led the industry to proclaim that "agricultural biotechnology has been adopted faster than any other farming improvement since introduction of the tractor in the 1800's."[23] A small number of powerful companies own large percentages of the world seed market, consolidating their seeds and agricultural chemical operations through buy-outs and licensing of technology.[24] "Monsanto's role as probably the most incessant promoter of genetic engineering in agriculture has been bolstered by its acquisitions of many of the largest, most established seed companies in the U.S."[25] Monsanto is publicly touting bringing to the market their "second generation traits" and their "commercial head start is helping [Monsanto] move new products through pipeline development to market faster."[26] In fact, some say that transgenic crops have been developed, introduced, and adopted quickly in the United States, perhaps in part because approval is cheaper and faster than the approval process for a new chemical pesticide.[27] With its focus on marketing, speed, and market share, this biotechnology company clearly sounds like the big business that it is, rather than a scientific organization that gives greater consideration to public policy and safety concerns.

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22. *Id.*

23. Monsanto, *Learn About Agricultural Biotechnology*, http://www.monsanto.com/monsanto/layout/feature02.asp (last visited Aug. 18, 2007).

24. *See, e.g.*, Delta and Pine Land Company (DPL), *D&PL Investor News*, http://www.deltaandpine.com/press_investors.asp (last visited Aug. 18, 2007). This U.S.-based transnational "seed giant that vows to commercialize Terminator seed technology is expanding its global reach with the recent acquisition of Syngenta's global cotton seed business. The new acquisition gives Delta & Pine Land's cotton seed business a bigger stake in India, Brazil, and Europe. The company is the world's leading cotton seed company. In 2005, DPL had revenues of $366 million." *See* Ban Terminator, *Delta & Pine Land, developer of Terminator seeds, extends global reach*, May 22, 2006, http://www.banterminator.org/news_updates/news_updates/delta_pine_land_developer_of_terminator_seeds_extends_global_reach (last visited Aug. 18, 2007).

25. Brian Tokar, *Resisting Biotechnology and the Commodification of Life*, 18 SYNTHESIS/REGENERATION, Winter 1999, *available at* http://www.greens.org/s-r/18/18-01.html.

26. Monsanto, *Products and Solutions, Setting the Standard in the Field*, http://www.monsanto.com/monsanto/layout/products/default.asp (last visited Aug. 18, 2007).

27. DAVID E. ERVIN ET AL., HENRY A. WALLACE CTR. FOR AGRIC. & ENV'T POLICY AT WINROK INT'L, TRANSGENIC CROPS: AN ENVIRONMENTAL ASSESSMENT 14 (Nov. 2000), *available at* http://www.winrock.org/wallace/wallacecenter/documents/transgenic.pdf.

These facts raise key queries: Do we trust companies like Monsanto to make these significant decisions about the future of our food supply? Given their inherent focus on profit, are they the appropriate parties to make ethical determinations about where our resources and technology should be directed?[28]

A recent survey on GM foods revealed that a significant majority of consumers believe that the government should include ethical and moral considerations when making regulatory decisions about genetic engineering.[29] Moreover, consumers "seek an active role from regulators to ensure that new products are safe."[30] In making these decisions about the public health, participation of all stakeholders is essential.

In view of the mandate from consumers and the critical role of food safety in human health and the environment, more reflective thought must be given to the direction of biotechnology in the future. Part II of this article will analyze the promise of this technology to see whether it has fulfilled its purported goals of reducing world hunger, decreasing pesticide use, improving nutritional content, and increasing farmers' income. It will then contrast these results with the potential risks of GM plants and GMOs in the food supply. In Part III, this article will examine some of the key ethical issues arising from genetic engineering: respect for nature and the value of life; consideration of the environment; rights and responsibilities; equity, power, and the economically disadvantaged; and conflicts of interest in public research. Part IV will present a proposal that takes into account these ethical concerns and, accordingly, advocates involving all stakeholders, including farmers, consumers, the environment, and underprivileged populations, as well as the biotechnology industry; educating the public on the science and risks; requiring comprehensive labeling to enable informed consumer choice; and promoting a more active and independent role for government agencies in regulating biotechnology companies. Part V will conclude with an exploration of some questions that would aid policymakers in implementing a new regulatory scheme in the United States, including comparisons to the approach

28. *See generally* HELENA PAUL & RICARDA STEINBRECHER, HUNGRY CORPORATIONS: TRANSNATIONAL BIOTECH COMPANIES COLONISE THE FOOD CHAIN (2003).

29. *See* The Melman Group, Memorandum to the Pew Initiative on Food & Biotechnology, at 7, *available at* http://pewagbiotech.org/research/2005update/2005summary.pdf.

30. *See generally* Pew Initiative on Food & Biotechnology, *Public Sentiment About Genetically Modified Food* (Nov. 2005), *available at* http://pewagbiotech.org/research/2005update/.

taken by the international community. An incorporation of ethical issues into U.S. law would call for the government to fulfill its responsibility to protect its citizens, respond to their concerns, and not betray their trust by compelling them to bear the risks of GMOs without informed consent. This article will also consider global interests such as the disparities in natural resources and technical expertise between the United States and economically developing countries, and urge that biotechnology not be used to divert important resources from the research and application of more sustainable solutions for world food security.

II. THE FAILED PROMISE

The promoters of biotechnology in agriculture promised great benefits of genetically engineered crops. A study commissioned by the World Health Organization (WHO) cited several expected benefits of this food technology, including the potential for increased agricultural productivity and improved nutritional values, along with "reduced agricultural chemical usage and enhanced farm income, and improved crop sustainability and food security, particularly in developing countries."[31] Supporters tout the goals of reducing hunger by increasing food productivity, conserving the environment by reducing pesticide and herbicide use, enhancing nutritional content, and improving food quality.[32]

However, the same study found that many of these goals have not been met.[33] "Some [farmers] report lower yields, continuing dependency on chemical sprays, loss of exports, and critically reduced profits for farmers as a consequence of using biotechnology."[34] A closer look at each of the claimed benefits reveals that the promise of this technology has not been realized. In fact, the potential risks may far outweigh any expected benefits.

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31. World Health Organization (WHO), *Modern Food Biotechnology, Human Health and Development: an Evidence-Based Study*, at iii (June 24, 2005) [hereinafter WHO Study], *available at* http://www.who.int/foodsafety/publications/biotech/biotech_en.pdf.

32. *See, e.g.,* Tzu-Ming Pan, *Current Status and Detection of Genetically Modified Organism*, 10 J. FOOD & DRUG ANALYSIS 229, 230 (2002).

33. WHO Study, *supra* note 31, at 53-55.

34. *Id.* at 53; *see also* Press Release, Soil Association, GM crops increase chemical use by 70 million pounds (Jan. 13, 2004), *available at* http://www.soilassociationscotland.org/web/sa/saweb.nsf/848d689047cb466780256a6b00298980/4111f557521ae02680256e1a005eba55!OpenDocument.

A. The Reduction of World Hunger

Despite its noble goals to increase the food supply on the planet, the technology has not been applied in that direction. So far, the large yield increases, which had been anticipated from crops such as engineered Bt-corn and cotton, have not been documented.[35] Experimental trials now indicate that genetically engineered seeds do not increase crop yields.[36] Moreover, genetically modified (GM) products currently on the market appear to benefit seed companies and some large farmers, rather than offering higher quality or lower prices to consumers.[37]

Fundamentally, the notion that GM crops hold the solution to world hunger misconceives and oversimplifies the problem, which is not due to a lack of food. Experts affirm that enough food exists to feed the world population and that the hunger problem is due to a lack of access, distribution, and sustainability of practices.[38] In denouncing the view that hunger is due to a gap between food production and human population growth, others point to poverty, inequality, and lack of access to food and land as the real causes.[39] The use of this technology cannot be effective as a quick fix for a larger social problem.

There are suggestions that the use of biotechnology in agriculture may even worsen the situation by diverting attention and resources from the real issues and solutions. Studies show that much of the needed food can be produced by small farmers located throughout the world using agroecological technologies.[40] Farmers

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35. Margaret Rosso Grossman, *Biotechnology, Property Rights and the Environment*, 50 AM. J. COMP. L. 215, 218 (Supp. 2002) (outlining the risks and benefits associated with GM foods); ERVIN, *supra* note 27, at 20-21, 30.

36. Miguel A. Altieri & Peter Rosset, *Ten Reasons Why Biotechnology Will Not Ensure Food Security, Protect the Environment and Reduce Poverty in the Developing World*, 2 AGBIOFORUM 155, 156 (1999), *available at* http://www.agbioforum.org/v2n34/v2n34a03-altieri.pdf.

37. *See* Grossman, *supra* note 35; *see also* John Hodges, *The Genetically Modified Food Muddle*, 62 LIVESTOCK PROD. SCI. 51, 52 (Dec. 1999).

38. Sophia Kolehmainen, *Precaution before Profits: An Overview of Issues in Genetically Engineered Food and Crops*, 20 VA. EVNTL. L.J. 267, 286 (2001) (Director of Programs at the Council for Responsible Genetics discussing risks of GMOs to human health and environment).

39. Altieri & Rosset, *supra* note 36.

40. Norman Uphoff & Miguel Altieri, *Alternatives to Conventional Modern Agriculture for Meeting World Food Needs in the Next Century* (Report of a Bellagio Conference, Cornell International Institute for Food, Agriculture and Development) (1999), *available at* http://rodaleinstitute.org/international/conference/bellagio.pdf.

and non-governmental organizations initiating new rural development approaches and low-input technologies are making progress in securing food sustainability at the household, national, and regional levels in Africa, Asia, and Latin America.[41] Supporting GM technology may actually hamper these efforts, in that "[f]ailure to promote such people-centered agricultural research and development due to the diversion of funds and expertise towards biotechnology will forego an historical opportunity to raise agricultural productivity in economically viable, environmentally benign, and socially uplifting ways."[42] Most significantly, these alternate, arguably preferable methods do not carry the same risks to human health and the environment that are involved with the use of biotechnology. In contrast, any promise to end world hunger has been thwarted as the companies have utilized this technology to produce Terminator seeds, so that the farmers and poor nations are forced to buy the seeds every year and change the traditional ways of farming.[43] To make matters worse, the Terminator gene can spread to the farmers' other crops through cross-pollination, contaminating them and effectively condemning all future generations of these plants to a death sentence.[44] The security of the world's food supply has never been more precarious.[45]

B. The Reduction of Pesticide Usage

As part of its pledge, Monsanto promises to "use sound and innovative science and thoughtful and effective stewardship to deliver high-quality products that are beneficial to [its] customers and to the environment."[46] Contrary to its marketing materials which promise farmers that they will reduce pesticide use or chemical inputs, the

41. Altieri & Rosset, *supra* note 36, at 159 (citing JULES PRETTY, REGENERATING AGRICULTURE: POLICIES AND PRACTICES FOR SUSTAINABILITY AND SELF-RELIANCE (1995)).

42. *Id.*

43. *Id.*

44. *See* Martha L. Crouch, *How the Terminator Terminates: An Explanation for the Non-Scientist of a Remarkable Patent for Killing Second Generation Seeds of Crop Plants*, 18 SYTHESIS/REGENERATION (1999) (explaining the patent for killing second generation seeds of crop plants and the environmental risks involved).

45. *See* Ricarda A. Steinbrecher & Pat Roy Mooney, *Terminator Technology: The Threat to World Food Security*, 28 THE ECOLOGIST 276 (1998), *available at* http://www.orpheusweb.co.uk/john.rose/ttech.html.

46. Monsanto, *Our Pledge,* http://www.monsanto.com/monsanto/layout/our_pledge/monsanto_pledge.asp (last visited Aug. 18, 2007).

herbicide resistant plants may in fact do the opposite.[47] Instead of applying pesticides sparingly, farmers can spray even more toxic chemicals on the plants because they are not concerned about killing the GM crops as they would be with non-genetically engineered varieties.[48] Moreover, this GM product may increase pesticide use even further in the future with the inevitable development of herbicide resistant weeds.[49] One expert has predicted that "[a]lthough in a few instances [herbicide-resistant crops] may result in a reduction of toxic herbicide use, it is more likely that the use of herbicide-resistant crops will increase herbicide use and environmental pollution."[50] In addition, he notes that "farmers will suffer because of the high costs of employing herbicide-resistant crops [particularly since herbicide-resistant crops] may increase weed control costs two-fold."[51]

The profit motive of the biotechnology companies is obvious, as they also own the companies supplying the chemicals.[52] The names of the products themselves clearly indicate this connection, for example, Monsanto's Roundup® pesticide to be used with Monsanto's Roundup Ready® (Roundup® resistant) plants.[53] It is not surprising, then, that "more than forty percent of the research conducted by biotechnology firms focuses on the development of herbicide-resistant crops."[54] If the use of these crops increases sales of pesticides, these companies raise their revenue exponentially. Juxtaposed in Monsanto's promotional materials is a statement of its record sales of $5.95 billion in the first three quarters of 2006, which Monsanto attributes primarily to its seed and traits business and

47. Institute of Science, Technology, and Public Policy, *Genetic Engineering: A Cautionary Approach* (Feb. 13, 2001), http://www.istpp.org/genetic_engineering.html (last visited Aug. 22, 2007).

48. *Id.*

49. *Id.* "Some scientists estimate that not only will herbicide use triple as a result of herbicide resistant crops, but will ultimately give rise to herbicide resistant weeds as well." *Id.*

50. David Pimentel, *Overview of the Use of Genetically Modified Organisms and Pesticides in Agriculture*, 9 IND. J. GLOBAL LEGAL STUD. 51, 63 (2001) (a study by a Professor of Ecology and Agricultural Science at Cornell University of the effect of GMOs on pesticide use in agriculture).

51. *Id.*

52. Altieri & Rosset, *supra* note 36.

53. *Id.*

54. Pimentel, *supra* note 50.

higher sales of Roundup herbicides in the United States and Argentina.[55]

In addition, even plants that are genetically engineered for pest resistance, such as Bt crops, may need the application of pesticides. When farmers plant Bt-engineered crops that kill their target predators, they still need to spray their fields to control other insects that are resistant to Bt.[56] Moreover, these pest-resistant varieties may trigger the creation of Bt-resistant "super bugs."[57] Bt crops violate the widely accepted principle of integrated pest management (IPM)—that reliance on any single pest management technology tends to trigger shifts in pest species or the evolution of resistance through one or more mechanisms.[58]

It should also be noted that as the effectiveness of Bt as a pesticide is ultimately reduced by this extreme overuse, the organic farmer will be further impacted. Currently, Bt is one of the only resources available to organic farmers, who use it in small quantities in its original form as a natural pesticide.[59] The insertion of the Bt gene directly into the cells of these plants may render useless the natural Bt pesticide that is relied upon by organic farmers and others desiring to reduce chemical dependence.[60]

Theoretically at least, the use of engineered plants in sustainable and integrated agriculture should reduce pesticide use, but this is not the current trend. "The current products—especially herbicide-resistant crops and Bt-resistant crops–have serious environmental impacts."[61] These facts, combined with the risks associated with GMOs and the greater threat that GM crops pose to the organic farming industry, reveal that the use of genetics to control weeds and pests in this situation may not be as beneficial as

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55. Monsanto, *Seed and Traits Business Drives Record Third-Quarter Sales: U.S. corn seed and traits business sees continued market share gains, broader adoption of stacked corn traits*, http://monsanto.mediaroom.com/index.php?s=43&item=17 (last visited Aug. 18, 2007).

56. *See* Andy Coghlan & Barry Fox, *Keep that Spray: Crops Made Resistant to Pests Still do Better With Chemicals,* NEW SCIENTIST, Dec. 18, 1999, at 5 (explaining that Novartis patent applications indicate that farmers may need to use more pesticides to get the most out of GM plants).

57. *Id.*

58. *See* NATIONAL RESEARCH COUNCIL, NATIONAL ACADEMY OF SCIENCES, ECOLOGICALLY BASED PEST MANAGEMENT (1996).

59. Altieri & Rosset, *supra* note 36, at 157 (citing James Mallet & Patrick Porter, *Preventing insect adaptations to insect resistant crops: are seed mixtures or refugia the best strategy?*, 250 PRO. ROYAL SOC'Y LONDON B 165 (1992)).

60. *Id.*

61. Pimentel, *supra* note 50, at 64.

claimed.[62] Moreover, a fundamental ethical question resounds: is it a noble end of man to use biotechnology to cause plants to be resistant to insecticides, so that whenever stronger pesticides are sprayed on the fields, only these resistant plants are left standing?

C. The Improvement of Nutritional Content

In answer to the question of whether GMOs are the best way to ensure nutritionally adequate food, one expert responds "no," explaining that "food insecurity is a problem of inadequate access, and GMOs promise to do little to remedy that problem."[63] The commercial interests that dominate the developments in Genetically Modified Organisms (GMOs) perceive "too little financial return to develop products targeted towards poor, malnourished populations" who would be the most likely beneficiaries of vitamin or mineral-rich grains.[64] Moreover, the focus on GMOs and public investments in biotechnologies for developing countries diverts research and development from the "agroecological, people-centered approaches that are more likely to benefit small-scale producers in the short and long term."[65] Citing this "clash between monocrop, high-tech seed, cash chemical-intensive agriculture on the one hand, and diversified, farmer-controlled, management-intensive agriculture on the other," the author concludes that "the best way to make new technologies serve the people is by having more control over these technologies in the public sector."[66]

In an apparent response to these criticisms, the biotech industry has recently focused its marketing campaign on the production of rice that is genetically fortified with vitamin A, called "Golden Rice."[67] This genetically engineered rice produces beta-carotene in its endosperm, giving it a distinct yellow color. The industry claims that Golden Rice will aid people in developing countries who lack vitamin A in their diets.[68] Critics of the biotechnology industry,

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62. *See, e.g.,* Kolehmainen, *supra* note 38, at 285-86.

63. Ellen Messer, *Food Systems and Dietary Perspective: Are Genetically Modified Organisms the Best Way to Ensure Nutritionally Adequate Food?*, 9 IND. J. GLOBAL LEGAL STUD. 65, 89 (2001).

64. *Id.* at 67.

65. *Id.* at 88.

66. *Id.* at 87.

67. Kolehmainen, *supra* note 38, at 286.

68. *See id. See also* Trisha Gura, *New Genes Boost Rice Nutrients*, 285 SCI. 98 (1999); Press Release, GE Food Alert, Monsanto Joins First Lady's Vitamin A Outreach Efforts: Beta Carotene Technology Offered to Developing World Farmers

however, cite the use of genetic engineering technology as another example of a "quick techno-fix to a larger, more complex problem."[69] They say that such GM products will not end vitamin A deficiencies because a paucity of a single micronutrient like vitamin A "seldom occurs in isolation, but is one aspect of a larger context of deprivation and multiple nutrient deficiencies."[70] In other words, people suffer from vitamin A deficiency, not because their rice contains too little vitamin A or beta-carotene, but because of a lack of variety in their diet, and they suffer many other dietary illnesses that cannot be addressed by beta-carotene.[71] "A magic-bullet solution that places beta-carotene into rice—with potential health and ecological hazards—while leaving poverty, poor diets, and extensive monoculture intact is unlikely to make any durable contribution to well-being."[72]

Furthermore, this situation presents as much a social problem in that "the obstacles of access and distribution," as with non-GE rice, "must still be overcome to get the rice to those who need it."[73] There may also be cultural barriers; in the past, non-white grains have not been accepted by some societies.[74] The Rural Advancement Foundation International (RAFI)[75] has suggested other "low-tech and more cost-effective initiatives, [including the planting of] many vitamin-rich food plants that were once cheap and available."[76] This organization argues that, "[r]ather than nurture a strategy that encourages biodiversity, golden rice could promote monocultures

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(March 16, 1999), http://www.gefoodalert.org/News/news.cfm?News_ID=165 (last visited Aug. 20, 2007).

69. Kolehmainen, *supra* note 38, at 286.

70. Genetic Res. Action Int'l, *Engineering Solutions to Malnutrition* (March 2000), http://www.grain.org/publications/reports/malnutrition.htm (last visited Aug. 18, 2007).

71. Peter M. Rosset, *Transgenic Crops to Address Third World Hunger? A Critical Analysis*, 25 BULL. OF SCI. TECH. & SOC'Y 306, 310 (2005), *available at* http://www.landaction.org/gallery/RossetGMhunger.pdf.

72. *Id.*

73. Kolehmainen, *supra* note 38, at 287.

74. *Id.* at 286-87.

75. RAFI, now called the Action Group on Erosion, Technology and Concentration (ETC group), is an organization "dedicated to the conservation and sustainable advancement of cultural and ecological diversity and human rights." *See* ETC, *About ETC Group*, http://www.etcgroup.org/en/about/ (last visited Aug, 17, 2007).

76. RAFI, ON GOLDEN PAWNS: THE GOLDEN RICE DEAL—DO THE POOR GET UNPROVEN GM RICE WHILE ASTRAZENECA GETS THE GOLD? (June 20, 2000), *available at* http://www.etcgroup.org/upload/publication/319/01/geno_ongolden.pdf.

and genetic uniformity. This is the wrong strategy."[77] Thus, although the use of this technology in this manner provides good publicity for the industry, it may not be able to fulfill its promises.

D. The Increase in Farmers' Income

Results on farmer profitability have been mixed, at best. A United States Department of Agriculture (USDA) report on the economic consequences of GM crops summarized a positive impact of the adoption of Bt-cotton on net farm returns, but a negative impact in the case of Bt-maize.[78] "An improvement of returns has also been seen with herbicide-tolerant maize, whereas no significant impacts were observed with herbicide-resistant soybean."[79] A study by the European Commission on the economic impact of GM crops on agriculture found that "a quick adoption by farmers in the United States was the result of strong profitability expectations" but "there was no conclusive evidence on farm-level profitability of GM crops."[80] In addition, a report by the Soil Association found that farmers are not achieving the higher profits promised by the biotechnology companies due to the collapse of markets for GM foods and widespread GM contamination.[81]

The WHO study determined that the cost-efficiency of GM crops appears to vary with the specific situations, such as growth conditions that are dependent on regional agro-ecological factors, particularly the baseline of pest pressure and pesticide uses.[82] As a consequence, the study concluded that in certain situations "other

77. Justin Gillis, *Monsanto offers patent waiver on 'Golden Rice,'* WASH. POST, A1, Sept. 30, 2000, *available at* http://www.grain.org/bio-ipr/?id=175.

78. WHO Study, *supra* note 31, at 53.

79. *Id.* (citing JORGE FERNANDEZ-CORNEJO & WILLIAM MCBRIDE, U.S. DEPT. OF AGRIC., GENETICALLY ENGINEERED CROPS FOR PEST MANAGEMENT IN US AGRICULTURE, AGRIC. ECON. REP. NO. AER786 (May 2000), *available at* http://www.ers.usda.gov/publications/AER786/).

80. *Id.* at 53-54 (citing EUROPEAN COMMISSION DIRECTORATE-GENERAL FOR AGRICULTURE, ECONOMIC IMPACTS OF GENETICALLY MODIFIED CROPS ON THE AGRI-FOOD SECTOR (Working Document), *available at* http://europa.eu.int/comm/agriculture/publi/gmo/ch3.htm).

81. "The Soil Association estimates that GM soya, maize, and oilseed rape could have cost the U.S. economy $12 billion since 1999 in farm subsidies, lower crop prices, loss of major export orders and product recalls." Press Release, Soil Association, GM crops are economic disaster shows new report (June 5, 2003), *available at* http://www.soilassociation.org/web/sa/saweb.nsf/848d689047cb466780256a6b00298980/80256ad80055454980256c320058c60e!OpenDocument.

82. WHO Study, *supra* note 31, at 54.

practices for planting may be more valuable because of various regional or market-related reasons."[83] In fact, in some countries prohibiting the planting of GM crops would give the region a marketing edge by guaranteeing that none of its food exports contain GM crops.[84] In other countries, potentially expensive efforts to segregate GM crops from crops of conventional or organic farming include specific isolation distances, buffer zones, pollen barriers, control of volunteer plants, crop rotation, and planting arrangements for different flowering periods, as well as monitoring during cultivation, harvest, storage, transport, and processing. Moreover, the WHO study identified additional costs from the issues of liability and compensation for economic loss due to contamination.[85]

As a means of decreasing poverty in developing countries, GM crops do not appear promising. A study of global hunger data analyzed the constraints affecting the productivity of small farmers in the third world and found that in impoverished nations, people are too poor to buy the food that is available (but often poorly distributed) or lack the land and resources to grow it themselves; in fact, overproduction—and consequent low crop prices—is one of the most persistent problems generating poverty (and thus hunger) in rural areas.[86] Rather than helping the situation, GM crops could have the opposite effect because "[a]n examination of the special risks these varieties pose for poor farmers in the complex, diverse, and risk-prone environments that characterize peasant agriculture on a global scale suggests that transgenic crop varieties are likely to be more of hindrance than a help to the advancement of poor farmers."[87] In particular, the environmental risks would be heightened for the vulnerable peasant farmers; cross-contamination could cause the loss of the locally adapted varieties that they depend on and the biodiversity critical for world food security.[88]

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83. *Id.*

84. *Id.* (citing NUFFIELD COUNCIL ON BIOETHICS, THE USE OF GM CROPS IN DEVELOPING COUNTRIES (1999), *available at* http://www.nuffieldbioethics.org/go/browseablepublications/gmcropsdevcountries/report_153.html; Hans van Meijl & Frank van Tongeren, Agric. Econ. Res. Inst., *International diffusion of gains from biotechnology and the European Union's Common Agricultural Policy* (2002), *available at* http://www.cepr.org.uk/meets/wkcn/6/ 6608/papers/tongeren.pdf; and Novis, *Economy to benefit from GM-free zones?* (Dec. 22, 2003), http://www.foodnavigator.com/news/ng.asp?id=48708 (last visited Aug. 21, 2007)).

85. *Id.* at 53.

86. *See generally* Rosset, *supra* note 71.

87. *Id.* at 306.

88. *Id.* at 312.

In addition, most products and new technologies are designed for western agriculture systems, not for developing countries. "For example, if Terminator genes enter the seed market, it will not be possible for traditional or small farmers to use their plants to produce seeds."[89] For this reason, peasant farmers and developing countries have been protesting the development of Terminator technology and pressing for the ban of these seeds.[90] Rafael Alegría of Via Campesina, an organization representing over 10 million peasant farmers worldwide, declares, "Terminator is a direct assault on farmers and indigenous cultures and on food sovereignty. It threatens the well-being of all rural people, primarily the very poorest."[91]

For the organic farmer, too, the effects of GM crops could prove detrimental. In addition to the negative implications of the overuse of Bt by the biotechnology industry discussed above, organic farming could be impacted by direct contamination of organic fields due to cross-pollination.[92] Organic farmers are now struggling to isolate their fields with only limited success and greater economic costs because they need to leave fields uncultivated as a buffer.[93] For example, "a farmer may harvest 100 rows from the sides of non-GMO fields to avoid cross-pollination and have additional costs for travel to an elevator that handles non-GMO crops."[94] Once contamination has been detected, their crops are useless.[95] In one incident, Bt corn cultivated in Texas contaminated the fields of a certified organic farmer.[96] When Terra Prima, a Wisconsin food processing company that had used the organic farmer's corn to make organic tortilla chips, detected traces of genetically engineered corn through DNA testing, it had to destroy 87,000 bags of chips, worth

89. *See* Pimentel, *supra* note 50, at 63-64.

90. *See, e.g.,* Press Release, Ban Terminator, UN Upholds Moratorium on Terminator Seed Technology, Worldwide Movement of Farmers, Indigenous Peoples and Civil Society Organizations Calls for Ban, March 31, 2006, http://www.banterminator.org/news_updates/news_updates/un_upholds_moratorium_on_terminator_seed_technology (last visited Aug. 15, 2007).

91. Ban Terminator, *Introduction to Terminator Technology*, http://www.banterminator.org/the_issues/introduction (last visited Aug. 17, 2007).

92. *See* Kolehmainen, *supra* note 38, at 280.

93. *Id.*

94. Grossman, *supra* note 35, at 222.

95. Kolehmainen, *supra* note 38, at 280.

96. *See* Anthony Shadid, *Blown Profits Genetic Drift Affects More Than Biology–U.S. Farmers Stand to Lose Millions from 'Genetic Drift' Phenomenon*, BOSTON GLOBE, G1, Apr. 8, 2001.

over $ 150,000.[97] Organic farmers may even lose their organic certification and face income loss during the years needed to be recertified as organic producers.[98] Worse yet, if this contamination goes undetected, these foods can cause potential harm to the consumers who purchased the organic food precisely to avoid ingesting GMOs—and without their knowledge and consent.

Despite the expectation that farmers and the hungry should be the main beneficiaries of agricultural research, this technology is controlled by the private sector with its development centered on profitability.[99] "By controlling germplasm from seed to sale, and by forcing farmers to pay inflated prices for seed-chemical packages, companies are determined to extract the most profit from their investment."[100] Thus, the only real beneficiaries are the companies with the capacity to use this genetic engineering in agriculture.[101]

As a result, many would conclude that the opportunity to direct biotechnology to meet these lofty goals has been squandered (e.g., on the development of herbicide resistant plants engineered to survive the spraying of the company's own pesticides or Terminator seeds that cannot reproduce, forcing these impoverished developing countries to buy additional seeds from the manufacturer). Moreover, these largely unrealized benefits in fact may be outweighed by the potential of new dangers to human health and the environment.

E. The Potential Risks

Unlike traditional pesticide use, which involves the application of highly toxic chemicals to the outside of the plant in carefully measured amounts so as not to kill the plant and can be washed off the food by consumers, genetically engineered plants contain the herbicide tolerance or pesticide resistance in *every* cell of the plant. Thus, these toxins are unavoidably ingested by people, animals, and beneficial insects. Although the effects on humans are as of yet un-

97. *See id*.

98. Grossman, *supra* note 35, at 222.

99. Altieri & Rosset, *supra* note 36 (citing SHELDON KRIMSKY & ROGER P. WRUBEL, AGRICULTURAL BIOTECHNOLOGY AND THE ENVIRONMENT: SCIENCE, POLICY AND SOCIAL ISSUES (1996)).

100. *Id.*

101. Christian J. Peters, *Genetic Engineering in Agriculture: Who Stands to Benefit?* 13 J. AGRIC. & ENVTL. ETHICS 313, 322-23 (2000).

known, the deleterious effects on the monarch butterflies[102] and the lacewings[103] do not bode well for the future.

It should be noted that the process of creating GM plants differs from ordinary hybrids because it forces recombinations that do not occur in nature, directly injecting genetic material to induce traits that are not natural for the plant, for example, insect resistance, herbicide resistance, or nut protein in a soybean to increase protein content. In contrast, hybridization "works harmoniously with superficial aspects of nature without fully disturbing the essential life force at the center of each cell."[104]

Scientists have warned of the uncertainties and dangers inherent in genetic engineering of food products and crops. In the international community, the WHO study identified several risks presented by GMOs and GM foods to human health as part of its safety assessment, including: "(a) direct health effects (toxicity); (b) tendencies to provoke allergic reactions (allergenicity); (c) specific components thought to have nutritional or toxic properties; (d) stability of the inserted gene; (e) nutritional effects associated with the specific genetic modification; and (f) any unintended effects which could result from the gene insertion."[105] In addition, GMOs generate risks to the environment such as unintended effects on nontarget organisms, ecosystems, and biodiversity, including heightened development of resistant insects; outcrossing of transgenes; and cross-contamination that may lead to genetically modified crops as the dominant species.[106] Many of these risks have already become a reality both in initial studies and alarming incidents.[107]

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102. John E. Losey, Linda S. Rayor, & Maureen E. Carter, *Transgenic Pollen Harms Monarch Larvae*, 399 NATURE 214 (1999), *available at* http://www.biotech-info.net/butterflies_btcorn.html.

103. *See* A. Hilbeck et al., *Effects of Transgenic BT Corn-Fed Prey on Mortality and Development Time of Immature Chrysoperla carnea,* 27 ENVTL. ENTOMOLOGY 480 (1998). *See also* Kolehmainen, *supra* note 38, at 285.

104. *See* Nathan Batalion, *50 Harmful Effects of Genetically Modified Food* (2000), http://www.cqs.com/50harm.htm (last visited Aug. 15, 2007). *See also* Ronnie Cummins, *Problems with Genetic Engineering,* 18 SYNTHESIS/REGENERATION (1999), *available at* http://www.greens.org/s-r/18/18-02.html (chronicling the dangers associated with the insertion of "[a]nimal genes and even human genes into plants or animals to create unimagined transgenic life forms").

105. WHO Study, *supra* note 31, at 12.

106. *Id.* at 20.

107. *See* Debra M. Strauss, *Genetically Modified Organisms in Food: A Model of Labeling and Monitoring With Positive Implications for International Trade*, 40 INT'L LAW. 95 (2006) [hereinafter *Genetically Modified Organisms in Food*] (providing a detailed discussion of the risks and the mounting evidence).

The amount that is unknown about genes significantly outweighs the amount that is known, prompting serious questions about how much risk is too much and who should bear the burden of this risk.[108] Since foods with GM ingredients are not identified, American consumers are forced to accept the potential consequences of these foods.[109] In effect, U.S. citizens are the guinea pigs in a grand experiment without their knowledge and consent because these genetically altered foods are not labeled, segregated, or monitored in the United States.[110] Query, has the risk reached the level where it has outweighed any potential benefit? Do individuals have the right to determine their own fate?

The dangers to the ecosystem and biodiversity may return to haunt the inventors; once the creation is let loose, it may spread through the planet and become the dominant species. Since GMOs are not currently segregated or labeled in the United States, and their genetic mutations can mingle with natural species, if health hazards are uncovered will it be too late to recall GM products from the food chain? As a consequence, the outcome of man as the ultimate conqueror of nature may be deeply disturbing. The WHO study concludes that "[t]he risks of biotechnology, the problems of interfering with nature, evolution and creation, and ethical considerations are of increasing importance in the civil-society debate on the development and introduction of GMOs."[111] The scientific community has devised methods to handle disagreements over scientific facts, but disagreements over the value and ethical components of food-safety assessments are often much more difficult to resolve.[112] Yet discussions of the ethical implications are essential to society's decision on how to proceed in this area.

III. THE ETHICAL ISSUES

To address from an ethical perspective the claims being made in the ongoing debate about Genetically Modified Organisms (GMOs), the Food and Agriculture Organization of the United Nations (FAO) has formed an expert panel on ethics in food and agri-

108. *See* Kolehmainen, *supra* note 38, at 277.
109. *Id.*
110. *See* Strauss, *Genetically Modified Organisms in Food*, *supra* note 107 (comparing U.S. law to the international law regulating GM foods).
111. WHO Study, *supra* note 31, at 56; *see generally* JANE MONTGOMERY & SIVRAMIAH SHANTHARAM, BIOTECHNOLOGY, BIOSAFETY, AND BIODIVERSITY: SCIENTIFIC AND ETHICAL ISSUES FOR SUSTAINABLE DEVELOPMENT (1999).
112. *Id.* at 57.

culture.[113] The first report of the FAO panel, *Ethical issues in food and agriculture*, introduces ethical questions related to its mandate,[114] such as: What is the value of food? What is the value of human health? What is the value of nature and natural resources? The FAO panel identifies as values the right to adequate food, trust, optimization, informed consent and equity, in asserting that these questions and ethical concerns are central to the debate about the future.[115]

The FAO's second report, *Genetically modified organisms, consumers, food safety and the environment*, highlights the role of ethical considerations in food and agriculture, both in view of discussions on GMOs and in relation to food safety and the environment.[116] Issues discussed include ownership of the necessary tools to produce GMOs, potential consequences of their use, and undesirable effects that could result from their application, both now and in the future.[117] Above all, the report advocates the participation of all stakeholders in making decisions regarding GMOs, emphasizing that "[w]idely communicated, accurate and objective assessments of the benefits and risks associated with the use of genetic technologies should involve all stakeholders . . . . Experts have the ethical obligation to be proactive and to communicate in terms that can be understood by the lay person."[118]

These economic and moral concerns have prompted the European Union (EU) and other countries to restrict the import of bioengineered foods or to require labeling of foods with genetically modified (GM) ingredients.[119] The continued development of genetically modified plants raises broad ethical issues, several of which will be explored below: respect for nature and the value of life; consideration of the environment; rights and responsibilities; equity,

113. For more information about the Food and Agriculture Organization (FAO), see http://www.fao.org/ (last visited Aug. 15, 2007).

114. FAO, ETHICAL ISSUES IN FOOD AND AGRICULTURE (2001) [hereinafter FAO REPORT 1], *available at* http://www.fao.org/DOCREP/003/X9601E/X9601E00.HTM.

115. *See id*. *See also* WHO Study, *supra* note 31, at 56-57.

116. *See* FAO, FAO ETHICS SERIES 2: GENETICALLY MODIFIED ORGANISMS, CONSUMERS, FOOD SAFETY AND THE ENVIRONMENT (2001) [hereinafter FAO REPORT 2], *available at* ftp://ftp.fao.org/docrep/fao/003/x9602e/x9602e00.pdf.

117. *Id.*

118. *Id.* at 25.

119. Farid E. Ahmed, *Detection of Genetically Modified Organisms in Food*, 20 TRENDS BIOTECHNOLOGY 215 (2002). *See also* Strauss, *Genetically Modified Organisms in Food*, *supra* note 107 (discussing international laws regarding GMOs).

power, and the economically disadvantaged; and conflicts of interest in public research.

A. Respect for Nature and the Value of Life

In the international community, the United Nations' Convention on Biological Diversity (CBD) recognizes the implicit value of nature itself.[120] The CBD by its terms embraces life, including "the conservation of biological diversity" and "the sustainable use of its components."[121] Thus, the CBD recognizes that "biological diversity is about more than plants, animals and micro organisms and their ecosystems—it is about people and our need for food security, medicines, fresh air and water, shelter, and a clean and healthy environment in which to live."[122] In describing the CBD, the World Health Organization (WHO) report observes, "[t]he summary of these objectives shows that all the main arguments usually discussed in a risk-benefit evaluation of food biotechnology interfere with each other, thus requiring a high level of ethical consideration."[123]

In contrast to the principles of the CBD, the biotechnology industry, with its production of genetically engineered crops, reflects a view of nature as objects to be manipulated and controlled with life forms as commodities. One author recognizes that, despite this consumerism, the United States "also share[s] an ethical commitment to democracy, freedom and love for the land, however manipulated these ideas have been in the past."[124] He thus urges U.S. citizens to question their blind allegiance to science fiction and deepen their understanding of the integrity of the natural world.[125]

The use of biotechnology on the cellular level to target agricultural issues does not involve only science and the law, but raises ethical and policy issues that strike at the very essence of life. Doing

120. *See* FAO REPORT 1, *supra* note 114; *see also* WHO Study, *supra* note 31, at 56. The UN Convention on Biological Diversity (CBD) was adopted in Rio de Janeiro in 1992. *See* IISD Linkages, *A Brief Introduction to the Convention on Biological Diversity*, http://www.iisd.ca/biodiv/cbdintro.html (last visited Aug. 15, 2007). The United States signed the CBD but did not ratify it.

121. CBD, art. 1, *available at* http://www.biodiv.org/convention/articles.asp?lg=0&a=cbd-01.

122. CBD, *About the CBD*, http://www.biodiv.org/convention/default.shtml (last visited Aug. 16, 2007).

123. WHO Study, *supra* note 31, at 56.

124. *See* Tokar, *supra* note 25.

125. *See id.*

so should not be taken lightly without consideration of all of the ramifications, recognizing that

> [w]hen we start to alter the genetic composition of organisms, we take into our own hands the instructions for life—instructions that have been slowly and carefully evolving since the first appearance of life on this planet, instructions that support the delicate balance of our ecosystem. In assuming the immense responsibility to change those basic instructions, we must honestly and thoroughly analyze every possible motivation and ramification of this novel technology—not only environmental, but social, political, ethical, and economic as well.[126]

The biotechnology industry acts on a drive to convert into a marketable product all that is alive, altering the patterns of nature so as to suit the whims of the commercial market. Genetic engineering contradicts the unpredictability and freedom that is an inherent component of life, to control that which cannot be the controlled. As a result,

> [n]othing in nature, from the bacteria that live deep within boiling hot geysers to the molecules that form the human immune and reproductive systems, would be immune from such exploitation and, where possible, redesign. Biotechnology offers a way to continue ignoring underlying problems, and perpetuates the myth that the inherent ecological limitations of a nature-denying way of life can simply be engineered out of existence.[127]

In imposing a non-living model on nature, this use of technology ignores critical values and reflects a lack of respect for life itself.

From an ethical perspective, Terminator seeds represent the height of this folly—the biotechnology companies have taken away the essential function of life to reproduce. In addition, this technology involves issues of ownership and the appropriateness of patenting life forms.[128] Patenting genetic material is inherently prob-

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126. MARTIN TEITEL & KIMBERLY WILSON, GENETICALLY ENGINEERED FOOD: CHANGING THE NATURE OF NATURE: WHAT YOU NEED TO KNOW TO PROTECT YOURSELF, YOUR FAMILY, AND YOUR PLANET 18 (1999).

127. Tokar, *supra* note 25. *See also* VANDANA SHIVA, BIOPIRACY: THE PLUNDER OF NATURE AND KNOWLEDGE 24 (1997) (arguing that genetic engineering, far from being socially useful, is "the ultimate expression of the commercialization of science and the commodification of nature").

128. As a legal matter, the patenting of life has been permitted, commencing with the U.S. Supreme Court decision in *Diamond v. Chakrabarty*, 447 U.S. 303 (1980), which allowed a live organism (bacterium) to be patented. The availability of utility patent protection for plants and seeds was confirmed in *J.E.M. Ag. Supply, Inc. v. Pioneer Hi-Bred Int'l, Inc.*, 534 U.S. 124 (2001). As a result of this treatment by the courts and U.S. Patent Office, biotechnology patents have proliferated.

lematic as it also raises issues of social ethics.[129] Others have concluded that allowing such monopolies through patents on genes hampers scientific progress and is therefore not in the public interest.[130] For years, these companies have tried to control seeds and their "new" creations as their property. Monsanto attracted attention in 1998 "with its aggressive prosecutions of farmers accused of 'pirating' its seed varieties" by following the traditional farming practice of saving and replanting the company's (now patented) seeds.[131] Rather than to continue to pursue these actions, the companies have now developed a direct enforcement mechanism.[132] The plants effectively self-destruct at the end of their cycle, by preventing farmers—or nature—from continuing its innate course of germination to future generations.[133]

For these reasons, in 2000 the United Nations (UN) through the CBD adopted a de facto moratorium on sterile seed technologies, which it calls Genetic Use Restriction Technologies (GURTs).[134] Earlier this year, despite pressure from Canada, Australia, and New Zealand—"supported by the U.S. government and the biotechnology industry"—the CBD upheld the international de facto moratorium on Terminator technology.[135] However, this UN ban has not stopped the development of this technology or the support by other

129. *See* Keith Douglass Warner, *Are Life Patents Ethical? Conflict Between Catholic Social Teaching and Agricultural Biotechnology's Patent Regime*, 14 J. AGRIC. & ENVTL. ETHICS 301, 316 (2001), *available at* http://www2.ucsc.edu/cgirs/research/environment/afsrg/publications/Warner_2001.pdf (stating that "[t]he privatization of germplasm formerly considered the common heritage of humankind is incompatible with notions of the common good and economic justice"). *See generally* DONALD BRUCE & ANN BRUCE, ENGINEERING GENESIS: THE ETHICS OF GENETIC ENGINEERING IN NON-HUMAN SPECIES (1998); MARTIN TEITEL & HOPE SHAND, THE OWNERSHIP OF LIFE: WHEN PATENTS AND VALUES CLASH (1997).

130. *See* WHO Study, *supra* note 31, at 55.

131. Tokar, *supra* note 25. *See also* Altieri & Rosset, *supra* note 36, at 156 (arguing that "[b]y controlling germplasm from seed to sale, and by forcing farmers to pay inflated prices for seed-chemical packages, companies are determined to extract the most profit from their investment").

132. *See generally* Tokar, *supra* note 25.

133. *Id.*

134. Ban Terminator, *The Campaign*, http://www.banterminator.org/the_campaign (last visited Aug. 17, 2007). *See* CBD, *Agricultural Biodiversity Genetic Use Restriction Technologies (GURTs)*, http://www.biodiv.org/programmes/areas/agro/gurts.aspx (last visited Aug. 17, 2007).

135. Ban Terminator, UN Upholds Moratorium, *supra* note 90.

countries that continue to issue patents.[136] Life continues to be treated as an inert commodity.

B. Consideration of the Environment

Tampering with the genetic blueprints for life carries the possibilities for enormous potential impact on the environment. As one consumer advocate warns,

> [n]o one has a crystal ball to see future consequences. Nevertheless, alarm signals go off when a technology goes directly to the center of every living cell—and under the guidance of a mechanical or non-living way of restructuring or recreating nature. The potential harm can far outweigh chemical pollution because chemistry only deals with things altered by fire—or things that are not alive. [137]

A farmer can use toxic chemicals and eventually convert the land back to its natural state, perhaps for organic farming, after the chemicals break down into natural chemicals in a matter of years.[138] In contrast, with genetic pollution the alteration of the life in the soil lasts forever.[139] Farms may someday be blacklisted for having once planted GM crops. As the acreage of GM plantings exponentially expands, "the spreading potential impact on all ecosystems is profound."[140]

The use of bioengineering in foods involves numerous threats to the environment, particularly cross-pollination and lack of biodiversity, as discussed above. "[G]enetically engineered plants may be more likely to exchange pollen with other plants than their non-genetically engineered cousins" and "[g]enetic contamination of neighboring crops has now been documented in the case of both corn and rapeseed (canola)."[141] The damaging effects of these transgenic plants on beneficial insects such as ladybugs and lacewings, as well as the potential impact on other wildlife, should be taken into

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136. Ban Terminator, *Delta & Pine Land, developer of Terminator seeds, extends global reach*, *supra* note 24.

137. *See* Batalion, *supra* note 104. *See also* Ricarda Steinbrecher, *What is Wrong with Nature?*, 18 SYNTHESIS/REGENERATION (1999), *available at* http://www.greens.org/s-r/18/18-12.html (quoting a genetic scientist who argues, "[a]t a time when our environment is already suffering extreme stress we should avoid risking the fragile balance or compounding our problems with genetic engineering").

138. *See* Batalion, *supra* note 104.

139. *Id.*

140. *Id.*

141. *See* Tokar, *supra* note 25.

account when deciding whether genetic engineering is worth the risk. Under the present analysis, the potential harm to human health and the environment does not appear to be outweighed by sufficient benefit.[142]

Despite these initial misgivings, one commentator calls attention to that fact that the number of scientists studying the ecological consequences of genetic engineering is far less than the multitudes of researchers and technicians "who are employed to develop the next generation of genetically engineered crop varieties."[143]

In making determinations on how to proceed, policymakers must consider the rights and responsibilities of all stakeholders—farmers, consumers, the environment, and underprivileged populations—as well as the biotechnology industry. The environment is a particularly vulnerable stakeholder, to whom we owe a special duty, because it does not have the voice to defend itself from the meddling of mankind. One is reminded of the late Justice Douglas' haunting dissent in *Sierra Club v. Morton*, when he lamented that natural resources that "feel the destructive pressures of modern technology and modern life" should have standing to sue for their own protection "before these priceless bits of Americana (such as a valley, an alpine meadow, a river, or a lake) are forever lost or are so transformed as to be reduced to the eventual rubble of our urban environment, the voice of the existing beneficiaries of these environmental wonders should be heard."[144]

C. Rights and Responsibilities

Genetic modification of plants and the failure of the U.S. government to treat these crops and food products as different from other foods raise critical ethical issues for consumers.[145] The nondisclosure of the fact that their food was developed using bioengineering techniques removes the right of informed choice. This fails the assessment from any ethical perspective, particularly a Kantian model. U.S. citizens have been deprived of their autonomy and freedom of choice, just as the farmers have been deprived of their

142. *See, e.g.,* Kolehmainen, *supra* note 38, at 281. *See generally* GERHOLD K. BECKER & JAMES P. BUCHANAN, CHANGING NATURE'S COURSE: THE ETHICAL CHALLENGE OF BIOTECHNOLOGY (1996) (listing some environmental and ethical considerations of genetically engineered plants and foods).

143. *See* Tokar, *supra* note 25.

144. *Sierra Club v. Morton,* 405 U.S. 727, 743, 750 (1972).

145. *See generally* Warner, *supra* note 129.

independent livelihoods and the plants have been deprived of their essence.[146] Individuals have the fundamental right to know what they are buying and eating, as well as the responsibility towards others and the natural world.

An economic model also favors the disclosure of information.[147] According to this reasoning, "the market for GMOs at both the consumer and producer level is unable to achieve a rational, efficient and socially optimal result due to asymmetrical information."[148] Without adequate information, consumers cannot make rational decisions about whether to purchase and consume GMOs, farmers do not have the tools to negotiate with biotech seed producers, and organic farmers cannot effectively allocate resources to protect their crops from contamination by genetic drift.[149] This market can only function efficiently "if a mechanism is established for ensuring that rational, scientifically-based information on the effects of GMOs on human health, agricultural production, and the environment is available to the public. Because transaction costs would be prohibitively high for individual consumers or farmers to obtain such information, a system of mandatory disclosures tied to discretionary participation in the market for GMOs should be established by the government."[150]

The government has a responsibility to protect its citizens, particularly in such a critical area as the safety of the food supply.[151] As a matter of ethics, the risks must not be placed on the unsuspecting public rather than on the companies who have created these genetic modifications.[152] To do so would also betray consumers' trust in their government to ensure their health and well-being as fiduciaries acting on their behalf.[153] The Food and Drug Administration (FDA) has recognized this mandate in its regulatory approach to other areas of the food supply.[154]

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146. Tokar, *supra* note 25.

147. *See* Luke Brussel, *Engineering a Solution to Market Failure: A Disclosure Regime for Genetically Modified Organisms*, 34 CUMB. L. REV. 427, 435 (2003-2004).

148. *Id.* at 430.

149. *Id.*

150. *Id.* at 432.

151. *See, e.g.,* Debra M. Strauss, *Reaffirming the Delaney Anticancer Clause: The Legal and Policy Implications of an Administratively Created De Minimis Exception*, 42 FOOD DRUG COSM. L.J. 393, 426 (1987).

152. *See id.*

153. *See id.*

154. *See id.* at 423 (applying a zero risk policy to prohibit the introduction into the food supply of food and color additives determined to cause cancer in laboratory animals).

Consumers have the right to choose what they eat, and informed choice can only be realized through labeling.[155] According to Consumers International, consumers' desires and opinions should be respected due to a fundamental right to know and make informed decisions.[156] For example, a lack of labeling as to the presence of an introduced gene removes the individuals' right to avoid known allergens and control their own fate. Eight percent of children in the United States possess food allergies, some of which can be fatal.[157] When Pioneer Hi-Bred spliced Brazil nut genes into a soybean to improve its protein content, the altered soybean provoked severe allergic attacks in eight individuals sensitive to Brazil nuts but not soybeans.[158] Without a label alerting consumers that a soybean could contain genes from a highly allergic nut, even individuals aware of their severe allergies would have no warning.[159]

While the risks generate a need for labeling of the presence of GMOs, such an approach is also necessitated above and beyond safety issues, as a matter of taste and preference and for many health-related reasons. It must be recognized that many consumers make food choices based on religious, ethical, and environmental considerations, for example, deciding not to eat veal, mass-produced chickens, or non-organic produce. If biotechnology raises similar ethical, health, and environmental concerns, it is not irrational for people to act on these preferences and aversions to risk.[160] In order to make these informed decisions, food products must be comprehensively labeled. As a matter of ethics and public policy, "[s]ince labeling laws are created to meet consumer needs, consumer opinion should be respected."[161]

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155. Jean Halloran & Michael Hansen, *Why We Need Labeling of Genetically Engineered Food*, 18 SYNTHESIS/REGENERATION (Winter 1999), *available at* http://www.greens.org/s-r/18/18-07.html.

156. *Id.*

157. Kolehmainen, *supra* note 38, at 278.

158. Julie A. Nordlee et al., *Identification of a Brazil Nut Allergen in Transgenic Soybeans*, 334 NEW ENG. J. MED. 688 (1996).

159. "About twenty-five percent of Americans have adverse reactions to foods. Eight percent of children and two percent of adults have food allergies as tested by blood immunoglobins." Batalion, *supra* note 104. Some "individuals... are so allergic to [the Brazil] nut, they go into apoplectic shock (similar to a severe bee sting reaction), which can cause death." *Id.* *See also* Marion Nestle, *Allergies to Transgenic Foods: Questions of Policy*, 334 NEW ENG. J. MED. 726 (1996).

160. TEITEL & WILSON, *supra* note 126, at 68. *See also* Halloran & Hansen, *supra* note 155.

161. Halloran & Hansen, *supra* note 155.

The decision to allow the public to consume unlabeled genetically engineered food strikes some people as "grossly undemocratic and slanted too far in favor of corporate interests."[162] "Should our society allow the purported commercial rights of a corporation to supersede the citizen's right to make informed decisions in the marketplace?"[163] Every person has a right to make choices about what they eat. Every person has a right to know.[164]

For consumers who are sensitive about the content of the food they eat, eating organic foods may be a choice they can make, but it is not a workable and equitable solution for the masses. Organic foods tend to be more expensive than non-organic products and they are not available for all foods, stores, and areas of the country. Thus, most consumers do not have the true choice to purchase organic foods as an alternative to what has previously been known as "traditional" foods. Moreover, issues of cross-contamination increasingly threaten the integrity and economic viability of the organic food supply.[165]

The government has the ethical obligation to protect the safety of the mainstream food supply for all of its citizens. The FAO expert panel on ethics recognized that

> [t]he right to adequate food, as understood today, carries with it obligations on the part of states to protect individuals' autonomy and capacity to participate in public decision-making fora, especially when other participants are more powerful, assertive or aggressive. These obligations can include the provision of public resources to ensure that those fora take place in a spirit of fairness and justice.[166]

The FAO report concluded that this right has not been fulfilled in connection with genetically engineered products.[167] The most important stakeholders have been excluded from the process because

> [c]itizens have a direct interest in technological developments, yet there are obstacles to their participation in decision-making that must be acknowledged and overcome. The public has not been adequately informed about the application of gene technology to food production or

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162. TEITEL & WILSON, *supra* note 126, at 61.
163. *Id.*
164. *Id.* at 73. *See also* Gerad Middendorf, Mike Skladany, Elizabeth Ransom & Lawrence Busch, *New Agricultural Biotechnologies: The Struggle for Democratic Choice*, 50 MONTHLY REV. 85 (1998).
165. WHO Study, *supra* note 31, at 53 (citing Codex Alimentarius Commission, *Guidelines for the Production, Processing, Labeling and Marketing of Organically Produced Foods*, *available at* http://www.fao.org/organicag/doc/glorganicfinal.pdf).
166. FAO REPORT 2, *supra* note 116.
167. *See id.* at 25-26.

> the consequent potential impacts on consumers' health and the environment.[168]

As a result, with the confusing and conflicting jumble of claims in the media, "the public is losing faith in scientists and government."[169]

Following similar reasoning, Geoffrey Podger, the Executive Director of the European Food Safety Authority (EFSA), favors a labeling approach as a means to regaining the support of the public.[170] He explains that the European opposition to GMOs was based on ethical grounds as a reaction to being denied a choice when GMO and non–GMO varieties could not be differentiated.[171] Thus, the European regulatory approach arose in part as a solution to this ethical and practical duty to inform. The advantage of labeling is that it provides a choice "[a]nd while the people who insist on choice may be quite a small part of the population, they are very vociferous and they are often in positions of power and prominence."[172] Accordingly, the key to public perceptions is a transparent regulatory process that gives people all available information on the science.[173]

In the United States, the public outrage at being denied a choice has generated a grassroots political effort to raise consciousness of consumers and alert them as to what they are not being told, while advocating labeling.[174] New legislative efforts attempt to respond to the public's right to know, as well as the safety concerns for consumers and farmers. On May 2, 2006, Representative Dennis Kucinich (Democrat-Ohio) introduced the "Genetically Engineered Food Safety Act" and four other bills regarding GMOs.[175]

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168. *Id.* at 25.

169. *Id.*

170. Geoffrey Podger, *European Food Safety Authority Will Focus on Science*, 5 EUR. AFF. (2004), *available at* https://europeanaffairs.org/archive/2004_winter/2004_winter_77.php4.

171. *Id.*

172. *Id.*

173. *Id.*

174. *See, e.g.,* The Campaign, http://www.thecampaign.org./ (last visited on Aug. 20, 2007) ("Do you know what is in your food? Is it genetically engineered? You don't know—because they won't tell you . . . .").

175. Genetically Engineered Food Safety Act of 2005, H.R. 5268, 109th Cong. (2006); Genetically Engineered Organism Liability Act of 2005, H.R. 5271, 109th Cong. (2006); Real Solutions to World Hunger Act of 2005, H.R. 5270, 109th Cong. (2006); The Genetically Engineered Pharmaceutical and Industrial Crop Safety Act of 2005, H.R. 5267, 109th Cong. (2006); Genetically Engineered Crop and Animal Farmer Protection Act of 2005, H.R. 5266, 109th Cong. (2006). *See* The Campaign, *Legislation*, http://www.thecampaign.org./legislation.php (last visited Aug. 20,

Most important is the responsibility of government to protect its citizens and respond to their concerns. This moral imperative would suggest mandatory labeling and monitoring of, and possibly a moratorium on, the use of GMOs in food.[176] Unlike the Europeans, U.S. citizens trust their government and regulatory agencies.[177] This fact offers an even greater reason why it is critical that the government does not betray that trust.

D. Equity, Power, and the Economically Disadvantaged

Any exploration of ethical issues should include consideration of equity, distributive justice, and the greater good. Of particular interest are two of the questions adopted by the Rotary Club as part of their statement of business ethics: "[i]s it fair to all concerned?" and "[w]ill it be beneficial to all concerned?"[178]

Contrary to these ethical principles, the story of biotechnology in food has become a matter of corporate control. "A small number of powerful transnational companies have come to increasingly dominate the fields of seed production, agricultural chemicals and pharmaceuticals."[179] According to the Action Group on Erosion, Technology and Concentration (ETC Group), the top ten multinational seed firms control half of the world's commercial seed sales (a total worldwide market of approximately $21 billion per year).[180] Corporate control and ownership of seeds—the first link in the food chain—has far-reaching implications for global food security. Sophia Kolehmainen, Director of Programs at the Council for Responsible Genetics, explains that

> [a] small number of corporations are taking legal and physical control over the world's food supply, thereby decreasing biodiversity while

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2007). *See also* Strauss, *International Regulation of Genetically Modified Organisms*, *supra* note 12, at 186-87 (describing these bills the last time they were introduced by Rep. Kucinich in May 2002).

176. For more on the proposals for a regulatory response, see Strauss, *International Regulation of Genetically Modified Organisms*, *supra* note 12.

177. George Gaskell et al., *Worlds Apart? The Reception of Genetically Modified Foods in Europe and the U.S.*, 285 SCI. 384 (1999) (describing an attitudinal study analyzing public perceptions of biotechnology, together with press coverage and policy formation).

178. Rotary International, *About Rotary*, http://www.rotary.org/aboutrotary/4way.html (last visited August 21, 2007).

179. Tokar, *supra* note 25.

180. ETC Group Communiqué, *Global Seed Industry Concentration–2005*, Sept./Oct. 2005, Issue #90, *available at* http://www.etcgroup.org/upload/publcation/pdf_file/48 [hereinafter *Seed Industry Concentration*].

> working within systems of food ownership at the genetic level. The issues of patents on living organisms, ag-biotech monopolies, and the creation of monocultures all raise serious questions about the soundness of genetically engineering the world's food supply.[181]

The prevalence of large monopolies in the seed and chemical industry threatens to exclude the voices of farmers and consumers from the debate about genetically engineering food. This scenario is unwise for ethical and public policy reasons, as "[r]elying on a handful of self-interested corporations to make important and far-reaching decisions about agriculture and food cannot possibly result in equitable policies, because genetic engineering threatens even the small organic farmer with risks of genetic drift and genetic pollution."[182] For example, the creation of monocultures by biotechnology companies precludes the natural diversity that plants need to survive.[183] Given that the control of seeds and agricultural research is held in fewer hands—with the power and priority of protecting their financial interests in the technology—the world's food supply is "increasingly vulnerable to the whims of market maneuvers."[184]

The use of Terminator technology raises issues of equity as well, because it makes farmers dependent on biotech companies and takes away their livelihoods, preventing them from regenerating their plants from year to year.[185] The latter is particularly ironic for developing countries, adding a financial burden to an impoverished country that biotechnology was supposed to help—one of the original justifications for its development. The agrochemical industry has been increasingly usurping the choices that farmers make each year about that season's crops, from the systematic patenting of plant varieties, to the restricting of crops and usage of pesticides under contract.[186] With the Terminator, the self-destruct mechanism embedded in each plant has achieved the ultimate in corporate control of these natural resources.

As discussed earlier, unequal access and ability to pay for organic foods prevents this source from being a viable alternative for the masses. Moreover, in view of the dangers of cross-

181. Kolehmainen, *supra* note 38, at 282.
182. *Id.* at 283.
183. A classic example of the dangers of monocultures was seen in the 1845 Irish Potato Famine. *Id.*
184. *Seed Industry Concentration*, *supra* note 180. *See also* LAWRENCE BUSCH ET AL., PLANTS, POWER AND PROFIT: SOCIAL, ECONOMIC AND ETHICAL CONSEQUENCES OF THE NEW BIOTECHNOLOGIES (1992).
185. *See* Tokar, *supra* note 25.
186. *Id.*

contamination, organic fields cannot be relied upon as a solution to the security of the food supply in the long run.

Similarly, specialized equity concerns come into consideration with respect to economically disadvantaged countries, raising issues such as distributive justice, fairness, utility, and competing values systems. Developing countries who have access to natural resources often find the benefits diverted to the companies who possess the technology, distribution, and control. A group of experts at a roundtable on the ethics of biotechnology posed the question, "[h]ow can we foster collaborations with countries that have natural resources that may benefit all countries through technological development and provide a fair return to the country of origin?"[187] In the international realm, the principles of the CBD provide that, in addition to the conservation of biological diversity and the sustainable use of its components, countries should promote "the fair and equitable sharing of the benefits derived from utilization of genetic resources."[188] If in fact benefits come from biotechnology products that are derived from a country's natural resources, "how much of that value should fairly be shared?"[189]

E. Conflicts of Interest in Public Research

Many people have expressed concern that the academic community involved in research is predominantly tied to the industries and the patents they seek to develop.[190] This direct financial stake, via stock options or patent participation, creates an inherent conflict of interest. One fear is that "the lure of profit could color scientific integrity, promoting researchers to withhold information about potentially dangerous side-effects."[191]

Well-funded programs in plant genetics and genetic engineering are supplanting research to enhance organic methods and other low-input alternatives. A 1990 study discovered that "from [ten percent] up to one third of biomedical researchers at prestigious uni-

187. Diane E. Hoffman & Lawrence Sung, *Symposium Report: Future Public Policy and Ethical Issues Facing the Agricultural and Microbial Genomics Sectors of the Biotechnology Industry,* 24 BIOTECH. L. REP. 10, 25 (2005) (roundtable discussion by experts of the most significant public policy and ethical issues that will emerge as a result of biotechnology).

188. CBD, *art. 1.*, *Objective*, *available at* http://www.biodiv.org/convention/articles.asp?lg=0&a=cbd-01.

189. Hoffman & Sung, *supra* note 187, at 23.

190. *Id.* at 12-13.

191. Batalion, *supra* note 104.

versities such as Stanford and MIT had direct corporate ties."[192] With the exponential growth of the biotechnology industry since then, today's figures are no doubt even higher. Will this connection continue to divert more public funds to support the research agenda of the biotechnology industry?[193]

Some groups have also raised the issue of intellectual property practices as restricting the development of new genetically engineered crops. In July 2003, a coalition of public sector research institutions announced the formation of the Public-Sector Intellectual Property Resource for Agriculture (PIPRA).[194] PIPRA, which is funded by the Rockefeller and McKnight Foundations, argues that "the benefits of much publicly funded research come to private industry through university technology transfer programs, limiting universities' flexibility to conduct research."[195] The concern is that biotechnology patents will not be applied to developments with little commercial value that would benefit the poor.[196] Perhaps this is one reason the original goal of food security has not materialized.

Because the research at public institutions is often heavily influenced by the source of funding for these projects, this predominantly private funding has diverted research time and money away from projects that would benefit "the public good, such as biological control, organic production systems and general agroecological techniques."[197] This problem has prompted calls that "[c]ivil society must request more research on alternatives to biotechnology by universities and other public organizations."[198]

IV. AN ETHICAL PROPOSAL

Upon an examination of the issues discussed above, it becomes apparent that ethical principles should shape the solution of the future of biotechnology food products. Such a resolution should include a plan to: (1) involve all stakeholders—farmers, consumers,

192. Tokar, *supra* note 25.
193. *Id.*
194. Richard C. Atkinson et al., *Public Sector Collaboration for Agricultural IP Management*, 301 SCI. 174 (2003). *See also* Public Sector Intellectual Property Resource for Agriculture (PIPRA), http://www.pipra.org/ (last visited Aug. 21, 2007).
195. Hoffman & Sung, *supra* note 187, at 15.
196. *Id.*
197. Altieri & Rosset, *supra* note 36 (citing SHELDON KRIMPSKY & ROGER P. WRUBEL, AGRICULTURAL BIOTECHNOLOGY AND THE ENVIRONMENT: SCIENCE, POLICY AND SOCIAL ISSUES (1996)).
198. *Id.*

the environment, and underprivileged populations, as well as the biotechnology industry; (2) inform them on the science, including all potential and discovered risks to human health and the environment; (3) require comprehensive labeling, which is necessary for informed consumer choice; and (4) promote more active and independent involvement of regulatory agencies vis-à-vis the biotechnology companies.

The biotechnology companies have usurped the function of government and streamlined Genetically Modified Organisms (GMOs) into production without including the full scientific community, the public, and underrepresented stakeholders such as developing countries, the small farmers, and the environment. The government must reassert its duty to protect the public by adopting a more cautious approach with greater weight on safety concerns. At this point, labeling as to the use of GMOs or genetically modified (GM) processes is essential. But "labeling must not take away the responsibility of authorities for risk assessment and decision-making."[199] This should include, at the very least, segregation of GM products, monitoring and pre- and post-market safety assessments.[200] If warranted after a full investigation into the scientific, legal, and ethical ramifications, society may ultimately decide to severely restrict or ban GMOs in food. Most importantly, all participants should be wary not to be blinded by a brilliant but unfulfilled promise.

The future of biotechnology depends in large measure on appropriate public education on both the science and the ethics to allow consumers to reach an informed opinion. In the past, the industry has learned that public perceptions, in Europe for example, can have a detrimental effect on their acceptance and on international trade.[201] Accordingly, there must be public involvement in, and a forum for, legal and ethical issues with the realization that "[f]rom this collective knowledge, balanced public policies will be possible."[202]

It is significant to note that the roundtable on ethics in biotechnology identified as a top priority the "need for common regulations regarding labeling and risk reduction across international borders so that new GM products can be imported and exported with

199. WHO Study, *supra* note 31, at 54.
200. *See* Strauss, *International Regulation of Genetically Modified Organisms*, *supra* note 12, at 191.
201. Hoffman & Sung, *supra* note 187, at 24.
202. *Id.*

assurance that the products meet global standards of safety."[203] The global nature of the technology prompted a consideration of the harmonization of laws in the international community regarding intellectual property, public health and safety regulations, and natural resource and expertise disparities.[204] In addition, scientists should be encouraged to carry out research relevant to helping developing countries with new technologies.[205]

The World Health Organization (WHO) study also recognized the need and responsibility for communicating risks to the public so that "ethical components of food-safety decisions are clearly identified as early in the process as possible" and "value-laden choices made by risk managers are made in an open, participatory process that respects the rights and roles of all stakeholders."[206] The report by the Food and Agriculture Organization (FAO) of the United Nations concluded that "a strategy that is more sensitive to ethical issues should make food-safety risk analysis more effective, by making decisions sounder, more transparent, more democratic and better understood. This, in turn, should make risk-analysis decisions more acceptable to and useful for the governments and citizens of all nations."[207]

V. CONCLUSION

From an ethical perspective, the problem is not that this technology exists, but how that technology is being used. This article has raised for discussion some important issues to consider as to ethical dimensions of the technology and how it is being utilized. Is it being applied towards the greater good? Are genetically modified (GM) plants being cultivated to produce food for the masses, or to create profits for a company whose seeds have been genetically modified to require purchase every year and not regenerate as farmers have done for centuries in order to make their living? Are GM plants being used to help the environment, or is there a greater

203. *Id.* at 27; *see also* Strauss, *Genetically Modified Organisms in Food*, *supra* note 107.

204. *See id*.

205. *Id.* The participants observed that the cost-benefit analysis for each type of technology is very different. For example, a GM product like Golden Rice to address vitamin A deficiency would be considered more cost effective than Roundup Ready® soybeans, which are not positioned as the solution to world hunger. Hoffman & Sung, *supra* note 187, at 23-24.

206. WHO Study, *supra* note 31, at 56 (citing FAO REPORT 1, *supra* note 114).

207. *Id.*

potential for harm to human health and the environment? And do the current regulations or lack thereof violate our responsibilities to others by not allowing them a choice as to whether they knowingly and willingly assume the risks of ingesting these GM substances?

If anything, this new technology should be used to assist less-developed nations, rather than to further the disparities in natural resources and technical expertise between the United States and economically developing countries. Accordingly, research should be directed towards eliminating world hunger and lowering the barriers to food distribution. While the development of Golden Rice is certainly preferable as an ethical matter to Roundup Ready® crops, note that this justification for bioengineered food has been revealed to be flawed, as an oversimplification of the problems of world hunger, vitamin deficiencies, and more complex social issues. Biotechnology should not be used to divert important resources from researching and applying more sustainable solutions for world food security.

Raising global concerns, the World Health Organization (WHO) study concluded that there is a need to discover opportunities where biotechnology can contribute to the secure generation of nutritious foods in keeping with regional needs, recognizing that "[s]uch opportunities should be based on sustainable food production preserving biodiversity and respecting the values of nature, while taking into consideration ethical objectives and social equity in respect to regional conditions, needs and wants."[208] Thus, a secure future would encompass a respect for nature and the value of life, consideration of the environment, rights and responsibilities of all stakeholders, equity, and distributive justice. As proposed above, fully informing the public and transparency in the regulatory process are key.

The ethical implications are clear, followed by the expectation that the legal system will fill in the ethical gap as it has done in so many other areas and, at the very least, require labeling, pre-market approval, and monitoring of Genetically Modified Organisms (GMOs) in food products and ingredients. EU law takes into account ethical issues.[209] It is morally imperative for U.S. law to do so

208. *Id.* at 59.

209. *See, e.g.,* Council Directive 2001/18/EC, 2001 O.J. (L106), *available at* http://binas.unido.org/binas/regs.php (regulating and restricting the distribution of GMOs and foods containing GM ingredients; including language that the Directive "improves transparency of the decision-making through consultation and re-

as well. The government must fulfill its responsibility to protect its citizens, respond to their concerns, and not betray their trust by forcing them to bear the risk of GMOs without informed consent. As one scholar has queried, "[w]ill we be able to make ethical choices about what is humanly desirable, or will society become progressively more enslaved to the 'free-market' dictum that whatever *can* be done *will* be done?"[210]

Some opponents of genetically modified foods have labeled them "Frankenfoods."[211] The origins of this analogy, as a reaction to the proliferation of untested technology with consequences that are as yet unknown, cannot easily be dismissed. Perhaps policymakers should heed the advice of that classic moral: "Learn from me, if not by my precepts, at least by my example, how dangerous is the acquirement of knowledge, and how much happier that man is who believes his native town to be the world, than he who aspires to become greater than his nature will allow."[212] Fundamentally, genetically modified plants substitute human wisdom for the wisdom of nature.[213] Our society has yet to address the ultimate issue, particularly with regard to Terminator seeds—should mankind be usurping the basic functions of life?

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porting on ethical issues and the involvement of the public in the authorisation process").

210. Tokar, *supra* note 25.

211. John S. Applegate, *The Prometheus Principle: Using the Precautionary Principle to Harmonize the Regulation of Genetically Modified Organisms*, 9 IND. J. GLOBAL LEGAL STUD. 207, 209-12 (2001).

212. *Id.* at 212 (citing MARY SHELLEY, FRANKENSTEIN, OR, THE MODERN PROMETHEUS, at 56 (Airmont Publishing Co. 1963) (1817)).

213. *Id.* at 211-13.