PART V

BANQUET AND LUNCHEON SPEAKERS

Frankenfoods: What to do When the Devil Has All the Good Songs

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I would like to congratulate delegates at this conference for their contributions to helping reverse the erosion of "social capital." You may have heard of the idea of social capital in the context of a best-selling book entitled *Bowling Alone: The Collapse and Revival of American Community*. The author Robert Putnam (2000) defined social capital as the fabric of our connections with each other in a society. He argued that evidence showed social capital had plummeted in the United States, impoverishing lives and communities. Americans signed fewer petitions, belonged to fewer organizations that meet, knew their neighbors less, met less frequently with friends and socialized with their families less often. They bowl more than three decades ago, but they bowl alone more often.

A similar concern about disintegrating social connection has been voiced here in Canada during the current federal election campaign. Political observers are bemoaning the hollowing out of constituency organizations, once the backbone of political parties.

But opposition to agricultural biotechnology is bucking the erosion of social capital. It has managed to unite people across ideologies, social classes, education, income, and even in disparate neighborhoods. You are as likely to find opponents to agricultural biotech in Toronto's posh Rosedale as in the grim Jane-Finch corridor, or in Chevy Chase as in southeast DC.

Why? Well, of course, there's the media.

Media and Perceptions of Agricultural Biotechnology

As prime minister, Margaret Thatcher famously said, when chastising the British press for reporting IRA attacks, "Publicity is the oxygen of terrorism." But oppo-

sition to agricultural biotechnology is not simply a media construct, although extensive media coverage adds legitimacy to the opposition. It exists because of public distrust of this technology.

My conversations with people who aren't journalists, nor involved in public policy, lead me to believe that this distrust is visceral, almost primordial. That makes it very difficult to counter. People are not opposed to making agriculture more bountiful, to helping to feed more of the world's hungry mouths at affordable costs. And many would go further. At least in North America, I think (and public opinion polls suggest) that a majority approves of the idea of nutraceuticals.

Consider this contrast. Norman Borlaug, the "father" of the Green Revolution, had widespread name recognition among the public and was generally admired. By contrast, Swiss researcher Ingo Potrykus, the "father" of beta-carotene-enriched Golden Rice™, is largely unknown by name yet either vilified or demonized by his association with this development.

Why?

Correctly or otherwise, Borlaug was seen as working within nature's laws, of not trying to play God. By contrast, much of agricultural biotech (as with Potrykus) has become branded as unnatural, as attempting transformations that nature never intended, of playing God in fact—and without a proper safety net.

A widespread ignorance of even the most basic elements of science on the part of many journalists has contributed to this image of agricultural biotech.

Let me acknowledge right at the start that a widespread ignorance of even the most basic elements of science on the part of many journalists has contributed to this image of agricultural biotech. This lack of knowledge leads to too many journalists taking even the most exaggerated claims of extreme opponents at face value. Activists and axe-grinders can get a free ride on scientific topics that they would never enjoy in sports, business, entertainment and other areas. Even in politics, for instance, we run reality checks during a federal election campaign.

However I should note that two years ago my newspaper, *The Toronto Star*, gave prominent coverage to *Nature*'s disavowal of the research that journal had originally published claiming that genetically modified corn had made its way into native varieties in a remote area of southern Mexico. I wrote that retraction story, even though I had not covered the original research in November 2001.

The media's contribution is largely one of omission, of views and issues not reported, of risks not put into context. I will examine the reasons underlying the public distrust of anything that even smacks of agricultural biotechnology, no matter how it is gussied up and sold. Most of these reasons will be familiar to you.

There is skepticism, cynicism and widespread disbelief that governments are equipped to adequately regulate such fields, and the doubt that they would do it, even if capable.

Reasons for Public Distrust of Agricultural Biotechnology

The number one reason by far is the skepticism, cynicism and widespread disbelief that governments are equipped to adequately regulate such fields, and the doubt that they would do it, even if capable. There are ample grounds for such distrust. Nationally we had the shameful failure of public-health regulation in the tainted blood scandal. A commission headed by Judge Horace Krever found health officials had conspired to try to conceal their deliberate decisions to roll the dice with people's lives.

In Ontario we had the deaths at Walkerton caused by drinking-water treatment that was well below Third-World standards. Subsequent investigation revealed that a whole chain of public regulatory bodies had fallen down on the job.

In the field of agricultural biotechnology in particular, the reasons for public unease about regulatory rigor were laid out extensively in a report in February 2001 from an independent Expert Panel set up by the Royal Society of Canada at the request of the federal Health Department. In the United States, a similar review process is operated by the National Academy of Sciences.

The Royal Society panel concluded that the basic approach of federal regulation of agricultural biotechnology products was "scientifically unjustifiable." The review by federal experts was too often cursory, almost always secretive and overly dependent on unverified material supplied by the parties who stood to benefit directly. This flawed approach exposed Canadians to potentially severe health risks, including toxicity and allergic reactions.

The Royal Society singled out the overly cozy relations between federal regulators and the biotech industry, and the virtual co-opting of many university researchers by industry funds. Both arrangements led to excessive secrecy and contributed to "the general erosion of public trust in the objectivity and independence of the science *behind the regulation of food technology*." [emphasis added]

Maybe this report would have been a two-day wonder, and passed quickly from the public consciousness, except for the reaction of the top officials in the federal health department. They attacked the fifteen experts on the panel, saying they hadn't grasped how the regulatory system worked and how thorough and rigorous it was.

Consider that as a tactic in winning the public's confidence; you invite outside experts to examine your system, expecting some suggestions for a minor tune-up

here-and-there, but overall anticipating the Good Housekeeping Seal of Approval. Instead you're told that the system may have worked so far but it's inadequate for the next generation of products entering the pipe-line.

Your response is to call the experts "dumb." Think of the message this sends to the public. If a Royal Society expert panel isn't competent to make a considered judgment, then who is? Only the Health Department itself, and maybe also their good friends in the agricultural biotech industry? The public distrust and suspicion only grew when it became clear that the federal health officials had not given the Royal Society experts access to some key material about their major misgiving—the application of the principle of substantial equivalence.

Barely mentioned in the Royal Society report was another reason for public suspicion of the government's commitment to rigorous regulation. The fox is guarding the hen-house. One of the biggest promoters of agricultural biotechnology is the federal government itself. Admittedly the promotion and regulation functions are in different departments. But the same perception issue with nuclear power was addressed by setting up an independent, arms-length regulator, the Canadian Nuclear Safety Commission.

That was all three years ago. No outside review of federal regulation of agricultural biotechnology has been done since, so there is no independent evidence that anything has changed.[1]

A second reason for public suspicion of this field is the presence of so many large multinationals, mostly American in origin.

A second reason for public suspicion of this field is the presence of so many large multinationals, mostly American in origin. As must be evident after the Enron scandal, Michael Moore's movies and the revelations of falsehoods at the *New York Times*, few in North America have reason to trust large corporations to tell the truth or to act ethically. And when corporations divide the Supreme Court of Canada 5–4 over the right to patent plant genes, they may have won a legal battle, but they are well on the way to losing the public relations war. Without even taking into account beating up on someone with an inoffensive name like Percy Schmeiser.

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[1]However, on October 5, Prime Minister Paul Martin announced a 10-year, $35-million federal grant to establish the Canadian Academies of Science. One of the chief tasks of the Academies is to continue the Expert Panels begun by the Royal Society, one of the three constituent members of the new body.

There is cognitive dissonance between the avowed goals of agricultural biotechnology, of feeding more people at lower cost, and the reality of the existing applications.

Third, there is cognitive dissonance between the avowed goals of agricultural biotechnology, of feeding more people at lower cost, and the reality of the existing applications. As the FAO (2004) noted in an overview report in May, corn, soybean, cotton and canola aren't leading crops in much of the developing world. Yet those crops are where most of the agricultural biotechnology effort has been centered.

Modifications like genetically engineered herbicide resistance in crops have largely cut input costs for participants in a sector already heavily subsidized by the public purse, and boosted profits for all concerned. They have not substantially improved agricultural output in many areas. In countries like Argentina, genetically modified soybean has produced an environmental crisis through overuse of herbicides. This may be a mishandling of the technology rather than an inherent fault of the technology itself. But as the nuclear accidents at Three Mile Island demonstrated, that's a distinction that usually gets lost where public distrust is concerned.

Fourth, we get to the actual title of this talk, the topic of popular culture. When General William Booth, founder of the Salvation Army, was asked why he instituted the famous "hallelujah" bands he declared: "The Devil has no right to all the good tunes!"

That's one thing that sustains public doubts about agricultural biotechnology once they have been planted. Your field doesn't have many good songs. You don't even have any catchy titles. As a wordsmith, I appreciate that proponents might wince at genetically *engineered* foods, in the same way that *nuclear* magnetic resonance was a big turnoff in the health-imaging field. But the health folk replaced "NMR" with "MRI." I'm afraid "products/plants with novel traits" just does not cut it. Not against "frankenfoods," that's for sure.

Genetically modified (GM) foods are seen as the first step on a slippery slope that leads, inevitably, to the genetic manipulation of animals and humans.

Nor does such language stand a chance against the assault from *Oryx and Crake*, the most recent bestseller by Canada's Margaret Atwood. Some people abandon this book because they can't bear the thought of a world where everyone has been

genetically modified. But Atwood is an example of the cross-pollution that affects agricultural biotechnology. Already we have the production of a mouse starting with genetic material from only two female mice. Few people who follow the field believe that cloned humans will be far behind, despite all the supposed regulations to control it. And if we are unable to fend off cloned humans, are frankenfoods really so hard to believe?

This cross-pollution works both ways too. Earlier this year, I carried out several interviews with researchers in British Columbia working on the genomes of the Atlantic salmon and the cabernet sauvignon grape. They repeatedly emphasized that they were not attempting any genetic manipulation. Just the initials GM were considered a kiss of death for the salmon and wine industries.

The last reason for public suspicion is the tardiness and miserliness in funding research into what I'm going to call "public good" applications of biotechnology in the food area, and into the ethical, societal and legal dimensions of agricultural biotech.

The last reason for public suspicion is the tardiness and miserliness in funding research into what I'm going to call "public good" applications of biotechnology in the food area, and into the ethical, societal and legal dimensions of agricultural biotech. Both these areas were essentially unfunded in Canada until a year ago when the Advanced Foods and Materials Network was established, one of the Network of Centres of Excellence established across the country. The food network has just $22 million funding over five years to support the work of more than eighty researchers from government, industry and academia. You can do the math and figure out just how much your project could count on.

One of the network's goals is to pool the best Canadian scientific capacity "to do the research that will lead to new discoveries and new, socially acceptable, value-added products and processes." As far as I can tell, this November 4, 2003, announcement from the University of Guelph marks the first time in Canada that any agricultural biotechnology initiative has conceded that social acceptability is something that has to be earned by the nature of the research, rather than by the size of the profit.

Those are six elements that help nurture and sustain public distrust of agricultural biotechnology. Now add to those some institutional peculiarities of the media.

- Among most reporters and editors in North America, there exists a deep-rooted ignorance of basic scientific and technical information.
- Journalists are even more suspicious than the general public of the government's competence to regulate agricultural biotechnology.

- Journalists assume that regulators are often captured by the industries they regulate.
- Struggling daily to express complexities in plain language, journalists react badly to "jargon" or specialized polysyllabic words. They see this as elitism, laziness or deliberate obfuscation. They're usually right.

Come up with some better songs.
Lobby for an arms-length regulatory body for agricultural biotech.
Accentuate the positive.

What Recourse?

Is there anything you can do about all this—the widespread public distrust and the media's own peculiar take on agricultural biotechnology? Even if this is all misperception, rather than reality, you still have to tackle it. Here are some ideas:

Come up with some better songs.

Lobby for an arms-length regulatory body for agricultural biotech, perhaps modeled on the Canadian Nuclear Safety Commission.

Accentuate the positive. Energetically publicize the involvement of industry and academic partners in undertakings like the Advanced Foods and Materials Network.

Convince the gatekeepers in the media that their reporters and copyeditors could profit from workshops on some of the scientific concepts underpinning agricultural biotechnology, including risk analysis. Facilitate the workshops but don't control them. Buttress your case by noting that the Canadian Broadcasting Company is now running a Critical Skills course internally for its employees that includes segments on basic science and risk.

Of course, I could be dead wrong about all this. As you likely know, there's an active branch of research pursuing the concept of selecting various dormant gene-expression patterns in organisms. I think the public could see this as far more natural than inserting genes from a foreign organism. And all of the industry's problems would be solved. Just don't let anyone dub these new organisms with a disparaging name as catchy as frankenfoods.

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Mr. Calamai graduated with a BSc in physics from McMaster University in 1965 and worked as correspondent and editor with the Southam company for 30 years. As a Southam Fellow at Massey College, 1982–83, he studied Canadian history and constitutional law. In 1985–86, he was Max Bell Visiting Professor in the journalism school at the University of Regina. From 1990 until 1996, he was editorial page editor of *The Ottawa Citizen*. Recently he co-authored *Subsidizing Unsustainable Development*, a report to the Rio +5 Summit for the Earth Council. He also served as a guest columnist for the Microsoft Network's online coverage of the 1997 Canadian general election. He is a three times winner of Canada's highest print journalistic honor, the National Newspaper Award, and an adjunct research professor in the School of Journalism and Communication at Carleton University.

His spare-time pursuits include conchology with specialization in the cowry (*Cyprae)*, ornithology, astronomy, and the genetic engineering of tomatoes.

Agriculture's Future: "Reading the Tea Leaves"

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The agricultural industry is capital intensive, technology driven, and absolutely critical to the health and welfare of every person on this planet. Unfortunately agriculture has become politicized and, to a degree, marginalized in our society. Although the results that we have been able to deliver via the application of technology to a natural resource-based industry have been absolutely phenomenal over the past 50 years, our profile—our political clout—has diminished.

I will discuss a new way forward that I believe will place our agricultural industry and the fruits from the application of the biosciences "on the table" (pun intended) in a dramatic way. Hopefully, I will leave no doubt that agriculture is a foundation—a pillar—necessary for societal progress.

One of the limitations in this industry is our inability to come to grips with long-range planning. When I talked with Alan Wildeman about this presentation, he suggested looking at the tea leaves to about 2050. In some societies, particularly parts of Asia, people do have a focus beyond 5 or 10 years, to 20 years or more. But, 2050 seems too far out beyond those time horizons. It leaves too large a gap in an industry fluctuating between reasonable profitability and uncertain survival, for people to cross. It is hard to think about draining the swamp when you are up to our thighs in alligators.

Recently I visited a processing company in the mid-west of the United States. In discussions about long-range planning, I focussed on 2015. Senior management said that they cannot plan effectively beyond 5 years, and 3 years is a better horizon. In agriculture, much of our planning has been done on a 3-year time period, but by drawing a straight line from last year to next year.

We must go out to the future then return to the present in order to long-range plan effectively. I will discuss three trends—drivers—that I think will shape the next 15 to 20 years. Hopefully we can weave these drivers together into a strategy, into a recipe for the future. Finally, I will make some comments on a new process that we have undertaken in Canada that will, hopefully, provide one option as a path forward to the future.

Trends and Drivers

Recently, a speaker at a conference in Florida talked about hard trends and soft trends and the difference between them. He classified a soft trend as something that may happen based on a set of circumstances at present and a hard trend as one that is solid and verifiable scientifically with physical evidence to back it up. As an example of a soft trend, within a year of the death of Elvis Presley in 1977 there were so many imitators that a trend indicated that by the year 2000 one in three people in the United States would be a Presley impersonator!

Global population growth is a hard trend. Eight billion people will be trying to find standing room on this planet by the year 2020. The population doubled, from three billion to six billion, from 1960 to 1999, just 39 years. Now add another 33% in the next two decades—where does that kind of trend end and what will be the effect on the enclosed biosphere that we call Earth?

I worked in the broiler-chicken feed business in my first years out of college. Those of you in poultry or animal production know what happens when you concentrate large numbers into a limited space. We are doing the same thing with *Homo sapiens*.

China and India and also, potentially, smaller Asian nations will emerge as the economic tigers of the twenty-first century.

First Trend

China and India and also, potentially, smaller Asian nations will emerge as the economic tigers of the twenty-first century. We talked about population growth from three billion in 1960 to eight billion in 2020, a 133% increase in six short decades. Peeling those gross numbers reveals that, in 2020 the population of India and China will equal that of the world in 1960. These two countries are industrializing rapidly and will devour limited natural resources like we have never seen before.

In North America, we are gluttons when it comes to energy use. In 2002, the United States consumed oil at a rate of 67 barrels/1,000 people/day, Canada 62. China consumed only 3.8 barrels and India 1.9. China's industrialization and push to prominence will significantly increase global consumption of energy even in the short term—between now and 2015. It is expected that, within 30 years, China and India's rate of oil consumption will be at least half that of North America. For this reason the issues of alternative energy and energy security are increasingly important, which is reflected in current pricing. However, $40 per barrel of oil will look really cheap in 15 years.

The same trend will apply in the agricultural industry; we will have to deal with increased growth in animal-protein consumption and changes in diet and absolute increases demanded by newly affluent consumers in Asia. We are most used to thinking about animal protein in the form of terrestrial animals and poultry. However, farming the oceans in various shapes and forms of aquaculture will eclipse our beef industry, for example, which is based on high intake of plant-based protein to produce a pound of animal protein for human consumption. As hard as it is for us to plan long term in agriculture, we have to make the attempt and we must deal with it, because change, like time, will not wait for us. The future is all about demands for enormous volumes of healthy food plus energy security.

Second Trend

The population of the developed world is aging. Japan is the oldest in terms of average, but North America is coming on strong. In the United States alone, almost 80 million baby-boomers—born after 1946 as a result of soldiers returning from the Second World War—are approaching retirement: one turns 50 every 7 seconds! The population born between 1946 and 1964 is the greatest demographic "bubble" that we have ever faced. Truly, an "age wave" is sweeping over society. This population is technology literate, mobile, wealthy, and inheriting from their parents (the generation that scrimped and saved through the depression) anywhere between $12 trillion and $40 trillion, depending on what source you use. This population is also very health conscious, quality-of-life conscious, and wants to live forever. As the boomers age, they will place a tremendous demand on the healthcare system, a demand larger than ever seen before. Remember: two thirds of all people throughout all of history who have lived to be 65 years of age are alive today.

Third Trend

As society demands environmental sustainability, more and more responsibility is being taken by the individual for the environment. People are looking to hybrid cars, to retrofitting their homes to be more energy-efficient (albeit that much of this is driven by economics as energy prices rise). Energy conservation is becoming more a part of daily life. Much media noise and debate exist around the Kyoto Agreement and greenhouse-gas emissions. New studies emerge almost daily about endangered species; a recent report from Oslo, predicting that the Arctic Ocean may be inhospitable to polar bears within 20 years, has helped raise public awareness. This new consciousness will drive a demand by society that everything we do in our daily lives—government, corporate, or individual—must be tempered by the desire to leave the smallest possible environmental footprint as we pass by.

Managing Dramatic Changes

In my opinion, these three trends will drive the future. They also must drive our

actions, to develop and implement strategies to manage these dramatic changes. Let's look at these three drivers, as three points on an equilateral triangle. Our strategies must deal with what's inside the lines because there is a great deal of overlap, cause and effect between the three points.

China and India as industrial powers. . . . will drive consumption of animal protein, vegetable oils and energy from all sources at rates never seen before.

China and India

Let's start with population growth and dominance early in the twenty-first century by China and India as industrial powers. Each of these countries will have between three and four times the combined population of Canada and the United Station and their economies will have increasingly affluent consumers. That factor of three to four will drive consumption of animal protein, vegetable oils and energy from all sources at rates never seen before. The economies of India and China are in take-off phase much like an airplane roaring down the runway. They aren't airborne yet, but there is going to be a dramatically increased need for energy and power as they move up the steep slope of economic growth like a climbing plane. It will attack availability of energy, it will attack availability of certain foods and it will drive up pricing. We in North America must be able to produce abundant high-quality food and we must become as energy secure through alternative sources as we possibly can. We must unhook from our dependence on fossil fuels whether domestically produced or from overseas. Expensive and timely technology development, energy conservation, and even a sacrifice in style and quality of life are all options on the table. The message from last August's blackout should resound with all of us. That was a great wake up call. We cannot be complacent: we must plan for the possibility of blackouts, power interruptions and oil and gas shortages. This calls for a strategy on energy security, which I believe is recognized in the United States but not yet in Canada. To achieve that goal will require new technology, new management and conservation techniques, a longer-term view by our politicians and, most of all, a new acceptance of individual responsibility. North America is a like an island with three nations clustered on it. We must develop a North American strategy if we are to deal with this issue in the right time frame and with the right spirit.

Environmental Sustainability

Environmental sustainability is hooked to population growth, to energy use and to lifestyle, and it must become a way of life for all of us. We cannot pay lip service to it. We cannot say that it is too costly. Each and every one of us must con-

sciously say that we are going to leave a smaller environmental footprint for other generations to follow. We cannot leave a huge debt for our children and grandchildren to pay, a debt that may not be repayable in some cases because the damage may not be repairable. The need to reduce greenhouse-gas emissions is real and must be dealt with. The need to conserve energy is real and must be dealt with.

Let's use the power of our marketing, our access to the press and our powers of persuasion to get every person in North America to realize that it is their responsibility individually and our responsibility collectively to leave this planet better than how we found it.

Aging Population

The most immediate and most impactive concern is the effect of the aging population in Canada, the United States and in the developed world as a whole. In Canada, we are on the threshold of having to pay a huge bill; over the next 10 years, healthcare delivery is going to cost $1.4 to 1.5 trillion. We cannot avoid the bill, but we can do something about how we pay it. The population of seniors over 65 grew 130% between 1970 and 2000 and will grow another 125% between 2000 and 2020. Thus in North America, increasing numbers are predisposed to the degenerative diseases associated with aging. Furthermore, Statistics Canada has determined that 48% of Canadians between 20 and 64 are overweight, and 15% are obese. Excess weight leads to high cholesterol and heart disease, and to diabetes and numerous other diseases. Already, 41 million Americans either have diabetes or are pre-diabetic. The demand on Canada's healthcare system will chew up 75% of new budgetary expenditures—three out of every four new dollars in our provincial budgets. Keep in mind that provincial governments pay 75 to 80% of Canadian healthcare-delivery costs. Canada has only three provinces with a population base and budget that can sustain and pay for the healthcare system currently envisaged. "Healthcare is the policy gift adored ferociously by Canadians that keeps on taking," Jeffrey Simpson commented rather cynically in the *Toronto Globe & Mail* recently. This healthcare monster is on our doorstep chewing through the front wall. Canadians have two choices: figure out a new strategy to pay and hopefully reduce the bill or raise personal income taxes by 65% over the next 10 years.

This is lemonade time. We have a big lemon; let's make lemonade. The lemonade is the opportunity that agriculture and the bioscience industry offers to reduce the costs, increase the value of technology and fuel the new knowledge-intensive, bio-economy of the twenty-first century. Agriculture must move beyond a cheap food policy and being marginalized to becoming a health-utility industry that can be a pillar in the delivery of quality human healthcare. We need value strategies that provide options to the healthcare community in the forms of nutrition targeted initially at preventative medicine then moving to population medicine with products and diet regimes that prevent disease. Peel the three drivers apart and there are huge opportunities for technology-intensive agricultural industry to have

a greater profile and a stronger position to play in the future, a future dominated by the demand of an aging population for access to better healthcare and the demand of society as a whole for environmental sustainability.

We must create a vision of what our industry could be in the future.

Role for Agri-Industry

What do we need to do? First, we must create a vision of what our industry could be in the future; we need a national vision that people can touch, feel and believe in. We need a compelling vision that everyone, from all parts of society, can see and will want to be a part of. We need a vision that proves that the destination is worth the price and the hardship of the trip. This is the essence of leadership. In Canada and United States there has been no compelling vision of what we as an industry could be. If our politicians cannot see beyond power for power's sake, we can make a start in this industry, because we are a pillar for a healthy future for Canadians, Americans and other peoples of the world.

Every one of us in all parts of this industry must align our actions on two deliverables: better healthcare and environmental sustainability.

Secondly, every one of us in all parts of this industry must align our actions on two deliverables: better healthcare and environmental sustainability. In every action contemplated, we must ask whether it helps to potentially improve the efficiency and effectiveness of healthcare delivery and/or whether it leaves a potentially smaller environmental footprint.

Thirdly we must build from a foundation of strength. We have a foundation of science, we have a foundation of good farms and farmers, and a foundation of solid industries, but our number-one competency to move our vision and strategy forward is trust. Ipsos-Reid did a study in the summer of 2002 on the fallout in society of the catastrophe of September 11, 2001, in New York. Ipsos-Reid found North American society to be very uncertain about its future—searching for certainty—a society in which the future would be based on competition for public trust.

In the Leger poll announced on February 27, 2004, in the *Toronto Star*, Canadians and Americans ranked firemen the most trustworthy with a trust level of 99%. The second highest level of trust, at 97%, was in nurses. The third level, at

91%, was in physicians, and the fourth level, 89%, was in farmers. (Used car dealers, at 19%, were deemed more trustworthy than politicians at 14%.)

Stop and think about marrying strengths: Nurses plus healthcare delivery, doctors plus healthcare delivery, farmers plus healthcare delivery—that's what it's about. We have that foundation of trust within a society searching for certainty where the dimension of competition is for public trust.

We now need alignment of the like-minded. We began to attack the alignment question in April, 2004, here in Canada by putting together a group of people in a think-tank hosted by the University of Guelph and the Royal Bank. We ended up with seventeen participants comprising roughly a third in provincial government, a third in industry and a third in academia. We did not want a group of people representing all sectors of society. We wanted knowledgeable committed people with the right personal chemistry to work effectively in a closely knit team. Our goal was to construct a vision of the agrifood industry in Canada in 2020.

Vision Statement

We developed a vision statement over a day and a half of facilitated creative thinking here at Guelph, having backed off to 2015 as the time horizon because we wanted to link all parts of society to a compelling reachable destination:

> *In the year 2015, Canada is a world leader in the enhancement of human, animal and environmental health through the application of research, technology and social innovations in agriculture and the bioscience industry.*
>
> *As a solution-provider to society, we reduce the burgeoning health deficit, improve quality of life, and embrace environmental sustainability.*
>
> *We are the trusted standard against which others measure themselves.*

Bumper-Sticker Version

- Agriculture: A fundamental pillar for a healthy Canada.
- The future is going to happen. We will have to pay the bill for healthcare. We will have to foot the bill also if we fail in terms of environmental sustainability.
- The future is going to happen. We can let it happen or we can shape it and lead it.

I believe that the only way to predict the future is to create it. The option is ours.

Raised on a mixed farm near Napanee, Ontario, **JOHN OLIVER** has more than 35 years experience in agricultural science and agribusiness. He began his career as an agricultural market specialist after receiving his BSc in agriculture from Ontario Agricultural College (University of Guelph) in 1961.

Mr. Oliver is president of Maple Leaf Bio-Concepts and Lojon Associates International, consulting firms in biotechnology and government affairs. He was a founding member and past chairman of the Canadian Animal Health Institute; a founding member of the Canadian Agri-Marketing Association (CAMA); chairman, Crop Protection Institute of Canada (now CropLife Canada); and president, DowElanco Canada, Inc. His achievements include being the recipient of the first CAMA lifetime achievement award; currently, he is a member of the Agricultural Institute of Canada.

Disaggregating Biotechnology and Poverty: Finding Common International Goals

Ronald J. Herring
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Ithaca, NY

I was asked to provide concluding commentary for this conference. Fortunately, everyone attending realized that this task is unmanageable: the papers have been far too rich and wide-ranging for any tidy summary or conclusion. I will instead try to provide some sense of the thoughts stimulated by the sessions, in the hope that others may find them useful.

The wealth of empirical materials engaged in the plenary and breakout sessions should send a strong signal to analysts of the public-policy issues in biotechnology: disaggregate, disaggregate, then disaggregate.

The wealth of empirical materials engaged in the plenary and breakout sessions should send a strong signal to analysts of the public-policy issues in biotechnology: disaggregate, disaggregate, then disaggregate. There is significant variation in the relationship between technical change in agriculture and societal welfare implications along numerous dimensions. This variation is by crop, by agro-ecological system, by social structure, by property relations, by policy regime — both domestic and global. I will illustrate this lesson below with discussion on the relationships between biotechnology and poverty.

To begin disaggregating at the top, I suggest that we abandon use of the term "developing countries." Though common shorthand, the construct increasingly strikes me as empirically imprecise, deceptively linear, philosophically glib, and vaguely patronizing. Equally, we need to keep before us the distortions that excessive aggregation creates for analytics of poverty. Mahatma Gandhi once said something to the effect that India was not a poor nation, but rather a rich nation inhabited by many poor people. What benefits a powerful landlord in rural India may have no effect whatsoever, or a negative effect, on a landless worker with nothing to sell but her labor power in a crowded market. There are far more of the latter than the former. Because of inappropriate aggregation, we hear discussion of "India's interest" in biotechnology, or other technologies, when in fact there are multiple interests, often conflicting. Disaggregation gives us a better reading of the effects of new technologies of various sections of the population, and thus grounds for thinking about complementary policy.

Moreover, "development" is a process of—etymologically—"unfolding." The meaning of development for a tadpole is beyond dispute, genetically given; one can tell whether or not the frog is coming into being. There is a defined end-state: a frog lacking lungs, or possessed of three legs, has not developed properly; something in the development process has gone terribly wrong.

Nations are quite different; much of politics is a struggle to define what vision, what potential should be unfolding, what criteria should mark progress as opposed to retrogression. In 2002, the United States, for the first time since 1958, experienced an increase in the infant mortality rate, already the highest rate of any OECD country. This outcome would consensually be a step backwards on any developmental trajectory, however large the GDP may become. There is no consensual end-state: all societies are at all times potentially "developing"—or slipping. Human societal development presents continuous challenges, moving targets, redefinitions of what is possible, conflicts over what is best, what is unacceptable. There is no consensual analog of a tadpole-to-frog template. Finally, the use of the construct "developing countries" suggests that currently low-income nations are on some defined path moving upwards. The reality is progress and retrogression, radically uneven over time and space, across epochs. To talk of "developing countries" when referring to most of Africa in the 1990s, for example, would not only imply a gloss that is imprecise and naïve, but analytically distorting. Just as imperial powers rise and fall over time, development miracles come and go: Pakistan of the go-go 1960s to the crisis-ridden 1970s to contemporary volatility is archetypal.

Finding Common International Goals is an ambitious conference theme in this context. As elaborated by Alan Wildeman (2004), all three constituent elements of this theme are of special importance to the poor: ensuring safe and healthy food, reducing ecological damage, and improving quality of life. We find in the optimistically evoked "international community" repeated declarations of a global commitment to reduction of poverty; in some formulations, poverty reduction

through application of biotechnology tools rises above the level of opportunity to the level of moral obligation (Nuffield Council, 1999). The absolute numbers of the absolute poor continue to increase globally, despite striking growth of GDPs and other measures of economic activity in many parts of the world. Of the many definitions of poverty available, one used by Robert McNamara as president of the World Bank in 1974 has always struck me as most apt, and I paraphrase here: absolute poverty is a condition of life so limiting as to deny the potential of the genes with which humans are born.

The very existence of absolute poverty in this sense constitutes a global imperative to apply new knowledge to alleviate limits on achievement of human potential. What might biotechnology have to do with alleviating such conditions as part of common international goals? For many in the NGO community, this very question is part of an instrumental ideological cover for corporate globalization. This flatly oppositional view of biotech lacks nuance, and certainly comes to premature conclusions about the poor, but is rooted in serious concerns about property and costs of cultivation of greatest importance to the marginal producer. The empirics thus far do not seem to bear out the most pessimistic scenarios of opponents to transgenics, yet their premises warrant our collective attention if we are serious about the condition of the poor.

Development Context: Dr. Swaminathan's Challenge

In my breakout-session group, there was considerable puzzlement and surprise at the comment of Dr. M.S. Swaminathan in the keynote session to the effect that glyphosate-resistant transgenic crops are not appropriate for India. The reason for surprise is a persuasive Malthusian approach to world hunger and world poverty in the standard narrative of transgenics and the poor. If India is a poor country, should any productivity-increasing technology in agriculture not be of benefit to the poor? The ghost of the good Reverend Malthus remains quite influential. For example, Per Pinstrup-Andersen and Ebbe Schioler, in a book that won the World Food Prize for 2001, concluded, "Once again Malthus's clash between population growth and food production looms threateningly on the horizon" (Pinstrup-Andersen and Schioler, 2000). Though sophisticated analysts such as Pinstrup-Andersen and Schioler understand the many caveats embedded in the Malthusian narrative, there remains a widespread misconception—echoing corporate public-relations—that biotechnology means more food and more food means less poverty. Dr. Swaminathan's comment puts us on another, and more fruitful, analytical track, but one that is conceptually and empirically challenging.

Broad statements about whether advances in biotechnology will benefit or disadvantage the poor are unlikely to be useful.

Broad statements about whether advances in biotechnology will benefit or disadvantage the poor are unlikely to be useful. Both "biotechnology" and "the poor" are heterogeneous categories. Yet the public and political discourse around biotechnology has largely taken a dichotomous and generalizing form[1], though more so in agriculture and food systems than in pharmaceuticals.

Biotechnology covers a wide range of practices and products. The most contentious—and potentially powerful—sphere is genetic engineering, though it is already clear that advances in biotechnology outside the transgenic realm make significant contributions to plant breeding. It is recombinant DNA work that has energized the debate, because of its unique potential and consequent susceptibility to suspicion. Transgenic organisms are regarded by proponents as offering unprecedented benefits to humanity and by their critics as introducing unacceptable uncertainty, perhaps serious risk. This disagreement becomes more pointed when proponents claim that genetic engineering offers means of improvement in the lives of the poor that can be approached in no other way, for example in creating nutrient-dense varieties of rice (Bouis, 2003). The ethical assumption is clear: poverty produces unnecessary suffering; human knowledge is a collective product and good; knowledge must be utilized to alleviate suffering if at all possible. Critics claim that it will be precisely the most vulnerable sections of the population that will be put most at risk by novel technologies, whether from ecological degradation, unsafe foods introduced via foreign aid or public distribution systems, allergenicity from new proteins, or monopoly control of genetic materials and thus of pricing and access to technology by multinational firms (Shiva, 2000; Altieri, 2001).

To take Dr. Swaminathan's comment in this context, it is clear that disaggregation across nation states and agrarian structures is necessary to talk sensibly about transgenics and the poor. Herbicide-resistant crops save farmers money and labor under certain agronomic conditions. Dr. Swaminathan was implicitly disaggregating a largish, indeed continental, entity we call "India" into constituent interests and suggesting that the vector sum effect of reducing labor via herbicide-resistant crops was not good policy. This is a plausible claim. The largest class of absolute poor is the rural landless who must find daily employment to maintain themselves. Reducing aggregate demand for labor under those agrarian conditions either destroys livelihoods directly or puts downward pressure on wage rates or both, in either event deepening poverty if no other systemic parameters change simultaneously. Worse, the rural poor who engage in weeding labor for a livelihood are frequently those cumulatively disadvantaged along other dimensions of social stratification: women, depressed castes, ethnic minorities. In those circumstances, even if herbicide-resistant crops would be desirable on other grounds—to encourage soil conservation, for example—a pro-poor approach would necessarily

[1]A very useful overview is Winston (2003); see also Dawkins (l997), McHughen (2000), Shiva (2000), Shiva *et al.* (2000), Altieri (2001), Charles (2001) and Paarlberg (2001).

begin discussion of land reforms, rural public works, food subsidies, and other mechanisms to avoid making the poor pay for others' profits (*e.g.* Herring, 2003a).

But the story is surely more complicated than Dr. Swaminathan suggested. Where farm labor is either scarce or mostly supplied by farmers who own their own land, ability to control weeds may enhance yields, returns for labor, and opportunities to take on more land for cultivation when available. All these outcomes could be pro-poor, depending on the net effect on costs and returns to direct producers. This view has been long advocated as correct for African conditions, and was advocated from the plenary floor by Florence Wambugu. There are rural poor in both India and Africa, but their objective interests in herbicide-resistant technology may well diverge. Moreover, even in India, demand for rural labor is highly uneven temporally: an aggregate surplus of labor, indicated by insecurity and poverty among landless workers, does not mean that acute labor shortages do not occur in times of peak demand. Farmers will frequently tell investigators that labor is in short supply. This observation may occasionally be literally true, but often means only that they cannot hire labor in discrete bundles at times separated by enforced idleness at a wage that gives them a decent profit. This farmer-profit wage may well leave the laborer below a pitiful poverty line over the course of a year, as labor demand is seasonal (Herring and Edwards, 1983). Agrarian structure matters fundamentally.

Because disaggregation produces complex analytics that require significant empirical research, the serious literature on transgenic crops and poverty is in its infancy. There is little doubt that development of affordable, scale-neutral technologies for reducing biotic and abiotic stresses on crops of special importance to marginal farmers would be important to global poverty reduction, assuming reasonable seed prices. Indeed, the great promise of recombinant DNA technology is that the specific problems of poor farmers can in principle be addressed in new and efficient ways (Lipton, 2000). The poor often face special agronomic difficulties because they are driven to the margins of agrarian systems; the best land, water, drainage, locations, credit connections, knowledge are not in their hands. Their crops do not attract the attention of the best-funded research institutions. Drought- or salinity-resistant crops are of special importance to the poorest farmers, but the technical problems in these traits exceed those of single-gene solutions such as insect resistance through *Bacillus thuringiensis*. There is thus both need and promise for transgenics developed specifically to alleviate the obstacles faced by poor farmers; but the distance between promise and delivery is long, and made longer by the political controversy surrounding biosafety and regulation, as discussed below.

The implication of this promise is that directed research and development become necessary. Critiques of biotechnology as a force for poverty alleviation thus target the incentives for and record of current research and development. Most of the currently available technology was developed for crops and agrarian conditions of wealthier farmers and countries as opposed to crops widely grown by

poor farmers in poor countries [for representative data on global distribution of crops, see James (2003)]. This critique would be more powerful were the technology not so young and were there not so many new potential players at the national and global levels. Moreover, the *Bt* approach to insect control seems to be widely applicable to a common agricultural problem, regardless of size of holding. Nevertheless, the point about research and development concentration has some validity as a generalization. The political economy of this outcome, even if overstated, is very clear: unlike the international research and distribution regime of the "green revolution," most of the research in genetic engineering is in the hands of for-profit firms, rather than international public-sector and national research institutions. There is little private incentive to produce for small markets of poor people, especially when the political climate for acceptability of transgenic crops in poor countries is so uncertain or even hostile (Potrykus, 2004). Orphan crops join orphan drugs as instances of market failure. At its best, development policy is ideally suited to address such market failures. Getting the institutions right—public, private, national, global—for biotechnology is a necessary condition for purposive pursuit of poverty-reducing outcomes (Cohen *et al.*, 2003).

The spirit of pro-poor transgenic policy must begin reasoning from the needs of the poor, rather than from potentials of the technology.

Reasoning From the Bottom Up

The spirit of pro-poor transgenic policy must begin reasoning from the needs of the poor, rather than from potentials of the technology. This is explicitly a comparative enterprise: the question is always, implicitly, under what conditions do particular dynamics obtain? Though the poor are obviously a heterogeneous category, some primary desiderata can be posited universally:

- The poor need opportunities to improve incomes, which by definition would reduce poverty. Net employment and wage effects (shadowing productivity gains) relative to food prices are most important for the most vulnerable poor, whose main—often only—saleable asset is labor power.
- The poor need more affordable and more nutritious food to improve their health and to live longer and more productive lives. Affordable food is obviously important for the poor; yet the poor consumer's gain can be the poor farmer's loss when over-production causes prices to fall. Poor producers will be harmed by surpluses unless total factor productivity on farm rises and no new extractions of intermediaries—seed merchants, moneylenders—siphon off additional farmer income.

- The poor need environmental protection. This is true both because more often than for the rich, their livelihoods depend on ecological integrity, and because environmental degradation affects most quickly and seriously those with the least flexibility in life choices.

This simple accounting does not exhaust the needs of the poor; one thinks of land, shelter, political access, cultural acceptance, and personal security among other conditions. Nor should consideration of transgenics obscure the major levers through which poverty might be alleviated. The international regime of subsidies and protectionism in rich countries, for example, has a much larger impact on incomes of the rural poor than any transgenic yet developed. These macro and structural determinants of poverty and its effects must be bracketed for a discussion of biotechnology *per se*, but must not be forgotten.

Income

The easiest question concerns farmers who own their own land: what is the evidence that genetic engineering allows scale-neutral deployment with substantial benefits for very small and marginal farmers? In the narrative of proponents of transgenic crops, scale-neutral technical change can lower the size threshold of a viable farm, rescuing smallholders from the problem of having too small a farm to be viable—an increasingly troubling phenomenon. In the narrative of opponents, poor farmers in particular lack the power, autonomy or knowledge to avoid victimization by powerful purveyors of an alien and dangerous technology.

This is no place for a literature review, but the evidence seems to be squarely in favor of the scale-neutral interpretation. That is, new technology embodied in seeds does not face the lumpy investment hurdle of such innovations as tractors or tube wells that favor wealthy farmers over poorer farmers. The clearest evidence is probably from *Bt* cotton, where small farmers have increased their net income through two mechanisms: less cash expenditure on insecticides and better protection from pests, increasing production per acre (*e.g.* James, 2002; Lipton, 2003; Pray and Naseem, 2003; Zilberman *et al.*, 2003; Herring, 2005). The evidence that small farmers can take advantage of *Bt* technology to avoid debts for inputs such as pesticides and provide some insurance against crop failure and raise production has led to endorsements by global organizations such as the United Nations Development Program (UNDP, 2001)—certainly no corporate shill—and the Food and Agriculture Organization (FAO, 2004).

The most obdurate problem of poverty is, however, in many settings that of the landless poor who must seek wage employment on whatever crops need labor. More an Asian than an African problem, as suggested above, the rural landless are everywhere especially disadvantaged in economies that generate too few jobs and experience urban bias in social support services. Labor-displacing ("saving" in the discourse of maximizing managers) transgenics then come under special scrutiny. Insect- or herbicide-resistant crops, by reducing the labor needed for applying insecticides or weeding, may reduce hired farm labor, thereby affecting the de-

mand for labor from the most vulnerable class. At the same time, increased income for farmers could generate more rural employment: the familiar trickle-down dynamic (typically assumed by those who do not have to wait for trickles for their well-being, but live rather farther upstream). The dynamic of lower labor applications on transgenic crops would be attenuated under conditions of smallholder self-cultivation: so, for example, less prevalent in *Bt* cotton in China, in theory, than in India, where cotton holdings, though small, are larger than those in China [data from James (2002)]. On yet another hand, work opportunities lost in chemical applications may be compensated by more harvest labor, less polluted ground water and less exposure to toxins. This scenario could present a difficult trade-off for the very poor, but may not be inevitable. For example, in *Bt* cotton in India, if wages are based on weight harvested—rather than a daily basis—income would increase with yield and with density of viable bolls of cotton. The inverse is that there is no income for the landless at all in harvesting crops destroyed by bollworms. To the extent transgenics reduce risk of crop failure, they serve as a macro-insurance policy for the landless poor, as they do for farmers.[2]

Poverty implications for farmers and states seeking hard currency through agricultural export earnings are complicated by segmentation of global markets; segmentation in turn is a function not of poverty concerns but of differential interpretation of the science on issues of risk and uncertainty. Here European consumers have proved disproportionately powerful. Though there seems to be some softening of official European hostility to transgenics, it is still not clear how *identification and labeling of transgenic products* in *the global market will affect opportunities for poor farmers. The example of Japan's banning of transgenic papayas underscores the vulnerability of small farmers to discrimination against transgenic crops—ironically in this case to the benefit of a multinational firm dominating the market (Lee et al., 2003).*

Finally, income effects are difficult to specify with limited data and unanswered questions about the regime of property rights and mix of public/private investment in new technologies. It is becoming clear that the burden of patents, property claims and consequent fees has been exaggerated by opponents of transgenics. Activists in India said that Monsanto would crush the peasants, for example, but a) seed costs are typically only 7–10% of the cost of cultivation, b) most farmers who use the very expensive Bollgard® seeds seem to find that net income goes up, and c) farmers who wish to avoid the high costs of officially sanctioned seeds have many gray-market unapproved *Bt* cultivars as options, some of which are

[2]*Bt* cotton in India has been in the field for too short a time, and with too few independent and credible studies, for there to be firm conclusions on this point. See Herring (2005) for some sources and evidence. It is clear that the storm-generating claims on positive yield effects of the Qaim and Zilberman (2003) piece in *Science* were based on an unusually devastating bollworm infestation and represent not a typical outcome but a limiting case, as the authors recognized. Nevertheless, such catastrophes do occur from time to time, and *Bt* crops survived when others failed.

quite inexpensive and some of which are held superior to the Monsanto version by some farmers (Herring, 2005). The monopoly powers of political rhetoric and TRIPS negotiations prove difficult if not impossible to enforce on the ground, whether in Southern Brazil (soy) or Western India (cotton). It is certainly true that Monsanto has been quite vigorous and somewhat successful in demanding enforcement of its property claims in North America, and comes down very hard on farmers to set examples, but it is equally clear that such strong interpretations of intellectual property are anomalous on a global scale. Moreover, it is the public sector that seems to be supplying more and more of the transgenic research and products in the low-income countries (Cohen, 2005).

The potential of bio-fortification of food crops figures heavily in claims for the life-saving potential of transgenics.

Health

Most of the world's poor are not farmers at all. The overwhelming fact of poverty is insecurity and restricted options: food comes first, and consumes a larger share of expenditures the poorer one is. Moreover, food expenditures of the poor tend to be weighted towards staples rather than fruits, vegetables and animal protein. For the poor family, there is not enough food and it is not adequate nutritionally. As deadly as protein-calorie malnutrition is, it is increasingly recognized that micronutrient deficiencies generated by excessive reliance on staples in an unvaried diet may be equally or more debilitating. The potential of bio-fortification of food crops—of which pro-vitamin A rich "golden" rice is the poster plant—figures heavily in claims for the life-saving potential of transgenics. The model is clear: having plants make nutrients that will be bioavailable in staples for those who cannot afford the varied diets recommended by nutritionists seems superior both in terms of cost and sustainability to alternatives such as supplementation or fortification of processed foods (Bouis, 2003).

This topic was treated well in plenary by Suzanne Harris and mentioned in passing by others. It is hard to imagine that this contribution of biotechnology is not the most significant for the poor; cash can be lost, crops can be destroyed by natural catastrophe, recessions can dry up wage labor opportunities, but as long as adequate entitlements to food staples can be maintained for the poor, nutritional enhancement of those staples contributes to health in the most direct way. What is not known is how practical nutritional enhancements are in different agronomic regions and crops, how consumers will accept transgenic foods, whether farmers will grow bio-fortified varieties, and whether or not there are dangers in over-dosage of specific micronutrients for specific people.

Environmental Integrity

The poor are the first victims of environmental degradation. They depend on the environment more and have fewer options in comparison to the rich. There are dichotomous positions on the environmental consequences of transgenics. Proponents argue for substitution of destructive agro-chemical inputs in ways that improve environments. Synthetic chemicals in agriculture are among the most toxic substances in circulation; the poor are especially vulnerable. If someone is going to put on a backpack sprayer and walk unprotected and often half-naked through fields spewing toxins, the probability that it will be a rich male is close to zero. If anyone is going to drink contaminated surface water, or water from shallow wells, that person is most likely to be found at the bottom of the social hierarchy. Here the claim of *Bt* technology, especially in cotton, is very powerful. The evidence from China on farmer health in *Bt*-protected fields as opposed to sprayed fields is clear (Huang *et al*., 2002; James, 2002; Pray *et al*., 2002). Reduction of pesticide spraying can be expected to conserve water as well, and reduce the destruction of beneficial insects in the fields and wildlife that depends on agro-ecological niches.

Against this clear benefit is the prospect of uncertainty—not risk, yet, for no probability distributions are known—but an uncertainty about possible ecological dangers. The magnitude of the uncertainty is not known. Pitting certain benefits against uncertain dangers presents a difficult public-choice situation. It is not helpful to say, as techno-optimists sometimes do, that science should decide; there is no scientific means of placing values on uncertain outcomes. Rather, there are widely varying distributions of risk aversion and risk acceptance (Douglas and Wildavsky, 1982). This is true for societies as for individuals. Most North Americans consume transgenic foods with little thought of allergenicity; Europeans—and some African and Asian societies—take a much more risk-averse position. Risk aversions are not subject to refutation; some people fear airplanes, others fear statistically uncommon crimes, others fear rare diseases; no data will settle the issue of their preferences or relative risk aversion. The only solution to this public choice problem is some interaction between democratic processes and biosafety institutions. The poor are the least likely to be heard in these forums under existing institutional arrangements.[3]

INSTITUTIONS: BIOSAFETY, REGULATION AND PROPERTY

There is always one institutional caveat in the standard narrative of transgenics and the poor: the assumption that an effective regulatory regime can be put in place. On this point both proponents and opponents agree. There are three huge

[3]For results from a major project testing the conceptual and empirical dimensions of this issue, see *Democratizing Biotechnology: Genetically Modified Crops in Developing Countries,* Institute for Development Studies, University of Sussex, Brighton, UK (www.ids.ac.uk/biotech).

issues: how much regulation? will regulation work? is the result worth the cost? Joel Cohen confidently said in plenary, "Risk assessment will happen," but later added somewhat more ominously, "Farmers will find a way."

Seeds are not only divisible as working capital—contributing the scale-neutral characteristic of at least some transgenic crops, and hence their contribution to raising poor-farmer income—but largely invisible to regulators (Herring, 2003b). Seeds are also highly portable; the very idea of borders becomes as problematic in the genomics revolution as it has proved to be for drugs, arms, people and information. The contemporary conflict over genetically modified (GM) soy in Brazil underscores the point: the federal state is less a means of enforcing Brazilian law than a forum in which struggles take place over regularization of a transgenic crop that farmers clearly want. "GM-free" zones declared by governmental institutions are a fantasy.[4] Likewise, underground, unauthorized *Bt* cotton seeds spread without the knowledge of either Monsanto's Indian partner Mahyco or the nodal federal authority for enforcement of Cartegena provisions, the Genetic Engineering Approval Committee in Delhi. As a result of farmer stealth and underground seeds, a kind of genetic anarchy evolved in India's cotton regions. Farmer-generated *Bt* crosses, F2 seeds of earlier crosses, unauthorized transgenic varieties produced by small companies, and the three officially approved Monsanto Bollgard® varieties approved by the biosafety regime, were all competing for space in the fields at different price points. In the face of farmer political power, regulators basically retreated (Herring, 2003b, 2005). Gene police will be hard to come by in the villages.

Ironically, the same forces that preclude effective biosafety surveillance also preclude enforcement of property rights that both firms and opposing NGOs assume. The concern for the poor is quite straightforward. For poor producers, the shift from public-sector dominance of intellectual property in the "green revolution" to private-sector dominance in the transgenic revolution could deepen market-determined disadvantages. The worst-case scenario for poor farmers would be one in which technology fees were prohibitively expensive, yields were dramatically improved on the farms of early adopters of new transgenic crops, and the poor were caught in a backwash of lower output prices because of increased yields on adopter-farms, but with no reduction in input costs or increases in yields on their own farms. Technical change in this scenario would accelerate agglomeration of ownership and the ruin of small farmers.

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[4]See for example, *Seed Quest*, Brazil Introduces Bill to Regulate GM Crops, Rio de Janeiro, Brazil, October 30, 2003. The national state sought first to limit underground transgenic soy to one state, Rio Grande do Sul, where farmers have been growing seeds smuggled in from neighboring countries for some time. The neighboring state of Parana then banned the crop and seized shipments from the port of Paranagua, but part of this shipment was grown in Paraguay, not Brazil, raising an international dimension to the conflict. The establishment of a biosafety regime at the national level led to significant political conflict, within and outside the government (Poddar, 2004).

Market-driven distribution with strong property rights is inappropriate for serving the needs of the poor.

As the transgenic cropping revolution unfolds, though, it seems that, to date, property rights have been much more fluid, contingent and variable than opponents of the technology had feared. China's public-sector *Bt* cotton seems to be quite successful and is likely to travel to India via a partnership with Nath Seeds. In India itself, public-sector research is picking up, though still is far behind that of China (Pray and Anwar, 2003). Private-property claims also turn out to be quite negotiable. The "golden rice" property claims have been sorted out to segment the market in a way friendly to poor producers; this outcome may serve as a model for future humanitarian transfers of technology. The analogy to pharmaceuticals seems clear: market-driven distribution with strong property rights is inappropriate for serving the needs of the poor. When the Indian firm Cipla entered the African market, multinationals with prohibitively priced AIDS drugs had either to write off the market or adapt with competitive pricing. Of course the possibility remains that just as "orphan drugs" are abandoned for lack of markets because only poor people get the disease in question, there may well continue to be orphan crops, as the poor lack both economic and political power.

If some of the most pessimistic projections of the effects of strong intellectual property rights in transgenics seem exaggerated, there remains much that is uncertain. It is still true that high upfront technology fees will disadvantage poor farmers. To the extent that transgenics require more upfront cash than alternatives, they will reinforce the advantages of deep-pocket farmers over poor farmers. The poor are excluded from or disadvantaged by credit institutions and, by definition, are less likely to be able to afford cash payments from savings. They often pay more for credit. Black farmers in the United States won a massive settlement from the Department of Agriculture in 1999 to compensate for credit discrimination and loss of farms historically. Precisely the same probabilities of lower ranking in the social hierarchy that make poor farm laborers especially vulnerable to ravages of income insecurity and nutritional crisis afflict small farmers in stratified agrarian systems (Herring, 1977). More creative credit institutions are in general of special importance to the poor, and especially under conditions of technical change. By the same token, to the extent that transgenics substitute for upfront cash costs of inputs, they are of special benefit to the poorest farmers; in the case of *Bt* cotton in India, debts at usurious rates to pesticide firms have been a significant source of farmer financial crisis and the widely publicized farmer suicides of 1998 (Centre for Environmental Studies Warangal, 1998; Department of Agriculture and Cooperation, 1998). It is now clear that the Cry1Ac protein in practice substitutes for sprayed pesticides in a very cost-effective way, more so when technology fees are avoided than when they are paid (Roy, 2003; Herring, 2005).

These observations on underground seeds raise a serious concern about the feasibility of biosafety regimes. The discourse of Cartagena could well be more symbolic politics than real barrier to gene flow. If the benefits of introduction of transgenics are captured by a subset of farmers and seed companies, but the costs are spread to society generally, the case for transgenics is proportionately weaker on developmental grounds.

The first ethical dictum of development policy is to do no harm. The history of development is one of innovation, accepting risks to achieve gains. As always, the question of social justice is: who bears the risk, who is likely to gain, at whose expense? There is no dispute, for example, that the regulatory regime for genetically engineered organisms mandated by the Cartagena Protocol on Biosafety of the Convention on Biological Diversity will be costly and difficult to implement—particularly in the poorest countries—and perhaps ineffective. The opportunity costs of implementing this regime are high in terms of brain-power, skills and funds. Confronting these costs in the calculation of potential benefits of transgenics is a challenging but necessary task, one typically dodged in the standard discourse on biotechnology.

Among the common international goals for biotechnology, poverty alleviation must rank highly.

The Goldilocks Paradox

Poverty has been important, at least rhetorically, in the globally contentious politics surrounding transgenics. Supporters and opponents of transgenics have a poverty story to tell. This essay has argued that among the common international goals for biotechnology, poverty alleviation must rank highly. Conceptually, and to some extent experientially, this goal seems realistic, but is no easy mark.

The standard narrative of transgenics and the poor produces a Goldilocks outcome: societal well-being requires not too much regulation, nor too little regulation, but rather, an amount that is just right. Though reassuring for mass publics and policy analysts, the "just-right" parameters in real agro-ecologies in real social systems are extremely difficult to specify with anything approaching scientific rigor. We quickly enter the realm of Donald Rumsfeld's "unknown unknowns." In the social choice matrix into which transgenic policy must be inserted, the most complex question is then about the marginal dollar of development expenditure: where does genetic engineering lie in relation to alternatives? Every policy choice curtails or preempts others. There are, for example, a number of innovations in the area broadly known as "agroecology" that might be considered, possibly as complements, possibly as alternatives, to transgenics (Uphoff, 2003). Where should the marginal dollar of scarce development funding go? More difficult still is the

question of regulation and biosafety regimes. These expenditures entail an enormous burden for low-income countries: the opportunity costs are high. The worst-case scenario is one in which biosafety costs are high, born by poor countries at the expense of pro-poor alternatives, and prove to be ineffective in practice. The evidence from *Bt* cotton in India confirms Joel Cohen's observation: "Farmers will find a way."

Though often posed as a matter of societal choice, in fact technical change typically produces differentiated costs and benefits and is driven by particular interests. Conflicts over new technologies have a long history in development studies. Ned Ludd contributed his name to one hostile characterization of opponents of technical change, yet his program was what economists tell us is the natural human condition: pursuit of individual interest. The critical developmental question for technical change is always: at whose cost, to whose benefit? To make a gross but fairly accurate generalization, capital prefers freedom to operate, labor prefers social protection – a reflection of their relative power in market society (Polanyi, 1944/1957). Because the poor are unlikely to win when dollars are criteria for power, the political system and resultant policies become critical for pro-poor outcomes.

Adoption of pro-poor strategies then presupposes political feasibility. "Finding common international goals" works better as conference theme than as political program. NGOs speaking on behalf of the poor have intermittently blocked even field trials of transgenic crops designed to find out whether or not there is environmental threat (Shiva *et al.*, 1999). This disagreement indicates the absence of even the most basic epistemological and methodological grounds for resolution of the politics. Those social forces that could form the base of a pro-poor coalition—public intellectuals, public-spirited NGOs, progressive political parties, social movements mobilizing the poor—are to date those most likely to be hostile to transgenics in poor countries. The discussion of developmental trade-offs above indicates a reasonable basis for opposition: not that transgenics make frankenfoods, but that the opportunity costs in terms of research, development, testing, monitoring, and regulation are too high. If these are the grounds of objections, there are grounds for negotiation. If the grounds of disagreement are more fundamentally epistemological, or have to do with irreducible conflicts over approaches to uncertainty and risk, there is less prospect for settlement. Democratic mediation has a Goldilocks character as well; dissent needs to fall within an elastic band: not too much, not too little, but sufficient distance for societal resolution through democratic means. There is much at stake in these politics: wrong conclusions on either side of the argument could have adverse consequences for the poor. If the critics are correct but proponents persist, the lives of the poor could be made even worse than they are now. If proponents of biotechnology are correct but critics prevail, the poor would be denied significant opportunities for improving their lives.

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