Panelist's Remarks

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For years academicians have assumed that agriculture poses no special problem for environmental ethics, despite the fact that human life and human civilization depend on the artificial use of nature for agricultural production. Even critics of the environmental impacts of pesticides and of the social implications of agricultural technology have failed to conceptualize a coherent environmental ethics applicable to agricultural problems (Thompson 1995). Most supporters of sustainable agriculture, driven by a technological determinism, do not understand the structural roots of the environmental degradation linked to capitalist agriculture. Therefore, by accepting the present socioeconomic and political structure of agriculture as a given, they are prevented from putting in place an alternative agriculture that challenges this structure (Levins and Lewontin 1985). This is worrisome, especially today, as profit motivations rather than environmental concerns shape the type of research and modes of agricultural production prevalent throughout the world (Busch and others 1990).

Here we contend that the key problem facing agroecologists is that modern industrial agriculture, today epitomized by biotechnology, is founded on philosophical premises that are fundamentally flawed. These premises are precisely the ones that need to be exposed and criticized in order to advance toward a truly sustainable agriculture. This is particularly relevant in the case of biotechnology, where there is an alliance of reductionist science and a multinational monopolistic industry. These jointly perceive agricultural problems as genetic deficiencies of organisms, treat nature as a commodity, and will take agriculture further down a misguided route (Levidow and Carr 1997).

This paper challenges the false promises made by the genetic engineering industry: that it will move agriculture away from a dependence on chemical inputs, that will increase productivity, as well as decrease input costs and help reduce environmental problems (OTA 1992). By challenging the myths of biotechnology we expose genetic engineering for what it really is; another "technological fix" or "magic bullet" aimed at circumventing the environmental problems of agriculture (which themselves are the outcome of an earlier technological fix), without questioning the flawed assumptions that gave rise to the problems in the first place (Hindmarsh 1991). Biotechnology develops single-gene solutions for problems that derive from ecologically unstable monoculture systems, designed on industrial models of efficiency. Such a unilateral approach was already proven ecologically unfit in the case of pesticides (Pimentel and others 1992).

Ethical Questions about Biotechnology

Environmentalists critical of biotechnology question the assumptions that biotechnological science is value free; that it cannot be wrong or misused, and call for an ethical evaluation of

genetic engineering research and its products (Krimsky and Wrubel 1996). Supporters of biotechnology are perceived as having a utilitarian view of nature and as favoring the free trading of economic gains for ecological damage with indifference to the human consequences (James 1997). At the very heart of the critique are biotechnology's effects on social and economic conditions and religious and moral values giving rise to questions such as:

- Should we alter the genetic structure of the entire living kingdom in the name of utility and profit?
- Is there something sacred about life, or should life forms, including humans, be viewed simply as commodities in the new biotechnological marketplace?
- Is the genetic makeup of all living things the common heritage of all, or can it be appropriated by corporations and thus become the private property of a few?
- Who gave individual companies the right to the monopoly over entire groups of organisms?
- Do biotechnologists feel they are masters of nature? Is this an illusion constructed on scientific arrogance and conventional economics, blind to the complexity of ecological processes?
- Is it possible to minimize ethical concerns and reduce environmental risks while keeping the benefits?

There are also questions that arise specifically from the nature of the technology, while others such as the domination of agricultural research agendas by commercial interests, the uneven distribution of benefits, the possible environmental risks, and the exploitation of the poor nations'genetic resources by rich ones demand a deeper inquiry:

- Who benefits from the technology? Who looses?
- What are the environmental and health consequences?
- What alternatives have been sacrificed?
- To whose needs does biotechnology respond?
- How does the technology affect what is being produced, how it is being produced, and for what and for whom?
- What are the social goals and ethical criteria that guide research problem choices?
- What social and agronomic goals can be achieved by biotechnology?

Biotechnology Myths

The agrochemical corporations which control the direction and goals of agricultural innovation through biotechnology claim that genetic engineering will enhance the sustainability of agriculture by solving the very problems affecting conventional farming, and will spare farmers in developing countries from low productivity, poverty, and hunger (Molnar and Kinnucan 1989; Gresshoff 1996). By matching myth with reality the following section describes how and why current developments in agricultural biotechnology do not measure up to such promises and expectations.

Myth 1: Biotechnology Will Benefit Farmers in the United States and in the Industrial World.

Most innovations in agricultural biotechnology are profit driven rather than need driven, therefore, the thrust of the genetic engineering industry is not to solve agricultural problems as much as to create profitability. Moreover biotechnology seeks to further industrialize agriculture and to intensify farmers'dependence on industrial inputs, aided by a ruthless system of intellectual property rights which legally inhibits the right of farmers to reproduce, share, and store seeds (Busch and others 1990). By controlling the 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.

Because biotechnology is capital intensive, it will continue to deepen the pattern of change in U.S. agriculture, increasing the concentration of agricultural production in the hands of large corporate farms. Biotechnology increases productivity, and as with other labor-saving technology, tends to reduce commodity prices and set in motion a technology treadmill that forces out of business a significant number of farmers—especially small-scale farmers. The example of bovine growth hormone confirms the

hypothesis that biotechnology will accelerate the foreclosure of small dairy farms (Krimsky and Wrubel 1996).

Myth 2: Biotechnology Will Benefit Small Farmers and Favor the Hungry and Poor of Developing Countries.

Green revolution technology bypassed small and resource-poor farmers, who will be further marginalized by biotechnology which is under corporate control and protected by patents. Biotechnology is expensive and inappropriate to the needs and circumstances of indigenous people (Lipton 1989). As biotechnology is primarily a commercial activity, this reality determines the priorities of investigation, application, and benefit. While the world may lack food and suffer from pesticide pollution, the focus of multinational corporations is profit, not philanthropy. This is why biotechnologists design transgenic crops for new marketable quality or for import substitution, rather than for greater food production (Mander and Goldsmith 1996). In general biotechnology companies are emphasizing a limited range of crops for which there are large and secured markets, targeted at relatively capital-intensive production systems. As transgenic crops are patented plants, indigenous farmers can lose rights to their own regional germplasm and not be allowed under the World Trade Organization (WTO) to reproduce, share, or store the seeds of their harvest (Crucible Group 1994). It is difficult to conceive how such technology will be introduced in developing countries to favor the masses of poor farmers. If biotechnologists are really committed to feeding the world, why is the scientific genius of biotechnology not turned to develop varieties of crops more tolerant to weeds rather than to herbicides? Or why are more promising products of biotechnology, such as nitrogen-fixing and drought-tolerant plants not being developed?

Biotechnology products will undermine exports from the developing countries, especially from small-scale producers. The development of a thaumatin product through biotechnology is just the beginning of a transition to alternative sweeteners, which will replace developing countries'sugar markets in the future (Mander and Goldsmith 1996). It is estimated that nearly 10 million sugar farmers in developing countries may face a loss of livelihood as laboratory-processed sweeteners begin invading world markets. Fructose produced by biotechnology has already captured over 10 percent of the world market and caused sugar prices to fall, throwing tens of thousands of workers out of jobs. But such foreclosures of rural opportunities are not limited to sweeteners. Approximately 70,000 vanilla farmers in Madagascar were ruined when a Texas firm produced vanilla in biotech labs (Busch and others 1990). The expansion of Unilever-cloned oil palms will substantially increase palm oil production with dramatic consequences for farmers producing other vegetable oils (groundnut in Senegal and coconut in the Philippines).

Myth 3: Biotechnology Will Not Transgress the Ecological Sovereignty of Developing Countries.

Ever since the North became aware of the vital role of biodiversity—of which the South is the major repository—developing countries have witnessed a "gene rush" as multinational corporations aggressively scour forests, crop fields, and coasts in search of the South's genetic gold (Kloppenburg 1988). Protected by the WTO, multinational companies freely practice "biopiracy," which the Rural Advancement Foundation estimates is costing US$5.4 billion a year through lost royalties from food and drug companies using indigenous farmers' germplasm and medicinal plants (Levidow and Carr 1997).

Clearly, indigenous people and their biodiversity are viewed as raw materials for the multinational companies, which have made billions of dollars on seeds developed in U.S. labs from germplasm that farmers in developing countries have carefully bred over generations (Fowler and Mooney 1990). Meanwhile peasant farmers go unrewarded for their millenary farming knowledge, while multinational companies stand to harvest royalties from developing countries estimated at billions of dollars. So far biotechnology companies offer no provisions to pay farmers from developing countries for the seeds they take and use (Kloppenburg 1988).

Myth 4: Biotechnology Will Lead to Biodiversity Conservation.

Although biotechnology has the capacity to create a greater variety of commercial plants, and thus contribute to biodiversity, this is unlikely to happen. The strategy of multinational companies is to create broad international seed markets for a single product. The tendency is toward uniform international seed markets (MacDonald 1991). Moreover the provisions of the patent system prohibiting farmers to reuse the seed yielded by their harvests—dictated by the multinational companies—will affect the possibilities of in situ conservation and on-farm improvements of genetic diversity.

The agricultural systems developed with transgenic crops will favor monocultures, which are characterized by dangerously high levels of genetic homogeneity leading to higher vulnerability to biotic and abiotic stresses (Robinson 1996). As the new bioengineered seeds replace the old, traditional varieties and their wild relatives, genetic erosion will accelerate in developing countries (Fowler and Mooney 1990). Thus the push for uniformity will not only destroy the diversity of genetic resources, but will also disrupt the biological complexity that underlines the sustainability of traditional farming systems (Altieri 1994).

Myth 5: Biotechnology Is Ecologically Safe and Will Launch a Period of Chemical-Free Sustainable Agriculture.

Biotechnology is being pursued to patch up the problems that have been caused by previous agrochemical technologies (pesticide resistance, pollution, soil degradation, and so on) which were promoted by the same companies now leading the biorevolution. Transgenic crops developed for pest control follow closely the pesticide paradigm of using a single control mechanism, which has proven to fail over and over again with insects, pathogens, and weeds (National Research Council 1996). Transgenic crops are likely to increase the use of pesticides and to accelerate the evolution of "super weeds" and resistant insect pests strains (Rissler and Mellon 1996). The "one gene-one pest" resistant approach has proven to be easily overcome by pests, which are continuously adapting to new situations and evolving detoxification mechanisms (Robinson 1996).

There are many unanswered ecological questions regarding the impact of the release of transgenic plants and micro-organisms into the environment. Among the major environmental risks associated with genetically engineered plants are the unintended transfer to plant relatives of the "transgenes" and the unpredictable ecological effects (Rissler and Mellon 1996).

Given the above considerations, agroecological theory predicts that biotechnology will exacerbate the problems of conventional agriculture, and by promoting monocultures will also undermine ecological methods of farming such as rotation and polycultures (Hindmarsh 1991). As presently conceived, biotechnology does not fit into the broad ideals of a sustainable agriculture (Kloppenburg and Burrows 1996).

Myth 6: Biotechnology Will Enhance the Use of Molecular Biology for the Benefit of All Sectors of Society.

The demand for the new biotechnology did not emerge as a result of social demands, but it emerged out of changes in patent laws and the financial interests of chemical companies in linking seeds and pesticides. The supply emerged out of breakthroughs in molecular biology and the availability of venture capital as a result of favorable tax laws (Webber 1990). The danger is that the private sector is influencing the direction of public sector research in ways unprecedented in the past (Kleinman and Kloppenburg 1988). As more universities enter into partnerships with corporations, serious ethical questions emerge about who owns the results of research and what research is carried out. The trend toward secrecy by university scientists involved in such partnerships raises questions about personal ethics and conflicts of interest. In many universities a professor's ability to attract private investment is often more important than his academic qualifications, taking away the incentives for scientists to be socially responsible. Fields such as biological control and agroecology which do not attract corporate sponsorship are being

phased out and this not in the public interest (Kleinman and Kloppenburg 1988).

Conclusions

In the late 1980s Monsanto issued a statement indicating that biotechnology would revolutionize agriculture in the future with products based on nature's own methods, making farming more environmentally friendly and more profitable for the farmer (Office of Technology Assessment 1992). Moreover, plants would be provided with built-in defenses against insects and pathogens. Since then many others have promised several more valuable rewards that biotechnology can bring through crop improvement. The ethical dilemma is that many of these promises are unfounded, and many of the advantages or benefits of biotechnology have not, or may not, be realized. Although clearly biotechnology holds promise for an improved agriculture, given its present orientation it mostly holds promise for environmental harm, for the further industrialization of agriculture, and for the intrusion of private interests too far into public interest sector research. Until now the economic and political domination of the agricultural development agenda by multinational companies has thrived at the expense of the interests of consumers, farm workers, small family farms, wildlife, and the environment.

It is urgent for society to have earlier entry points and broader participation in technological decisions so that corporate interests do not dominate scientific research. National and international public organizations such as the Food and Agriculture Organization of the United Nations (FAO) and the Consultative Group for International Agricultural Research (CGIAR) will have to monitor carefully and control the provision of applied, nonproprietary knowledge to the private sector, to make sure that such knowledge will continue in the public domain for the benefit of rural societies. Regulatory regimes which are publicly controlled must be developed and used to assess and monitor the environmental and social risks of biotechnological products (Webber 1990).

Finally, the trends toward a reductionist view of nature and agriculture—set in motion by contemporary biotechnology—must be reversed by a more holistic approach to agriculture, to ensure that agroecological alternatives are not neglected and that only ecologically sound aspects of biotechnology are researched and developed. The time has come to counter effectively the challenge and the reality of genetic engineering. As it has been with pesticides, biotechnology companies must feel the impact of environmental, farm labor, animal rights', and consumers'lobbies, so that they start reorienting their work for the overall benefit of society and nature. The future of biotechnology-based research will be determined by power relations; farmers and the public in general, if sufficiently empowered, could influence the direction of biotechnology toward sustainable agriculture.

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