THE "POLITICAL ECONOMY" OF AGRICULTURAL BIOTECHNOLOGY FOR THE DEVELOPING WORLD

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At the beginning of the new millennium, a 150-year-old conceptual skeleton—the "political economy"—is rattling loudly in the closet. Marx described early on in his work that there is a close and circular relationship between the social conditions of a nation and its conditions for production—and consequently the economic development.[1] In this context, institutional structures and social values as well as ways of thinking and attitudes of members of civil society are very important. In the current discussion of agricultural biotechnology for developing countries, this part of the Marxian analysis seems highly relevant, particularly for urban impoverished groups as well as resource-poor farmers and their families. This paper looks at the impact that today's politicized discussion in Europe is having on public research for the developing world and proposes elements for building a bridge over the troubled waters currently dividing proponents and opponents of agricultural biotechnology.

The Future of Food Security

The United Nations observed October 12, 1999, as the Day of Six Billion—the world's population had doubled since 1960. In some parts of the developing world, the population grew even faster; in sub-Saharan Africa, for example, it tripled. The number of people in Asia grew most in absolute terms, by nearly 2 billion. Most population experts expect that world population will grow by another 50 percent—this means at least 3 billion more people by 2050. Almost all this growth will occur in less developed regions.[2] (See Table 1.)

Table 1: Current and Projected Population, by Region, 2001–50 in Mio

Region	Population		
	2001	2025	2050
World	6,137	7,818	9,036
More Developed	1,193	1,248	1,242
Less Developed thereof in	4,944	6,570	7,794
• Africa	818	1,268	1,800
• Asia	3,720	4,714	5,262s
• Latin America	525	697	815

Source: Population Reference Bureau, 2001 World Population Datasheet, Washington, DC. 2001

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1 K. Marx, "Zur Kritik der Politischen Ökonomie," Preface to K. Marx and F. Engels, *Werke*, Bd. 13, (Berlin: Dietz Verlag, 1985), p. 616 f.

2 United Nations Population Fund, *The State of World Population 1999* (New York: Oxford University Press, 1999), Ch. 1; see also Population Reference Bureau, *World Population Data Sheet 2000* (Washington, DC: 2000) or at <www.prb.org>.

In the developing world today, an estimated 800 million people already do not have enough to eat. Countless children there die from nutritional deficiencies or grow up with reduced physical or intellectual abilities, and will later suffer from lower productivity.[3]

In addition to the absolute increase in the number of people to be fed, structural changes will have an impact on the production quantities needed. Urbanization will soar, for example. The global urban population is expected to nearly double from 2.6 billion people in 1995 to 5.1 billion in 2030. By then, 57 percent of the population of developing countries will live in cities.[4] A high rate of urbanization will not only confront inhabitants with social, environmental, and probably political problems of unprecedented magnitude—it will also have notable consequences for food security.

Whatever the hopes for urban gardens and nearby farms, people living in cities are not able to feed themselves through subsistence food production in the same way that people in rural areas do. This necessitates a significant increase in marketed food surplus—which again requires a higher production volume. Since the eating patterns of urban populations differ substantially from those of rural folk, different food will have to be produced. Since the amounts of high-value, transportable, and storable grain (such as rice and wheat), animal protein (both meat and milk), and vegetables are higher in urban diets, the proportion of traditional foodstuffs in the diet decreases. This means that there will be a diversion of cereals from food to feed.

If incomes continue to rise for urban professional groups as they have in the past 10 years, the number of people who move up the food chain and eat more livestock products will continue to grow rapidly. This again means that the demand for grain will probably grow even faster. For political, cultural, economic, logistical, and other reasons, this increased demand should be met as little as possible by imports from North America, Europe, or Australia, so there is a need to increase production in developing countries.

If increased production is done in a sustainable way and with increased productivity, additional benefits will be achieved in poverty alleviation and improved livelihoods. Nearly three quarters of the poor live in rural areas. As long as the number of rural poor is high—and for sub-Saharan Africa, it is even expected to rise—food security as a general political goal cannot be achieved. A higher productivity for those who depend on agriculture and on common property resources is a precondition for poverty alleviation. For the quality of life of poor people in cities, who depend on the market for nearly 90 percent of their food supply, a low and stable price for food is the most important variable.[5]

Higher productivity is also of significant ecological value. If average annual per hectare productivity increases just 1 percent, the world will have to bring more than 300 million hectares of new land into agriculture by 2050 to meet expected demand. But a

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3 United Nations Food and Agriculture Organization (FAO), *The State of Food Insecurity in the World 1999* (Rome: 1999), p. 6 f; see also L.C. Smith and L. Haddad, *Overcoming Child Malnutrition in Developing Countries. Past Achievements and Future Choices*, Food, Agriculture, and the Environment Discussion Paper No. 20 (Washington, DC: International Food Policy Research Institute (IFPRI), 2000).

4 United Nations Population Division, *World Urbanization Prospects: The 1996 Revision* (New York: 1998), p. 2.

5 A.F. McCalla, "Agriculture in the 21st Century," CIMMYT Economics Program, Fourth Distinguished Economist Lecture, El Batan, March 2000, p. 2.

productivity increase of 1.5 percent could double output without using any additional cropland.[6]

To increase local output through larger production volumes or higher productivity will be very difficult, however. A world of 9 billion by 2050 will meet with significant constraints.

Water Scarcity:Water, the source of all life, is going to become increasingly scarce. More than a quarter of the world, and a third of the population in developing countries, lives in regions that will experience severe water scarcity.[7] The deforestation of the planet continues unabated, reducing the capacity of soils and vegetation to absorb and store water.[8] Water demand continues to rise much faster than supply, and the distributional battles between industry and urban households on the one hand and agricultural irrigation on the other hand are not likely to be won by agriculture.

Today the irrigated sector accounts for close to 60 percent of the food grown in all developing countries. The Consultative Group on International Agricultural Research (CGIAR) estimates that, taking into account the constraints on increasing output from rainfed agriculture, the irrigated sector will have to meet 80 percent of the increased food demand in developing countries, which will be home to 2 billion more people in 2025.[9] If, however, the availability of irrigation water stagnates or—what is more likely—decreases, average yields are likely to fall.

Water supply for agriculture has already started to decrease in India, for example, due to overpumping in highly productive agricultural areas and in China because of reallocation for industrial purposes or higher urban demand.[10]

Pressure on Land:There is growing concern that the developing world is facing a decline in long-term productivity of agricultural soils. Wide areas of land are already heavily degraded, and this process, including salinization and waterlogging of irrigated land, has negative effects on rural food consumption, on agricultural markets, and hence on rural incomes.[11] Low and declining soil fertility is a serious problem in Africa, where about 86 percent of the countries show losses of nutrients greater than 30 kilograms of fertilizer (NPC) per hectare per year.[12]

In 1960 the world still had 0.44 hectares of arable land per person; today the figure is about 0.22 hectares per person, and by 2050 it is expected to drop to 0.15 hectares.[13]

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6 See I.M. Goklany, "Meeting Global Food Needs: The Environmental Trade-offs between Increasing Land Conversion and Land Productivity," *Technology*, vol. 6 (1999), pp. 107–30.

7 International Water Management Institute, *Water Scarcity in the Twenty-First Century* (Colombo, Sri Lanka: 1999); see also the documents of the Hague Water Conference, March 2000.

8 FAO, *The State of the World's Forests 1999* (Rome: 1999).

9 Consultative Group on International Agricultural Research (CGIAR)/TAC, *A Food Secure World For All: Towards a New Vision and Strategy for the CGIAR in 2010* (Rome: March 2000).

10 S. Postel, *Pillar of Sand: Can the Irrigation Miracle Last?* (New York: W.W. Norton & Company, 1999).

11 S.J. Scherr, *Soil Degradation: A Threat to Developing-Country Food Security by 2020?* Food, Agriculture, and the Environment Discussion Paper 27 (Washington, DC: IFPRI, 1999).

12 P. Pinstrup-Andersen, R. Pandya-Lorch, and M.W. Rosegrant, *World Food Prospects: Critical Issues for the Early Twenty-First Century* (Washington, DC: IFPRI, 1999), p. 25 f.

13 World Resources Institute at al., *World Resources 1998–99* (New York: Oxford University Press, 1998), p. 280.

Since the reserves of unused arable land are dwindling, the expansion of cultivated areas will contribute a mere 20 percent to the increase of food production (mainly cereals).[14] Thus higher food quantities to meet the needs of a growing world population will have to come from higher yields, which is more easily said than done.

***Reduction in the Rates of Increase in Basic Grain Yields*:**There is considerable debate about the outlook for agricultural productivity. The Green Revolution increases in yields of cereals from conventional breeding have reached a plateau and are beginning to decline.[15] Even the gap between yields obtained on experimental stations (maximum potential) and those obtained by the best farmers in the best production regions is narrowing.[16] The question for agriculturists has therefore been and remains how to attain and sustain higher yields.

Scientific agriculture is one of the most important answers, not only to achieve desired production goals, but also to improve resistance to both biotic and abiotic stress. Reducing total costs of production by reducing chemical inputs through genetic research has both production and environmental implications. Moreover, research to reduce high post-harvest losses of crops can result in significant increases in the amount of usable agricultural production. This research ought to be publicly financed in order to reach those who do not have the purchasing power to buy the results of agricultural research at market conditions.

***Unforeseeable Changes in Climate*:** Although difficult to predict, climatic change might create additional problems for countries whose economies are heavily dependent on agriculture. Climate change is expected to have dramatically adverse effects on food security in the low and middle latitude areas of low-income countries. In addition, the warming of Earth is expected to bring extreme climate events, such as Hurricane Mitch.[17]

Food Security and Good Governance

Summing up, population growth, urbanization, and rising incomes will increase food demand, which will necessitate increases in food production. As water and land for agricultural use become increasingly scarce, more food will have to be produced through higher yields per unit of water and land. But to avoid any misinterpretation, let me clarify that more food production is not the only issue that matters for the welfare of poor people—what they need is more food security.

The Food and Agriculture Organization of the United Nations (FAO) defines food security as a situation in which all people at all times have access to safe and nutritious food to maintain a healthy and productive life.[18] Food security has at least three characteristics: first, producing or importing safe, nutritious food in sufficient quantities;

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14 Pinstrup-Andersen, Pandya-Lorch, and Rosegrant, op. cit. note 12, p. 5.

15 Ibid., p. 14 f.; FAO, *FAOSTAT Statistical Database*, at <www.fao.org>. See also McCalla, op. cit. note 5, p. 9.

16 P. Pingali and P. Heisey, "Cereal Crop Productivity in Developing Countries: Past Trends and Future Prospects," Conference Proceedings: Global Agricultural Science Policy for the Twenty-First Century, Melbourne, 1996, pp. 51–94.

17 L.R. Brown et al., *State of the World 1999* (New York: W.W. Norton & Company, 1999); see also the Worldwatch Series *Vital Signs* (New York: W.W. Norton & Company, annual).

18 See FAO, *Food Security Assessment*, Document WFS 96/Tech/7, Rome, 1996, p. 5.

second, giving economic and physical access to rich and poor, male and female, old and young, on a continuous basis.[19] The third characteristic has to do with the use and preparation of available food. This depends on the knowledge, skills, and care of mothers as well as the health of those who eat. Since parasitic and other diseases substantially hamper the metabolism and assimilation of sustenance taken, health conditions figure significantly in the food security equation.

Shortfalls in food security can and do result from various interlinked adverse conditions in a country's socioeconomic and political system.[20] Most of what is politically right or wrong for food security is known; also known are the emerging issues and the unfinished business.[21] In the end, the only reliable pathway to food security is sustainable human development.

We know what needs to be done. The "wheel" of sustainable development does not have to be reinvented. "Good governance"—that is, transparency of political decisionmaking, accountability for politicians and state employees, institutional pluralism, the rule of law—is the most important prerequisite. Lack of sufficient allocations in national development planning and budgets in the socioeconomic areas of health, education, and food security are often the result of denial of civil and political rights, such as the right of democratic elections, free speech, and information dissemination. Authoritarian governments that deny freedom of speech and the right to vote do not provide adequate information on the causes of famine and lack of food security, or on the low levels of literacy and health.

The best of present thinking indicates that a human-centered and market-friendly approach with an emphasis on good governance is the most effective way to break the vicious circle of continuing poverty, environmental deterioration, and acute institutional deficiencies in a particular country. There may be a need for adaptations to different sociopolitical and national circumstances, but in comparison to the available knowledge with regard to the political, economic, social, and ecological essentials of sustainable development, adaptation is a relatively minor issue.[22] Good governance alone, however, will not be sufficient for food security—something has to happen on the supply side as well.

More Local Food Production—Not More Imports

In order to supply enough food to the growing populations of Asia, Africa, and Latin America without increasing dependence on international markets or food aid, more food has to be produced where people live. This, as Alex McCalla points out, will be

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19 For a comprehensive analysis of the conditions of access, see J. Drèze and A. Sen, *The Political Economy of Hunger*, 3 Vols. (Oxford: Clarendon Press, 1990).

20 See A. Sen, *Poverty and Famines: An Essay on Entitlements and Deprivation* (New York: Oxford University Press, 1981).

21 P. Pinstrup-Andersen, "Food Policy Research for Developing Countries: Emerging Issues and Unfinished Business," *Food Policy*, vol. 25 (2000), pp. 125–41.

22 For the political framework, see, e.g., Commission on Global Governance, *Our Global Neighborhood* (New York: Oxford University Press, 1995). On the economic basics, see, e.g., World Bank, *World Development Report 1996* (New York: Oxford University Press, 1996). On the social essentials, see, e.g., United Nations Development Programme, *Human Development Report 1994* (New York: Oxford University Press, 1995). On the ecological basics, see World Commission on Environment and Development, *Our Common Future* (New York: Oxford University Press, 1987), and the World Bank's Environmentally Sustainable Development Studies and Monographs Series.

predominantly in the tropical and subtropical, low-yielding farming systems.[23] Imports may be appropriate to bridge short-term gaps or in cases of emergency, but for most developing countries, imports cannot substitute for local production. The argument that global food production is sufficient and that food security problems can be solved by redistribution is inadequate for a number of reasons.

First and foremost, the agricultural sector of developing countries is far more than just a producer of food. In most cases it still provides 60–80 percent of all gainful employment. Agriculture is a source of income not only for rural farm workers but also for those employed in related trades and small industries, be they landless laborers, small traders, or those working in cottage industries. Whatever productivity increase can be achieved, the income effects will be even higher. A dynamic agriculture is not only the best remedy against rural poverty: overall economic development through the sustained growth of industry and services has rarely been possible without the basis of growth fueled by a flourishing agriculture.

Second, appropriate agriculture always means sustaining ecological intactness and caring about the environment. Third, as the word implies, agri-"culture" is a constituent of the many-faceted cultural patrimony of developing countries. And last but not least, the idea of feeding the African or Asian poor with surplus grains from the United States, Europe, Australia, or Argentina implies the heroic assumption that immense logistical problems could be solved in a sustainable way.[24]

Overview of Potential Contribution of Biotechnology and Genetic Engineering

While good governance and appropriate rural and agricultural development endeavors remain necessary conditions, they are far from sufficient. There is a need for technologies that raise agricultural productivity and hence rural welfare.

Considering ongoing absolute population growth, threats of water scarcity, and the shrinking of arable land, and bearing in mind that the yield increases from conventional breeding for at least some crops are moving in the wrong direction, whatever has to happen on the production side will have to happen with new varieties. Hence, something has to happen on the technology side. Biotechnology and genetic engineering—used wisely within a pluralistic technological portfolio—can play a crucial role in the development of the modern varieties that will be needed.

The term "biotechnology" describes the integrated application of biochemistry, microbiology, and process technology with the objective of turning to technical use the potential of microorganisms and cell and tissue cultures (including parts thereof). The key components of modern biotechnology include:

- *genomics*—the molecular characterization of all species;
- *bioinformatics*—the assembly of data from genomic analysis into accessible forms ("genetic fingerprinting");
- *tissue culture*;
- *transformation*—the introduction of single genes conferring potentially useful traits into plants, livestock, fish, and tree species;

23 McCalla, op. cit. note 5, p. 4.

24 A.F. McCalla, "Agriculture and Food Needs to 2025: Why We Should Be Concerned," Sir John Crawford Memorial Lecture, Consultative Group on International Agricultural Research, Washington, DC, 27 October 1994.

- *molecular breeding*—increased efficiency of selection for desirable traits in breeding programs using molecular marker-assisted selection; and
- *diagnostics*—the use of molecular characterization to provide more accurate and quicker identification of pathogens.[25]

In addition, there is hope for new health technologies such as *vaccine technology,* which uses modern immunology to develop recombinant DNA vaccines for improving control of lethal diseases. In view of the vastly increased capacity to accumulate knowledge that is made possible by molecular techniques, the goal of a "knowledge-driven" agriculture and in particular plant breeding is now entirely realistic, provided sufficient support is given to plant sciences.

Technologies such as molecular breeding or diagnostics are relatively noncontroversial. This is not the case, however, with *genetic engineering*—the precise modification of hereditary genetic material in living organisms by the addition, removal, or exchange of one or more genes, resulting in altered genetic information being passed on to descendants. One of the key differences between conventional breeding and genetic engineering is that with the latter it becomes possible to overcome natural cross-breeding barriers—in other words, to insert genes from one species into another unrelated species to produce "transgenic varieties."

This part of biotechnology has triggered enormous controversy in some European countries, raising similar concerns all over the world. In Germany, the United Kingdom, or Switzerland, the broader public perceives genetic engineering to be structurally different from other new technologies. Public opinion regarding the use of biotechnology in agriculture is predominantly skeptical or negative.[26]

In order to assess the value of biotechnology and genetic engineering for a growing population in the developing world, we must look at what has been achieved so far and what is likely to be achieved, consider the risks, and then weigh risks and benefits in a fair way.

Expectations and Objectives of Agricultural Biotechnology

The main objectives of biotechnological research and development for food security are basically similar to those of conventional breeding:

- secure the given yield potential,
- increase the yield potential, and
- raise productivity.

Efforts to achieve this include research for varietal qualities such as resistance to or tolerance of plant diseases (fungi, bacteria, viruses) and animal pests (insects, mites, nematodes) as well as to stress factors such as climatic variation or aridity, poor soil quality, and crop rotation practices. FAO recognized in its recent Statement of Biotechnology that genetic engineering "has the potential to help increase production and productivity in agriculture, forestry and fisheries. It could lead to higher yields on marginal lands in countries that today cannot grow enough food to feed their people."

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25 G.J. Persley and J.J. Doyle, "Biotechnology for Developing Country Agriculture: Problems and Opportunities. Overview," *2020 Vision Focus 2*, Brief 1 of 10 (Washington DC: IFPRI), p. 1.

26 See The Environmental Monitor, *Global Public Opinion on the Environment: 1998 International Report*, pp. 40 ff.

Ideally, crop varieties that result from such research endeavors should lead to the cultivation of plants that fall into the category of "sustainable agriculture"—that is, they should not abet erosion or leaching of the soil. To complete the packet of desired characteristics, seed of improved varieties should be affordable to resource-poor farmers and have better product quality traits (more protein, minerals, or vitamins).

Conventional crop-breeding programs will remain important for the foreseeable future. They have a competitive disadvantage, however, in that they have to proceed in small steps toward single targets and are thus time-consuming; in addition, conventional breeding is more limited in scope as it cannot overcome natural cross-breeding barriers. If, in contrast, selection systems are developed that can be implemented in the test tube—through characterization of genetic markers for certain properties, for example—then research can be carried out with much greater efficiency. With the help of biotechnology, it seems likely that apomixis (asexual type of reproduction) for hybrids will be achieved—a potential breakthrough for small and big farmers alike.

In the long term, plants may be developed that can produce vaccines for humans.[27] Edible vaccines delivered in locally grown genetically engineered crops could do more to eliminate disease than the Red Cross, missionaries, and U.N. task forces combined—and at a fraction of the cost.[28]

Case studies show that over the past few years biotechnology and—so far, to a lesser extent—genetic engineering have helped make progress toward food security, be it through resistance to fungal and viral diseases in major food crops or through improved plant properties.[29] The implementation of these research results is theoretically scale-neutral—that is, it can benefit both the small farmer in Mali and the industrial farmer in Iowa. The small farmer in southern India or northern Kenya does not have to learn a sophisticated new agricultural system; he or she has only to plant the new seeds embodying the research results. But research and science are only able to solve problems that are allowed to be solved by political leaders and the social setting. What is needed to put the theory into practice is well known by anyone who looks for the answer.

Hopes continue to be high. A World Bank panel predicts, for example, that efforts to improve rice yields in Asia through biotechnology will result in a production increase of 10–20 percent over the next 10 years.[30] A German poll of scientists found that they

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27 See J.M. Staubl, "High-Yield Production of a Human Therapeutic Protein in Tobacco Chloroplasts," *Nature Biotechnology*, March 2000, pp. 333–38.

28 M. McGloughlin, "Ten Reasons Why Biotechnology Will Be Important to the Developing World," in University of Missouri (ed.), *The Economics of Biotechnology in Developing Countries*, at <www.agbioforum.org>; T. Arakawa et al., "Efficacy of a Plant-Based Oral Cholera Toxin B Subunit Vaccine," *Nature Biotechnology*, vol. 16 (1998), pp. 292–97; T. Haq et al., "Oral Immunization with a Recombinant Bacterial Antigen Produced in Transgenic Plants," *Science*, no. 298 (1995), pp. 714–16; C.O. Tacket et al., "Immunogenicity of a Recombinant Bacterial Antigen Delivered in a Transgenic Potato," *Nature Medicine*, vol. 4 (1998), pp. 607–09.

29 See I. Potrykus (ed.), "New Horizons in Swiss Plant Biotechnology—from the Laboratory to the Field," Proceedings of a Symposium organized at the ETH Zurich on the occasion of the 125th anniversary of the Department of Agronomy and Food Sciences, Zurich, 1996; see also A.F. Krattiger and A. Rosemarin (eds.), *Biosafety for Sustainable Agriculture* (Stockholm: Stockholm Environment Institute, 1994), section 1.

30 H.W. Kendall et al., *Bioengineering of Crops: Report of the World Bank Panel on Transgenic Crops*, Environmentally and Socially Sustainable Development Studies and Monographs Series 23 (Washington, DC: World Bank, 1997), p. 15.

expect genetically engineered drought and salt tolerance will be achieved by 2012 and nitrogen fixation by 2017—within the next generation, and before world population reaches 9 billion.[31]

Achievements So Far

First of all, by using nonrenewable resources more efficiently, germplasm enhancement with genetic engineering has in most instances the same effects on preserving natural resources and improving the environment as germplasm enhancement through conventional methods. To quote an example used by Norman Borlaug, in 1999 India produced about 220 million tons of grain, with an average yield of 2.2 tons per hectare. In 1961–63, the yield figure stood at 0.95 tons per hectare. If India had continued using the agrarian technology of the 1960s—that is, if the yield per hectare had not more than doubled—India would need more than twice the amount of arable land to produce today's food quantity. That land is simply not available; creating some of it would have involved conversions at high ecological cost.

Much has been achieved during the past 10 years.[32] Genome mapping and biotechnology research offer powerful tools for crop improvement, for example, in China, where transgenic varieties are now routinely produced in crops such as rice, corn, wheat, cotton, tomato, potato, soybean, and rapeseed. The objectives of this research and development are crops that are disease-resistant, tolerate abiotic stress, and have improved product quality and increased yield potential.[33] According to Gordon Conway, president of the Rockefeller Foundation, China is doing "spectacularly well" with *Bt* cotton, increasing yields and reducing the number of pesticides sprayings from about 12 to 3 per season.[34]

Achievements in India include tissue culture regeneration, stress biology, and marker-assisted breeding, as well as new types of biofertilizer and biopesticide formulations. Research to develop genetically improved (transgenic) plants for brassicas, mung bean, cotton, and potato is well advanced.[35] Programs adapted to local needs and priorities are under way in the Philippines, Thailand, Brazil, Costa Rica, Mexico, Egypt, Iran, Jordan, Kenya, South Africa, and Zimbabwe.[36] Of particular interest for Africa are the research results on the transgenic sweet potato resistant to feathery mottle virus in Kenya and on South African transgenic sweet potatoes that contain up to five times the normal protein levels.[37] Early laboratory results of research for nematode resistance in

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31 ISI/Fraunhofer Institut für Systemtechnik und Innovationsforschung, Delphi 1998 Umfrage, *Studie zur Globalen Entwicklung von Wissenschaft und Technik, (im Auftrag des Bundesministeriums für Bildung und Forschung)* (Karlruhe: 1998).

32 See, e.g., G.J. Persley and M.M. Lantin (eds.), *Agricultural Biotechnology and the Poor* (Washington, DC: CGIAR/National Academy of Science, 2000); T. Hohn and K.M. Leisinger (eds.), *Biotechnology of Food Crops in Developing Countries* (New York: Springer, 1999).

33 Q. Zhang, "China: Agricultural Biotechnology Opportunities to Meet the Challenges of Food Production," in Persley and Lantin, op. cit. note 32, p. 45 ff.

34 See his interview with David Stipp, "The Voice of Reason in the Global Food Fight," *Fortune*, 21 February 2000.

35 M. Sharma, "India: Biotechnology Research and Development," in Persley and Lantin, op. cit. note 32, p. 51 ff.

36 In Persley and Lantin, op. cit. note 32, pp. 64–121.

37 See F. Wambugu, "Why Africa Needs Agricultural Biotech," *Nature*, no. 400 (1999), pp. 15–16; M. Egnin et al., "Enhanced Protein Content and Quality in Sweetpotato Engineered with a Synthetic

potatoes of indigenous Bolivian small farmers give rise to great hopes for a resource-poor population.[38]

In many countries tissue culture has produced plants that increase crop yields by providing farmers with healthier planting material. In addition, marker-assisted selection and DNA fingerprinting allow a faster and more targeted development of improved genotypes for important agricultural species. Moreover, FAO points out, these technologies make available new research methods "which can assist in the conservation and characterization of biodiversity. The new techniques will enable scientists to recognize and target quantitative trait loci and thus increase the efficiency of breeding for some traditionally intractable agronomic problems such as drought resistance and improved root systems."[39]

Among the many achievements to date, one is of particular value: it has become possible to genetically modify rice so that it contains increased levels of Vitamin A. It will soon be possible to achieve a similar result with regard to iron. This could be of immense benefit to about 250 million poor, malnourished people who are forced to subsist on rice. The consequences of this restricted diet are well known: 180 million people are Vitamin A-deficient. Each year 2 million of them die, hundreds of thousands of children turn blind, and millions of women suffer from anemia, one of the main killers of women of childbearing age.[40]

Another achievement could turn out to be a major breakthrough. Researchers from Washington State University were able to transfer a maize gene into rice. The new strain of genetically modified rice, unveiled in late March 2000 in the Philippines at an international conference on rice biotechnology, boosts yields by a massive 35 percent. As an added benefit, the genetically modified (GM) rice, which has been tested in China, South Korea, and Chile, extracts as much as 30 percent more carbon dioxide from the atmosphere than controls, offering a way of curbing climate change.[41]

Since I will later deplore the fact that some of the louder critics seem to see risks only, to overemphasize them and fail to put them into context, I want to put these benefits in perspective: Agricultural biotechnology is no *deus ex machina*. No technology is of intrinsic value. Humanity has always used and will continue to use technologies as a means to an end—to facilitate living or to achieve other desirable goals. In their decision processes, societies and individuals have always weighed benefits and risks to arrive at a benefit/risk assessment they can live with.

Advocating the use of biotechnology and genetic engineering to help improve food security in developing countries is not meant to support these technologies for their own sake or out of context. Biotechnology and genetic engineering should always be seen in the

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Protein Gene," presented at the Plant Biology ´99 Annual Meeting of the ASPP, Baltimore, MD, 1999.

38 H.J. Atkinson et al., "Developing a Paradigm for Safe Adoption of GM Crops with a Poverty Focus: A Specific Example of Nematode Resistance for Potato in Bolivia, Leeds, Cochabamba, Bangor 2000," offered to the Brussels Conference on Issues of Genetic Engineering for Developing Countries, organized by Friends of the Earth and financed by the European Union. The paper was rejected without explanation by the organizers.

39 See FAO, *Statement on Biotechnology* (Rome: 2000).

40 See World Health Organization, *Nutrition for Health and Development: Progress and Prospects on the Eve of the 21st Century* (Geneva: 1999); U.N. Sub-Committee on Nutrition (ACC/SCN)/IFPRI, *The 4th Report on The World Nutrition Situation* (New York: 2000).

41 See *New Scientist*, no. 2232 (2000), p. 19.

context of a wider technological pluralism.[42] Using them is desirable only if and where on a case-by-case basis they have a comparative advantage in solving constraints related to agricultural objectives—that is, if they prove superior to other technologies with regard to cost-effectiveness.

Potential Risks

Are there potential risks associated with this technology? Of course there are—every action has implicit and explicit risks. No technology in and of itself is good or bad, safe or unsafe, although some are inherently riskier than others, such as live vaccines versus new crop varieties. What makes a technology safe or unsafe is the way it is applied and the outcome of that application. The quantification of any perceived risk can broadly be described as a function of four interrelated variables:[43]

- the scale of the potential harm *adjusted by*,
- the likelihood of that harm occurring *net of*,
- the ability of an effective response to be put in place *adjusted by*,
- the likelihood of that response mechanism being deployed effectively.

To a significant extent in today's debate about biotechnology and genetic engineering in Europe, risk analysis is not done that way: risks are too often isolated from benefits and blown out of proportions, immensely small probabilities are not revealed in public discussion, and available effective responses are ignored or denied. Countless Web sites and publications tell horror stories about the perceived risks of biotechnology—few discuss the weight and management of risks in a scientific manner.[44]

For a variety of good reasons, perceived risks must be divided into those that are technology-transcending and those that are inherent to a technology.[45] Fairness of discussion would also demand to differentiate technology-inherent risks into hypothetical and speculative. Hypothetical risks are ones scientists know can occur, and they know how they occur, in the given technological or biological context. Speculative risks are those related to potential (hitherto) unknown mechanisms and interactions. Speculative risk assessments are commonly brought forward in a dramatic scenario of assumptions that can neither be scientifically proven nor refuted. As there is scientific consensus that "the same physical and biological laws govern the response of organisms modified by modern molecular and cellular methods and those produced by classical methods," notes the U.S. National Research Council, and as "no conceptual distinction exists," the

42 During the preparation of this paper, the International Rice Research Institute announced the introduction of a new high-yielding rice variety that could raise global output by 10–15 percent; see Dolly Aglay, *Reuters*, 14 March 2000.

43 See M.H. Daniell, *World of Risks: Next Generation Strategy for a Volatile Era* (Singapore: John Wiley, 2000), p. 11.

44 For the horror stories, see <biotech_activists@iatp.org> and J. Rifkin, *The Biotech Century: Harnessing the Gene and Remaking the World* (New York: Penguin Putnam, 1999), and bibliography; for a scientific discussion of risks, see <www.agbioworld.com> or <www.cropgene.com> and <kamman@sgi.unibe.ch>.

45 K.M. Leisinger, "Disentangling Risk Issues," in G.J. Persley (ed.), *2020 Vision Focus 2*, Brief 5 of 10 (Washington, DC: IFPRI, October 1999), p. 1.

introduction of speculative risks into the debate on transgenic crops is a deliberate attempt to stir up controversy.[46]

Technology-Inherent Risks

As far as technology-inherent risks (such as allergic reactions or the unwanted flow of genes into wild species or landraces) are concerned, the best of present judgment indicates that genetically modified organisms (GMOs) pose no substantial or unmanageable long-term health hazards for humans or animals.[47] Many unsubstantiated claims continue to circulate, but let the record show the following:

- The sensational report of Pusztai and Even (potatoes transformed with a lectin protein could end up to be poisonous to human health) has been rejected by the vast majority of reviewing scientists either because the methodology was flawed or on the grounds that the data do not support the conclusions.
- The old L-Tryptophane scare story (EMS syndrome due to the use of a genetically altered *Bacillus amyloliquefaciens*) has been proved wrong.[48]
- Even the much-quoted Monarch butterfly laboratory study has been put into empirical perspective. Follow-up studies at Iowa State University and the University of Guelph have indicated that harm to Monarchs under field conditions are minimal. According to Mark K. Sears, chair of the Department of Environmental Biology at the University of Guelph in Canada, reports that *Bt* maize kills monarch butterflies are overly alarmist. After a six-month study of how pollen from GM maize affects monarch butterfly larvae under field conditions, the preliminary findings of Sears and others indicate that 90 percent of pollen fell within 5 meters of the corn field. Pollen counts on milkweed leaves were lower than those demonstrated to be toxic to neonates, hence posing little risk to monarch larvae.[49] In addition, there is increasing evidence that the time overlap of the pollen flight and the vulnerable development of the larvae is very small.
- The risk of allergy to genetically modified foods seems to be controllable and therefore minimal.[50]
- In 1999, nearly 100 million acres around the world were planted with transgenic crops. No serious issues—forget about uncontrollable risks—came up.

To date, most empirical evidence supports the 1987 conclusion of the U.S. National Academy of Sciences: the safety assessment of a recombinant DNA-modified organism

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46 National Research Council, *Field Testing Genetically Modified Organisms—Framework for Decision* (Washington, DC: National Academy Press, 1989).

47 J.J. Cohen (ed.), *Managing Agricultural Biotechnology—Addressing Research Program Needs and Policy Implications* (London: CAB International, 1999); see also the excellent overview study organized and financed by the German Friedrich-Ebert-Stiftung: M. Quain and D. Virchow, *Macht die Grüne Gentechnik die Welt satt? Herausforderungen für Forschung, Politik und Gesellschaft* (Bonn: Friedrich-Ebert-Stiftung, 1999).

48 See <www.agbioworld.org>, viewed 8 March 2000.

49 See M.K. Sears, D.E. Stanlex-Horn, and H.R. Mattila, *Preliminary Report on the Ecological Impact of* Bt *Corn Pollen on the Monarch Butterfly in Ontario*, University of Guelph, ON, Canada, 17 January 2000.

50 S.B. Lehrer, "The Potential Health Risks of Genetically Modified Organisms: How Can Allergens Be Assessed and Minimized?" at the International Conference on Ensuring Food Security, Protecting the Environment, Reducing Poverty in Developing Countries: Can Biotechnology Help? Washington, DC, 21–22 October 1999.

should be based on the nature of the organism and the environment into which it will be introduced, not on the method by which it was modified.[51] The same view is contained in the declaration signed by more than 1,500 scientists worldwide (including several Nobel laureates) in support of agricultural biotechnology:

> No food products, whether produced with recombinant DNA techniques or with more traditional methods, are totally without risk. The risks posed by foods are a function of the biological characteristics of those foods and the specific genes that have been used, not of the processes employed in their development.[52]

If and where unresolved questions arise concerning risks of genetically modified food, science-based evaluations should be used on a case-by-case approach to answer them.

Technology-Transcending Risks

As far as social and political risks are concerned, today's criticism of genetic engineering and biotechnology is structurally similar to discussions about the Green Revolution in the 1970s. The improved plant varieties that gave rise to the Green Revolution of the 1950s and 1960s were developed through systematic selection and crossing (hybridization), with the objective of increasing production and averting famines, particularly in Asia. Despite undisputed success in achieving significantly higher food production and an overall positive employment effect, there was (and still is) substantial criticism of the Green Revolution as being responsible for growing disparities in poor societies and for the loss of biological diversity.[53] These developments, however, were not a consequence of the technology per se but of the use of the technology in a particular social setting. Risks of such type are neither caused by nor able to prevent the technology as such. Consequently, the successful management of such risks depends on an appropriate national framework for socially and ecologically sustainable agriculture.

In terms of environmental problems, yes—the Green Revolution has created some, but it has reduced others, such as allowing farmers to concentrate production on the best cropland and hence preventing the destruction of vulnerable biotopes or protected areas. As far as social problems are concerned, the overall effects are also good for small farmers. Yes, due to a social setting that was described by Gunnar Myrdal more than 30 years ago, the rich got richer.[54] But the poor also got less poor.[55]

A New Category: Risks of Not Acting Proactively

Normally not part of technological risk assessments are the social, economic, and political risks of not using genetic engineering for developing-country agriculture. In view

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51 National Academy of Sciences, *Introduction of Recombinant DNA-Engineered Organisms into the Environment: Key Issues* (Washington, DC: National Academy Press, 1987).

52 See note 48.

53 For discussion of the successes, see R. Barker, R.W. Herdt, and B. Rose, *The Rice Economy of Asia* (Washington, DC: Resources for the Future, 1985).

54 G. Myrdal, *Asian Drama*, 3 vols. (Harmondsworth, U.K.: 1968).

55 P.B. Hazell and C. Ramasamy, *The Green Revolution Reconsidered* (Baltimore, MD: Johns Hopkins University Press, 1991); M. Lipton (with R. Longhurst), *New Seeds and Poor People* (London: Unwin Hyman, 1989); G. Conway, *The Doubly Green Revolution: Food for All in the 21st Century* (London: Penguin Books, 1997).

of expected population and natural resource developments over the next 50 years, an approach that tends to overemphasize present perceptions and underestimate the vulnerabilities of future generations presents a great risk to humankind and those future generations.

In this context there is an accountability issue. Who stands accountable for the anti-GMO activism that results in denying poorer nations access to a technology that could help them produce more and better food? Who stands accountable for scientific results not available in 10–15 years due to political resistance today—results that might make the difference between food shortages and normal supply in resource-poor countries? There is no "polluter pays principle" for pressure groups that poison today's discussions and are proud to go on record that they—as self-appointed attorneys for poor people in the South—can prevent agricultural biotechnology for the developing world.

The Dominance of Private-Sector Research

If society approves of better access to improved technologies by food-insecure countries in the South, then public research has to be supported. Today, two thirds to four fifths of R&D in agricultural biotechnology is carried out in the private sector. On the one hand, this is desirable, as the public sector should cease supporting activities wherever the private sector can do things better or more cost-effectively. On the other hand, this dominance is a cause for concern to some who favor and most who oppose agricultural biotechnology.[56]

Because the life sciences corporations must compete to appear attractive to the international financial community, their research priorities are determined by the financial returns on investment, and hence the needs of those who wield purchasing power in the relevant markets. To put this another way, it is not very likely that these corporations will be willing to fund research for drought tolerance, tolerance to soil and mineral toxicity, or other characteristics of relevance to the typical resource-poor farmer family in poor countries. Even if they were to make progress in these areas, the costs of developing useful products would be high and hence the products would remain out of reach for those who need them most. Part of the explanation for this is intellectual property rights—the knowledge and technologies, including DNA sequences, research tools, and output traits are today largely proprietary. This, according to the CGIAR, has partly impeded secondary innovation and led to conflicting proprietary claims and high transaction costs.[57]

For private industry, a focus on profitable markets is necessary for survival. Some people can regret this reality—but then they should move on to look for alternatives. The alternative to private-sector research is public research. There the emphasis can be given to plant species that are most relevant to poverty reduction and income generation of specific ecoregions, and research can focus on losses caused by biotic and abiotic factors and on stabilizing yields on poor soils. The fruits of public research can be passed on to small farmers at cost or, via subsidized government channels, even free of charge to the end user. As in the past, the CGIAR, with its focus on the needs of developing countries, will have to play a conspicuous role in such efforts—in close cooperation with the

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56 See, e.g., M. Lappé and B. Bailey, *Against the Grain: Biotechnology and the Corporate Takeover of Your Food* (London: Earthscan, 1998).

57 See CGIAR/TAC, op. cit. note 9.

different national agricultural research systems. The record shows how much has been achieved in the past 30 years through CGIAR and its local partners.[58]

Public agricultural research systems such as the CGIAR, however, depend heavily on public funding, which depends on political goodwill. Political goodwill in turn depends to a large extent on judgments made by civil society about the objectives of the research. If these are seen as contributing to solutions, it will be feasible to raise funds. If they are seen to be adding to the problems, it will—at least in the long run—become impossible to raise funds.

In order to make cutting-edge biotechnology available to small farmers, more public research has to be financed and more public-private partnerships—as when the private sector provides access to cutting-edge technology and gives permission to use it for the benefit of resource-poor farmers—need to be established. These are the only ways to give the needs of poor, small farmers (if and where they are different) high priority. Successful public-private cooperation for the poor will do a lot to improve the perception of a complex technology. The Insect Resistant Maize for Africa Project—which involves the Kenya Agricultural Research Institute, the International Maize and Wheat Improvement Center (CIMMYT), and the Novartis Foundation for Sustainable Development—could serve as a pilot for more projects with different constituencies.[59]

But a politicized discussion in some northern countries about biotechnology and genetic engineering is likely to prevent the wider use of these options.

The Tenor of the Current Public Debate

Over the past several years we have witnessed an intense and highly controversial discussion of biotechnology and, especially, genetic engineering. Protests against food containing GMOs cross all social barriers, and opponents range from members of the English royal family to Indian trade union leaders. The degree of polarization is very high, as are the passions. While technological innovations are always associated with some anxiety and fears (remember the early story of the railway, penicillin, and vaccination), the degree of scaremongering and the heat of the current discussion cannot be explained in terms of natural science, or at least not in these terms alone.

Genetic engineering is not very different from other types of activities that are carried out with the objective of creating organisms with desirable characteristics. Conventional plant breeding also involves the transfer of genes. Genetic engineering differs from conventional breeding inasmuch as it allows genes to be transferred more easily across taxonomic boundaries, but this difference in technology cannot account for the difference in public perception. Clearly, there are more complex elements at work here. Analyzing the current debate, it seems that highly sophisticated anti-biotech activists are easily able to mislead a scientifically uneducated public about issues of high scientific complexity.

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58 J.R. Anderson and D.G. Dalrymple, *The World Bank, The Grant Program, and the CGIAR: A Retrospective Review* (Washington, DC: World Bank Operations Evaluation Department, 1999); CGIAR, *Synergies in Science: Intercenter Collaboration to Eradicate Hunger and Poverty* (Washington, DC: 2000); M. Shah and M. Strong, *Food in the 21st Century: From Science to Sustainable Agriculture, Highlights of the System Review 1998/99* (Washington, DC: CGIAR, 1999); CGIAR, *The Impact of Knowledge (Annual Report 1998)* (Washington, DC: 1998); see also <www.futureharvest.org>.

59 For further information, contact either CIMMYT through <s.mugo@cgiar.org> or <d.hoisington@cgiar.org>, the Kenya Agricultural Research Institute (KARI), P.O.Box 5781, Nairobi, Kenya, or the Novartis Foundation for Sustainable Development at <www.foundation.novartis.com>.

"Hate Sites"

One of the most important constraints to the social acceptance of biotechnology and genetic engineering is an unusually negative social marketing. There are biotech related Web sites that read like "hate sites." Far away from any scientific evidence and often in contrast to the truth, biotechnology is associated with the worst disasters of modern history.

On several Web sites, risks of field trials with GMOs are compared with the impact of a nuclear disaster such as Chernobyl. This is not only far from a scientific risk assessment, it ridicules and derides innocent victims of Chernobyl. A recently opened Web site shows the ugly face of Adolf Hitler to associate biotechnology with the eugenics of the Nazis—what a slap in the face this is for the victims of Auschwitz![60] Food containing GMOs is referred to as "Frankenfood," and food from genetically modified crops is labeled "contaminated."

Opponents even criticize food aid to drought- stricken countries in sub-Saharan Africa, such as Ethiopia, as a conspiracy between the U.S. government and the World Food Programme, "dumping unsafe, American genetically modified crops into the one remaining unquestioning market-emergency: Aid for the world's starving."[61] This is an enormously cynical view to dump on the backs of starving people in a country that spends all its money in a useless war against its neighbors.

Several Web sites use sophisticated Machiavellism instead of reason: On the one hand, they warn about unknown risks in the context of the environmental impact of a release of GMOs, and they ask for more studies. On the other hand, they call for vandalism and destruction of trials that have been set up to answer unresolved questions. Where more research is needed to create more data for the assessment of the likelihood and seriousness of risks, such research ought not to be prevented. Obviously, those who oppose the research have no interest in the results—at least in terms of the traditional concept of rationality that is based on plausibility and comprehensibility. Still worse, masters of political social marketing blow up risks with an extremely low likelihood through worst-case scenarios (for example, "genetically altered food could trigger rare but deadly allergies") to become monstrous "Bio-twisters."

This again offers attractive headlines to the media. Aware of the importance of media coverage and in order to exploit the media as effectively as possible, an Activist Guide to Exploiting the Media is offered on the Internet.[62] There, hints are given about which newspapers to approach and which to stay away from, journalists are described as "weak and cowardly," and news is portrayed as "managed and manipulated." The Guide presents hints on "How to get the Press to Come to Your Action" and gives advice on coordination and timing as well as on ways and means to make a press release effective and follow it up. Journalists may draw their own conclusions from messages such as "Be friendly towards them, whoever they are. Bite your lip. Don't put their backs up even if you hate the bastards."

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60 See <matu1.math.auckland.ac.nz/~king/Preprints/book/genes/genes.htm>.

61 D. Walsh, "America Finds Ready Market for GM Food—The Hungry," *The Independent*, 30 March 2000.

62 See <www.gene.ch/pmhp/gs/media.htm>.

Industry and International Agricultural Research Centers might learn a few tips from this Web site, as in the advice given on Rules and Tactics: “be informed,” “be calm,” “be concise,” “get to the points you want to make,” “don’t let yourself be bullied,” and “turn hostile questions to good account.” But while activists may get away with efforts to “deliberately misinterpret the question” or “undermine the factual content of the question,” proponents of agricultural biotechnology should not even try.

Misuse of Ethics

In the name of “ethics,” “peace,” and “human welfare,” we find calls for attacks on research facilities and corporate headquarters—resulting in the firebombing of biotechnological research institutes.[63] Theologians from the Institute for World Religion pull religious values into the debate and call genetic engineering an “unprecedented lethal threat to life on the planet.”[64] Is it not part of ethical thinking to respect the professional ethics of other disciplines? And if so, does this not mean that first and foremost biologists should assess the biological implications of these technologies, legal experts the legal implications, and so on for economists, sociologists, political scientists, and others? Once professional experts have established the facts, we can call upon the ethicist to do the ethical assessment. Is it asking too much that people who do not have an in-depth understanding of molecular biology refrain from making judgments on issues that require such understanding?

Diffuse *Angst* and emotional rejection by concerned laypersons have in many fora the same weight during discussions as irrefutable facts presented by scientists. Feelings that something somehow cannot be the way it is meant to be stand against judgments of Nobel laureates in biochemistry and molecular biology.

For many, nothing that has any relation to biotechnology and genetic engineering seems acceptable. For example, when the good news broke that rice was genetically engineered to contain beta-carotene, the pigment that yields Vitamin A, there was an almost immediate rejection from those opposed to biotechnology. The argument of activists such as Vandana Shiva that this kind of rice is not really necessary since Vitamin A tablets are already available is cynical enough. Her additional argument that people should simply eat liver, egg yolks, chicken, and meat as well as spinach, carrots, mangos, and so on was put in the right context by Dennis T. Avery of the Hudson Institute: “These statements make Shiva the modern equivalent of Marie Antoinette. When told the French peasants were rioting because they had no bread she was supposed to have said, ‘Then let them eat cake’.”[65]

Where the quality of science cannot be refuted and emotions do not achieve the goal of denouncing the technology, the moral quality of the researchers is questioned. Wild stories about insinuated lack of moral responsibility (or brains) of scientists in combination with a subtle anti-Americanism as well as a not-so-subtle rejection of multinational corporations plus ideological opposition to GMO technology on the grounds of western-

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63 See <www.tao.ca/~ban/ar.htm>.

64 R. Epstein, *Redesigning the World: Ethical Questions about Genetic Engineering*, at <online.sfsu.deu/>.

65 V. Shiva, “Genetically Engineered Vitamin ‘A’ Rice: A Blind Approach to Blindness Prevention,” a statement mentioned on AgBioView@listbot.com on 14 February 2000, see also D.T. Avery, “What Do Environmentalists Have Against Golden Rice?” *The BridgeNews Forum*, 7 March 2000.

style capitalism or involvement of the World Trade Organization have created an explosive chemistry.

The moralization of rational issues and the retreat to basic personal convictions are ultimately divisive and destructive, because those involved in the debate usually cannot retreat to the compromises that are indispensable for professional decisions—especially when they concern future issues and the fate of people elsewhere on the planet. A kind of bio-McCarthyism is taking place, leading to the slandering and vilification of anybody who sees genetic engineering and green biotechnology as anything but an evil to be avoided at any cost.

It seems to me that ethicists participating in the GMO debate could contribute much more constructively by applying their expertise and core competence to the development of ethical guidelines to all actors in the debate. These could call for:

- disclosure of financial and other interests;
- willingness to retract publicly any errors or misinterpretations when they become apparent;
- a statement of training background, potential biases, and prejudices;
- refusal to participate in violent acts against persons or property;
- avoidance of presenting selective findings and giving a misleading picture;
- differentiation between evidence and opinion;
- use of the same critical standard to all sources of information; and
- establishment of the credibility of sources of information, and
- acknowledgment of any highlighted opinions that are not mainstream.

A last word in the context of ethics: Let us remain aware of Max Weber's masterpiece on "Politics as Profession." There he postulates that we have to be clear in our mind that every ethically oriented course of action can rest on two altogether different and opposing maxims: it can be oriented to either an ethic of conviction or an ethic of accountability. This is not to say that the ethic of conviction is synonymous with irresponsibility or the ethic of accountability with lack of conviction. But there is a profound difference between acting in accordance with the ethic of conviction and acting according to the ethic of accountability, and hence feeling responsible for the (foreseeable) consequences of what you have done or omitted to do.

The decision for or against genetic engineering and biotechnology cannot be based solely on the ethic of conviction. It can be neither "genetic engineering by all means" nor "no GMOs at any price"—there is simply more to it than that. All technological decisions must be the result of a scientific weighing of arguments and be based on a sober and disinterested benefit-risk analysis in a specific situation and within a wider technological portfolio—that is, they have to be decisions based on the ethic of accountability.

Regulation as a Political Process

As a result of the negative tenor of the discussion, even politically neutral regulators want to be on the safe side. Thus, food from genetically modified crops is "held to standards that are irrational, far beyond those that any other product can or should meet, and that prevent their competing successfully."[66] Instead of applying the scientific consensus for a risk analysis—that the risk-based characteristics of a new product should

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66 See H. Miller, "Anti-Biotech Sentiment Has Its Own Risks," *Financial Times*, 22 March 2000, p. 10.

be the focus of attention, regardless of the production techniques used—the method by which a product was created becomes the bone of contention.

The current work of a task force of the Codex Alimentarius is “en route to codifying various procedures and requirements more appropriate to potentially dangerous prescription drugs or pesticides than to GM tomatoes, potatoes and strawberries. They include long-term monitoring for adverse health effects and batteries of tests for genetic stability, toxins, allergenicity, and so on.”[67] In industrial countries, food production has a low profit margin, and in developing countries regulatory absorptive capacity is low, so such overregulation is likely to achieve the political goal of preventing GM-food from reaching markets. Regulation of this degree violates a fundamental principle of regulation—that the degree of scrutiny should be commensurate with the risk.

Labeling should also be commensurate with the issues at stake: Would it serve the purpose of warning consumers of food risks if all organically produced food were labeled “May contain bacteria and aflatoxin”? Would the consumer be wiser or better off if all meat from the European Community carried the label “May contain BSE”? And if not, what difference in substance makes the labeling of GM food mandatory?

It is a fact that not all regulators are politically neutral, and it is my perception that at the moment there is no political downside to being against biotechnology and genetic engineering. While those promoting the technology are kept busy producing assessment after assessment, those opposing it get away with their self-made image of saving the world from disaster. The outcomes of publicly funded symposia may be manipulated by organizers inviting predominantly opponents while rejecting offers of lecturers with positive case studies on GM crops.[68] The results of such conferences can then be used as “evidence” by politicians and regulators who had made their mind up against the technology long before, but needed “events” to go public with their negative preoccupations.

There is some evidence of obvious conflicts of interest: The long-awaited report from the U.S. National Academy of Sciences on proposed Environmental Protection Agency (EPA) regulation of biotech plants as “plant pesticides” was criticized by the Senior Research Fellow at Stanford University’s Hoover Institution, Henry I. Miller, on procedural, scientific, and policy grounds. Miller goes on record saying that the report corrupts the reputation and credibility of the Academy, as it is not only internally inconsistent and scientifically obtuse, but conflicts directly with previous reports by the Academy and other prominent scientific groups. This, says Miller, may have a simple reason:

> The committee members and the invited reviewers were included with apparent disregard for obvious conflicts of interest, including ideological opposition to biotechnology and having worked on the policy under review while employed at EPA. Three members of the twelve-person committee…are former EPA staffers who had helped to craft and defend the policy while in the government; and another…has produced a litany of anti-biotechnology tracts over the past decade. And during the formal review process, the document was reviewed by another former EPA

67 Ibid.

68 See note 38.

official...who was instrumental in crafting and defending the policy in question, and by another anti-biotechnology crusader.[69]

The U.S. case may not be the only one where committees—supposed to be bipartisan, but in fact negatively preoccupied—wrote reports that became the basis for biotech-unfriendly decisions of authorities. The report that led to the ban of trials with a *Bt* corn in Germany was written by the Freiburg Oekoinstitut, a group long on record as anti-GMOs.[70]

In other words, tell me on what political grounds you want to decide and I tell you which institute or "expert" should be given the job to write the report you need as "scientific evidence" for your decision. Is it any surprise that public has developed a considerable amount of distrust about "experts"?

Whereas in a perfect world, regulation should rest on independent and unbiased expert knowledge, the real world has different parameters. In most states there is a close relationship between regulators and politicians. While scientists can assess the structure and extent of a risk, the decision on what exactly represents an "acceptable" risk is a purely political one. As politicians decide on the key personnel of regulatory authorities, it should be no surprise that this has consequences for the direction of decisions. This political judgment is today different—in my view, biased in a negative way—in Europe than in the rest of the world. While this bias will not make a difference to the food security of Germany, Switzerland, the United Kingdom, or the United States, it may affect resource-poor farmers in the developing world significantly and in a negative way.

Consequences for Public Agricultural Research Funding

As noted earlier, public agricultural research is of great importance for a sustained growth of food production in the developing world. But despite the known facts about population growth and environmental pressures, funding for this research for developing countries has declined. For example, the CGIAR—despite high praise for its work, which sparked an agricultural revolution in Asia and Latin America with dramatic increases in food production and reduced food costs—has experienced a significant downturn in funding over the past few years. In most developing countries, where drastic reductions in public support for agricultural research have taken place, there are no compensating increases in private-sector support for scientific activities. Unfortunately, the outlook for a substantial increase in funding is bleak.

Over the past 10 years, most of the world went through dramatic changes in terms of geostrategic interests, political concepts, understanding of "good governance," the role and understanding of technology, and other determinants of life. Partly as a result of this, the concept of the state's role in sustainable development and development assistance changed. Different ideas about what the state is best able to do led to critical choices about what to do and what not to do—and this had practical consequences. In addition, the value of macroeconomic stability and fiscal discipline for economic development is today better understood, which led to consistent efforts to close budget deficits.

During this time, donor countries' official development assistance (ODA) dropped significantly, reversing a long-term trend, while private flows rose appreciably (albeit

69 Miller H.I.: Nescience, not Science, from the Academy, see miller@hoover.standforf.edu

70 E. Peerenboom, "German Health Minister Calls Time Out for Bt Maize," *Nature Biotechnology*, April 2000, p. 374; downloadable PDF file at <biotech.nature.com>.

concentrating mostly on a limited number of emerging countries). This necessitated cuts within ODA budgets. In one area—mainly due to a negative public perception of agricultural research in the context of the Green Revolution and genetic engineering—politicians obviously did not have to be afraid of incurring the wrath of the electorate, and that was support for research in favor of resource-poor farmers. Very personal convictions of individual critics and pressure groups about right and wrong, along with very different living conditions and natural resource bases, form the basis of protests that will have a negative impact on people in sub-Saharan Africa and Asia.[71] The fact that farmers in developing countries who are short of resources are thereby deprived of options for the future is either not apparent or not considered important.

Reviving Dialogue and Consensus-Driven Action

To a certain extent, pluralism of opinion is normal in modern societies, which are immensely pluralistic in their values, interests, and beliefs. And the knowledge and experience that inform these societies also show an extremely diverse range of content and form. Modern, open societies are thus much more sophisticated social organizations than closed authoritarian societies—at a price that is worth paying. The assessment of new technologies occurs within this pluralistic structure; simple answers and undisputed processes for consensus are therefore not at hand.

The strength of the negative overtones that currently dominate the debate about agricultural biotechnology and affect the views of the public and, as a consequence, of many politicians does not give cause for optimism. Fair discussion on the Internet and elsewhere remain the exception to the rule.[72] My concern is that in the next two to three years, little can be done to turn around the public perception. Recent public opinion polls indicate substantial skepticism about scientists working for the chemical industry and about regulatory authorities. Environmental pressure groups advocating against GMOs are seen in a much more favorable light.[73] According to one recent poll, 63 percent of British citizens tend to oppose or strongly oppose GM crop testing in their local area, being at least somewhat afraid of a potential negative impact.

The widespread negative public perception in Europe (things look different in the US) is no incentive for politicians to use public funds for biotechnology research—be it for the South or the North. A negative spillover with regard to funding agricultural research in general is certainly possible. The cumulative circular interdependence of negative Green Revolution myths, genetic horror stories, and globalization uneasiness is likely to perpetuate the negative tone in the debate.

It seems that things will have to get worse in order for them to get better. More visible consequences of the low productivity of resource-poor agriculture will have to occur.

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71 For example of claims that public funds spent for biotechnology and genetic engineering are funds wasted, see <www.swissaid.ch/pressecke.htm>.

72 See, e.g., the excellent work done by C.S. Prakash of the Center for Plant Biotechnology Research at Tuskegee University, Alabama (<prakash@tusk.edu>), and Klaus Ammann, director of the Botanical Garden of the University of Berne, Switzerland (<kammann@sgi.unibe.ch>) as well as of all those who contribute to <AgBioView@listbot.com>.

73 See R.M. Worcester/MORI, "Risks and Public Trust in Policy on Chemicals," presentation at the British-German Environment Forum, London, 21 March 2000; see also J. Hampel and U. Pfenning, *Biotechnology and Public Perception of Technology. The German Case* (Stuttgart: Akademie für Technikfolgenabschätzung in Baden-Württemberg, 1998).

Issues like increasing poverty-driven migration, political upheavals, humanitarian disasters in these contexts, and environmental destruction will be needed to bring the message home to the broader public: research that can raise the productivity and hence the income and the quality of life in poor countries is in the enlightened self-interest of all. It is preferable from a human dignity point of view and also more cost-effective than the political management of poverty-driven mass migration.

Thus while doing whatever can be done technically, legally, in the media, and otherwise to improve the situation in the short term, we must focus on the medium and longer term. The current impasse is only to a small degree due to lack of information. It is much more a matter of attitudinal rejection. There is already a wealth of information on all important aspects of agricultural biotechnology, and there is excellent advice for all parties on how to deal with this information.[74] But more information alone is not the answer. Rather, those of us who are convinced of the potential benefits of biotechnology and genetic engineering must engage in spreading the "gospel" through dialogue and cooperation.

To turn the situation around, we need a number of changes. First and foremost, research in agricultural biotechnology must come up with results that are more tangible and more easily understood by a wider public. Empirical social science suggests that laypeople strongly believe that some scientific developments are beneficial and others are not.[75] Their opinions are mainly colored by whether people will benefit from the development and whether the application will be safe to use.[76] While characteristics such as insect or herbicide resistance might warm the hearts of some researchers or farmers, most consumers will neither understand nor appreciate the blessings of this technology.

The blessings of agricultural biotechnology will have to be brought home to a wider public by success stories such as the Vitamin A rice or "iron-rice" or by other improvements of the nutritional profile that are easier understood—and by putting potential risks into perspective. If they perceive the technology as beneficial, people are prepared to overlook benefit/risk trade-off objections. If the expected benefits are of questionable value (such as extended shelf life for tomatoes in countries with ample refrigeration facilities), then there may be little justification for accepting any appreciable amount of risk. But if the expected benefits are clearly enormous (such as Vitamin-A enriched rice), then it may make sense to accept a limited degree of risk.

Advantages for the consumer (better nutritional value, reduction of toxins) as well as advantages for farmers (less costly inputs) and the environment (less chemicals) must be empirically substantiated and properly explained. It should be possible to explain to a

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74 For the basic information, see Nuffield Council on Bioethics, *Genetically Modified Crops: The Ethical and Social Issues* (London: 1999); IPGRI, IDRC, and Dag Hammarskjöld Foundation, *Seeding Solutions: Policy Options for Genetic Resources* (Crucible II – Report: People. Plants and Patents Revisited) (Rome, Ottawa, and Stockholm: 2000). For how to deal with the information, see H.V. Fineberg and S. Rowe, "Improving Public Understanding: Guidelines for Communication Emerging Science on Nutrition, Food Safety, and Health," *Journal of National Cancer Institute*, 4 February 1998; see also <www.ificinfo.org/resource/guidelines.htm>.

75 Hampel and Pfenning, op. cit. note 72.

76 See Worcester/MORI, op. cit. note 72.

broader public the benefits of insect-resistant cotton—achieved by genetic modification with *Bt*—that cut the use of cotton insecticides by nearly 40 percent.[77]

Dialogue and Cooperation: From Ritualistic Fights to Issue-Oriented Discourse

In addition to positive case studies for the improvement of human quality of life, consistent and coherent dialogue as well as practical cooperation are necessary to bring about a change in public perception of agricultural biotechnology. Dialogues are able to improve mutual understanding by providing and exchanging information, learning about other people's concerns, and reducing prejudice. In addition, cooperation between different members of civil society can build up and strengthen mutual trust.

As people do not trust what they do not understand, communication becomes crucial. What cannot be communicated cannot be done. Experience from other social or political conflicts suggests that the vast majority of those involved in discussions want to be taken seriously and hence given competent and reliable information.[78] Most people look to minimize possible risks through fair controls and want to participate in the decision process about values and objectives. This is possible, but quick results are unlikely. The fight for public acceptance will be a lengthy uphill battle and will have to involve many different constituencies.

Dialogue

All institutions—be they business enterprises, research centers, government agencies, or nongovernmental organizations—tend to be self-referring. That is, every organization has a more or less self-contained system of values and interests that it takes for the full version of reality. If people proceed on the assumption that their convictions are the sole correct ones, their ideas the best, their proposals the most telling, then—like all narcissists—they court danger: unable to size up chances and risks dispassionately, they commit errors that could have been avoided.

Dialogues are search processes for better solutions, but they are not easy. In a perfect world, all parties can listen, evaluate, learn, and, if necessary, change their opinion. The fact that people get into arguments over their positions only shows that they are concerned about the same things. A plurality of opinions and a competition of ideas are the expression of a dynamic intellectual climate. A plurality of interests in a society gives rise not only to conflicts but to significant opportunities as well. Why not make the most of this pluralistic situation when it comes to working out a path to consent on a politically sensitive issue such as agricultural biotechnology? To be sustainable, solutions to problems must reflect more than the narrow horizon of a one party. They also need to

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77 See G. Traxler, J.B. Falk-Zepeda, and G. Sain, "Genes, Germplasm and Developing Country Access to Genetically Modified Crop Varieties," Contribution to ICABR Conference: The Shape of the Coming Agricultural Biotechnology Transformation, Rome, 17–19 July 2000. Such a substantial reduction has not been achieved in all years and in all areas where *Bt* technology is applied; see Economic Research Service, U.S. Department of Agriculture, *Genetically Engineered Crops for Pest Management* (Washington, DC: 1999). The easily understandable reasons for this are explained in L.P. Gianessi and J.E. Carpenter, *Agricultural Biotechnology: Insect Control Benefits* (Washington, DC: National Center for Food and Agricultural Policy, July 1999), p. 91 ff.

78 see for example European Federation of Biotechnology / Task Force on Public Perceptions of Biotechnology: BIOTECHNOLOGY for non-specialists. A handbook of information sources. Delft / London 2000;

include other varieties of experience and different constellations of interests. In view of the urgency and complexity of the many problems besetting our time—including the need to achieve food security for a growing world population—a narrow-minded approach to problem analysis and solutions is just as hazardous as thinking in simplistic “left/right” terms.

In the real world of the agricultural biotech controversies, there is a strong polarization of views. Invariably the parties most heavily involved in the debate end up claiming that they alone are privy to the real truth, and they ascribe absolute truth to what in fact is only partial truth. Mutually exclusive “worst” and “best” case scenarios are juxtaposed and lead the nonspecialists down a path of disorientation, perplexity, uncertainty, or, in the worst case, diffuse anxiety. In this situation, critical reflection becomes almost impossible for most people. Information and arguments are classified according to constructivist principles—that is, on the basis of pre-existing convictions. This can be very frustrating. And yet, there is no alternative to dialogue.

Dialogue does not do away with conflicts, of course, but—in most cases, at least—it does help to resolve them constructively. The four prerequisites of dealing rationally with conflicts posited by Ralf Dahrendorf are of eminent importance in this connection:[79]

- Conflicts must be looked upon as right and meaningful, for they can inaugurate or speed up significant social change.
- Intervention in conflicts must be limited to agreeing ground rules on the forms it should take.
- Conflicts must be organized and channeled, for example in political parties, trade unions, employers’ associations, and so on.
- There must be agreement on the “rules of the game” governing how a conflict is resolved.

Yet even with these stipulations, dialoguing is and remains an open-ended process. The course dialogues take cannot be planned beforehand, and their outcomes and consequences are comprehensible only to a limited extent.

Dialogue Participants

The question of who should be represented in a dialogue is difficult to answer. On the one hand, the full spectrum of opinion should be represented. On the other hand, at least in my experience, there is little sense in including fundamentalist advocates of particular interests. Organizations that explicitly state a preferred strategy of confrontation choose not to be involved in genuine dialogue. They seem to be so bent on confirming the “truth” of their opinions about the way the world works and so preoccupied with the public splash this makes that they would feel themselves completely invalidated by any kind of compromise.

So-called issue champions often seem unable to permit themselves the luxury of objectivity. They have molded themselves to the opinion profile that works for their public, and the slightest compromise could mean a loss of face or lead to an identity crisis. So the role assignment that defines their persona takes on the function of a hypothesis corroborated by every act that does not conclusively refute it. Ideological reasoning adopts a given thesis as the unquestionable truth—also known as dogma.

79 R. Dahrendorf, *Gesellschaft und Freiheit* (Munich: Piper, 1981).

Very often, even qualified experts—depending on whether they are on the supporting or the opposing side of a controversial issue—will evaluate one and the same set of facts quite differently. “Schools of thought” tend to exert on their adherents a certain pressure to conform. Diverging opinions, being institutionally unacceptable or upsetting, are brushed aside. Yet many of the positions on technical and political issues espoused 10–15 years ago by then-outsider minority groups enjoy broad acceptance today. There is a phenomenon that Hans Küng has dubbed “unsimultaneities of mindfulness.”[80] The social learning period can be decisively shortened to the benefit of all if everyone who has something to contribute to solving a problem is drawn into the communal endeavor to broaden and advance our knowledge.

In order to reach a consensus, both sides must be willing to join in learning together and in this way—perhaps—to arrive at a new, shared platform of certainty. This calls not only for scientific understanding but also for methodical efforts to keep dialogues between different actors with different interests and values results-oriented. One path to this state of affairs, already mapped out in antiquity, is still useful today:

- First, find out what everyone can agree on.
- Discuss the remaining areas of disagreement in a spirit of aiming to reconcile them.
- Ascertain the consensus reached at this point in the discussion.
- Identify the areas of disagreement still remaining. These usually have to do with different priorities in considering pros and cons or differing expectations where decisions attended with uncertainty are concerned.
- Strive for a fair compromise.

By fair compromise I do not mean the arithmetical mean between two standpoints. If that were the definition of a fair compromise, all the participants would simply demand twice as much as what they actually hope to get. A fair compromise consists of a reasonable joint framework of action elicited through forthright argumentation and based on the participants’ elementary interest in coexisting in concord.

Essential Ingredients of Productive Dialogue

The ingredients of a constructive and productive dialogue are known: bring together all relevant factual knowledge; clarify the value questions that divide the participants; honor the right of self-determination of individuals and groups as indispensable in a democratic society.

For a discussion to lead to better understanding and more consensus, it can be neither a playground for politics nor a stage for boosting NGO portfolios or making exaggerated promises by life sciences corporations or research institutes. All must lower the rhetoric and deal honestly with the issues. More subtlety must allow more differentiation. All opportunities for dialogue must be used and include as many people of good will as possible. New coalitions must be formed to find constructive ways out of the impasse. The interests of the participants should be made explicit, along with the responsibilities, rights, and duties.

Criticism and opposing views—whether based in science or emotions—have to be taken seriously. Euphemistic or horror language has to be avoided. Once mutual

80 H. Küng, *Projekt Weltethos* (Munich: Piper, 1990), p. 104.

understanding and respect for each other's intellectual integrity has been established, open issues can be solved in a scientific manner rather than discrediting the personalities voicing the opposing view.

Credible dialogue will never focus on benefits only. As all human actions (or nonactions) have risks, these too must be part of the communication. If risks can be anticipated, they must be named and discussed proactively—there is nothing more destructive for the credibility of science or industry than pretending that there are no risks only to be forced later by circumstances to admit their existence. Such behavior is also incompatible with high professional competence and integrity.

Tolerance and Waiving Claims to Superiority

Tolerance is surely one of the most important character traits for anyone who wants to participate in a dialogue. It differs fundamentally from disinterest, noncommittal, or a fixation on harmony. On the contrary, tolerance implies that someone holds firm convictions yet respects those of others. Aptitude for dialogue and steadfastness are not contradictory. Tolerance begins with the ability to listen to others who have a totally different mindset. Rigorousness of inquiry is not the same thing as a tearing-down attitude.

Tolerance is especially incumbent on those who, thanks to sizable financial and institutional resources at their disposal, wield greater clout. If the partners in a discussion are unevenly matched, there is a danger that consensus will owe more to constraint than to agreement. Not only is such pressure unfair, it also drives the weaker parties into putting up resistance with all their might. If power corrupts and absolute power normally corrupts absolutely, the same can be said of powerlessness.

Dominance-Free Communication

When masters and underlings talk to or about one another, the conversational tone is not the same as between those who are free and equal. Dominance-free communication denotes an ideal situation in which the rulers do not try to impose their claims to the truth on the ruled, but in which all participants have the same chance to speak their piece. In this model situation, the interlocutors must not deceive themselves or others as to their intentions, and there is no place for privileges in the sense of "rules of order" binding on one side only.[81]

A further part of dominance-free communication is the timely imparting of information, ensuring that everyone is equally informed. Whatever information is available and needed for the dialogue must be made freely available before discussions start. Tactically produced knowledge deficits are neither helpful nor necessary. Publications such as the one by Feldmann, Morris, and Hoisington are a good start, especially for information disseminators such as science journalists, political advisors, and public servants of national and international institutions.[82] The information provided must be honest, complete, comprehensive, and factually accurate.[83] Unsupported claims or accusations are a waste

81 J. Habermas and N. Luhmann, *Theorie der Gesellschaft und Sozialtechnologie* (Frankfurt a.M.: Suhrkamp, 1971), p. 137 ff.

82 "Why So Much Controversy over Genetically Modified Organisms? Answers to 10 Frequently Asked Questions about GMOs," *Choices. The Magazine of Food, Farm, and Resource Issues* (forthcoming).

83 As a good example, see <www.cropgene.com>.

of time and counterproductive to reaching informed consent. Appropriate information emanating from a joint venture of different constituencies could help an interested lay public to digest conflicting or controversial information and deal with the pressure of activist groups.

To expect that science will provide final proof at any time and in any event as a condition of taking action would be to paralyze our very ability to act . To put the "precautionary principle" into perspective, every act, not excluding an act rooted in scientific theory, is "tainted with provisionality." But perhaps that is not our real problem, for no matter how narrow the margin of uncertainty in scientific pronouncements may become, people will bet on it when theory appears inadmissible and unbearable in practice.

Relinquishing Animosities and "Searchlights"

Time and again we can see how people take up a hostile stance the moment their opinions encounter opposition. From that point on the mind is no longer open to impulses or ideas emanating from other directions; it only takes in the arguments that come from a "friendly" quarter and therefore jibe with its own set convictions. Under such circumstances, it is not the facts that determine whether an argument is accepted or rejected but rather two mirror-image hypotheses:

- the "presumed friend hypothesis," which lets people place their trust in what they have direct knowledge of and are able to understand; and
- the "presumed enemy hypothesis," with the help of which everything that is unfamiliar or incomprehensible is seen as a potential enemy that must be foiled.

Who turns out to be friend and who an enemy depends, of course, on personal experience and interests and on socially conditioned preconceptions. So truth "does not present itself to us unvarnished and never did. It has to appear suitably attired, otherwise it will not find acceptance. Every culture—also every discussion culture—is grounded in the principle that the truth can be expressed most plausibly in certain symbolic forms—forms that another culture may view as trivial or inconsequential."[84]

With his "searchlight" theory of science, Karl Popper drew attention to the fact that laypeople are not alone in being susceptible to prejudices. Every scientific description of facts is also selective and dependent on hypotheses. The situation, said Popper, can best be described by comparison with a searchlight. What the searchlight makes visible will depend on its position, our way of directing it, and its intensity, color, and so on. It will, of course, also depend very largely on the things illuminated by it. Similarly, a scientific description will depend largely on our point of view and our interests, which as a rule are connected with the theory or hypothesis we wish to test. It will also depend on the facts described. No theory is final, and every theory helps us to select and order facts.[85]

As we all have our intuitions and assumptions, preconceived opinions, fiercely held beliefs, and other searchlights, and as we all have tendencies to avert loss and a preference for the status quo, we all should do our best to be aware that it is not only our opponents who have limits. So do we.

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84 N. Postman, *Wir amüsieren uns zu Tode. Urteilsbildung im Zeitalter der Unterhaltungsindustrie* (Frankfurt a.M.: Fischer, 3. Aufl. 1985), p. 34.

85 K. Popper, *Die offene Gesellschaft und ihre Feinde*, Bd. 2 (Tübingen: Francke, 6. Aufl. 1980), p. 322.

The Practical Limits to Dialogue

In practice, a dialogue cannot go on being prolonged until every last potentially or actually involved party is convinced. So it is necessary to agree on guidelines governing the technical aspects (beginning, end, breaks, sufficient familiarity with the subject) and the content (a demarcation of what is to be discussed). And there must be rules defining what constitutes a majority. Less than absolute majorities have to suffice for a decision, otherwise action will be stymied. The right of the majority does not rest on the erroneous assumption that it is always right. Nor does it rest on the assumption that one group has a natural authority over the other just because it is more numerous. Rather it rests on the absence of something like a higher authorization.

Dialogues are not ends in themselves. Dialogues lacking in what Jürgen Habermas once called "pre-communicative intention to act" readily degenerate into alibi exercises for Machiavellians who do not have the slightest desire to see people change their behavior.[86] For them, dialoguing is merely a delaying tactic, a way of gaining time. Yet nonaction may have graver negative consequences than a less-than-perfect course of action, as can be demonstrated quite clearly in the context of sustainable development.

And there is another obstacle. Years of experience in stakeholder dialogue show that those who are normally delegated by companies or regulatory authorities to take part are not usually those who are able to implement what has been achieved as a compromise through consensus. Although the top management of companies and regulatory authorities—at least among the enlightened institutions—have no problem delegating representatives to such talks, the persons doing the delegating do not go through the all-important learning processes that the delegates experience. This gives rise to divergent perceptions and realities of the task ahead.[87]

In the end, it is the benefit/risk analyses—the weighing of benefits versus risks—that should convince not only the scientists and experts but also a broader public. Democracy—not oligarchy—has to work also here. This also means that scientists will have to learn to explain their work in a manner that is understandable at least by an interested lay public. Myths have their own life and will only slowly fade away through continual communication and a consistent and coherent "walk-as-you-talk" attitude by all parties involved in agricultural biotechnology.

86 J. Habermas, *Theorie des kommunikativen Handelns, Bd. 1, Handlungsrationalität und gesellschaftliche Rationalisierung* (Frankfurt a.M.: Suhrkamp, 1981), p. 378.

87 This, incidentally, was the major difference in the Business Council for Sustainable Development around Stephan Schmidheiny in the UNCED process: although staff members and specialists prepared the texts and documents there, the status quo of the discussions were regularly analyzed and approved—usually with slight corrections and supplements—by the CEOs of the participating companies. The top management was thus subject to the same learning process as the delegated staff experts, and for this reason the two realities remained relatively congruent.

Cooperation

Dialogues will not suffice—there must also be "dialogue through cooperation," cooperation in the highest professional quality and greatest possible transparency. Common research can lead to positive case studies of societal learning for different constituencies, including scientific committees, science journalists, and other interested stakeholders. When people join together to work on a concrete project to achieve goals that are judged to be important to everyone, prejudices eventually disappear and labels that have been acquired lose their importance. The cooperation in the laboratories and fields allows differentiation between justifiable hopes and worries and unjustifiable ones. The opportunities, mechanisms, and limits of such cooperation are made clear in the Tlaxcala Statement on Public/Private Sector Alliances in Agricultural Research initiated by CIMMYT.[88]

Different stakeholders can contribute diverse knowledge, on an equal footing and without any differences in social class, for the benefit of all. Controversies are dealt with on a case-by-case basis and as a side effect of the concrete work at hand. The process of moving from ignorance through arrogance and then to tolerance of different views of the world cannot be delegated. It has to be lived. It is a unique opportunity to discover parallel perceptions of reality, to cope with them, and to combine them to form a larger whole. The ability to engage in constructive teamwork will separate the chaff from the wheat: anyone who is not capable of breaking free from the kind of friend/enemy thinking anchored in dogma and of working toward coalition, who prefers demarcation to teamwork for political reasons, will have to put up with the slur of being a fundamentalist.

Those who have broader shoulders must exercise visible solidarity in a consistent way. First and foremost, in view of today's limitations, capacity and institution building for biotechnology must be supported and funded by development assistance resources.[89] Only if there is a national absorptive capacity to understand the technology and deal with it safely can the benefits of technology transfer be maximized and its risks minimized. This support—consisting of all kinds of software and hardware—can range from consulting for state-of-the-art biosafety regulation, best practices of capacity building, and clearinghouse advice to genetic material and laboratory equipment. Support from the private sector can also make a major contribution to putting constructive partnerships into practice in developing countries.

Provisional Conclusions

Public acceptance for agricultural biotechnology is at a critical juncture. The next two to three years will be decisive for the long-term viability of this technology. The discussion today in Europe is a predominantly political one, and has—in the old Marxian sense—a direct influence on society and the economy. In addition, it has a negative impact on the public acceptance of this technology outside Europe and on the support for public research for resource-poor farmers.

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88 See <www.cimmyt.cgiar.org>.

89 See C.A. Falconi, *Agricultural Biotechnology Research Capacity in Four Developing Countries*, ISNAR Briefing Paper No. 42 (The Hague: ISNAR); J. Komen, J. Mignouna, and H. Webber, *Biotechnology in African Agricultural Research: Opportunities for Donor Organizations*, ISNAR Briefing Paper No. 43 (The Hague: ISNAR, February 2000).

The political economy of agricultural biotechnology could well turn into a missed opportunity to provide the developing world with a highly effective technology to facilitate food security for a growing population with shrinking natural resources. Given the complexity of socioeconomic, political, and ecological problems behind deficits in food security, agricultural biotechnology cannot be a silver bullet or a miracle cure for all problems in all countries. A successful battle for food security in the developing world requires battles on many different fronts—economy, social policy, gender policy, ecology, water and soil management, agronomy, breeding programs, agricultural extension, farm management, pest management, and others. New technologies, however, are part and parcel of a successful package. If agricultural biotechnology is used wisely in conjunction with conventional breeding, improved agricultural methods, and better agricultural policies, it can become a powerful tool in the fight for higher productivity in the small farmer's field.

More than 100 years ago, it took the scientific world a whole generation to understand the significance of Gregor Mendel's findings. I hope that it will take much less time to grasp the importance of genetic engineering for a world that will have to feed nearly 9 billion inhabitants in 2050.