Ethical Evaluation of New Technologies: Genetically Modified Organisms and Plants

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One of the major lessons of the 20th century is a warning that explicit ethical evaluation of the implications of a new technology with significant potential to cause widespread social or physical harm should precede its widespread use. The leading example, not least because of the dire circumstances that prompted even worried experts to urge its development, is nuclear technology. However, several other industrial technologies had sufficient environmental or other consequences to increase demands that new technologies receive ethical as well as technical and economic scrutiny before they enter widespread use.

Genetic modification (GM) technology has inspired considerable concern since its initial development in the late 1970s and early 1980s. Genetic modification is based on the ability to produce recombinant DNA (rDNA) by "splicing" genes that trigger emergence of some desired trait (such as ability to produce particular nutrient or increased resistance to a particular disease) present in the DNA of one organism into the DNA of another to produce a new DNA sequence that will yield a plant or organism of the latter type that also has the desired trait. Since its introduction genetic modification has been touted as a major – even revolutionary – advance over earlier forms of creating new plant varieties through hybridization because it allows much more specific selection of traits. It is also seen as revolutionary because it is a "deeper" technology: hybridization works at the level of whole organisms; GM operates at the more basic level of individual genes. Like the other forms of "biotechnology" – tissue culturing, cloning, adding synthetic ingredients or inputs to the cultivation, husbandry, or processing of feeds and foods, GM technology inspires all the main forms of ethical concern that arise with new ways of handling physical objects: about impacts on the natural environment, about impacts on human health and physical well-being, about distributional consequences, about processes of decision-making regarding whether and if so when to use the technology.

Philosophers, ethicists, and others have expressed four types of objections to GM technology. Objections of the first type are what ethicists call "intrinsic objections" and involve claims that developing and using some technology is inherently wrong regardless of the results of doing so. The others are "extrinsic objections" involving claims that the technology (or action) is not inherently wrong but can be wrong if it causes or contributes to morally unacceptable situations or outcomes.

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1.) Objections based on conceptions of the divine order or of nature as independent of humans and valuable in itself:[1]

   a.) GM technology is fundamentally unnatural and hence contrary to ecological sustainability because it substitutes highly error-prone human manipulation for the natural working of life processes.

   b.) GM technology constitutes a fundamental assault on nature by disrespecting the inherent character and intrinsic worth of nature as it is.

   c.) GM technology constitutes a sacrilegious effort to redesign nature (natural varieties of life) to fit human convenience or preferences that substitutes human judgment for divine benevolence and divine guidance of the workings of the universe.

   d.) GM technology violate the sanctity or intrinsic character of life by

      i.) reducing it to genome sequences;

      ii.) destroying naturally-established species barriers;

      iii.) promoting the treatment of living things as commodities to be owned, bought or sold, and redesigned at will.

2.) Objections based on level of risk to human physical well-being

   a.) GM technology poses unacceptable risk of causing severe and irremediable ecological harm that will reduce ecosystem ability to sustain all life, including that of humans. Critics have identified at least five sources of such risk:

      i.) accidental creation of "superweeds" as GM plants and native plants growing near each other exchange pollen and produce offspring that severely disrupt ecosystems either by overwhelming other plants or requiring massive applications of pesticides to control;

      ii.) aggressive spreading of artificially-created plants that crowds out naturally occurring ones and reduces species diversity to a point the ecosystem cannot function effectively;

      iii.) large populations of genetically identical plants proving susceptible to some unanticipated disease or pest that wipes out whole crops, resulting in mass starvation;

[1] Gary Comstock, *Vexing Nature? On the Ethical Case against Agricultural Biotechnology* (Dordrecht: Kluwer, 2000) outlines the first three objections; Jeremy Rifkin, *Algeny: A New Word, a New World* (New York: Viking, 1983) raises the fourth.

iv.) pests robust enough to overcome plants with GM modifications for insect resistance will multiply and their control will require increasing amounts of or increasingly strong pesticides causing more harm to soils;

v.) GM crops have characteristics that will decrease soil quality more severely than native or even traditionally-bred plants, this will require greater use of chemical fertilizers that harm ecosystems and/or lower agricultural productivity to the point that additional wild habitat needs to be taken over for farming.[2]

b.) GM technology is another manifestation of the human hubris that led to massive environmental degradation; its development and use encourages continued under-estimation of the potential for ecological harm from human action and continued over-estimation of human ability to develop a "fix" for environmental harms already sustained.[3]

c.) GM technology promotes "industrial farming" – monoculture of similar plants in large fields relying on repeated applications of chemical fertilizers, pesticides, and herbicides – that harms ecosystems by contributing to species loss, soil depletion, soil erosion, loss of nutritional value in foods and feeds, pollution of aquifers, streams, rivers, and lakes, and the emergence of chemical-resistant insects and weeds. [4]

3.) Objections based on considerations of equity, fairness, or justice

a.) Risks from use of GM technologies are borne mainly by persons exposed to them involuntarily – those living near places where GM plants are grown or GM research proceeds, those consuming foods made from or with GM ingredients or derived from animals or plants raised on GM nutrition sources, those in societies where GM products comprise a large part of the total food and feed supply.

b.) GM technologies disproportionately benefit the relatively small groups who monopolize sources through patents or other forms of intellectual property rights: the companies (usually large ones because of the cost of using GM technology) developing GM organisms, the companies selling the seeds, rootstocks, fertilized eggs, or other source of GM plants or animals (often the same company as the developer).

c.) The marginal benefits provided by GM organisms to consumers create a situation in which benefit is enjoyed without risk, and risk is shouldered without benefit whereas in a more just world the two would both fall on the same persons.

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[2] Noted in Norman Ellstrand, "When transgenes wander, should we worry?" in Micheal Ruse and David Castle, editors, *Genetically Modified Foods: Debating Biotechnology* (Amherst NY: Promethius Books, 2002, pp. 325-330);

[3] E.g., Bill McKibbon, *The End of Nature* (New York: Anchor Books, 1999, part 2; Eric Katz, "The Big Lie: The Human Restoration of Nature," in William Throop, editor, *Environmental Restoration* (Amherst NY: Humanity Books, 2002), pp. 85-86.

[4]E.g., Marc Lappe and Britt Bailey, "Biotechnology's negative impact on world agriculture," in Gregory Pences, editor, *The Ethics of Food* (Lanham, MD: Rowman and Littlefield, 2002), pp. 156-167.

d.) GM technology increases economic inequality within countries because the size of organization needed to develop and the size of farm needed to benefit most from planting GM crops favors large multinational firms and large industrial type farms over small firms and farmers.[5]

e.) GM technology increases economic inequality between countries by imposing on developing countries agricultural techniques that are inappropriate to their climates and social circumstances; the effect is worse if a foreign-based company has been able to engage in "biopiracy" – patent a GM organism consisting wholly or partly of a variety traditionally used in a developing country's traditional agriculture.[6]

f.) Decisions about when and how to use GM technology are driven by the individual interests of developers, distributors, and users, not by considerations of public good or general welfare.

4.) Objections based on considerations of transparency and accountability in decision-making.

a.) With GM technology, as with any other, the scientific expertise needed to develop and assess the potential physical risks and benefits of the technology, and the economic expertise needed to determine whether use of the technology offers efficiency advantages over alternate ways of performing the same task are necessary to but insufficient for determining whether all or some uses of the technology are "safe," are in the public interest, and are ethically or morally acceptable. Therefore, decisions should be submitted to processes permitting extensive input from various stakeholders.

b.) GM technology, like any other likely to have large-scale effects because of the patterns of its use, should be subject to public scrutiny and widespread consideration before placed into use.

Impacts of GM Technologies

Most ethicists would agree with Ronald Sandler's view that the proper goal of technology use is "to promote human welfare in just and sustainable ways, within appropriate moral boundaries,"[7] though deep ecologists would object to the emphasis on human welfare and insist on at least equal consideration for the environment and/or other forms of life. Yet, those who focus more on human welfare often come to similar judgments on particular questions if they pay attention to the harm environmental degradation causes to human physical and mental well-being.
However, they would go about making their evaluations in different ways depending on the ethical system that they apply. Sandler applies the tradition of virtue ethics. Virtue ethics evaluates choices and actions

[5]E.g., Jack Ralph Kloppenburg, Jr. *First the Seed: The Political Economy of Plant Biotechnology* (Cambridge: Cambridge University Press, 1998); Britt Bailey and Marc Lappe, *Against the Grain: Biotechnology and the Corporate Takeover of Your Food* (Monroe, ME: Common Courage Press, 1998.

[6] E.g., Vandana Shiva, "Genetic engineering and food security," in Gregory Pences, editor, *The Ethics of Food* (Lanham, MD: Rowman and Littlefield,), pp. 130-147 and Vandana Shiva, *Biopiracy: The Plunder of Nature and Knowledge* (Boston: South End Press, 1998);

[7] Ronald Sandler, "GM Food and Nanotechnology," in A.M. Cutter and B. Gordjin, editors, *In Pursuit of Nanoethics: Transatlantic Reflections on Nanotechnology* (Springer, forthcoming), p. 7.

by determining whether they would accord to what a virtuous person would do in the situation at hand. Thus, the primary concepts applied in virtue ethics are notions of the human virtues – such as courage, honesty, humility, or compassion – and the human vices – such as cowardice, dishonesty, arrogance, or cruelty – and attention paid to the connection between the action and both the original dispositions that framed the choice or action and the impact of the choice or action on the chooser's or doer's future dispositions (or character). Virtue ethicists first ask what virtues are relevant to the situation at hand. They next consider what dispositions would be present in a person having the virtue or virtues relevant to the situation. When more than one virtue is relevant, they also consider which virtue or virtues should be subordinated to another in that particular situation, so they can identify which of the several dispositions that might apply should guide the choice or action. The focus on human virtues and vices might seem to cut off any consideration of nature, and some deep ecologists have criticized virtue ethics on that basis, but any form of virtue ethics that regards "external goods" – material things and social relations that permit experiencing a better quality of life than would be attained in their absence – as a component of the good life can easily incorporate concern for nature and the viability of ecosystems into ethical reasoning.

Sandler approaches the question of whether to use GM technology by asking first whether its use would enhance or inhibit the ability of natural and agriculturally-modified environments to produce the external goods that "nature" has traditionally provided. A virtue ethicist of a deep green hue would define these to include not simply the clean air and water, healthy soils, and raw materials that most directly affect humans, but also the range of habitat conditions for other forms of life, and this broader definition might lead the deep green virtue ethicist to see more danger to external goods from a technology than does a pale green virtue ethicist. Virtue ethicists who regard all sentient life forms as proper recipients of compassion can incorporate nature and ecosystems into ethical reasoning via the impact of environmental degradation on other species. No matter how any individual virtue ethicist justifies paying attention to the condition of nature, any virtue ethicist would oppose using GM technology if, as some of its critics content, its use would harm nature significantly and irreversibly reduce its capacity to produce external goods. A virtue ethicist concluding that use of GM technology would not have this effect then proceeds to a second question about nature, whether use would be contrary to any of the human virtues that apply to human interaction with nature. Virtue ethicists disagree about which virtues are relevant in these interactions because they, like others, disagree on the broader question of how humans should relate to nature and divide into "conservationist" (at least maintain and if possible increase the value of nature for humans) and "respect-based" (value nature in and for itself) camps.[8] The respect-based approach is likely to be more restrictive of GM technology use because it will be concerned not only with whether GM crops reduce agricultural productivity but whether they cause harm to other species or individual creatures of other species. Here, too, GM technology could violate the rules of conduct a virtuous person would follow or not. If it does, a virtuous person would not use it. If it does not, virtue ethicists proceed to a third question, does use of the technology serve virtuous human-related ends without violating any virtue-based reasons counseling against their use. The virtuous ends Sandler regards as most relevant to decisions about use of GM technology to produce new agricultural crop varieties are compassion and justice. Compassion is the attitude of attention to and concern for the situation of others; justice is a broad term covering considerations of equity and fairness among people.

[8] Gifford Pinchot, *The Training of a Forester* (Boston: J.B. Lippencott, 1937) is the classic exposition of the conservationist approach; Paul Taylor, *Respect for Nature: A Theory of Environmental Ethics* (Princeton: Princeton University Press, 1986) exemplifies the respect-based approach.

While insisting that each use of GM technology has to be evaluated separately because different transgenic plants have different impacts on nature and different implications for human social relations, he concludes that most uses of GM technology should not be encouraged. Though doubting that GM technology will have the ecosystem-collapsing effects that some critics claim, Sandler believes it usually does violate the ethics for human interaction with nature relation because they foster the attitude of hubris and the way of seeing nature as a something to be manipulated rather than adjusted to that has caused most of today's environmental harm. He further objects that most commercial applications of GM technology also violate the requirements of justice, but notes that a virtue ethicist would lead with that objection only when the particular use of GM technology does not violate the standards of virtuous behavior toward nature because the GM plant involved has been developed mindful of likely effects on nature and have or are designed to have low impact. In the end, Sandler supports those uses of GM technology serving a virtuous goal without violating a virtue-based prohibition. This, he argues, is the case with "golden rice," a variety of rice with genes inserted to increase its ability to produce beta-carotene (a good source of Vitamin A). It is respectful of nature in that it was developed to enhance vitamin synthesis rather than resistance to diseases, pesticides or herbicides so has low potential to spread or dominate other varieties of plants, and will serve justice because its developers at the Swiss Federal Institute of Technology intend to cross breed it with local varieties of rice in developing countries where Vitamin A deficiency is widespread provide it to local farmers.[9]

Peter Singer, best known for his work on animal rights, adopts a partly rights-based and partly circumstantial form of ethical reasoning. He and co-author Jim Mason suggest starting from five ethical principles "we think most people will share" when considering food choices:[10]

1.) Transparency: each person has a right to know how any food or food product is produced. This covers production processes, and the impact of production processes on the environment, as well as ingredients. In their view this not only shows respect for others but also serves as a safeguard against bad practices by permitting consumers to use production information as part of their purchasing choice.

2.) Fairness: food production should not impose the sort of costs economists call "negative externalities" on neighbors or the environment. Thus, "factory farms" that smell bad and attract lots of insects because animals are overcrowded impose externalities on their neighbors. Prices of food should reflect full costs of production. Non-environmentally sustainable methods of food production fail this test because they pass costs on to future generations

3.) Humanity (Humaneness): inflicting significant suffering on animals for minor reasons is wrong. Taken to its full consequences, this principle endorses a vegan diet above all others. Singer and Mason acknowledge, however, that not everyone can adopt such a diet; in some parts of the world conditions for growing plants are not sufficiently favorable while some people have metabolic conditions that prevent their absorbing full protein from plant sources. They also acknowledge that many people differentiate between wild and domesticated animals, and regard the latter as legitimate food. For meat-eaters, humaneness means choosing meats produced in ways that keep animal discomfort and suffering to a minimum.

[9] Ronald Sandler, "A virtue ethics perspective on genetically modified crops," in 222-23.

[10] Peter Singer and Jim Mason, *The Way We Eat: Why our Food Choices Matter* (Emmaus, PA: Rodale, 2006), pp. 270-1

4.) Social responsibility: workers have rights to safe working conditions, fair workplace practices (no forced labor, no discrimination in employment), and rights to form unions and bargain collectively. While many of these same conclusions could be drawn from principle 2 on costs, having a separate principle covers aspects of decent working conditions that do not cost extra.

5.) Needs before desires: actions preserving life and health are more justified than those merely advancing pleasure. Within and between countries this principle suggests ensuring that everyone has a nutritional minimum. Singer and Mason also use it to argue that overeating and poor food choices leading to obesity should be condemned not only for their effects on the individual but also because of the higher health care costs imposed on others wherever health care is financed through taxes or private insurance funds.

Singer has also expressed views about use of GM technology in food and feeds. He has argued that complaints GM organisms are not "natural" are beside the point. As he put it in a recent interview, "It is a mistake to place any moral value on what is natural. I mean many things are natural, including racism, sexism, war, and all sorts of diseases that we try to fight all the time. So the argument about GM food being unnatural and therefore wrong oversimplifies this debate."[11] He adds that each proposed GM organism has to be examined separately to see whether the potential gains (better nutritional value, greater drought resistance, better adaptation to particular soil conditions) outweigh potential dangers (GM crops cross-pollinating with other farmed or wild plants and creating new environmental problems, producing foods with more allergens than previous varieties, producing varieties that interfere with other aspects of human or animal metabolism or hormone systems). He also estimates the distributional consequences of GM seeds differently than many commentators. Though expressing some preference for development through what he calls "public benefit organizations" – non-profit institutes or NGOs, he argues in the *Brown Journal* interview, that "It's offering new seeds. If they're better, people will grow them; if they're not better, people won't grow them" and suggests that use of "terminator technology" (engineering the crop so that seeds taken from the first year's crop cannot be used to start the next year's crop) is self-limiting because farmers who want to be able to grow from saved seed will avoid seeds known to incorporate that technology.

Decisions about GM Technologies

In contemporary debates about how to design decision-making processes, the alternatives available are often presented in binary terms involving either an "elite" or a "democratic" processes. In these debates the term "elite" covers not only the political leaders and corporate executives holding the authority to commit governments and firms to particular courses of action, but also persons with scientific, technical, and economic expertise relevant to determining the basic physical possibility of using some technology, the relative feasibility of use as compared to other technologies serving the same broad purpose, and the relative benefit/cost ratio of using different technologies or using the same technology at different scales or in different conditions. Thus, decisions confined to corporate offices and government agencies register as "elite" even if technical experts as well as CEOs and other top executives, political leaders and agency heads participate. In an elite process, a few people participate in the process of assessing the technology and deciding whether and when to use it. In a democratic process, assessment occurs in a publicly-visible

[11] Peter Singer, "Genetically modified food and foreign aid: An interview with Krishna Chokshi," *Brown Journal of World Affairs* 14/1 (Fall/Winter 2007), pp. 135-143.

way and the choice whether or when to use is set after input from a wide variety of participants including developers, providers, intermediate users (persons who use the technology to produce a good or service ultimately bought by others), final users, and members of the general public.

Advocates of democratic governance maintain that decisions about whether and how to use a new technology or a significant innovation in an existing technology – or at least those that seem likely to make major changes to the way tasks are accomplished or have significant impact on human health or the environment – should be made in public through political processes affording wide participation.[12] In their view, knowledge of the scientific or engineering feasibility and the economic efficiency of using a technology is not sufficient for determining what action ought, may, or ought not be undertaken; social values are equally relevant and experts have no special insight into the ethical dimensions of a technology. Though competitive markets decentralize technology decisions among numerous firms, and thus provide multiple separate looks at a technology, strong democrats regard market-organized processes as insufficient because decision-making is still held within firms and competitive dynamics are likely to push the spread of a technology before its full implications are known.

This aspect of the deep democratic view goes against most traditional thinking about ethics. For much of human history, and even in some communities today, certain individuals – often the leaders of religious congregations, but also philosophers, shamans, hermits, and others believed to have particularly strong connection to sources of wisdom – are regarded as better able to make the requisite ethical judgments than individual "ordinary folk" or even a whole community considering a matter together. Deep democrats object to relying on a small circle of moral guides not because their wisdom is weak but because relying on them is another type of closed process all too likely to be skewed to elite advantage.

Yet, strong democrats are aware that groups as well as individuals can get caught up in emotional and other psychological dynamics that inhibit clear ethical thinking. To reduce the probability of that happening, they recommend open and multi-stage public deliberation processes designed to promote participation by persons of varying backgrounds and interests so that the small like-minded groups most likely to suffer from "groupthink"[13] cannot dominate the entire decision-making process. In the end, however, there is need for a determinate decision and thus of a process by which deliberation leads to a moment of choice, even if that choice can be revisited if its consequences prove undesirable later.

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[12] Such as B. Manin, ""On legitimacy and political deliberation," *Political Theory* 15: 3-27 (1987); John S. Dryzek, *Discursive Democracy: Politics, Policy, and Political Science* (Cambridge: Cambridge University Press, 1990);

[13] See Irving L. Janis, *Groupthink: Psychological Studies of Policy Decisions and Fiascos* (Boston: Houghton-Mifflin, 1983).