The Importance of Ag-biotech to Global Prosperity

Anatole Krattiger
Executive Director, ISAAA

Keynote Address
ABIC '98 Conference: *"Biotechnology—The Science of Success"*
Saskatoon, Canada, 9-12 June 1998

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Mr. Chairman, Ladies and Gentlemen:

"In my beginning is my end," wrote T. S. Eliot, and as we begin this conference, we should be very clear about it's ending. What will be the result? After the papers, panels, and posters, what will we walk away with? I hope we will walk away with greater courage to face the challenges posed by biotechnology and with a renewed investment in ideas that breach the borders between science, technology, and applications.

The world of biotechnology has always moved fast, but now it's moving even faster. More traits are emerging; more acres than ever before are being planted with genetically improved varieties of an ever-expanding number of crops. Biotechnology companies are investing billions of dollars in consolidations to ensure access to these rapidly growing markets, all the while investing billions more in further research and development. And the public debate about the future of agricultural biotechnology is more mature as the public becomes better informed and sees more clearly the benefits of biotech. The field is energized.

Despite this accelerated activity, however, the world of biotechnology still does not extend to the world that needs it most: the world of the rural poor, of small-scale, resource poor subsistence farmers in developing countries. Extending the benefits of biotechnology to the world's citizens is one of the most critical challenges that biotechnology faces today. This word "challenge" frequently appears in the context of biotech. As far back as 1992 the US Office of Technology Assessment wrote:

The Challenge Ahead

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. . . there will be a push for . . . biotechnology . . . to be used commercially, adopted by industry, and accepted by the public . . .

. . .The challenge, however, will be whether government, industry, and the public can strike the proper balance of direction, oversight, and allow these technologies to flourish."

(OTA, 1992)

What was meant by "challenge"? And what kind of challenge is it? The word itself contains these two definitions: "A call to engage in a contest or fight", and "the quality of requiring full use of one's abilities, energy, and resources".

We cannot be complacent if we are to harness the potential of biotech, but the challenge we face is neither a fight nor a contest. It is not a fight over biotech's legitimacy that should motivate us to give "the full use of our abilities, energy, and resources." The challenge we face is not a public relations challenge either, but the challenge to meet the many needs of people around the world who are not yet in a position to receive the benefits of biotechnology. It is their plight that requires "the full use of our abilities, energy, and resources." By bringing their world within the circle of biotechnology, we add to the public debate their legitimate voice, the voice of hunger and poverty. Their real needs must take precedence over hypothetical, paranoid imaginings. To achieve the "proper balance" called for by the OTA, the voice of poverty and the cry of hunger must be heard and included in the equation and in the debates about biotechnology's future.

The needs for increased food, feed and fiber production, for the conservation of natural resources and biodiversity, and for poverty alleviation exist now. The first and most important need is to rapidly increase food, feed, and fiber production. In the next two generations our world will consume TWICE as much food as has been consumed in the entire history of humankind. The amount of arable land cannot really be increased, so we must make the land produce more and we must do it sustainably. If we fail, then more marginal land will be put into the service of agriculture, creating more environmental problems, ensuing poverty, and in some cases even disasters.

Cultivable Land Per Capita

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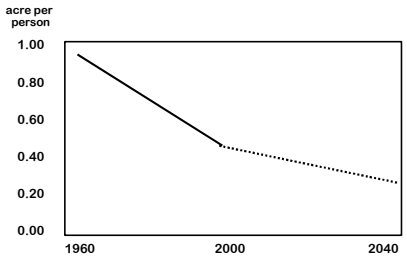

Overall, the available cultivable land per person is declining rapidly and will be reduced by half, once again, over the next 50 years. Here is a real life example:

A man in the highlands of Mount Kenya used to have a 7 acre farm. His three sons inherited ¼ of the farm to nourish their families, to barter with neighbors, and to sell surpluses for their children's shoes, education, and so on. (His daughter became the director of ISAAA's *Afri*Center). The remaining quarter stayed with him, and now there are many more children, parents and grandparents to feed on the same 7 acres.

After the family is fed, what surpluses can be produced, you may ask, on 1.8 acres? Their only option is to either sink further into poverty or to encroach on marginal lands.

The second need is to preserve our natural resources and protect the environment. Agriculture will remain any society's most important interface with the environment. The need is to make agriculture and forestry more productive in an environmentally sustainable way, rather than letting it go up in flames and destroy much valuable biodiversity along with it.

The global scientific community agrees that biotechnology gives us an important additional tool towards meeting these needs. Meeting these needs means first and foremost reducing poverty. It continues to perplex me that over 70% of the world's poverty is in rural areas.

Furthermore, 60% of that rural poverty is in marginal environments. In the very same areas where food is produced, 100 million people go hungry each and every day, and 800 million people are not well nourished.

Agriculture is the engine of growth in most of the developing world where soon nearly 90% of the world's people will reside. Already today, three billion people have to survive on less than US$ 2 a day—today. Of these, one billion three hundred million people survive on less than US$ 1 per day. And this, ladies and gentlemen, at the end of the century when more wealth has been created than ever before. Do we really want to begin the next millennium like that? Can we really afford this inequity ?

We must also never forget that poverty is the most important polluter. Hence, anything we do to alleviate poverty serves all of us: the environment, the local economies, and the health of people everywhere. In many ways it is the most self-serving, yet altruistic action we can take.

In concert with different ingredients, such as traditional technologies and institutional reforms, ag-biotech is an important element in this strategy. The Green Revolution (which is still spreading, and associated institutional reform is also still in process), to-date, has spared 700 million acres of agricultural land, an area almost equivalent to the entire size of India, or 1/3 of the size of Canada or ten times the entire corn area of the USA.

But for the poor to take advantage of the new seeds of the Green Revolution, they needed access not only to the seed but also to capital for fertilizers and irrigation. Bio

tech, by and large, is fundamentally different. Anyone can take advantage of the superior biotech seed, without additional inputs—all you need is access to the improved seeds.

We must either find, develop, or invent, mechanisms to get the seed out to rural areas in the developing world. This is what will make biotech not just the "science of success," but, to paraphrase the title of this conference, a "global technology of success".

Farmers in the western hemisphere know that there can be no prosperity without markets, without exports. Consider Chile. In less than 15 years, the country transformed itself, to a large extent through agricultural reform into a net agricultural exporter, producing a stronger economy, better quality of life of their people, and as a consequence, increased imports of ag-products and other items from around the world.

Globalization has taught us that local prosperity, *here and there*, depends on exchanging products that people can afford to buy. Increasing prosperity "over there", in the developing world, increases the potential for well-being "here". So if you truly want to think globally and act locally *here*, you must first act locally *there*!

And the way to act locally is to help spread the improved seed.

If we meet that challenge, access to biotech will lift these farmers out of poverty and allow them to escape the vicious circle of subsistence farming. But the challenge requires the full use of our energies and abilities right now. The markets are moving fast and resource-poor farmers must be included if they are not to be made victims of the powerful changes that biotech will bring to all of us.

And the market forces are powerful and can be harnessed to assist the rural poor. This is the greatest opportunity we have had in a long time—if only we get it right.

The speed with which this new technology is being commercialized is amazing. In 1996, there were 7 million acres of transgenic crops. There were 31 million in 1997, and over 75 million acres have been planted this year.

Transgenics Worldwide

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	USA (million acres)	World (million acres)
1996	3.6	7.0
1997	20.1	31.5
1998 [1]	≅ 60.0	≅ 75.0

Increase in area from 1996 to 1998 is over 10 fold.

Figures for 1996 by James and Krattiger (1996), for 1997 by James (1997) and for 1998, preliminary estimate.

That's more than a ten-fold increase in the first three years of commercialization. Most of the production is in North America, with the US and Canada leading the way, followed by Argentina (later this year 40% of their soybeans are expected to be transgenic), China, Australia, Mexico, and South Africa. Commercialization is also beginning in Europe, including Germany, and in Eastern Europe and possibly Turkey. Within a few years, I expect Brazil to be one of the major players as well. We will soon publish ISAAA Brief No. 8 by our Chairman, Clive James, on the global status of commercialization of transgenics in 1998 which will provide comprehensive data and analysis.

The rapid commercialization follows from the innovative new uses of biotechnology in crops. Most products to-date are input traits, led by herbicide tolerance (60%), followed by insect resistance (30%) and virus resistance (10%).

For the farmer, there is nothing different about the seed of these crops, but packed inside is a powerful technology.

Today's insect resistance technology, the first wave of it, could already substitute for nearly $3 billion worth of the $9 billion market in insecticides (see right hand column below), increasing yields by as much as 5-10% as well.

Insect control costs

Summary

Crop	Control Cost	Value of Sub.
Cotton	1,870	1,161
Corn/maize	620	158
Rice	1,190	422
Fruit & Vegetables	2,465	891
Other	1,965	
US $million	8,110	2,632

Modified and extended after James (1991) by Krattiger (1997)

In cotton alone, nearly $1.2 billion in insecticides could be substituted today with the currently available technology.

So far, the efficacy of insect resistant crops through *Bt* has been shown, overall, to be comparable to or better than the efficacy of current control methods. One reason is that fewer insecticide applications are required and in some cases a *Bt* crop may not require any insecticide sprays at all. Fewer applications save cost and time, in addition to reducing health risks to workers (a particularly hazardous activity in many developing countries).

Ecological benefits should not be underestimated either, since the *Bt* toxins are highly specific against certain insects without affecting predators and other beneficial insects. This is not the case for many insecticides, such as the broad-spectrum pyrethroids.

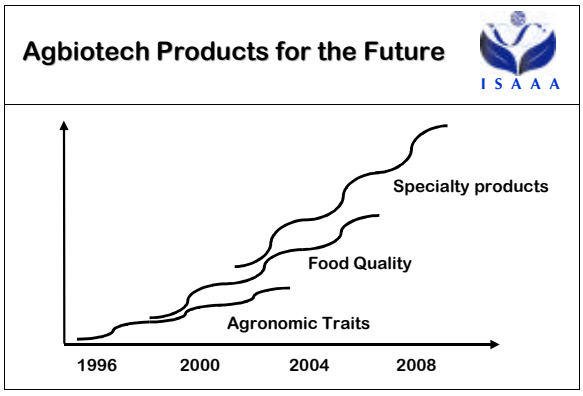
Imagine what herbicide tolerance could do to reduce the overall amount of herbicides applied. In the US alone, herbicide tolerant soybeans led to a 33% reduction of overall herbicide use in 1997 on these transgenic soybeans. This led to better water management and soil conservation, which is so critical in the fragile ecosystems and marginal environments of the developing world. In Canada, AgrEvo's herbicide tolerant canola also led to a 10 to 20 percent yield increase—plus there was a higher proportion of #1 Grade grain, 85% versus 63%.

Now imagine the benefits of both herbicide reduction and improved erosion control for the developing countries. Imagine the potential benefits for African countries where, for example, women produce 75% of the food and do all the weeding by hand (or don't due to lack of labor), …

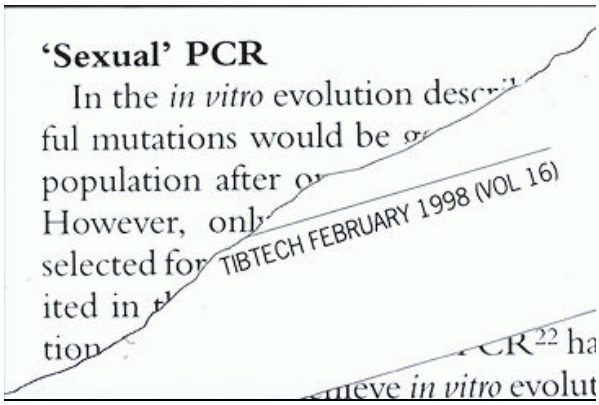
… with much of the consequent erosion, yield losses, health risks, and so on.

This may illustrate that biotechnology contains its own synergy, producing benefits beyond the agricultural problems it works to solve. Are there risks with biotech ? As with any technology, there are technology inherent and technology transcendent risks. The risk of not harnessing this tool is an important factor to consider. Equally important is to ask how we will use this new science and technology responsibly**,** how we will manage its risk. The public must be educated about both its promise and the possible pitfalls. The public should be well-educated about biotechnology—and about the need for it in developing countries. Questions should be asked in the context of the pressing needs we face to produce more food, feed, and fiber, while preserving our environment. This is a process, and currently several developing countries are looking carefully at the appropriateness of several applications, including herbicide tolerance.

But herbicide tolerance and all these "input" traits are just one side of biotech. Many more products will follow. I see three waves of transgenic introductions: input traits (agronomic traits), output traits (from food to industrial quality), and the production of specialty products in plants.



I drew waves on the slide above (opposite page) because, as new technologies are emerging (think of what functional genomics is still to bring), new traits will be developed and incorporated. In addition, new technologies are being invented that might bring something, someday!



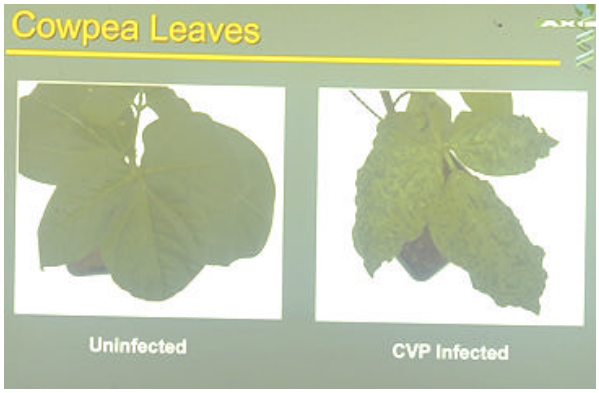
You never know! More importantly, new systems are being discovered, such as Systemic Acquired Resistance …

… in plants, which will provide very broad and effective resistance to multiple diseases. We should see the first products within a few years.

In terms of output traits, we will see an even broader range of products:

- That keep fruits and vegetables fresh for longer which is extremely important in tropical countries
- That possess healthy fats and oils
- That have increased nutritive value (higher expression of vitamins for example)
- Or soybeans with a higher expression of the anti-cancer proteins naturally found in soybeans
- A whole range of higher value feeds (next year we will see higher lysine corn)
- Other applications such as lignin modification in trees, for example, that will make possible much higher fiber extraction rates in the paper and pulp industry.
- Finally, new substances will be produced in plants, including biodegradable plastics, and small proteins or peptides such as prophylactic and therapeutic vaccines.)

The list seems to be limited only by our imagination.



On this slide, above, Axis Genetics, a Cambridge firm, UK, produces chimaeric virus particles in plants as a way of producing immunologically (e.g. vaccines) or pharmaceutically active peptides or proteins, including for the possible future treatment of cancer. This plethora of output traits is one major reason for the recent wave of vertical integration, the flurry of mergers and acquisitions, we've seen in the agribiotech industry.

Agri-biotechnology acquisitions, mergers and alliances in 1997

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Company	Acquisitions, Mergers and Alliances	Est. value ($billion)
Monsanto	Calgene, Agracetus, DeKalb, Delta & Pine Land, Asgrow, Holdens (acquisitions and mergers)	2.0
Pioneer	Dupont (alliance)	1.7
Novartis	Ciba and Sandoz (merger)	1.0
ELM	Asgrow, Petoseed, Royal Sluis, DNAP (aquistitions)	1.0
AgrEvo	PGS, Sun Seeds (aquisitions)	1.0
ADVANTA	ZENECA and van der Have (joint venture)	0.5
DowElanco	Mycogen (46% investment)	0.2
Others		0.6
Estimated total value		8.0

Source: Clive James (1997)

Last year's $8 billion spending spree for mergers and acquisitions has already increased at least five fold if we include the 32 billion dollar Monsanto/American Home Products merger.

At the same time, we've seen the creation of life sciences companies: the integration of seed, food, and health products. This is because in mature markets you can capture the highest added value through output traits, particularly if your chain of production is well integrated. In developing countries, however, you need to start with the

agricultural basis for added value products, the input traits, before moving on to better foods and health products. The integration and consolidation of biotechnology companies will continue well into the next decade. Then, new opportunities will open for smaller companies in the areas of specialty products to meet specific consumer needs, …

… new technologies, or, in the context of developing countries, to incorporate multiple traits into locally adapted and adopted germplasm:

One technology, such as enhanced vitamin A production in canola, may fit all, but one envelope does not fit all.

Part of our challenge is ensuring that the enormous amount of capital being poured into biotechnology includes adequate investments in the adaptation and transfer of agronomic traits so desperately needed across the world. In countries with low productivity, these traits will be even more important to individual farmers than here in North America, speaking relatively.

But putting all the acreage together, the global effect will be much more important in absolute terms.

Consider the following demand-driven examples of transferring biotech applications to developing countries that we at ISAAA brokered. For those who don't know about ISAAA, we are an international non-profit group, an "honest broker", facilitating proprietary biotech transfer, mainly between companies and developing countries, addressing primarily the needs of small scale and resource poor farmers . We work with a selected list of countries to identify needs and priorities, monitor and assess appropriate agbiotech applications, put together collaborative transfer projects, seek funding or financing, and monitor program implementation.

At this stage, we have convinced many large corporations, including Novartis, AgrEvo, Monsanto, Zeneca, and Pioneer Hi-Bred, that it is in their interest to donate valuable biotech applications. The rationale is that appropriate regulations, seed distribution systems, and trust and confidence have to be built both for humanitarian reasons and as a pre-cursor for licensing arrangements and the building of various forms of alliances and joint ventures, both of which we are gradually engaging in. The following two projects brokered and developed by ISAAA both responded to urgent social priorities identified by the principal stakeholders themselves.

In eastern and central Africa there are 10 million small-scale farmers growing bananas, some 90 million or so plants, most of which are diseased. In collaboration with a South African company and a company from Kenya, and with the Kenyan national program, we transferred relatively simple tissue cultured seedlings to Kenya. In 2 years this doubled and even tripled productivity in selected locations.

The major challenge was to get the distribution of the plantlets going. The results so far show that the technology

itself is so valuable that the farmers *pull* the technology. The project we brokered started the process by initially giving free banana plantlets (with funding from IDRC and the Rockefeller Foundation) to selected key farmers in different communities. These farmers were selected through participatory rural appraisal. The demonstration of the technology's effectiveness was so convincing that these very same farmers and others are now distributors of seedlings. And what did they do? They sold their first harvest to be able to buy more seedlings, which, in turn, they sell to other farmers, at a good profit.

All we needed to do was to get the system going. And you can replicate and emulate similar systems with transgenics—the principles are the same.

The difference that the income from half a dozen or so productive banana plants can make is remarkable. If a woman can make 2 dollars a day selling these extra bananas in the market, it means doubling her daily income: it is the difference between her children having or not having shoes, an education, and, with time, health care.

This small investment grows much fruit, literally and figuratively.

The difference made in the quality of life for millions of people makes this work of transferring agri-biotech to developing countries very critical—and very rewarding.

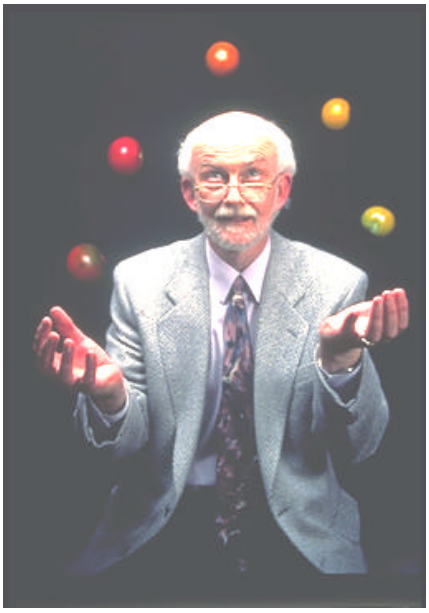
In Southeast Asia, we are in the process of launching a project on papaya, the region's second most important fruit. It's a critical source of Vitamin A (deficiencies impact 300 million people in developing countries, mainly children) and other important nutrients. The project aims at turning papayas like this:

and that:

into something like this:

Papaya production in these countries suffers from pre-harvest losses of 30-40% due to viral diseases. With all the energy gone into producing the remaining 65%, post-harvest losses, because of bad roads to markets, no refrigeration, and inadequate storage, reduce that amount by 40% again, cutting the overall productivity down to probably less than half of its potential.

The project involves collaboration between five countries in Southeast Asia and several collaborators, including Zeneca, a biotech company of the UK, Don Grierson of Nottingham University,...



and the University of Hawaii, among others. Initial priority will be on the development of virus resistant papayas and independently of delayed ripening that could transform papaya production like no breeding efforts ever have or ever will.

We also have a series of other projects with support from and technology by Novartis, on the slide below on Sweetpotato weevil resistance in Vietnam, and with Monsanto, AgrEvo, Cargill Seed, and others. All of these companies participate in model projects that transfer technologies that we hope will eventually lift millions of people out of poverty.

Unfortunately, some who pretend to speak for the developing countries say that biotech will destroy sustainable agriculture. What should we say to them? The best way to meet this challenge is to do what I am trying to do here. Urge them to look at the problem from the subsistence farmers' point of view. Ask them to:

Talk to the farmers and ask them what they want.

And then…

Have the humility to listen to the farmers.

Sometimes, we should simply look at ourselves …

…but not take what we see all too seriously.

In this new "information world" we live in, who says something is often so much more important than what is being said. I wished I could have brought Jane Njuguna …

… from Kenya who had shown me her nine crops on a couple of acres, barefoot and asked by showing me her multiple problems: "What can you do to help?"

Suman Sahai recently asked in *The Biotechnology and Development Monitor*: "Is it more unethical to interfere in God's work than to allow hunger deaths when these can be prevented?" Citizens in developed countries do not face such stark questions when they think about biotech-

nology. In Europe, consumers are asking why they should accept input traits when the standard of food availability—and choice—cannot be improved, and when billions of *Euros* are spent to destroy surpluses, or to pay farmers not to cultivate their lands? An interesting question in an environment in which OECD countries spend US $150.8 billion in farms subsidiaries, cheap loans and guarantee price subsidies. Once the output traits arrive on the market, greatly improving foods in so many different, healthful ways, then the consumer will see, touch, and feel the benefits.

It is easier to get the message across clearly when the consumer benefits. In developing countries biotech will get hold faster than in Europe because most consumers are also farmers and so they will realize the benefits of biotech products immediately. There are millions of farmers demanding these technologies; indeed, their physical—if not cultural—survival depends on it. And what the farmers I have met in developing countries are asking, farmers in Kenya, is "When will you deliver on the promise"?

There will be no excuse for not delivering it to developing countries, *no excuse for failure*.

There are of course other hurdles to overcome to harness the biotech revolution for global prosperity. We lack appropriate and workable intellectual property systems, for example. And to turn this loose-loose-loose situation (where neither the farmer nor the company nor society benefit) into a win-win-win proposition, getting the seed out will require many ingredients.

Countries in Latin America, Asia and Africa have already recognized the importance of biotechnology's promise. Many are developing the needed public/private partnerships to build trust and confidence, develop micro enterprises, and bring policy reform.

Although a recent example here in Canada might seem simple (I am referring to the agreement between Agriculture Canada and Monsanto to jointly develop Roundup-Ready wheat for Canadian farmers), building successful partnerships and alliances between the private sector and developing countries will be more complex. Rice is a case in point.

Global Crop Production (million MT)

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Crop	World	Asia		
		million MT	% of World	% of DC
Fruit and Vegetables	880	430	50	75
Cotton (lint)	18	9	50	80
Rice	530	490	90	93
Corn/maize	570	140	25	75

Rounded figures; Compiled based on data by FAO (1997)

Of the 530 million metric tons of rice, 90% is produced in Asian developing countries. Resistance to rice blast, the most important disease of rice, will be available within less than 5 years. Although the 1,350 or so patents on transgenic plants now pending in the US will not be transferred to Asia very soon, mechanisms will be found to transfer such technology to selected countries where national governments are perceived to own the rice varieties. This is a firm basis for a type of joint venture in which the country provides the germplasm and a company the genes.

If only three technologies were shared and deployed, stemborer resistance with *Bt* or other insect resistance systems, rice blast, and herbicide tolerance, then I would expect that rice paddies like these…

will be 25% more productive *without additional inputs*. In fact, $450 million could be saved in insecticides and lead to increased yields. The additional production could equal

as much as 75 million MT if the new rice were grown in all rice paddies of Asia. (In comparison, Canada produces 24 million MT of wheat and the US some 80 million MT of corn!).
To conclude, we need to recognize that for resource poor farmers added value is much higher in relative terms than it is in industrialized countries. And so once we get the ball rolling, it will lead not to a Second Green Revolution, but to a win-win Double-Green Revolution. But this time, the role of the CGIAR is much less clear, at least for the moment, than during the 1960's and 1970's first Green Revolution.

At the moment, we at ISAAA focus our limited resources on getting the ball rolling. It is not an avalanche as yet. That's still some years away. But we can make it happen, especially if we, all of us here at this conference, share some of the optimism of the late Julian Simon, who urged us to find "skilled, spirited and hopeful people who will exert their will and imagination for their own benefit, and so, inevitably, for the benefit of us all."

Julian, to the horror of Paul Ehrlich, never believed that natural resources will be depleted. Let's prove Julian right. I am certain that this appeal, in many different ways, captures the "heart" of what you, me, and others at this conference mutually share: a belief that people, especially the disadvantaged, should be able to share equitably in the benefits of biotech. I personally, and Maria Luisa Gutierrez (slide below) from San Rafael, Oaxaca in Mexico, also count on your support, to ensure that we meet this challenge and spread the seed in the fight for global prosperity, using our abilities, energy, and resources to become better, responsible Stewards of this Earth.