
A Scientist's Perspective: the International Arena

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While preparing this paper, I pondered what a scientist's perspective should be. Although I no longer work at the bench, I am closely involved in the continuum of scientific research through technology to its application, and especially in its transfer to developing countries. I will briefly consider six aspects of science and end with a challenge: to come up with new proposals for action. How can people in the over-stocked grocery stores be made to change their attitudes to the new science and technology so that its benefits will accrue to those who are most deserving—the disadvantaged millions in the developing world?

SCIENCE AND PUBLIC POLICY

The modern world-view includes science as a central element. Indeed, almost everyone demands scientific certainty, *e.g.* with regard to global warming, ozone depletion, and biotechnology's safety. Yet, many people do not hold scientific views as to the origins of life and other areas that affect our daily lives. On one hand, we "demand" scientific certainty, yet on the other hand we reject scientific information, data, and conclusions. How does that paradox continue to exist? Evidently, it persists because we all seem to have a high degree of tolerance for contradictions, and because we select the areas in which we demand scientific certainty to suit our impulses. Consequently, it seems impossible for policy makers to formulate science-based policies.

Paradoxically, although Europeans reject biotechnology that affects their food, they accept it in the pharmaceutical area. But in developing countries the most pressing health hazard is malnutrition. Diseases related to under-nourishment kill approximately 40,000 children per day. So what is a luxury for Europeans—safer food with fewer pesticide residues, more plentiful and less expensive—is a matter of survival for the majority of the inhabitants of this Earth.

A sufficiency of high-quality food is the most basic element of good health. By denying the transfer of this technology to developing countries through restrictive policies so prevalent in Europe and elsewhere, we deny it also to most of the people on this planet. But how does one cope with the environmental luddites and anti-industry activists who claim to be cleaning things up as they misquote, misrepresent, misunderstand, or knowingly fail to read the scientific literature? How should we respond to their propagation of error-riddled rhetoric?

Even those who see biotechnology as a potential “problem” at least acknowledge current population/resource problems. Yet many fail to recognize that agricultural biotechnology is an imperative for the 2.4 billion people—40% of the world’s population—who survive on less than \$2 per day. They somehow fail to see the potential for biotechnology to increase the productivity of existing farmland and thereby reduce the impact of agriculture on the environment, particularly in marginal and fragile ecosystems.

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The critics of biotechnology, with their often-mindless comments, are doing little to meet the developing world’s growing food needs, and, in a paradoxical twist, this will result in even more environmental destruction. We need to make it clear to people, such as Prince Charles, that the latest environmental catastrophe in Mozambique will seem like a royal garden party compared to the consequences of the social shifts and environmental degradation to come. Denying the poor access to the benefits of biotechnology will deny them the means of lifting themselves out of poverty. Denying technological advances is surely one way of sustaining subsistence farming, which farmers do not want and which does not help the environment.

I conclude from these few considerations and thoughts about science and policy that the power of politics has trumped the truth of science. Therefore, we must better communicate the science of biotechnology to the public and to

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politicians, and supplant current views with more-convincing arguments. In view of the paradox outlined in the first paragraph of the section, if biotechnology is to flourish, it will not be science-based arguments that will win the day.

SCIENCE AND COMMUNICATION

Scientists are notoriously inept at communicating their progress. This is partly because science is often far removed from technology. Debating positive effects of technology on society and on the consumer is a very different matter from debating scientific advancements.

The general public's views of science and technology are strongly influenced by overall education level, science education, and cultural and social background, to name but a few criteria. Yet, divergent social groups are united by common cultural values. Hence, for each group, communication strategies have to be adapted to reflect the target audience's cultural values. Communicating values is vital for public acceptance of new technologies, and requires widening of scientists' perspectives. An attempt to widen perspectives of the impacts of biotechnology is long past due. The goal, however, should not be to take the issue away from environmentalists, but to ensure that more voices from more constituencies are included in the discussion. Similarly, the "negative" debate that industry has initiated in the context of organic agriculture—by pointing out its limitations and dangers—is also a shortsighted approach that may backfire.

We could attempt to characterize what different constituencies want, ranging from farmers, commodity traders, food processors, consumers, environmentalists, and parents, to ministers of agriculture and heads of state (Table 1). It is immediately apparent that the primary concerns of the various constituencies are varied; hence, the messages to them must be different. Unfortunately, the benefits of biotechnology have been conveyed to the public mainly by scientists, whose talents, generally, do not include ability to communicate effectively with lay people. Scientists must step outside the province of science itself and abandon the belief that the truth is their bailiwick. The truth is, nobody holds the truth.

Indeed, according to Roger Highfield, Science Editor of the *Daily Telegraph*, “Many journalists would like you to think that they are seekers of the truth, but I suspect that most are like me: curious gossips who like to show off by sharing hot news with a big audience. That audience distrusts hacks as much as boffins. But scientists could still learn from journalists. Journalists think carefully about their audience and communicate accordingly.”

TABLE 1.

Constituency	Objectives/Goals	Environmental/Development impact
Farmers	High-yielding crops. Less use of pesticides. More-efficient use of inputs (e.g. water, less transport). High-quality products.	Decreased environmental impact. Decreased secondary environmental impact. Productivity increases, value added, healthier crops.
Plant breeders	Better tools to make their work more efficient. Produce varieties that farmers want and need. Provide consumers with more nutritious and all-round better varieties.	Scientists in developed and developing countries are now able to breed disease-resistant, delayed-ripening, and hardier varieties of crops.
Scientists	To advance the frontiers of science. Discover and invent exciting new technologies. Benefit humankind.	Progress has been made, especially in medicine, where disease diagnostics and the production of substances that were too expensive, such as insulin, are now allowing people everywhere to lead healthier lives.
Consumers	Plenty of food with good and increasingly better nutritional value at relatively affordable prices.	Biotechnology is making progress in that direction possible—these are the most exciting applications in the research and development pipeline.
Company (large and small) CEOs	To sell what the consumer needs in a way that ensures that the company is sustainable and profitable.	The economic potential of biotechnology is enormous, for industrialized and developing countries. It can be a win/win proposition if we work together and resist fear and distrust.
Government officials	To ensure that the people of their country equitably enjoy the benefits of science and technology. To cast out the specter of national poverty.	Biotechnology could help worldwide, but only if the politicians are true friends of the earth!
Parents	To ensure that their children can enjoy a better life on this planet.	Biotechnology is helping already, in agriculture, health, and the environment, to make the world a better place.

Scientists have failed to recognize that, for the lay public, biotechnology is neither a technical nor a scientific matter. It is now part of the intricate question of life itself. Hence, we must communicate this science and technology in all-encompassing ways, invoking both traditional concepts of human culture and economic development, and that of stewardship. Also, we must give credence where it is due, including to organic agriculture. Contrary to what activists and industry try to make the public believe, these are not two opposing principles, but complementary ideals that should guide the creation of our vision of the future and the steps we take to reach it.

Finally, communication has to begin at the school level. I believe it will take a generation before biotechnology will be fully accepted.

SCIENCE AND INTELLECTUAL PROPERTY

It is evident that resolving the intellectual property (IP) aspects of this science and technology is a rather multifaceted matter that daily increases in complexity. The typical plant biotechnology company has a budget of millions of dollars, sometimes into the hundreds of millions of dollars, for legal costs. But scientists fail to see this as their concern—and indeed it is not—they would rather avoid it and use the funds for research.

One of the fundamental problems is that the knowledge revolution enabled by biotechnology has not been followed by a revolution in IP law. Once a sacred right of the inventor, IP was stimulated both by metaphysical arguments over ownership and by a desire to take practical measures to make inventions quickly available. But times have changed. Consider Linux, the open-source software to which everyone can contribute. It has seen the fastest software evolution ever. At first Linux was developed as a response to Microsoft Corporation's domination of the operating-system world. Although driven by this ideology, it makes good business sense too. The collaborative efforts of programmers from around the world have created an impressive operating system that is rapidly gaining market share. This "open-source," group effort has turned a fundamental business assumption on its head: people now see that the value in software is not the software *per se*, but the productivity gains it affords.

The same may apply to DNA and genes. One might well argue that we need an open platform where everyone can contribute, where everyone benefits. What a difference it would make if everyone could contribute to, and benefit from, the productivity gains enabled through a better understanding and knowledge of DNA and genes!

What proposals for action make sense? To make such an "open platform" happen, a new definition of patents is needed to foster continued investment in the science and technology and products. Perhaps a working group is needed to try to come up with something new to save companies hundreds of millions of dollars in legal fees. Yet, today we are bogged down in discussions about the morality of ownership. We need less dogma and more common sense.

BRINGING TECHNOLOGY TO THE CONSUMER

Food labeling is a typical aspect that may help or hinder the transfer of technology to the consumer. It can be a barrier, including a trade barrier. In the context of the title of this paper, who will make the decisions for the world? Wealthy, middle-aged, white, well fed, well clothed, well educated activists in Seattle? Bureaucrats in Brussels? Let us remember that at least 60% of the world's consumers do not care about labeling—they simply want food on the table. And of these, nearly 40% cannot read anyway. In any case, the majority of foods sold to local consumers comes without packaging. Who is representing the hungry and poor in such debates?

This gives us another criterion for our proposals for action: they must be based on the world as it is rather than based on a romantic image of how the world should be. We need to stop holding more than half the world's population hostage to poverty under the guise of debates about "safe" foods or "safe trade." In any case, safe food is not on offer; only safer food is on offer.

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The "debates" are more about lifestyle choices in the industrialized, western countries than they are about science-based analyses of new agricultural technologies or of socio-economic realities affecting the 2.4 billion poorest of our world. Further, the biotechnology debate is about technological acceptance and not about science. This is something scientists find extremely difficult to understand and even more so to accept. They prefer to indulge in the well entrenched celebratory discourse because of the technological power that biotechnology bestows.

SCIENCE AND BUSINESS

Whereas large companies spend huge amounts on legal fees, research *per se* is being conducted more and more by smaller companies, often start-ups. Large companies increasingly depend on small companies as sources of new products and enabling technologies. Hence science—and research—is far from moribund. There are many ways by which companies acquire research results. They range from purchasing other companies to contract research to various intermediate forms. The strategic alliance, one such intermediate form, is a most critical part of technology-based industries. For example, 60% of Merck's products in the pipeline stem from alliances and partnering. This is nothing

new. Similar shifts took place in other industries such as computers and automobiles, and are still taking place in different forms in the chemical industry.

Hence, in agricultural biotechnology, major shifts are likely, such as mergers for consolidation. Some of these shifts have already been brought about by those who oppose multinational companies. Other changes will be forced by governments due to public opinion, which will significantly shape the decade to come.

Some of these changes are due to the fact that agricultural biotechnology is being deployed so incredibly quickly. Monsanto today earns perhaps as much as \$650 million from its biotechnology-based products. This has never been seen in agriculture with any other product only five years after the first large-scale commercial launch. In an area where change has been notoriously slow, how come we are so surprised that the consumer has been unable to keep pace?

Naturally, scientists are as baffled as consumers are confused and as those in developing countries are mystified, about the many corporate changes. And more are to come.

SCIENCE AND INTERNATIONAL DEVELOPMENT

When considering international development, one invariably thinks of the “Third” World, of small-scale farmers, of poverty, of hunger, of neo-colonialism, of exploitation, of the Brazilian rain forest, of over-consumption, and of the WTO, to name but a few. Biotechnology rarely enters the debate.

Changed attitudes are needed to introduce biotechnology in an appropriate way in this area. And changing attitudes may result from two related approaches. First, for northern countries, biotechnology needs to be understood better in terms of its significance for the lives of individuals in industrialized countries and their children. One means of accomplishing this is to present the issues in tangible terms, emphasizing actions that can be taken in industrialized countries. Biotechnology needs to be understood as a global issue. Examples abound primarily in the biodiversity area. The mold for penicillin, for example, was discovered in North America, and a major Swiss pharmaceutical company has found useful soil organisms in Scandinavia. Yellowstone Park, a center of hot-spring activity, is a major source of heat-resistant microbes.

Care must be taken to present biotechnology as a concept. This message can be enhanced by the second approach: the advancement of environmental stewardship. Individuals, even those with limited contact with natural environments on a daily basis, seem to understand the need to conserve natural systems as the basis for life. And biotechnology must be presented more predominantly in the debates as an integrated form of production that reduces the farmer's imprint on the environment. This can be explained in terms of a legacy for future generations. Biotechnology can be presented as a component of good stewardship.

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The challenge is to bridge the gap between economic realities in the North and the aspirations of the billions of people living in developing countries, largely in the South. Clearly, the first problem to overcome is the communication gap due to differences in social and political heritage. Organizations that speak (or claim to speak) for local or indigenous communities, however, are often merely of the reactionary type with little or no support in those communities. Such are also the most vocal in international political forums with the effect of further delaying *rapprochement* among the systems, i.e. the establishment, corporations, and local/indigenous communities.

No matter how worthwhile the claimed aspirations of such activist entities may be, they contribute little in today's world but polarize the debates. True change in attitudes does not, and will not, come from the actions of environmental pressure groups nor from multinational conglomerates, but from a systematic sensitization of the public. This, in turn, will influence policy makers and corporations alike, and will yield results in the longer term.

The first conclusion from this discussion should be that the issues are complex, not so much in themselves but because they all meet at one place: the new technology of biotechnology.

SCIENCE AND HISTORY

Oscar Wilde said, "The one duty we owe to history is to rewrite it." I say it is better to make history rather than to rewrite it!

How might we make history in the area of biotechnology and international development? What institutional arrangements could ensure that benefits are "equitably" shared among companies and countries and individuals and the environment? How can we even define "equitable sharing" when equitable is so much a concept that depends more on the eye of the beholder than on measurable characteristics? Clearly, we need to bring about shifts in the perception of values, including prejudices about modern biotechnology. Perhaps a new type of biotech enterprise, one publicly owned and managed

like a private enterprise, would allow us to sway public opinion. We certainly need something big and bold if we are to bring about needed change.

The solution, perhaps, lies in the creation of an entirely new type of enterprise. We all recognize the exceptional achievements of the CGIAR in the latter part of the twentieth century, yet I challenge the CGIAR system that it is no longer appropriate for the twenty-first century. The CGIAR system's success was based on the transfer of public technologies, but it has not been able to "recover" from its successes and adapt to the changing environment in which it operates. After years of internal debate on the impact of IP and biotechnology, the CGIAR still does not have a consistent policy towards either, yet alone a comprehensive strategy on how to deal with the proprietary nature of the science on which it relies. The CGIAR operates in a global context, but so far it has failed to "use" globalization to its own advantage and thus it has failed to serve the poor most effectively with its dwindling financial and technological resources.

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Yet, with the advent of the life sciences, the potential to improve the human situation was unprecedented in history. Globalization is enabling the mobilization of worldwide science and technology for the betterment of humankind. Yet the promise is ours only if we manage to deploy improved products to the poor and wealthy alike. A new vision and initiative is warranted for biotechnology to produce and deliver its capabilities not only for the most vulnerable billion people but also the wealthy. The developing world is superbly and uniquely positioned to translate this vision into reality.

At a seminar at Cornell University in September 1999, I proposed the creation of a novel, highly efficient and sustainable organization as a model for the next century, with the potential to exceed many-fold the impact of the CGIAR and the green revolution of the twentieth century. In short, the vision is to "sustain globalization in the life sciences" by creating a new form of private/public partnership with the life science capabilities of a large biotechnology company as the keystone. Development, both economic and scientific, would be accelerated through the synergy of private/public energies.

At the centerpiece of the "privic" strategy would be, for example, a large biotechnology company's agricultural life sciences division. The science and technology would be poised to deliver the long-promised benefits of biotech,

gradually, to the entire world. Meanwhile, the value embedded in other divisions of the biotech company, including chemicals and seeds, would be returned to shareholders as these business units of the current enterprise are spun off.

Financing for the “privic” would come from public (government, multi-lateral), foundations, and private sources, and from future licensing of its technologies (to corporations and at a discount to developing countries). All would benefit from this strategy as the most effective means of sustaining agricultural and economic advancement, and human well-being.

Market growth would come by expanding biotech into developing-world markets where the technology is needed most. Current revenue streams would be maintained and expanded through licensing arrangements with corporations (current competitors), the CGIAR, universities, and national programs around the world.

Public opposition to plant biotech would be curbed rapidly as a result of the display of its startling value for the world’s poorer people, thus realizing biotech’s promise in the near term.

Research and development would be efficiently expanded by focusing on a mix of commercial (for licensing) and developing-country needs and priorities. Human capital would be enhanced by ensuring that researchers in developing countries would participate in the R&D and would have ready access to biotech’s tools to solve their national and regional agricultural and nutritional problems.

The staff, talent, strategies, R&D priorities, and finances of the “privic” would be managed according to corporate principles by a CEO supported by an executive and management board. A small non-executive oversight board of senior people serving in their individual capacities would represent national and topical interests.

CONCLUSIONS

Only two questions remain. First, is there a better idea on the table to bring about the change needed to make biotechnology flourish and deliver its promise to the world’s citizens at large? And if there is no better idea, then the question is: what is to be done next to make the “privic” work? Seven simple steps would be needed:

- Seek limited funding for a feasibility study.
- Prepare issues and options briefs (financing the deal, governance, management, R&D strategy, cash-flow projections, etc.).
- Commission an investment bank’s preliminary assessment of valuation and financial options.
- Approach the Chairpersons and CEOs of the other major agricultural biotechnology companies.

- Organize a “retreat”-type meeting with senior people and advisers to:
 - determine feasibility, refine concept, and set policy and implementation strategy,
 - elaborate specific areas for further investigation/determination and allocate follow-up tasks, and
 - identify members for a formal steering committee.
- Convene the formal steering committee meeting to implement strategy.
- Launch the “privic.”

It could all be done in 9 months, or perhaps even less. Because biotechnology is at the heart of the long-term sustainability of our environment, because biotechnology is at the heart of our survival in the long term, it represents an opportunity today to forge new partnerships for tomorrow.

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Q: As you mentioned, the green revolution resulted from research at CGIAR institutes in the Philippines and Mexico. I happen to know that biotechnology research is in progress at the International Institute of Tropical Agriculture in Nigeria and at the International Rice Research Institute in the Philippines, and, I assume that significant effort is being expended in biotechnology at the other international institutes. Please elaborate on that, and address the question: to what extent is it possible for the international institutes to make a significant contribution to increasing food production in developing countries, using the tool of biotechnology, without any involvement of industry?

A: Intellectual property rights are often blamed as a stumbling block, but I think that reveals a lack of understanding of IP and patents. The annual budget for the CGIAR centers, CIMMYT in Mexico, IITA in Nigeria, IRRI in the Philippines, CIAT in Colombia, etc. is about \$310 million, of which \$28 million are spent on biotechnology. A few years ago, the R&D budget of a typical company like Novartis may have been three to four times that amount for agricultural biotechnology alone. Based on published data, private investment in biotechnology in agriculture is approximately \$1.1 billion, whereas the entire developing world spends just over \$100 million, of which most goes into

capacity building and not into product development. So, the CGIAR system is not in a position to develop major biotechnology applications for the developing world. It can best do so by forging stronger alliances with the private sector. But progress in this has been very slow because, for the past seven or eight years, the CGIAR has been debating what their policy should be on biotechnology, so far without resolution. The reason is that, around the table are funding donors, bilateral agencies, representatives of developing countries, environmental pressure groups, and companies, all with conflicting agendas. It seems impossible for such an institution to elucidate a clear vision, which is very regrettable. The green revolution was successful because relatively few individuals were involved, Norman Borlaug among others. I think it is possible for the CGIAR to contribute a great deal, but not within the strictures of its current governance. That is why new institutions are needed, possibly as brokers or go-betweens, with dramatic new approaches, such as the development of the “privic” concept.