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Food production will be revolutionized by biotechnology

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Introduction

The subtitle for this paper could easily be “Frankenstein food or better living through chemistry?: Ethics and genetically-modified foods.” Biotechnology will truly revolutionize food production—in fact, that has already happened—and many of the existing and future technologies will raise both real and perceived ethical issues. This paper will outline some of the issues looming on the not-so-distant horizon.

The general concerns around biotechnology center around the risks of the unproven and unknown, these include the following:

- Research risks
- Safety of food and other products
- Environmental impact
- Questions about ownership claims (like patents) to animals and plants created through biotechnology
- The notion that tampering with nature is inherently wrong
- A basic unease with the idea of producing genetically modified animals, plants, and food

Research risks

We have various sorts of policies designed to minimize and contend with the variety of risks of research. There are programs within the NIH and FDA designed to assure that human subject protection policies are respected. We require an assessment of the risks to human subjects posed by research participation for individual research projects and careful attention to the consent of subjects, with oversight by local review bodies called institutional review boards (IRBs). There are a similar regulatory structures regarding research involving animals and additional USDA regulations pertaining to the care and housing of animal subjects. But both sets of rules are related to protection of human or animal subjects in research, and do nothing to address the risks to humans of animals produced using biotechnology.

More generally, there are at least three places within the federal government oversight process where the risks to humans posed by products created by biotechnology may be addressed. The FDA is charged with protecting the public by assuring that drugs and devices are both safe and efficacious. But genetically modified foods are neither, unless they are modified to be so-called nutraceuticals, which would then be subject to the same regulatory oversight as other drugs or devices. The EPA ought to have oversight over the environmental risks associated with genetically modified organisms (more on that later), but it is unclear how such risk assessment might be conducted. In the research context, environmental risk is controlled through safety measures intended to prevent unintended releases of organisms into the environment. Once genetically-modified organisms are in production, however, research-related controls would not apply. Finally the USDA seems the agency to best oversee research on genetically modified crops and food animals, but the sharing of responsibility among the relevant agencies has yet to be made clear.

Unlike research on animal and human subjects, there are less clear lines of local (institutional) oversight for research in agricultural biotechnology. One of the ongoing themes of this paper is a growing sense on the part of the public that less oversight exists in this realm and that the consequences of such research may be hard to control once its results are applied.

Food safety

There are always trade-offs in the development of food products—between cost, appearance, flavor, safety, and perception. The current debate about irradiated food is a case in point: The American public seems largely intolerant to using radiation but is apparently willing to accept unnecessarily high levels of food-borne illnesses as a result. But in genetically-modified foods, there are not entirely rational concerns about potential human health effects.

Some of these issues are not new—there are food safety concerns raised by herbicides, pesticides, fertilizers applied to crops, and hormones, antibiotics, and other drugs used in raising livestock. Genetic modification, of spe-

cies as well as their feed, raises additional safety questions, and the difficulty in addressing them is that it is very difficult to assess the risks such modifications may bring. This, along with a heightened awareness about genetically modified foods has (maybe unfairly) raised the bar for what counts as adequate proof of food safety. Even if we arrive at an acceptable approach for assessing safety, we still face an additional policy obstacle: What counts as genetically modified food? As the debate around organic food products should teach us, this will not be an easy question to answer, and only after we agree on a suitable definition can we discuss the proper regulation of genetically modified food products.

Environmental impact

Maybe the greatest unknown and the area of greatest concern is over the potential environmental impact of genetically modified crops and livestock. There is great concern, and the perception (if not the reality) of inadequate testing and knowledge regarding the effects of genetically modified crops on neighboring crops and wild-type plants. Cross-pollination or gene jumping could conceivably lead to genetic alteration of non-intended species and potentially lead to pest-resistant weeds or the introduction of newly dominant species, akin to the example of kudzu in the American south.

While such concerns have less importance for livestock production, there are worries that genetically modified animals may carry somewhat different bacteria or viruses that could cause infection of other species, including humans. However farfetched these concerns may be, they seem motivated by a belief that safety must be absolutely proven. The application of the so-called precautionary principle—that any chance of untoward or unpredicted effects are to be avoided—raises the level of what counts as sufficient evidence of safety, to a standard never before required in the production of food products.

Economic impact

As has started to occur in the European market, market acceptance or refusal of genetically-modified foods will have very important economic ramifications. Some parts of the world market are already refusing the import of genetically modified food products, with impacts all the way down the line from distributors to producers. In addition to the impact of consumer market acceptance, foreign producer acceptance of genetically modified animals for their own breed stock will have an impact on the research, development, and success of technologies developed in US research institutions and biotechnology companies.

A significant issue stemming from the development of genetically modified plant and animal technology is the

limits of intellectual property protections. At base this seems to be a fundamental question about whether genetically unique species of plants or animals can properly be “owned” by us, or at least how far claims of rights like patent protections ought to be honored. The system of patents exists to protect the interests of both inventors and society. Inventors have the incentive of a limited monopoly on their innovations, allowing them to sell or license their products or techniques for profit. But should such protections extend to the effective ownership of other living species?

Public perception

Whatever the science and public policy issues surrounding genetically modified food plants and animals, the perception of the public will largely dictate the acceptability, and therefore profitability, of biotechnology applied to agriculture. Even though efforts to genetically modify food crops and animals through selective breeding and hybridization have existed for literally hundreds of years, there is a perception that genetic modification techniques are unacceptable examples of tampering with nature. By putting human genes into animals (for health reasons, to retard spoilage, or even to allow organ transplantation), the perception is the creation of some sort of hybrid organism. In fact we could just as easily view all DNA as equal, with the only difference between human gene sequences and pig gene sequences being the base pair order and the proteins they code for. But the public is far from this level of understanding or acceptance, and so the concern over crossing species boundaries is real.

In addition to well-articulated concerns, there is also public squeamishness over genetic modification of the food they eat, which for lack of a better term can be called the “yuck factor.” There is a long history of early rejection of new technologies, with many examples in biomedicine. The first heart transplant left the public aghast that a beating heart would be taken from the chest of one person and placed into the body of another. But over time, the initial concern and revulsion was replaced by skepticism and principled objection, then grudging curiosity, followed by the novelty of the first application, and finally fully embracing the benefits of what has become a life-saving technology. The same pattern may be what is in store for genetically modified food, but we are apparently in the early stages of this process.

Recommendations

So what is next? There are a few recommendations I can make for what to expect and how to deal with them.

- There must be increased researcher and producer sensitivity to the issues I’ve raised here, with a dialogue

about them that is transparent and includes public participation.

- There must be more research on the science, policy, and ethics of genetically modified food products, to shed more light than is currently part a debate largely devoid of information but full of hot rhetoric.
- There must be more and better education of legislatures, both at state and federal levels, and of the public about what genetically modified food is and is not. Some of the large biotechnology firms have embarked on just such a campaign, so we can watch its results.
- There must be the option for consumers to choose whether or not to buy genetically modified foods, which means that we need definitions for what counts, and labeling requirements that give adequate information.

Lastly, there may be a need for discussion of self-imposed limits on the use of genetic technology in plant and animal production, along the lines of what was agreed for “genetic engineering” by a host of scientists and policy makers nearly twenty years ago at the Asilomar conference. That would require a summit of sorts to discuss these issues.

Without answering some, if not all of these concerns, we face a crisis of trust which can only undermine the science and economics of food production, which is too high a price to pay.

