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# *Tying It All Together*

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The Rutgers conference of the National Agricultural Biotechnology Council represents a potential turning point in public debates over the future of plant and animal applications of recombinant DNA manipulation and other techniques of biotechnology. Prior to the conference, debate over food and agricultural biotechnology was focused on three product groups: herbicide tolerant crops, animal drugs (especially BST), and crops engineered with the Bt gene. Although there are a few important exceptions, most products approved for use in the United States fall into one of those three groups. Debate over those products created an alignment of interests where agricultural input suppliers, the food industry, and commodity organizations opposed a coalition of interest groups representing food consumers, environmental and animal protectionists, and small scale farmers. Universities and government were caught in the middle. Only a few products (notably recombinant chymosin, the enzyme used in the production of cheese) escaped.

The Rutgers meeting provided an overview of the products that may come on-line from agricultural biotechnology early in the next century. The papers in this conference report describe new food products that will do far more to enhance the dimensions of quality that are important to consumers: taste, purity, and visual appeal. If the food industry can ensure the safety of biotechnology foods (arguably in place now at the Food and Drug Administration (FDA)) and protect the principle of individual consent and control (labels are arguably the answer), these new products will enjoy consumer support, rather than opposition. What is more, new food crops that emphasize disease resistance or that utilize less toxic forms of pest control (such as Bt crops) should garner support from the environmental community.

Authors for this NABC 8 report also note the potential for using crops and animals in the production of pharmaceutical and industrial products. If past history is any guide, the public will find the case for new or less expensive forms of human medicine a compelling one. New industrial products are among the most exciting possibilities, as applications of both plant and microbial biotechnology permit the production of fiber and cellulose crops that can relieve pressure on the world's forests. The potential for liquid fuels holds out the promise of transferring a significant part of global energy consumption from a non-renewable to a renewable basis. Granted, the potential for such products must not be allowed to substitute for the strides that society has made in conservation, but there is every reason to hope that they may become a new approach as we strive for a sustainable society.

*What constraints pose challenges to the emergence of these new uses for plant and animal biotechnology, and what new opportunities do these novel products portend?* The papers in this report provide some insight into this two-pronged question. One way of tying them all together is to recognize a synergy in both the challenges and the opportunities. A negative synergy of constraints places serious roadblocks in the path of developing these novel products, but with a few key changes that synergy could become strongly positive. Those key changes revolve around two points: trust and vision.

## CHALLENGES

The novel products discussed in the chapters of this report range from new foods that are entering the regulatory process (needing "only" regulatory approval and commercialization before becoming available on grocery shelves) to liquid fuels derived from plant biomass (that are, at present, largely a gleam in the eye of bench scientists conducting basic research). Yet, in every case, new technology will be needed to make the product a reality. In the former cases, it is scale-up technology needed for commercial production, or "soft" technology in the form of better marketing and consumer information. In the latter cases, basic problems in biochemistry, molecular biology, and process engineering are yet to be solved. The current state of knowledge is therefore a constraint that must be removed before the novel products described herein can become widely available.

Removing knowledge-based constraints will require research in biology, engineering, and social science. Research will require both human and financial capital. Although a lack of either could retard development of novel products, it seems reasonable to think that lack of money is a more serious constraint at the present time. Public sector funding for all forms of scientific research has been declining, and venture or investment capital for speculative biotechnology projects outside the area of human health has become scarce. The major agricultural biotechnology companies have herbicide tolerant or Bt crops and animal drugs to develop. It is questionable whether they will have the

additional resources, or be willing to invest in the research needed, to bring novel products to market.

One reason why investors may be reluctant to fund research in these novel products is that commercialization will require infrastructure and institutions that do not exist. Think for a moment about what will be required to get industrial fiber grown in Iowa or Illinois to the pulp mills that are now located near the pine forests of Alabama or South Carolina. Note that there are no commodity organizations for growers of hemp, or for producers of pharmaceuticals utilizing plants or farm animals. Do petroleum buyers or oil company executives traverse the Dakotas in search of new sources of supply? Novel products presuppose new and untried linkages between farm-based suppliers and the eventual buyers and users of their products; these linkages will have to be invented. It is reasonable to think that in the case of pharmaceutical products, vertically integrated firms will round-up the growers or husbandrymen they need, but even so, these contracting activities represent costs that must be included in the commercialization of such novel products.

The regulatory framework is also a crucial dimension of infrastructure for novel products. The FDA evaluates food safety, as well as the safety and effectiveness of new drugs. The direct environmental risks of new crops are also reviewed by the Environmental Protection Agency (EPA) and the Animal and Plant Health Inspection Service (APHIS) at the USDA. This much of the regulatory framework is in place. But do pharmaceutical or industrial crops and animals pose new risks to the food system? Is there any chance that milk from cows genetically engineered to lactate pharmaceutical products could contaminate the milk supply? Could crops engineered for fiber or ethanol production back cross into varieties produced for food, and if so, what are the risks? These do not seem to be insurmountable problems, yet they will require forms of regulatory oversight that do not currently exist.

Developing institutions and infrastructure will be very difficult if there is public opposition to the products themselves. Vertical organization of production may be the most cost effective method for coordinating suppliers or for maintaining the quality control needed for new food, pharmaceutical, and industrial products, but such changes in the structural organization of agriculture may be opposed by consumers and farm groups alike. Because it is unclear whether people will oppose the integration and industrialization of agriculture, the uncertainty itself comes to constrain efforts to build infrastructure or to design institutions, as well as being a disincentive for investing the money needed to support additional research. If there is a residue of public resistance to agricultural biotechnology—as a result of acrimony over BST or as a reaction against “playing God,” perhaps—the uncertainties are heightened, and the risks of undertaking the research and development of these novel (hence speculative) products begins to seem formidable indeed.

There is thus a synergy that binds the knowledge constraints, the funding

constraints, the infrastructure constraints, and the public acceptance constraints. Each constraint tends to reinforce the other three. How could the public be anything but skeptical of products descended from the heritage of controversy over herbicide tolerant crops and BST, especially when even their boosters acknowledge that too little is known at present to make those products a reality, and when even venture capitalists are reluctant to invest in them? Yet public skepticism retards the development of infrastructure (including regulatory frameworks) and undermines the support for funding that would ultimately address public concerns. One might conclude that the likelihood of seeing any of those novel products in our lifetimes is slim.

## OPPORTUNITIES

But, on the other hand, those products are more attractive to consumers, to environmental interests, and, if fears of vertical integration can be assuaged, perhaps even to small-scale producers. It is certainly the case that high quality fruit and vegetable production is already a mainstay of family farmers in the Northeast. New pharmaceutical products may well be produced on scales quite commensurate with small farms, and if drug companies do not insist on controlling the entire process, those products, too, may provide opportunities for small-scale producers to maintain a way of life. As such, it need not be a foregone conclusion that the public will oppose these products. A new coalition of interest groups might provide impressive support for them.

If a new coalition forms, it will have the capacity to address problems of infrastructure and funding in novel ways. Perhaps it will be possible for environmentalists to work with producers and industry to restructure the regulatory process for novel products. Perhaps regulatory functions can even be incorporated into organizations that reflect multiple constituencies, on the model of the Underwriters Laboratory. Small- and large-scale producers may wish to form new kinds of cooperative organizations to ensure that they maintain control over the market structure for those new products, and they may find themselves in partnership with industry giants as well as public interest groups that have a stake in seeing those technologies develop. Clearly such coalitions will have advantages in attracting investment funding, if only because they reduce uncertainty. The possibility of co-ops, working with consumer and public interest groups, in partnerships with industry for development of novel products produces a mind-bending alteration of what we might mean by “community supported agriculture” in the 21st century.

The potential for such new social amalgamations is no less innovative and radical than the biological amalgamations discussed throughout this volume. Tomorrow might look very different, and not only because we will have genetically engineered foods, fuels, and pharmaceuticals! This, of course, implies greater involvement of more people in setting the agenda for research on agricultural biotechnology, and it probably means that more kinds of

research will need to be done. The fact that such research will be popular bodes well for getting it supported not only by government but by private foundations, too. There is potential for a positive synergy, for research progress to beget public enthusiasm and cooperation, and for this enthusiasm to beget new institutions and new approaches to infrastructure. And these new institutions may provide both new sources of capital and renewed vigor in the old sources of government, foundation, and Wall Street fundraising.

This is an admittedly sketchy picture of the new positive synergy. A lot of problems will need to be solved along the way, and many of the real concerns about the novel products themselves, as well as residual problems from existing products of agricultural biotechnology, still need to be addressed. Nevertheless, there is reason to think that new coalitions will have enthusiasm for such tasks to the extent that they see themselves engaged in activities that are truly aimed at improving the human condition, including, of course, the environment on which that condition depends. Will it happen? Who knows, but at least two “big picture” items are key. One is trust, the other is vision.

#### KEYS TO POSITIVE SYNERGY: TRUST

A world in which the food industry, small and large food and fiber producers, and public interest organizations representing environmental, animal, and consumer interests work with each other (as well as with other industries) will require new levels of trust. It would be naive to suggest that such collaborations will come easily, and it is important to think carefully about what is meant by trust. Philosopher Annette Baier offers some guideposts in her recent book *Moral Prejudices: Essays on Ethics*. Writing from a feminist perspective, she encourages us to resist an interpretation of trust that confuses trust with power. It is an unavoidable fact of human society that some of us depend upon others for our jobs, our food, our health care, and for other aspects of our well-being. These relationships define relative positions of power and dependence. In democratic societies, we often speak of the rules for constraining or using power in terms of a social contract. Contractually specified power relations are “minimal moral traffic rules, designed to restrict close encounters between autonomous persons to self-chosen ones” (Baier 1994). Baier believes that while the social contract is indispensable to democracy, it is a poor model for trust. A better model emerges out of women’s experiences raising children, caring for families, and maintaining networks of care in the community.

Trust applies in situations where explicitly specified rules and contractual requirements are inadequate or inappropriate. To trust another person is to expect that there will be situations in which the trustee must exercise judgment and discernment of a sort that cannot be anticipated and spelled out in terms of contractual provisions. Trust requires that trustees make such decisions based upon a genuine and comprehensive concern for the interests, the well-being, and the whole person of those who have placed their trust in them. Yet it is also

true that relationships of trust are bounded, that they come with limits and with opportunities to monitor, revise, or revoke the trusting relationship. To put this as Baier does, children do not trust their parents; their dependency upon them is too great. Parents do trust their children to teachers, to baby-sitters, or to friends, however, and in doing so they expect something more subtle and responsive than letter-perfect adherence to the terms of an explicit contract. They expect situations that have not been anticipated by the contract, and that the trusted party will maintain trust by acting on behalf of the child, rather than interpreting the ambiguity or unexpectedness of the situation as an opportunity to revert to self-interest.

This means that some of the things Rebecca Goldberg and Caron Chess discuss—regulations that utilize conditional approval or site licenses that give citizens the power to revoke approval—may not be forms of trust in Baier's sense. Those measures seem to be negotiations of power, and our experience with such negotiations tells us that where there is ambiguity in the terms of the rule or the contract, we can expect each party to adopt the interpretation that is most favorable to themselves. Make no mistake, I am not arguing against institutions that spread power and that frame power relationships within explicit statements of rules and responsibilities. But let us not deceive ourselves into thinking that these are relationships of trust. As Baier writes, "Trust is rational in the absence of any reason to suspect in the trusted strong and operative motives which conflict with the demands of trustworthiness as the truster sees them. But trusting can continue to be rational, even when there are such unwelcome suspicions, as long as the truster is confident that in the conflict within the trusted the subversive motives will lose to the conformist motives" (Baier, 1994).

I take this to mean that each of the parties who must collaborate in order to create positive synergism for new products in biotechnology must share and remain true to a common vision, even when there are substantial individual incentives to defect from it. Perhaps an example will make this point more clearly. Many members of the National Agricultural Biotechnology Council have built a trust relationship with farmers, ranchers, and rural communities. Farmers, ranchers, and rural communities represent diverse interests, and there has always been difficulty when the knowledge produced in agricultural universities has benefited some representatives of agriculture at the expense of others. Agricultural research is also justified in terms of benefit to the larger non-agricultural public, but the trust relationship between agriculture colleges and their clientele continues to imply that the scientists, administrators, and faculty of agriculture colleges and research stations are making judgments on behalf of agriculture. Yet, though there can be little doubt that many of the novel products described in these pages are intended for public benefit, it is questionable for some (at least) as to whether they are truly agricultural biotechnology.

Novel products are exciting applications of the plant and animal sciences to the creation of products for human medicine or industrial processes, and they are in this sense good for the scientists, administrators, and faculty of agricultural colleges. But it is not obvious that such products will ever be produced by people who today recognize themselves as farmers or ranchers, or on the terms that characterize the traditional economic structure of agriculturally based communities. Are we being entirely honest, are we maintaining our trust, when we describe these as novel products of agricultural biotechnology? Will small-scale niche producers ever produce pigs for pharmaceutical production or xenografts, or will those pigs be cared for in facilities that are wholly owned and operated by medical supply or drug companies? Is it fair to say that we are helping agriculture, when in fact the most we are doing is creating wage labor opportunities to care for pigs in the employ of large multi-national corporations?

None of this is to say that such innovations should not be pursued, nor is it to say that scientists currently employed in agricultural universities should not do the work. Yet here, I think, is a way in which members of the research world can defect from the common vision of agriculture that underlies rural community support for research and education. Researchers may not *mean* to betray a trust. They may think, with some justification, that they are acting within their rights, but that is only to underscore Baier's point. Relationships of trust are not simply a matter of following the rules and obeying the law. Trust requires judicious thought about whether what is done is truly done for the sake of those who trust, or whether personal motives and opportunities may have colored the common vision. Since the point has now come to turn to vision, let us take up the second key.

### KEYS TO SYNERGY: VISION

Many of the institutional members of the National Agricultural Biotechnology Council have been engaged in processes of "visioning" during 1995 and 1996, so much so that the term may have lost whatever appeal it once had. Perhaps we would be better off to use Sister Miriam MacGillis' term, "cosmology." Whatever the terminology, the idea is to recognize that we tell one another stories about where we have come from and where we are going. Although these stories (visions) are seldom made explicit, they serve as underlying assumptions about what is real and what is worth doing. One of those stories that was told for centuries goes by the name of The Enlightenment Project. This intimidating phrase signifies the vision of science and technology relieving the many dimensions of human misery: hunger, disease, and deprivation. The individuals who conceived this vision, Francis Bacon, Thomas Hobbes, Robert Boyle, and Rene Descartes among them, lived during the sixteenth century, almost five hundred years ago. Although in some respects their vision has come true, they also thought that unleashing the forces of scientific inquiry would just automatically, naturally redress the social problems of injustice, of cruelty, of jealousies, and of corruption.

No one believes that science will automatically redress those moral problems anymore. What is more, we have learned that our technological solutions to problems of resource scarcity can create new problems of their own, problems in the form of pollution, health risk, and environmental degradation. There is no doubt that we must move beyond The Enlightenment Project, that we must find a vision (a cosmology if you will) that does not leave the resolution of moral problems facing us to a blind and inexorable notion of technical progress. However it has succeeded in other dimensions, that vision of progress has failed to create a state of bliss at the end of history. We have many problems that have always been with us, and more than a few new ones, to boot.

The mechanistic vision of nature and humanity that emerged from The Enlightenment Project has proved an inadequate basis for understanding social problems, environmental impacts, and the moral significance of technology's unexpected and unwanted effects. That much is clear. The Enlightenment Project may also have encouraged habits of mind that fixated on patterns of domination: domination of women, domination by race, domination of nature. The Enlightenment Project may have made us less sensitive to the potential for adapting to and living with our limitations, rather than trying to overcome them. It does not follow, however, that we would have been better off never to have undertaken The Enlightenment Project, nor does it follow from any of this that we should abandon all use of biotechnology. There is a huge inferential leap being made by biotechnology's critics in this regard. We should indeed devote serious and critical attention to the implicit vision that we may be working with. Formulating this vision is more important than any specific application of biotechnology, but only petty jealousy would permit us to blame biotechnology for our collective failure to address the fundamental spiritual issues of our time. The practitioners of biotechnology have been spectacularly successful in acquiring the rewards of new buildings, financial success, and public attention. It is easy (perhaps inevitable) that those who call for moral reflection over our pursuit of technological advance should feel neglected and cast aside. It is only too human to wish ill upon an industry that sometimes seems willing to exploit the state of disarray and dissolution in our collective moral vision by making fantastic promises, but the simple fact is that we will *need* biotechnology in any adequate response to the ecological and moral crises of our time.

Our new vision will almost certainly be meliorist. This forty dollar bit of philosophical jargon means that we will abandon the view that any scientific, technological, or political project will just automatically solve all our problems. We will abandon the view that progress is either inevitable or automatic. This means that we abandon both The Enlightenment Project of dominating nature's mechanisms and the conceit that there ever was a truly harmonious nature (disrupted by human activity) to which we must return. In place of this, we will recognize the ecologists dictum: everything is connected to everything else.

When we “solve” one problem, we must be prepared to find and fix whatever breaks next. Life is indeed an evolutionary process, but not one that is tending toward a state of perfection or bliss. Instead, each adjustment (whether human caused or not) adumbrates through the global ecosystem, producing myriad changes, and opening niches for novel life activities (both human and not). The evolutionary process goes on and on. It is never finished.

The vision for human action is one of ameliorating intolerable situations, one after another, and using whatever tools are at our disposal to do so. Plant and animal biotechnology will be among them. Our use of those tools should be evolutionary, rather than revolutionary. We should use biotechnology as wisely as we possibly can, and we should be vigilant in monitoring and learning from our mistakes. We can be sure that there will be some unintended consequences from using biotechnology, but there will be unintended consequences from not using biotechnology, too. We should not expect magic bullets from biotechnology or from not using it. We should do what we can humbly and reflectively. That is what meliorism means.

Yet, I would like to say a few words on behalf of Francis Bacon, Thomas Hobbes, and the other gentlemen of the Enlightenment. Their mechanistic vision of nature indeed led to the revolutions in health care, agriculture, and engineering that brought about the modern world. Would that we could formulate a vision half so productive! And while we cannot believe that exclusive attention to mechanisms will solve our moral and environmental problems, we should be reminded that thinkers like Bacon and Hobbes fully expected to spend two hours engaged in debates over philosophy and theology for every hour spent at the laboratory bench. Who knows what vision and what synergy we would discover if we were to collectively spend a similar proportion of our research effort on philosophy, history, and literature.

Reproducing a vision is even more important than the initial discovery of vision. The time that Enlightenment thinkers spent in debate over moral subjects not only honed their vision of nature and human possibility, it spread that vision to the clientele who would utilize scientific knowledge. The challenge of disseminating a vision is altogether different today. For one thing, we have tools of mass media at our disposal that were unavailable to Bacon and Hobbes, and we have the advantage of a generally literate society. But we also have a much larger client base; one that spans a much larger proportion of the population. It is far from clear whether we can afford to invest less in forming, articulating, defending, and disseminating a vision than could the founders of the Enlightenment, though it is evident that invest less we do.

The National Agricultural Biotechnology Council and its national conferences are for that reason all the more precious. They represent one of the few forums in which reflection over science and its impact on our future can take place. The novel products discussed in this meeting provoke a new reflection on what that future might entail. It is, for me, a more hopeful future than we

have hitherto seen. It will not come about without more work in both the laboratory and in reasoned public debates. To that end, let us dedicate our hearts and minds.

## REFERENCES

Baier, Annette C. 1994. *Moral Prejudices: Essays on Ethics*. Cambridge: Harvard University Press.