The Challenge of Poverty in the 21st Century: The Role of Science

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Harnessing the best in agricultural science to fight poverty and hunger is the special contribution that the CGIAR has made to development in the past, and will continue to make in the future. In doing so, we want to be quite sure that we capture the benefits of advanced science and guard against its hazards and risks. We want to maintain an effective balance between the two viewpoints so clearly expressed by university witnesses testifying earlier this month at a hearing of the sub-committee on basic research of the US House of Representatives' Science Committee.

One witness opposed "a knee-jerk reaction and fears" that could deprive society of demonstrably beneficial, genetically improved crops. Another argued that to push ahead "without stepping back and taking reasonable precautions would be a mistake." These are crucial considerations for the CGIAR as it continues to develop and fine tune a set of practical guidelines that will direct its efforts in the next decade and beyond.

The CGIAR cannot do this alone. It has to do so in close consultation with its partners. The experience, concerns, and expectations of the developing countries must be heard, as well as the views of the scientific and environmental community, farmers, and consumers.

We can approach the issues dispassionately, and review them on the basis of scientific fact. Rigorous science-based discipline can be combined with a deep sense of caring and compassion. Such a combination will make this effort a celebration of all that science can do for the disadvantaged and disconnected in the human family.

Context

The relevance of biotechnology and, specifically, agricultural biotechnology to development, is now at the forefront of international interest. The perceived promise and perils of biotechnology are under intense public scrutiny. The debate is widespread, complex and, frequently, inconclusive. Discussions are sometimes scientific and impartial, at other times ideological, sensational, and visceral. Why this intensification of interest?

First, despite the great advances that have been made in the decade now ending and in the preceding years, development challenges have grown more complex. The global scale of demographic pressures in the new millennium will be unprecedented. The world's population is expected to exceed 8 billion by 2025, an increase of 2.0 billion in the next 25 years. Much of the increase will occur in developing country cities, where urban populations will more than triple. There will be many more mouths to feed in complex circumstances. Norman Borlaug calculates that "to meet projected food demands, by 2025 the average yield of all cereals must be 80 percent higher than the average yield in 1990." These increases must come primarily from increasing biological yields, not from area expansion and more irrigation, because land and water are becoming increasingly scarce.

Meanwhile, poverty and hunger remain pervasive in our world of plenty, despite the enormous burst of output and productivity, the dazzling changes wrought by science and technology, and the amazing achievements recorded on the social indicators for so many of the people on the planet. Let me remind you: in the 47 "least developed" countries of the world, 10 percent of the world's population subsists on less than 0.5 percent of the world's income. Some 40,000 people die from hunger related causes every day. A sixth or more of the human family has been marginalized.

Comprehending and preparing for unprecedented levels of global population is the first part of the challenge we confront. The second part is to ensure that this population has access to food in adequate quantities at adequate prices, everywhere, at all times. The third is to produce this food in a way that does not destroy the natural resources on which we all depend. This is the triple challenge we face, and the CGIAR is concerned with the last two facets that combine to form the challenge of sustainable food security.

The challenge is both technological (requiring the development of new, high-productivity, environmentally sustainable, production systems) and political (requiring policies that do not discriminate against rural areas in general, and agriculture in particular), and will have to be accomplished at a time when attention to agricultural development and rural well-being is diminishing. An essential aspect of the response to this challenge is to harness *all* instruments of sustainable agricultural growth. Agricultural biotechnology is one such instrument. It has moved to the center of the development debate fairly recently, and that marks it out for particular interest and, indeed, concern.

Second, the world of science has grown and changed beyond most expectations. Today, a revolution is taking place in the biological sciences. It is fueled by the groundbreaking work in modern molecular genetics, the enormous advances in informatics and computing, and the enormous sums being invested in biotechnology research. It is truly an exhilarating time for the biological sciences; similar to what physics experienced in the glorious 40 years between 1905 and 1945, when all the concepts were changed, from cosmology to quantum physics, from relativity to the structure of the atoms. We are decoding the very blueprints of life; we are learning to manage the deployment and expression of genes.

So, we live in a time unmatched for the opportunities that science provides. We can dream of new scientific breakthroughs and new products that can help humanity as never before: New higher yielding plants that are more environment friendly, new remedies for killer diseases, edible vaccines, single cell proteins to feed cattle and clean wastes, hyper-accumulating plants to take toxins out of the soil, expanding forests and habitats where more species thrive, and so much more. We can dream of a future of sustainable development where humans thrive in harmony with each other and with the environment.

These opportunities are a necessary focus of interest among all of us who believe that the full potential of science has yet to be realized in our continuing efforts to fight poverty, end hunger, and protect the environment.

A third reason for the current scrutiny of biotechnology is that in recent years, agrobiotechnology has exploded into a major private sector activity, mainly in the industrial countries, with possibilities of even greater expansion in the future. The global area planted with transgenic crops was 1.7 million hectares in 1996, 11.0 million hectares in 1997, 27.8 million hectares in 1998, and 39.9 million hectares in 1999. The US led the field in 1999, as before, with 28.7 million hectares of transgenic crops representing 72 percent of the global area, followed by Argentina—6.7 million hectares (17 percent), Canada—4.0 million hectares (10 percent), China—0.3 million hectares (0.1 percent), and Australia and South Africa—0.1 million hectares (1 percent). Mexico, Spain, France, Portugal, Romania, and Ukraine (in that order) completed the roster, each with <0.1 million hectares (less than 1 percent). Some 82 percent of the world's transgenic crops were grown in OECD countries, about the same as in 1998 (84 percent). The seven principal transgenic crops grown in 1998 were (in descending order) soybean, corn/maize, cotton, canola/rapeseed, potato, squash, and papaya (James 1999).

The global market for transgenic crop products has grown rapidly during the period 1995 to 1999. Global sales from transgenic crops were estimated at US$75 million in 1995; sales tripled in 1996 and again in 1997 to reach US$235 million and US$670 million respectively, more than doubled in 1998 to reach US$1.6 billion and increased by more than a third in 1999 to reach an estimated US$2.1 to US$2.3 billion. Thus, revenues for transgenic crops have increased by approximately thirty fold in the five-year period 1995 to 1999. The global market for transgenic crops is projected to reach approximately US$3 billion in 2000, US$8 billion in 2005, and US$25 billion in 2010**.** In the last three years alone, corporations commercializing transgenic crops and involved with seeds, agricultural chemicals, and the life sciences have been engaged in more than 25 major acquisitions and alliances valued at US$15 billion, and this consolidation is expected to continue.

So the biotechnology revolution is here. But it has so far been very much the preserve of the richer countries, a fact that has distorted the debate on what biotechnology can do for the poor. Moreover, like physics in the first half of this century, developments in biological science today compel us to confront profound ethical and safety issues, complicated by the new issues of proprietary science.

Key Issues

Opportunities

Many scientific studies have concluded that the promise of biotechnology as an instrument of development lies in its capacity to improve the quality and quantity of crops and livestock, swiftly and effectively. One of the most far-seeing and prestigious was a report prepared in 1997 by a distinguished panel led by our late friend and colleague, Henry Kendall. Their study reminded us that the time required to identify and eliminate unfavorable traits through traditional crop breeding is greatly reduced by the use of genetic engineering techniques. Increased precision in plant breeding translates into improved predictability of the resulting products in desirable areas, such as performance and survival (Kendall and others 1997).

The application of biotechnology can create plants that are more resistant to drought and soil acidity and salinization. These attributes are critical to the development of agriculture in the poorest areas where soils are poorly endowed. They are also vital at a time when water scarcity is expected to be a major deterrent to development and, perhaps, a threat to life on the planet as we know it. Additionally, plant characteristics can be genetically altered for earlier maturity, increased transportability, reduced postharvest losses, and improved nutritional quality. Vaccines against diseases afflicting livestock are already important products of biotechnological research (Morrison 1999).

Most of the early products of agricultural biotechnology focus on crop protection. In 1998, transgenic crops that are herbicide tolerant covered about 19.8 million hectares. Use of herbicide tolerant varieties greatly facilitates weed control using certain types of herbicide and greatly reduces the amount of herbicide applied to the crop for effective weed control. This also enables farmers to employ soil conservation practices such as minimum tillage. Decreased tillage reduces soil erosion.

Increased plant resistance to pests has also been a major focus of agricultural biotechnology research. In 1998, an estimated 7.7 million hectares were planted to transgenic crops with introduced genes that produce substances toxic to target insect pests. The use of pesticides has dropped in areas using these crops, a positive impact not only on farm income but also on the environment.

More recently, research conducted at the Swiss Federal Institute of Technology's Institute for Plant Science has shown that serious problems of malnourishment can be tackled by genetic engineering. Researchers have been able to modify rice grains genetically, to improve the supply of iron and vitamin A in the human diet. The genetically improved rices can help to reduce global rates of iron deficiency anemia (IDA) and vitamin A deficiency (VAD), especially in developing countries where the major staple food is rice. IDA and VAD are major contributors to childhood blindness and maternal mortality and morbidity primarily in developing countries.

That is a very brief summary of the promise of biotechnology as an instrument of agricultural research and development. It is a promise that attracts many developing countries. Agricultural biotechnology programs, some of them substantial and some, only exploratory, have been established in Brazil, Burundi, China, Colombia, Costa Rica, Cote d'Ivoire, Egypt, Honduras, India, Indonesia, Jordan, Kenya, Malaysia, Mexico, Philippines, Singapore, South Africa, Thailand and Vietnam, amongst others.

Threats

Simultaneously, however, biotechnology has become a lightning rod for an increasingly impassioned debate, with opposing factions making strong claims of promise and of peril. Opposition has been mounted to the spread of transgenic crops or genetically improved organisms (GIOs) and protest movements have developed across the globe.

Opposition to biotechnology and specifically to genetic engineering is derived from several viewpoints. They include fears of high-tech farming destroying the livelihood of smallholders, concerns about artificially created products competing with and destroying the marketability of "natural" products, and the presumption of environmental threat. Many critics fear that biotechnology is a scientists' obsession which is being exploited to bring quick profits to the few even though it can do great harm to the many. Those who hold such views are profoundly concerned that the increased application of biotechnology will harm not only ourselves but even generations of the future. These concerns are genuine and cannot be ignored.

To the extent that we would transform the genetic makeup of a particular variety of plant through genetic transfer from another variety of the same species, that should not pose much of an ethical problem. In fact, it would simply be an accelerated way of achieving by biotechnological means what could be achieved through conventional breeding programs. This process of acceleration should not pose ethical or safety problems for anyone who does not oppose conventional breeding programs.

We might arguably extend this acceptance to the bioengineered product of a genetic transfer involving related but different species of plants such as wheat and barley for instance. Here we are already tinkering with nature, but the boundary to the conventional "natural" breeding system is so close, that for many that would also be acceptable. The likely result of such a gene transfer is unlikely to significantly modify or denature the plant. *Triticale* is such an interesting cross.

Beyond that area, we get into the slippery slope leading to the design of new plant types, based on the assemblage of desirable traits collected from individual plant species or even from other organisms. Are we then "playing God" and tinkering with the natural order?

In all societies, there is a profound distrust of scientists, or anybody else, assuming the right to change the natural order of things. One can argue, rightly, that by our very presence on this planet we are changing the natural order of things, and that our increasing numbers, ever more powerful technology and insatiable appetites for consumption and pollution are indeed affecting nature, and mostly in negative, and potentially dangerous ways. Global warming and biodiversity loss are but two examples. Yet against that general proposition we must set the welfare of the human species.

For instance, dare we argue that hunter and gatherer societies living "in harmony with nature" should be encouraged to stay as they are, with people forced to live in squalor, want, disease, and premature death. A humane treatment of the people would deal with improved diet, education and health, although the resulting reduction in infant mortality and increases in consumption are likely to put pressure on the natural system. The question then becomes how to handle that pressure, how to ensure that the patterns of development adopted are sustainable, for surely, even arguing from a human-centric point of view, it does not make sense to undermine the ecosystems on which our long-term survival depends. Viewed thus, the matter becomes a calculus of the potential benefits and potential risks associated with change, including the adoption of new technology.

Ethical Issues

Safety Concerns

Ethical issues of safety acquire a different level of concern in the case of GIOs being released into nature. Is there a risk that we would harm the very ecosystems on which all life depends? What if the results of these scientific efforts produce "super weeds" or "super viruses" with an impact so broad that they are devastating? Anxieties about biosafety led to the adoption of restrictive laws in some countries in the 1970s totally banning research into the possibilities of genetic manipulation. These laws have been rescinded, but fears about biosafety continue to bedevil the debate. Here again the question is one of evaluating the scientific evidence and assessing, to the best of our ability, the likely risks and if these can be managed.

Clearly, it is not possible to exclude certain classes of risks entirely, any more than one would be able to exclude the risk of an asteroid hitting the earth or of being struck by lightning. Yet these risks are considered so remote that one in fact goes through life ignoring them. This is not to say that the potential risks of releasing GIOs into the environment are in the same class of probability as either of these two examples, but that the discussion should not start on the basis that ANY potential risk, no matter how remote, would automatically veto the potential application of a technology.

In a case much closer to everyday life, we could ask if people would be willing to accept a technology that is contributing to global warming, kills about 50,000 persons per year and maims another 500,000 in the US alone, and is adding nothing vital to our lifestyles except the added convenience of personalized fast travel. Yet, who would agree to ban the automobile?

Patent Rights

Another broad area of ethical issues involved in biotechnology is that of patenting. One of the ethical questions raised is whether the patenting of life forms is acceptable. There is no direct answer for that, but we must take note that the ownership of animals and plants is recognized, so is the right of owning a particular breed. We could argue that allowing ownership rights to other life forms is a matter of degree. After all the varieties of flowers or livestock are themselves owned and sold, breeding of horses and other show animals is recognized, so what is specifically more offensive in patenting, that is establishing an ownership claim, on a gene or gene sequence, in comparison with asserting ownership on a whole animal or plant or variety thereof?

The difference lies in the idea of owning a "building block of life" rather than the actual living creature itself. The assumption being that the building block in question can then be part of many other living things. This is an issue that I am personally still struggling with, and that I cannot easily define to my satisfaction.

Nevertheless, the issue is one that affects a lot of people and we should strive to understand their qualms and to accommodate them. No legislation can function if it does not have the broad based support of the majority of the population, and the views of the minority today could well be the majority tomorrow. But such a transformation is best achieved by education and scientific evidence, not by assertive preemptive action by a vocal minority.

Intellectual Property and Knowledge Management

There is another side to the patenting story that raises another set of ethical issues. These include the progressive monopolization of knowledge and the increasing marginalization of most of the world population with a concomitant selectivity in focus of research and applications of the new biotechnology and its benefits, skewing it to the potential markets of the rich and excluding the concerns of the poor.

The issues operate at two levels:

- the privatization of the scientific research enterprise, and the meaning of proprietary science in the coming century; and
- the proprietary aspects of the biotechnology in terms of both process and product.

On the first, I am concerned by a growing gap between the industrial and developing countries in the rapidly evolving knowledge frontier which is exacerbated by the privatization of the knowledge enterprise. Elsewhere I have called this an emerging *scientific apartheid* (Serageldin 1999).

Also very much at issue are patenting and intellectual property rights (IPR). Supporters of patenting point out that if the private sector is to mobilize and invest large sums of money in agricultural biotechnology R&D, it has a powerful claim to protecting and recouping what it has put into the exercise. On the other side of the argument is the fear that patenting and the exercise of IPR will lead to a monopolization of knowledge, restricted access to germplasm, controls over the research process, a selectivity in the focus of research and, thereby, the increasing marginalization of the majority of the world's population.

Regulatory Arrangements

These concerns are complicated by the fact that safeguards governing agricultural biotechnology are uneven and, in some countries, non-existent. Safeguards involve regulatory mechanisms and this calls for actions by governments to put them in place, and ensure that they function effectively. In the US, the Food and Drug Administration decided in 1992 that genetically improved products would be subjected to the same scrutiny, and be required to maintain the same standards, as all other foods. Extra scrutiny is undertaken only with the introduction of "something truly new." The FDA is presently undertaking a series of public hearings to see if its procedures should be modified.

The process in Europe is much more complex, involving a process of third party refereeing, a vote by the European Commission, and legislation by member states of the union. Regulatory traditions are advancing in developing countries, but not as extensively or as speedily as necessary, mainly because of a lack of capacity. However, ideas are being cross-fertilized, through the influence of international institutions, such as the Convention on Biological Diversity, and under the umbrella of the CGIAR. Special efforts have been made by CGIAR centers, the Rockefeller Foundation, OECD, UNIDO, and UNEP to build developing country expertise in this critical area.

A Balance Sheet

Let me try, now, to draw up a balance sheet that answers the question—where do we stand?

We know that substantial transformation of smallholder agriculture in developing countries is key to meeting the complex and demanding challenges of the new millennium.

The production side of agriculture is a necessary but not sufficient condition to meet the challenge of hunger. If the production side is inadequate, however, discussion of other policies and practices becomes largely academic. Productivity-increasing technologies have to be ecologically sustainable, economically viable, and socially equitable.

Agricultural biotechnology is not a magic wand that can replace poverty and hunger with a regime of plenty, but all the available evidence suggests that it can be an effective additional weapon on the development front.

Agricultural biotechnology holds promise of effectiveness in increasing crop yields, reducing the need for chemical pesticides that degrade the environment; supporting resource-poor farmers by nurturing the adaptability of plants to harsh growing conditions such as drought, salinity, and extreme temperatures; improving health by introducing desirable nutritional characteristics into new varieties.

The potential benefits of biotechnology should not divert our attention from the real concerns about the application of the new science. All that is scientifically possible is not ethically acceptable. But the issues of bioethics and biosafety, and of intellectual property rights will be ceaselessly and inconclusively debated unless all those concerned have a genuine desire to reach accommodation based on practical realities, not on emotion or ideology.

Safeguards and regulatory mechanisms have not been established in many developing countries because they are essentially a new branch of law that requires the accumulation of new expertise. A much stronger and more focused international effort is required to strengthen regulatory know-how and practice. In fact, capacity building across the whole spectrum of agricultural biotechnology activities is necessary.

Concerns have also been expressed by civil society representatives that a new wave of high-technology farming will destroy the interests of small farmers in developing countries. This could be particularly detrimental to women in Asia where 60 percent of the farmers are women, hence the need for national and regional policies that take account of the rights and interests of all concerned.

The private sector is at the forefront of every aspect of the agricultural biotechnology revolution—from R&D, through product creation, sales and sharing, to the development of regulatory mechanisms. So an important question for the future is: how can the strength of the private sector be harnessed for the development effort?

The many issues that touch on private/public sector partnerships come together in the work of the CGIAR System, which can serve as knowledge broker, bridge builder, and catalyst.

The Way Ahead

Biotechnology research efforts in the CGIAR were initiated in the mid 1970s by two centers, CIP and ILRAD (now ILRI). Today, twelve centers are engaged in various research activities involving the use of biotechnology techniques. The centers' laboratories vary in terms of the types of biotechnology techniques being employed, from the relatively simple cell or tissue culture to the more complex methods aimed at developing transgenic plants. The main areas of the centers' biotechnology work are in crop disease diagnosis/detection, crop improvement including molecular breeding, germplasm storage and exchange, crop propagation, improvement of microorganisms, livestock disease detection and treatment through new vaccines, embryo storage and exchange, and livestock improvement. Biotechnology research funding in the CGIAR centers represents a small fraction of the total funding for the CGIAR research agenda; some US$30 million. Compare this with a total CGIAR budget of some US$340 million, and total annual agricultural biotechnology research investment in the industrial countries of several billion dollars.

Can the CGIAR let the existing situation stand—in terms of its research program and the investment to support it— if, demonstrably, there is substantial potential for biotechnology to contribute to more rapid and sustainable agricultural growth in developing countries? Or should it take the lead in ensuring that:

- access to the potential benefits of technology is guaranteed for the poor and the environment
- the risks of biotechnology are minimized, and adequate institutional mechanisms are in place to ensure biosafety and bioethics
- biotechnology research is directed at solving the problems of poor farmers rather than toward solely scientific priorities, that is, technology should be needs driven rather than science driven, as the latter would run the risk of adding more technologies that are irrelevant to the majority of small-scale producers and to sustainable agriculture
- biotechnology is recognized as a tool to be used in conjunction with other tools, not as an end in itself.

We are listening closely to our partners from the national agricultural research systems, the international science community, the civil society, and the private sector as this conference seeks answers to these and related questions. We will pay the utmost attention to views expressed on the potential as well as the risks of biotechnology. And we will take the consensus that emerges from this meeting to the CGIAR where the thematic focus of attention will be: "Reducing Poverty through Cutting-edge Science."

We want your expertise and experience to be blended with ours in a science-based attack on poverty and hunger in the new millennium. For us in the CGIAR, the critical issue is that every instrument of agricultural transformation should be mobilized in our efforts to feed the hungry, help the poor, and protect the environment. We cannot, do not, and will not accept the notion that deprivation is imprinted on the genes of the poor and destitute, and that misery is their inevitable destiny.

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