S. HRG. 106–766

THE ROLE OF BIOTECHNOLOGY IN COMBATING POVERTY AND HUNGER IN DEVELOPING COUNTRIES

HEARING

BEFORE THE

SUBCOMMITTEE ON INTERNATIONAL ECONOMIC POLICY, EXPORT AND TRADE PROMOTION

OF THE

COMMITTEE ON FOREIGN RELATIONS
UNITED STATES SENATE

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THE ROLE OF BIOTECHNOLOGY IN COMBATING POVERTY AND HUNGER IN DEVELOPING COUNTRIES

WEDNESDAY, JULY 12, 2000

U.S. SENATE,
SUBCOMMITTEE ON INTERNATIONAL ECONOMIC POLICY, EXPORT AND TRADE PROMOTION,
COMMITTEE ON FOREIGN RELATIONS,
Washington, DC.

The subcommittee met, pursuant to notice, at 2:07 p.m. in room SD–419, Dirksen Senate Office Building, Hon. Chuck Hagel (chairman of the subcommittee) presiding.

Present: Senators Hagel, Lugar, Ashcroft, and Sarbanes.

Senator HAGEL. Good afternoon. First I would like to welcome all of our distinguished witnesses.

This afternoon the subcommittee will look at the role of biotechnology and what role biotechnology can play in combating poverty, hunger, and environmental degradation in developing countries. Our first witness will be the Honorable David Sandalow, Assistant Secretary of State for Oceans and International Environmental and Scientific Affairs. Before coming to the State Department, he served as Associate Director for the Global Environment at the National Security Council and as Senior Director for Environmental Affairs at the White House Council on Environmental Quality. Prior to his work at the White House he worked in the General Counsel's Office at the Environmental Protection Agency.

On the second panel is the Honorable Andrew Young. Ambassador Young is chairman of GoodWorks International. GoodWorks International is a consulting group based in Atlanta that works with governments, companies, and individuals throughout Africa to help raise living standards and expand productivity, capacity, and individual opportunity. In this capacity, Ambassador Young has become personally involved in Africa's increasing interest in biotechnology.

Ambassador Young is well known to most Americans. In the 1960's he was a top aide to Dr. Martin Luther King, Jr. In the early 1970's he was elected to the House of Representatives from Georgia and during the Carter administration he served our Nation as U.S. Ambassador to the United Nations.

The second panel also includes Dr. Roger Beachy, president of the Danforth Plant Science Center of St. Louis, Missouri, and a member of the National Academy of Sciences. At the Danforth Center Dr. Beachy is working on a virus-resistant cassava plant for Af-

rica as well as other agricultural products for developing countries. Many consider Dr. Beachy to be the father of modern crop biotechnology. While on the faculty of Washington University in the 1980's, Dr. Beachy's work led to the development of the world's first genetically altered food group.

Prior to his current position, Dr. Beachy headed the Division of Plant Biology at the Scripps Research Institute in La Jolla, California. He was also the director of the International Laboratory for Tropical Agriculture Biotechnology.

Our final witness is Mr. Brian Halweil, staff researcher in Food and Agriculture Issues at the Worldwatch Institute in Washington, DC. Mr. Halweil joined the Institute in 1997 as the John Gardner Public Service Fellow from Stanford University. His publications include an article on genetically engineered crops, "The Emperor's New Crops," in the summer 1999 issue of Worldwatch Magazine.

Before coming to the Institute in 1997, Mr. Halweil established a student-run organic farm on the Stanford University campus and traveled extensively in Mexico, Cuba, and Central America studying indigenous farming techniques.

So, welcome to all our witnesses. Before I ask my friend and colleague Senator Lugar to present an opening statement or any comments he wishes, allow me to make a brief statement that I hope we will expand on during the course of the hearing.

Virtually all scientists agree that biotechnology offers great hope for developing new vaccines, improving nutrition, and improving crop yields while reducing the need for the application of expensive pesticides and fertilizers. The question has been whether there are risks inherent to biotechnology that exceed any possible advantages it may provide.

Clearly, biotechnology offers a great opportunity for the American economy, American farmers, and American workers. The United States leads the world in this technology, in its application in both pharmaceuticals and in agriculture, and in the export of biotech commodities and products. This advantage will continue even as the technology is adopted abroad.

Few, however, have been looking specifically at biotechnology's promise for developing countries. The technology was perfected in North America and Europe. It has been adopted primarily by Australia and countries in North and South America. But its application may be most needed in developing nations.

But for biotechnology to fulfill its promise in less developed countries, it must be tailored to meet the market needs of those countries. This point was made in a story in yesterday's Washington Post. This article reported on a largely positive white paper just released by the National Academy of Sciences. It was prepared jointly with the national academies in Britain, Brazil, China, India, and Mexico, together with the Third World Academy of Sciences.

The report concludes that without using biotechnology it will be impossible to feed the world's poor in the future without destroying the environment. It warned, however, that governments and biotech companies need to do more to make the technology relevant and useable by farmers in these same poor countries. Even though world population growth is slowing, the world's current population of six billion will grow by at least another two billion in the next

30 years. Virtually all that growth will occur in developing countries.

Traditional cross-breeding techniques produced the Green Revolution of the 1960's that led to significant increases in productivity in agriculture. The Green Revolution, however, depended on the adoption of new farming techniques and expensive applications of fertilizer. For this reason, its success was mixed in the developing world. African countries particularly reaped few benefits from the Green Revolution.

Further gains in productivity and nutrition can be made through biotechnology, which also offers the hope of reducing the need for agricultural inputs. For this reason, biotechnology also offers hope for avoiding the need for further environmental degradation in developing countries. Without the kind of productivity improvements offered through biotechnology, many developing countries will clear ever more tropical forests and plant on ever more marginal lands. We should be seeking better productivity from existing high quality crop lands in America as well as in developing countries.

I believe that biotechnology is good for both the American farmer and the developing country farmer.

Again, I welcome our distinguished witnesses and I look forward to your testimony. With that, let me welcome the distinguished ranking Democrat on the subcommittee, Senator Sarbanes from Maryland, and Senator Lugar, who I think everyone knows is chairman of the Senate Agriculture Committee. Senator Lugar, would you care to offer any comments?

[The prepared statement of Senator Hagel follows:]

PREPARED STATEMENT OF SENATOR CHUCK HAGEL

I would like to welcome our distinguished witnesses here today. This afternoon, the subcommittee will look at the role biotechnology can play in combating poverty, hunger and environmental degradation in developing countries.

Our first witness will be the Honorable David Sandalow, Assistant Secretary of State for Oceans and International Environmental and Scientific Affairs. Before coming to the State Department, he served as Associate Director for the Global Environment at the National Security Council and as Senior Director for Environmental Affairs at the White House Council on Environmental Quality. Prior to his work at the White House, he worked in the General Counsel's Office at the Environmental Protection Agency.

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The second panel also includes Dr. Roger Beachy, President of the Danforth Plant Science Center in St. Louis, Missouri, and a member of the National Academy of Sciences. At the Danforth Center, Dr. Beachy is working on a virus-resistant cassava plant for Africa, as well as other agricultural products for developing countries.

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where he was also the Co-Director of the International Laboratory for Tropical Agriculture Biotechnology.

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Again, I welcome our distinguished witnesses, and I look forward to your testimony.

[The prepared statement of Senator Sarbanes follows:]

PREPARED STATEMENT OF SENATOR PAUL S. SARBANES

Thank you, Mr. Chairman, for holding this important hearing. I also welcome the distinguished panel of experts, from the public and private sectors, before our subcommittee.

Biotechnology is a promising field and holds great potential for mankind. My own state of Maryland has a large and diverse biotechnology industry—it ranks among the top five states in the nation in terms of biotechnology concentration—so I am acutely aware of the benefits which have and will come from this part of our technology sector. Indeed, the National Institutes of Health, our universities, and numerous firms, many of which are on the cutting edge of research and many of which

are in the application stage, are all making an enormous difference in our medicine, our health practices, the food we eat, and the amount we produce. So I am very proud to say that Maryland and its biotechnology sector play a significant role in the progress we are making in getting more nutrient-rich foods to those in need.

The issue before us today is how biotechnology can help alleviate poverty and hunger in the developing world. This is indeed a timely topic. Unfortunately, the news from the developing world is decidedly mixed, and often negative. There are some countries in the developing world that have begun the process of lifting themselves out of poverty. Others, however, are mired in debt, disease, and drought. Last week's articles in the Washington Post about the AIDS epidemic in Africa is a telling reminder of some of the terrible problems that the "have-nots" in the world are encountering on a daily basis.

Biotechnology has led to higher food production in our country and thus can lead to greater exports of food to the developing world, where it is desperately needed. At the same time, biotechnology can help farmers in the developing world grow more and healthier crops on less land. This picture is seemingly a "win-win" situation for all concerned. However, like most things in life, the actual situation is not so simple.

Right now, the United States accounts for three-fourths of all "transgenic" cropland, meaning areas that are producing biotech crops. Argentina and Canada make up most the remainder of such cropland. There is very little cropland in Africa devoted to biotech farming.

If our goal is to help alleviate poverty in stricken areas like large parts of sub-Saharan Africa, then I believe we must work toward the goal of re-establishing stable farming communities in these lands. Ideally, farmers in these areas should be provided with biotech seeds, at low prices, so that they can produce high yields. We must also ensure that the introduction of biotechology in these areas does not upset other organisms. For example, some biotech pesticides, if not properly administered, can led to the suppression of other plants and affect grazing animals.

I raise these issues to highlight the great potential of biotech farming and to encourage all of us here to zero in on how best to address the food needs of the world's poorest citizens. In this way, we can truly have a "win-win" situation. I look forward to the testimony of our panelists.

Thank you, Mr. Chairman.

Senator LUGAR. Well, thank you, Mr. Chairman. I would ask consent that my statement be made a part of the record.

I simply want to comment from our work in the Agriculture Committee that we have taken a look at some of these issues, and this is why I welcome these distinguished witnesses today. Dr. Borlaug, of the Green Revolution that you referenced, has been a regular before the committee describing the remarkable changes in China and India in his experience, projects in Mexico dealing with maize and those in the Philippines dealing with rice, all with the cooperation of our country.

I have often referenced anecdotally, at least in our committee, my own farm situation. We have 604 acres in Marion County, Indiana, where my dad got about 40 bushels to the acre in the 1930's. He passed away in the fifties. I have been responsible for the farm for the last 44 years. We have seen an increase in productivity to an average of about 140 bushels to the acre on that same farmland during my lifetime.

USDA points out that the gains in yields in our country have been roughly of that order, about three times, in basic crops—corn, soybeans, and wheat. I make that point because others who have come before our committee—and each of you as expert witnesses may have some estimates of your own. But given anticipated world population changes in the coming half century, even given high, medium, and low demographic estimates, lead many to feel that yields may need to be increased by three times again. That is, on

the Lugar farm what is now 140 bushels per acre may have to be more routinely 400.

This is quite a stretch. It is not clear how you get there. It is all very clear that the need will be there unless a lot of people starve in this world or we have terrible plagues that change the demographics in horrible ways. We already understand from testimony to our committee that even as we lament the potential loss of the rain forests of the world, they are being routinely chopped down in southern Mexico and elsewhere. Documentation and papers here indicate that before people starve, they chop down the rain forests. It is a basic question, therefore, of human nutrition.

Having said that, the fact is that all of us in agriculture have approached this issue as a production agricultural problem, namely how do we got from 40 bushels to 140 bushels per acre. As a corn farmer, I was not as interested as I should have been in consumers of this corn. I am a lot more interested in that subject having seen this remarkable article from Dr. Delapena in the Science Magazine, who has been before our committee. He noted that 250 million children in the world, mostly in developing countries, suffer from vitamin A deficiency and, as a result, 500,000 children in the world are blinded each year. Through biotechnology, through staple foods, vitamin A literally can become a part of their diets.

Looked at from the standpoint of health and humanitarian causes, these are remarkable changes. But in the ag production community or even in the processed foods community, that was not our marketing objective. We were talking about production and we were talking about interesting foods for the diets principally of the American people or Europeans or others.

We will not only have to shift gears, because now we are faced with a reaction of persons who are engaged in a near-theology that somehow God has put together a corn seed in a certain form and that alteration is likely to lead to terrible results for humanity. That has to be examined, and it has been examined backward and forward now for many, many years.

We have not had a single instance of testimony before the Agriculture Committee that a single change of biotech has in any way harmed a single person on this Earth over all these years. But that has not quieted the anxiety for a moment. Now, I have visited extensively as a member of this committee, as have Senators here, with representatives from France and Germany. I have talked to their agriculture people, their ministers of agriculture, their committees, others who are responsible, and they understand the argument perfectly well. But they also say to me as a practicing politician: You have got to understand, we have got a lot of fearful people who are in a tizzy over biotech and we do not really feel our leadership skills are sufficient right now to tackle this thing. In due course, be patient.

Well, fair enough, but in the meanwhile years go by and the problems of those who are to be served and to be helped are manifested.

So I am hopeful, at least in this country, that those of us who feel deeply about this will be thinking about consumers in terms of health, humanitarian concerns, as well as the shear quantities required to feed the world and how that will happen. We had testi-

mony today from Dr. Frist, a member of our committee, who was in Sudan last week, a remarkable witness. Very few people have seen Sudan as Dr. Frist saw it last week. Even our Ambassador to the United Nations, Mr. Holbrooke, has not gotten into those places.

People are being routinely starved as a matter of foreign policy. So that goes on in other parts of the world, too. This is not an open flow in which all of us are thinking about how we feed people; but on occasion we do get on that track, thank goodness. Hopefully, we will get better at it in terms of both distribution and politics of food, even as we work out what we have here.

So, Mr. Chairman, I welcome your calling this hearing. I think it is tremendously important. It is a foreign policy problem of great dimensions, in addition to an agriculture and nutrition problem, a problem of health and humanitarian concern that others of our colleagues will want to take up.

[The prepared statement of Senator Lugar follows:]

PREPARED STATEMENT OF SENATOR RICHARD G. LUGAR

As we consider the debate surrounding agricultural biotechnology, there are a few important points that come to mind. First, opposition frequently accompanies technological innovation. Opposition arises from fact, myth or cherished belief. The obvious difficulty is to determine an elusive truth. Second, technologies that eventually win acceptance do so after demonstrating a clear benefit to society with few risks. Lastly, technology, spawned by the limitless bounds of human intellect, continues to evolve as knowledge and understanding of our world increases.

Agricultural biotechnology has inspired controversy but the debate has become polarized and reactionary so as to preclude reasoned public debate over merits of the new technology versus possible risks.

Exactly why agricultural biotechnology has attracted intense levels of opposition, especially in Europe, deserves consideration. Testimony received by the Senate Agriculture Committee during hearings last October strongly suggests that biotechnology holds enormous potential to improve the human condition. A prime example was the testimony about research on the use of biotechnology to increase the vitamin content of certain staple crops like rice and corn. In an article published in Science magazine, Dr. Della Penna of the University of Nevada-Reno noted that 250 million of the world's children, mostly in the developing world, suffer from Vitamin A deficiency. As a direct result, some 500,000 children are blinded each year. If staple foods that these poorest of the poor children eat each day could be fortified with additional Vitamin A through the application of biotechnology, a worldwide scourge of blindness from dietary deficiencies could be alleviated.

Biotech products on the market are already providing significant societal benefits, such as reduced use of pesticides. These are benefits for the farmers and their families who have had to handle these chemical products and for the environment in general.

It is necessary to consider the environmental implications of not developing agricultural biotechnology. Demographers predict that the population of the United States will double over the next 100 years and world population is set to increase 50% by 2050. Development and the need for housing will place an inexorable pressure on land that now constitutes a significant percentage of America's treasured open spaces. Simultaneously, more food will be required to support population growth and improving standards of living. If agricultural efficiency remains static, then more land will be needed to grow more food. Faced with the choice of starvation or cutting down forests, mankind will have few options. An alternative does exist, and if developed with the intent to improve the lives of people everywhere, biotechnology can increase agricultural efficiency, reduce use of chemical pesticides and improve food's nutritional value.

Agricultural biotechnology is a difficult public policy challenge, and difficult issues require that we act in a conscientious and responsible manner. This hearing today provides another opportunity for us to review this important issue in a rational and thoughtful way.

Senator HAGEL. Senator Lugar, thank you. You bring an insightful perspective from both the committees that you have either chaired or currently chair, plus your real life experience as a real live farmer. So thank you.

Senator LUGAR. Thank you.

Senator HAGEL. Senator Ashcroft from Missouri. Senator.

Senator ASHCROFT. Well, first of all, Senator, thank you for holding this very important hearing. I want to commend not only you, but the chairman of the Agriculture Committee, for his attention to these issues and these matters. A lot of members of this committee have been long-time advocates for biotechnology, which is advancing developments in pharmaceuticals, food, clothing, and energy. A number of us from the Midwest have seen what these advancements can do for rural agriculturally based economies, and we want developing countries to have the capacity to obtain these same agriculture-related development benefits.

Biotech can be used as a tool to help in the fight against poverty, in the fight against hunger, malnutrition, birth defects, disease. Just a few months ago this committee approved on March 23 a bill which I introduced that is designed to promote sustainable development in Third World countries. S. 2106, which is a bill entitled "Advancing Global Opportunities for Biotechnology in Agriculture," is supported by Chairman Helms as well as the ranking member of this committee, Senator Biden.

I have had the privilege of working on this initiative with two of the witnesses on the second panel, Ambassador Young and Dr. Beachy, and their support has been critical to the broad support the bill has gained.

So I thank you for this. I think to the extent that we can be a part of helping underdeveloped nations which have such great challenges relating to simply human survival, to the extent that we can help them in any way we ought to be finding ways to do it, and it is consistent with the United States and what we stand for. The humanitarian decency of the American people can be reflected in our eagerness to provide secure, safe opportunities to not only help in the survival skills, but in terms of avoiding some very serious problems. The wrong vitamin deficiencies result in some children, numerous children, being born blind needlessly, and we need to try and think of ways to address these issues, to demonstrate that the United States of America is a culture and society that has a compassion that goes beyond the Atlantic and the Pacific, but extends around the world.

So I thank you for this very important hearing and I look forward to participating.

Senator HAGEL. Senator Ashcroft, thank you.

Secretary Sandalow, please proceed.

STATEMENT OF HON. DAVID B. SANDALOW, ASSISTANT SECRETARY OF STATE FOR OCEANS AND INTERNATIONAL ENVIRONMENTAL AND SCIENTIFIC AFFAIRS, DEPARTMENT OF STATE, WASHINGTON, DC

Mr. SANDALOW. Thank you, Mr. Chairman, Senator Lugar, members of the subcommittee. Thank you for the opportunity to discuss the role of biotechnology in combating hunger and poverty in devel-

oping countries. This is a vitally important topic. Every day more than 800 million people on this planet go to bed hungry. More than one billion people live in abject poverty on incomes of less than one dollar per day.

There is no single cause of this misery. Poor education, pests, drought, disease, food distribution problems, and, as Senator Lugar was suggesting, civil strife are all in part to blame. But the enormity of the problem cannot stop us from shaping a response. As we search for solutions, we must explore all means available.

Mr. Chairman, in fighting hunger and poverty modern biotechnology must be part of our arsenal. In the past several months alone, the news has been filled with indications of the great promise of this technology. Researchers have found ways to enhance the vitamin A content of rice, promising great strides in the fight against blindness and other diseases. A working draft of the sequence of the human genome itself has now been mapped, offering tremendous potential in using the science of genetics to help fight disease.

At the same time, we must proceed with wisdom and caution. Biotechnology presents both potential benefits and risks. In the United States, we have had a strong and effective regulatory system to address environmental and other concerns from biotechnology for many years. As this technology advances, we will continue to refine our regulatory processes. For biotechnology to do the most good for the most people, we must encourage and support credible science-based regulatory systems around the world.

Today I will briefly address three topics: first, how biotechnology can contribute to the fight against hunger and poverty; second, barriers that must be overcome; and third, the U.S. Government programs in this area. I have a written statement which, with your permission, Mr. Chairman, I will submit for the record. I also have a supplementary statement from my colleague Tony Wayne, the Assistant Secretary of State for Economics and Business Affairs, whose office has substantial responsibilities in this area. With your permission I will submit that for the record as well.

Senator HAGEL. We will include both statements in the record.

Mr. SANDALOW. First, how can biotechnology contribute to the fight against hunger and poverty? There are many ways. As has already been suggested, some of the potential benefits include: enhancing the nutritional benefits of foods, increasing crop yields, reducing the need for chemical and water inputs, increasing resistance to crop stress, and producing medicines and vaccines that are more affordable and accessible.

Among the most promising applications of modern biotechnology are those that can enhance the nutritional content of food. Vitamin A-enriched rice has recently been developed and received much attention. Other possibilities include vitamin A-enhanced oil, vitamin A-enhanced tomatoes, and iron-enriched rice. Modern biotechnology can be used to fight the many scourges that accompany malnutrition around the world.

Some have questioned the need for such products, arguing that poor people need balanced diets, not vitamin-enriched rice. But we should not let the perfect become the enemy of the good. Sadly, access to balanced diets is limited in many countries by poverty, food

distribution problems, and other complex and entrenched social conditions. Staples such as rice may be the only foods available. As we attack all causes of hunger and malnutrition, increasing the nutritional content of staple foods can make a difference in people's lives.

In addition, modern biotechnology can be used to develop crops that are resistant to pests, drought, and disease. Already, in the developed world and indeed in China the technology is being used widely to reduce pesticide inputs, helping to improve agricultural productivity and protect the environment. Biotech pharmaceuticals can also make a difference.

Mr. Chairman, I could go on at length about these potential benefits. But rather than doing so, I would like to read some words that especially struck me as I read them yesterday. They were written by Florence Wambugu, director of an African agricultural institute with expertise in biotechnology. She wrote last year in Nature: "The African continent more than any other urgently needs agricultural biotechnology, including transgenic crops to improve food production. Africa missed the "Green Revolution." Africa cannot afford to be excluded or to miss another major global technological revolution. It must join the biotechnological endeavor."

Her comments are quite consistent, indeed similar to, the comments that you offered, Mr. Chairman, on the African Continent.

A second important question: What are the barriers to the use of modern biotechnology in the developing world? I would note in particular three: cost, adequate regulatory structures, and lack of knowledge and fear.

A threshold issue is cost: To gain the benefits of modern biotechnology, adequate financing must be found. Many experts have noted that, as with many technologies, initial applications of biotechnology have primarily benefited those with purchasing power in wealthier countries. For modern biotechnology to help the poor farmer, we must find ways to finance the use of this technology for the farmer's benefit.

Part of the answer to this challenge lies in the public sector. We must find ways to support the work of universities, research institutions, and in particular the Consultative Group on International Agricultural Research, whose work has been instrumental in fighting hunger and poverty for many years.

Part of the answer must be found in the private sector as well. Private companies, of course, often have fiduciary responsibilities to shareholders and have a very different role than public sector institutions or charities. But we must find creative solutions looking to public-private partnerships and other tools. One encouraging example of work to date is the collaboration between Monsanto, USAID, and the Government of Kenya to develop a disease-resistant sweet potato that will likely be among the first genetically engineered crops tested in sub-Saharan Africa.

A second issue is the need for adequate regulatory structures. Like any new technology, modern biotechnology presents risks that must be managed. Environmental testing is important, for example, to ensure gene transfer issues and other matters are addressed. This administration is deeply committed to helping developing countries build adequate regulatory systems to manage and

address biotechnology. Our commitment is one reason that I am especially pleased that the administration is strongly supporting Senator Ashcroft's bill, S. 2106, its major thrust and intent, in advancing the global opportunities for biotechnology in agriculture 2000. We look forward to discussions among staff to resolve some technical issues and then to working together to secure passage of this important legislation.

A final barrier, one that I believe is critically important, is lack of knowledge and fear. Around the world we have seen lack of knowledge and fear emerge as major factors in the development of modern biotechnology. In my view we should neither minimize nor bemoan this important fact. We should recognize and address it. We should work to promote scientific cooperation and reasoned dialog on this topic. We should recognize that this topic can implicate ethical and religious issues for some. In the long run, modern biotechnology cannot promote a better tomorrow unless people from around the world understand it and have a stake in the technology's future.

Mr. Chairman, the third topic is what the Government is doing today to address these issues. In light of time, I will leave that largely to my written statement and any questions that you and the panel would like to ask.

Let me conclude by saying that modern biotechnology is not a panacea, but it can help to make a difference in the fight against hunger and poverty. Using this new technology, we can feed hungry children, raise incomes, fight disease, and protect the environment. But these results are not guaranteed. To realize the full potential of modern biotechnology, we will need wisdom and creativity in the years ahead. We must find ways to overcome obstacles and address concerns.

This country should be proud to be a global leader in this remarkable new technology. In the years ahead, let us pursue a rational and open dialog on this topic, applying the lessons of science and respecting all points of view. If we do so, we will leave a better world behind for our children and theirs.

Thank you.

[The prepared statement of Mr. Sandalow and supplementary statement of Mr. Wayne follow:]

PREPARED STATEMENT OF HON. DAVID B. SANDALOW

INTRODUCTION

Good afternoon, Mr. Chairman and Members of the Subcommittee. Thank you for the opportunity to discuss the role of biotechnology in combating hunger and poverty in developing countries.

This is a vitally important topic. Every day, more than 800 million people on this planet go to bed hungry. More than one billion people live in abject poverty—on incomes of less than $1 per day.

There is no single cause of this misery. Poor education, pests, drought, disease, food distribution problems and civil strife are all in part to blame. But the enormity of the problem cannot stop us from shaping a response. As we search for solutions, we must explore all means available.

In fighting hunger and poverty, modern biotechnology must be part of our arsenal.

In the past several months alone, the news has been filled with indications of the great promise of this technology. Researchers have found ways to enhance the Vitamin A content of rice, promising great strides in the fight against blindness and other diseases around the world. A working draft of the sequence of the human ge-

nome has now been mapped, offering tremendous potential in using the science of genetics to help fight disease.

At the same time, we must proceed with wisdom and caution. Biotechnology presents both potential benefits and risks. In the United States, we have had a strong and effective regulatory system to address environmental and other concerns from biotechnology for many years. As the technology advances, we will continue to refine our regulatory processes. For biotechnology to do the most good for the most people, we must encourage and support credible, science-based regulatory systems around the world.

Today I will briefly discuss three topics: how biotechnology can contribute to the fight against hunger and poverty; barriers that must be overcome; and U.S. government programs in this area.

HOW BIOTECHNOLOGY CAN CONTRIBUTE

How do we feed a growing population—which some estimate will reach 9 billion in the next 30 years—when most arable land on the planet is already under cultivation?

How do we find new ways to deliver desperately needed medicines to desperately poor people?

Modern biotechnology is part of the answer. Some of the potential benefits of this technology include:

- Enhanced nutritional benefits of common staple foods.
- Increased crop yields.
- Reduced need for chemical and water inputs.
- Increased resistance to crop stress, such as drought.
- Smaller losses from spoilage and longer shelf lives.
- Increased income generation and rural development.
- Medicines and vaccines that are more affordable and accessible.

Among the most promising applications of modern biotechnology are those that can enhance the nutritional content of foods. Vitamin A-enriched rice has recently been developed and received much attention; other possibilities include vitamin A-enhanced oil, vitamin A-enhanced tomatoes, and iron-enriched rice. Modern biotechnology can be used to fight the many scourges that accompany malnutrition around the world, including illness, blindness, developmental problems and death.

Some have questioned the need for such products, arguing that poor people need balanced diets, not vitamin-enriched rice. But we should not let the perfect become the enemy of the good. Sadly, access to balanced diets is limited in many countries by poverty, food distribution problems and other complex and entrenched social conditions. Staple foods such as rice may be the only foods available. As we attack all causes of hunger and malnutrition, increasing the nutritional content of staple foods can make a difference in people's lives.

Drought and disease plague developing country farmers around the world. Here, too, modern biotechnology can make a difference. Scientists are exploring ways to make mangoes, cassava, plantains and other tropical crops resistant to drought and virus-born diseases.

Pests are also a significant barrier to agricultural productivity around the world. By using modern biotechnology, scientists can insert natural pesticides such as Bt into crops, reducing loss due to insect damage. This technology is already helping farmers increase productivity, while reducing pesticide usage, here in the United States. In the developing world, the technology can help promote food security and increase incomes among poor farmers.

Part of biotechnology's promise is to produce plants that are more productive with fewer inputs (such as chemicals and water). Such applications would reap enormous benefits for poor farmers, who could use their scarce resources to produce crops that would better feed their families while lessening or removing the need to convert new lands to agriculture. And, these applications would help to protect farmers from environmental fluctuations, such as drought. Such vagaries of agriculture have had extremely serious impacts on the poor, as we are seeing right now in parts of Africa, where drought is again taking a terrible toll. The ability to stabilize yields will obviously offer great benefits to U.S. farmers and consumers as well.

An eloquent statement on this topic comes from Florence Wambugu, director of an African agricultural institute with expertise in biotechnology. She wrote last year in *Nature:*

> The African continent, more than any other, urgently needs agricultural biotechnology, including transgenic crops, to improve food production . . .

> Africa missed the Green Revolution . . . Africa cannot afford to be excluded or to miss another major global technological revolution. It must join the biotechnological endeavor.

Biotech pharmaceuticals can also make a difference. Biotechnology is being used to create a variety of medicines, such as new vaccines, anti-cancer drugs and human insulin. Developing countries will benefit by biotechnology's ability to produce a broader range of medicines in a more timely and cost-effective manner. Vaccines for malaria and better treatments for HIV/AIDS may both be on the horizon.

BARRIERS TO THE USE OF MODERN BIOTECHNOLOGY IN THE DEVELOPING WORLD

Nevertheless, there are barriers to the use of modern biotechnology in the developing world. These include:

- Cost.
- Adequate regulatory structures.
- Lack of knowledge/fear.

A threshold issue is cost. To gain the benefits of modern biotechnology, adequate financing must be found. Many experts have noted that—as with many technologies—initial applications have primarily benefited those with purchasing power in wealthier countries. For modern biotechnology to help the poor farmer in developing countries, we must find ways to finance the use of this technology for the farmer's benefit.

Part of the answer to this challenge lies in the public sector. We must find ways to support the work of universities, research institutions and other organizations with expertise in this area. In particular, we must support the Consultative Group on International Agricultural Research, whose work has been instrumental in fighting hunger and poverty for many years.

Part of the answer must be found in the private sector as well. Private companies, of course, often have fiduciary responsibilities to shareholders and have a very different role than public sector institutions or charities. But we must find creative solutions, looking to public-private partnerships and other tools. We must find programs that improve the lives of the poor, promote long-term acceptance of this technology and help advance the goals of all concerned. One encouraging example of work to date is the collaboration between Monsanto, USAID and the Government of Kenya to develop a disease-resistant sweet potato that will likely be among the first genetically-engineered crops tested in sub-Saharan Africa.

A second issue is the need for adequate regulatory structures. Like any new technology, modern biotechnology presents risks that must be managed. Environmental testing is important, for example, to ensure gene transfer issues are addressed. Issues related to pest resistance may be important.

This administration is deeply committed to helping developing countries build adequate regulatory systems to manage and address biotechnology. Our commitment is one reason I'm pleased to announce that the administration strongly supports the major thrust and intent of S. 2106, "Advancing the Global Opportunities for Biotechnology in Agriculture of 2000," introduced by Senator Ashcroft. We look forward to discussions among staff to resolve technical issues and to working together to secure passage of this legislation. The programs described in S. 2106 can help developing countries establish regulatory systems to assess the opportunities and potential risks associated with modern biotechnology.

A final barrier is lack of knowledge and fear. Around the world, we've seen lack of knowledge and fear emerge as major factors in the development of modern biotechnology. In my view, we should neither minimize nor bemoan this important fact: we should recognize and address it. We should work to promote scientific cooperation and reasoned dialogue on this topic. We should recognize that this topic can implicate ethical and religious issues for some. In the long run, modern biotechnology cannot promote a better tomorrow unless people from around the world understand it and have a stake in the technology's future.

HOW U.S. IS ADDRESSING ISSUE

This Administration is strongly committed to finding ways for modern biotechnology to help fight hunger and poverty. Our work in this area cuts across many agencies, including the U.S. Agency for International Development (USAID), the U.S. Department of Agriculture (USDA) and the Department of State.

USAID spends roughly $7 million a year on agricultural biotechnology in developing countries. USAID's work emphasizes two aspects—cooperative research and technology development, and the promotion of science-based regulatory systems. Cooperative research and technology development efforts link U.S. universities and

companies with research and government institutions in developing countries. It is important that developing countries have the technical and institutional ability to access the potential of biotechnology for themselves. Creating ownership over the technology helps diffuse the political issues, and provides the basis for a science-driven regulatory system. In addition, USAID supports the development of biosafety regulatory systems and legal and management policies for addressing intellectual property rights associated with biotechnology.

USDA spends more than $60 million annually on biotechnology research, providing education programs to current and emerging agricultural biotechnology markets, and on cooperative efforts with researchers in developing countries. USDA has implemented special programs for a targeted group of developing countries, and it conducts training seminars, which provide a balanced view of biotechnology to selected consumer, producer, processor, trader or regulator representatives. In addition, USDA directs efforts toward educating regulators and journalists on the science-based regulatory process practiced in the U.S. for biotech crops and products, and it brings interested stakeholders for U.S.-based training. The Agricultural Research Service (ARS) of USDA not only conducts its own research into biotechnology, it also manages a germplasm system that shares germplasm freely with developing countries.

For example, USDA recently signed an agreement with sub-Saharan African countries and Tuskegee University to facilitate technology transfer related to agricultural biotechnology. Over $280,000 is also spent annually on biotech outreach efforts in developing countries, which includes biosafety symposia on the potential environmental risks of biotechnology. USDA has also implemented special programs for a targeted group of developing countries (including Thailand, Vietnam, Indonesia, Philippines, Malaysia, Chile, Uruguay, South Africa, Mexico, Czech Republic, Romania, Hungary, and Poland). USDA conducts training seminars, which provide a balanced view of biotechnology to selected consumer, producer, processor, trader or regulator representatives.

The Department of State is actively engaged as well, helping to promote the beneficial application of this technology through many channels. Our Public Diplomacy and Public Affairs Bureau has been working hard—organizing speaker programs, digital video conferences, an international visitors program, fact sheets on U.S. agricultural biotechnology regulatory processes for Embassy distribution, and multiple websites, including an electronic journal. To enhance information-sharing efforts, the Department of State recently allocated $360,000 toward assisting with the effective implementation of the Biosafety Clearing House. This web-based database of information concerning living modified organisms (LMOs), provides a means for sharing scientific and regulatory information among countries.

The issue of biotechnology in developing countries involves questions of trade, and our Economic Bureau has been proactively addressing this issue through multiple international mechanisms. These include the establishment of a U.S.-EU Consultative Forum on biotechnology, and the Secretary's Advisory Committee on International Economic Policy (ACIEP) Working Group on Biotechnology. Our Economic Bureau is also working to ensure that current discussions of biotechnology in international negotiations, such as recent OECD discussions, are driven by science.

CONCLUSION

Modern biotechnology is not a panacea, but it can help make a difference in the fight against hunger and poverty. Using this new technology, we can feed hungry children, raise incomes, fight disease and protect the environment.

But these results are not guaranteed. To realize the full potential of modern biotechnology, we will need wisdom and creativity in the years ahead. We must find ways to overcome obstacles and address concerns.

This country should be proud to be a global leader in this remarkable new technology. In the years ahead, let us pursue a rational and open dialogue on this topic, applying the lessons of science and respecting all points of view. If we do so, we'll leave a better world behind for our children and theirs.

PREPARED STATEMENT OF HON. E. ANTHONY WAYNE

Dear Chairman Hagel:

Thank you for the opportunity to address for the record the potential of biotechnology in agriculture to help alleviate global hunger and poverty. As with any promising new technology with broad application, we have seen that there are legiti-

mate questions and concerns. The United States Government has learned from experience the importance of ensuring public safety and confidence in new products while maintaining a climate conducive for economic growth and innovation. In the international arena as at home, we favor the consistent science-based, rules-based approach to assessing the opportunities and risks associated with new technologies, particularly those that affect food security and consumer welfare.

Biotechnology holds great promise to help alleviate poverty and hunger globally. To explore its potential effectively, we encourage the international community to avoid unnecessary restrictions or barriers to new technologies such as biotechnology, while proceeding with wisdom and care. We believe this can be done while protecting our domestic regulatory programs. We need transparency and the effective use of science-based decision making. Undue or unworkable trade restrictions or regulatory barriers, especially on agriculture, could raise food costs substantially and slow the safe development of biotechnology. It is true that many governments and companies are investing heavily in biotechnology—on which the U.S. has a strong start—and so it is obvious that its promise is not completely unknown abroad.

We believe it is important to enhance and share international understanding on the science of biotechnology. We also think that the consensus among scientists—that bio-engineered foods are as safe as other foods—is finally getting traction. We have worked hard to encourage a balanced, calm, apolitical discussion of biotechnology. Many fears about bio-engineered foods reflect a lack of complete knowledge about our solid regulatory system and about the basic science of biotechnology. The issue of biotechnology has serious implications for U.S. agricultural exports, for the trading system more generally, for global food security and development, and for how we manage effectively the international approaches to the safety and environmental aspects of promising new technologies. For these reasons, the State Department is fully engaged.

Our Under Secretary for Economic Affairs Alan Larson and I work closely in the interagency process on food safety and agricultural trade issues. We also take a coordinated approach on the environmental aspects of biotechnology with our Under Secretary for Global Affairs Frank Loy and with Assistant Secretary Sandalow's Bureau of Oceans and International Environmental and Scientific Affairs. We also work with Under Secretary for Public Diplomacy Evelyn Lieberman, who has organized an interagency "public diplomacy working group" to help coordinate the biotech issue internationally. We interact regularly with USDA, the FDA, Commerce, EPA, USAID, USTR, and both the NEC and OSTP at the White House on international discussions and negotiations on biotechnology. The Secretary of State has also engaged directly with her counterparts, and with interested stakeholders, to be sure we take a balanced and inclusive approach to this pathbreaking technology. And we are responding to many calls by U.S. constituents that we do still more.

We are making a very specific effort to address the interests of developing countries. Recently, we created a biotechnology working group under our Advisory Committee on International Economic Policy (ACIEP) comprised of 60 members. Among other items, it will consider how we can better work with developing countries so that they benefit safely from biotechnology's potential contributions to health, nutrition, food security and agricultural productivity. We have supported USAID, which is playing a very constructive role on biotechnology, to continue assisting in building the capacities of developing countries to adapt and use appropriately biotechnology to meet critical needs. Under Secretary Larson has met with UN Food and Agriculture Organization (FAO) Director General Diouf and discussed what his organization can do to better support biotechnology in developing countries.

We have successfully pressed for attention to the interests of developing countries in recent discussions of biotechnology in both the Organization for Economic Cooperation and Development (OECD) and the G-8.

It is important to remember that while foods derived from bio-engineered inputs or processes have been on the U.S. grocery shelves for less than a decade, farmers have been creating new plant species through genetic modification for centuries. Whether we call it risk-based decision making or scientific uncertainty, the precaution concept has been embedded in U.S. health and safety programs since 1906, and continues to be an essential element of the U.S. regulatory approach to food and environmental programs. American farmers are proud of their long-standing commitment to providing customers with products of the highest quality and safety in the world. They have every incentive to maintain that quality—including in our exports—and the consumer confidence that it engenders.

President Clinton has underscored that this Administration, with the help of our outstanding regulatory agencies, will continue to maintain the highest standards of

food safety, including biotechnology food products. The U.S. National Academy of Sciences published a report on April 6 that confirmed that the biotech food products currently on U.S. grocery shelves (estimated at 30,000 products, or 70% of all food sold in the U.S.) are as safe as traditional foods. Acknowledging that no new technology is risk-free, the study also stated the need for greater consideration of environmental risks and for continued assessment of regulatory approaches to food safety. We believe that such ongoing regulatory efforts will only improve our food safety system. We have also encouraged others in the international community to consider the value to consumer confidence and scientific innovation of having apolitical, science-based regulatory structures.

With the global population positioned to top nine billion or more in 30 years (up from six billion today), food security is of paramount concern. Land is fixed, water is scarce and malnutrition seriously impacts child development in many developing countries. As Ismael Serageldin of the World Bank has noted, biotechnology plants and micro-organisms are fundamental tools to help improve food production to meet the growing demand for basic and nutritionally-improved food, while reducing stresses on the environment caused by chemical pesticides and herbicides, over-tillage, water runoff, and conversion of existing wild habitats to agricultural uses.

Today an estimated 18% of the population in the developing world does not have access to sufficient food to meet their caloric and nutritional needs. Malnutrition kills 40,000 people every day. According to a number of studies, biotechnology has increased select crop yields by about 20% in particular areas (primarily due to reduction of loss to pests, increased flexibility in crop management, modification of plant architecture and development, and tolerance to salinity and drought).

Biotechnology may also already be contributing to a dramatic reduction of applications of chemical pesticides and herbicides. According to a study by the National Center for Food and Agricultural Policy, U.S. soybean growers made 16 million fewer active ingredient chemical applications in 1998 compared to 1995 (a 19% reduction). Scientists at the University of Arizona reported that U.S. biotech cotton farmers enjoyed a 22% yield increase and an average 30% reduction in pesticide use in 1998.

Improved food distribution and reduced energy consumption are other benefits from the use of biotechnology since scientists have successfully introduced genetic traits in fresh produce that prolong shelf life. Biotechnology is projected to be of major importance in the health care sector, where trials are advancing to store and deliver malaria and other vaccines worldwide—embedded in bananas, for example—thereby reducing the need for costly refrigeration, storage and distribution. It would be irresponsible and inhumane not to try hard to develop safely the incredible benefits which biotechnology may be able to bring to people of all income brackets everywhere. We are convinced that it is important to do so, with care and cooperation.

On July 6, the 1,800 member International Society for Plant Molecular Biology joined more than 2,400 other scientists (including Nobel Prize winners Norman Borlaug and James Watson) in signing a petition endorsing biotechnology as a "powerful and safe technology that can contribute substantially to agriculture, health care and the environment." On July 5, the Wall Street Journal reported that many scientists in the developing world have embraced the enormous potential of biotechnology. For example, Mexican researchers have bio-engineered the world's first acid-soil crops, which reportedly could significantly boost yields on half the arable land in the tropics and save huge tracts of the forests.

Yet, globally, the U.S. Government and others who see the potential of biotechnology for agriculture are facing challenges, including from some in the European Union, that threaten to slow the dissemination of this promising technology. The European Union's ambiguous approach to precaution is incongruent with the science-based, rules-based approach, which has served Americans and others very well.

Some believe recent EU actions are in part due to the serious food safety scandals that have eroded European consumer confidence in the regulatory agencies of the 15 EU member states, and to reports in Europe media which continue to link alleged risks of "Frankenfoods" with such real fears as beef from "mad cows." Heightened consumer fears in this atmosphere have heavily influenced public policy-making. The crisis in consumer confidence in Europe has overtaken the legislative and regulatory process. In addition, there are interest groups in Europe (such as subsidized industrial agriculture, and organic production supporters) with their own agenda that are pleased to support these developments. The result creates problems for the United States in terms of trade, and could affect the world's ability to benefit from the development of this technology.

A European Commission White Paper on Food Safety published last February projects that over 200 new food safety regulations will be proposed by 2001, affect-

ing biotech seeds, crops, commodities, and processed food and feed products. While the U.S. has adapted and successfully implemented a risk-based approach to food and environmental safety, the EU approach is currently based on a notion they call the "precautionary principle" which is vague and undefined and seems to leave product approval open to political judgement rather than science-based evidence. Discussion in the EU of new standards for agricultural biotechnology could impose fresh regulatory burdens on EU economies and even slow or derail the development of the technology worldwide, without scientific documentation of the potential risks. The impact is already evident; no bio-engineered crops have been approved in EU countries for over two years.

In the EU, the costs of production—and ultimately food prices—may rise. Dependence on heavy pesticide use may continue. The much-lamented "brain drain" of European scientists and academicians leaving to conduct their research in the U.S. may continue.

There would also be consequences beyond Europe. Many long-anticipated biotech breakthroughs may be delayed, as the EU works to convince others of its approach. "Golden rice," for example, was funded and developed by the Rockefeller Foundation and the EU—and the scientists pledged to find ways to adapt this technology to the developing world. ("Golden rice" contains additional beta-carotene to prevent the severe Vitamin A deficiency that contributes to blindness or death for millions of children per year and the iron deficiency that causes birth complications for a billion women and their babies.) However, according to the Journal of Science, under pressure by groups opposed to biotechnology, the EU has now diminished funding for plant biotechnology research. "Golden rice" research was among the projects that did not get further funding. USAID now plans to support the adaptation of "golden rice" to the developing world.

Another aspect of this problem is the very serious access problem the Europeans have created for U.S. bio-engineered crops. U.S. corn exporters are losing $200 million annually in exports since 1998, and other agricultural sectors are threatened because of the internal EU paralysis over handling biotechnology and agriculture. Not only this, the EU is endeavoring to convince others to adopt its restrictive and ambiguous approach.

As a result, U.S. Government agencies have become extremely active in the international arena, through organizations such as the U.N. Food and Agriculture Organization and World Health Organization-sponsored Codex Alimentarius to ensure that biotech agricultural products and foods are not singled out, demonized, or overregulated and, at the same time, that actual risks are appropriately controlled. Here, too, we are working with developing countries to understand their viewpoints and interests, and to share our concerns.

We are making strenuous efforts through the OECD process and the G-8 Summits of major industrialized nations. We have also proposed that biotechnology be addressed in the ongoing agriculture negotiations at the World Trade Organization.

We will continue to seek workable paths forward with the EU to overcome their concerns, while explaining our reservations with their proposed approaches. President Clinton discussed biotechnology with EC President Prodi last October and at the December 1999 U.S.-EU Summit. The President and his EU counterparts committed to establishing a "two-track" approach to addressing biotechnology issues. The first track consists of a government-to-government dialogue among senior-level officials from U.S. agencies and the European Commission to help resolve some of the problems and move the issue forward. The second track consists of the creation of a Consultative Forum of eminent non-government persons from both sides of the Atlantic to address a variety of issues related to biotechnology and to provide a report in time for the December 2000 U.S.-EU Summit. The forum may also address related aspects of the agricultural biotechnology issue, including consumer choice, environmental factors, ethics and the interests of developing countries.

The United States participants in the U.S.-EU Consultative Forum include eminent persons such as Nobel laureate Norman Borlaug and the Rockefeller Foundation's Gordon Conway. We hope that the work of this Forum of respected experts in their fields will help Europe move toward a reasoned discussion of the issues related to biotechnology, particularly agricultural biotechnology and its potential benefits for sustainable development. We have also engaged bilaterally with the EU through the Transatlantic Economic Partnership (TEP) Biotechnology Working Group.

We have also launched energetic diplomatic and outreach efforts to urge a careful, science-based approach to bolster international consumer confidence that biotech products are regulated effectively, and with a view toward maintaining high U.S. standards for food safety and environmental protection. Our program consists of the creation and maintenance of a website on biotech issues, and the initiation of semi-

nars, visitors programs, op eds, and videoconferences worldwide. We have also initiated ongoing outreach to foreign press and non-government organizations.

Our Embassies around the world are doing yeoman's work to help raise awareness on this issue and to convey that we seek a balanced approach to fair market access while addressing consumer and environmental concerns. We have encouraged an awareness of the current and potential benefits of this technology, stressed that we believe it can play a very positive role in developing countries, and made clear that we seek to ensure that the concrete benefits of biotechnology agriculture are shared worldwide, while assuring a careful, science-based regulatory approach.

Since February, the State Department's Bureau of Economic and Business Affairs assumed responsibility for coordinating the U.S. government's interaction with the Transatlantic Consumer Dialogue (TACD) to further the exchange of ideas between policy-makers and non-government organizations. Biotechnology has been one of the main topics of discussion by U.S. and EU government officials, along with U.S. and European consumer groups, comprising the TACD. U.S. consumer groups in the TACD trade working group discussed biotechnology when they met June 21 and the U.S. consumer groups in the TACD food working group will likely discuss the issue with U.S. government officials July 19. We expect the U.S. and EU government and NGO participants in the TACD to examine biotechnology issues again when they meet September 14-15 in Paris.

Despite these efforts, we are aware we are in an age where sound bites shape public opinion and that more is needed to convey our arguments for a careful, science-based approach and to make them comprehensible to consumers—and even to many policymakers in developed and developing countries. We will continue to focus our energy to ensure that short-term political pressures surrounding the biotech issue do not endanger our longstanding rules-based, science-based approach to trade. The rules-based approach has allowed trade and innovation to flourish and is the best means for the promise of biotechnology to contribute to the fight against hunger and poverty around the world.

Per capita food production has risen 25% since 1990, without commensurate increase in land use, and global food trade has kept prices down and hunger in check in many countries. All of which has provided great benefits for people worldwide. To sustain and multiply these positive results, the Department of State will, working closely with other government agencies, remain vigorously committed to resolving outstanding issues in a rational, science-based way in the multilateral fora where biotechnology and agriculture are being addressed.

We hope these efforts will contribute significantly to alleviate global hunger and poverty. Thank you Chairman Hagel for the opportunity to address these important issues.

Senator HAGEL. Mr. Secretary, thank you.

I would like to begin with a couple of questions from your written testimony before I ask my colleagues for their questions. Could you frame up for the committee what in fact the administration is doing to provide leadership in this area. I think you harnessed it in your statement, but now if you could develop your answer in some detail because I think there is some agreement that this technology represents a tremendous amount of hope for the future of mankind. Unless we are able to implement it and process it and get to the productive capacity that these nations need, then it will not do much good.

So with that, have at it, Mr. Secretary.

Mr. SANDALOW. Thank you, Mr. Chairman. This is a critically important topic and our work in this area cuts across a number of Agencies. I would emphasize three where there is significant work that is going on: USAID, USDA, and the Department of State.

USAID spends roughly $7 million a year on agricultural biotechnology in developing countries, and its work emphasizes two aspects: cooperative research and technology development and the promotion of science-based regulatory systems. The cooperative research and development takes place in part in efforts to link U.S. universities and companies with research and government institu-

tions in developing countries. USAID also has a critical role in funding the work of the Consultative Group on International Agricultural Research as part of these efforts.

USDA, the U.S. Department of Agriculture, spends over $60 million in this area and that is annually. It is an annual figure. It is work that relates to research primarily, biotech research, but also outreach efforts in developing countries, research into biotech and training and education programs. USDA actually maintains a germ plasm data base which is very useful in this area.

The Department of State, where I am privileged to work, has had an aggressive diplomatic program in this area for quite a while now. Our public diplomacy section has worked hard and at great length around the world to get out the message about biotechnology and its benefits and how it can be appropriately managed. That has included hosting major conferences, organizing speaker programs, digital video conferences, and more.

We have allocated $360,000 recently toward assisting with the effective implementation of the Biosafety Clearinghouse, which is a very innovative web-based site to gather information about biosafety for countries around the world, and this money will go toward training developing countries to participate.

Our Economic Bureau has been very engaged with this area. We have worked on the U.S.-EU Consultative Forum. The Secretary's Advisory Committee on International Economic Policy has a subgroup that relates directly to this issue and is actively involved in OECD discussions as well.

That is a brief summary, Mr. Chairman, and I am happy to provide more information if you like.

Senator HAGEL. You mentioned in your statement that the final barrier we are dealing with is "lack of knowledge and fear." What specifically is the administration doing to deal with that? I heard what you said regarding the three agencies and I suspect all three are dealing with the underpinning of misinformation and knowledge and fear. But specifically, how do you get—specifically how do you get underneath that, and then tie that to the international scope of this.

Mr. SANDALOW. Our work in this area, Mr. Chairman, cuts across all levels within the Government from the President on down. The President has spoken to this issue publicly. He has spoken to this issue in his private diplomacy as well. This is an area where the Department of State has been working energetically.

In January, just as one example, there was a major conference held in The Hague, I believe, in The Netherlands on this topic, gathering together opinion leaders and experts from around Europe to try to seek a rational dialog on the topic of biotechnology on the Continent, where that has been very challenging. Around the developing world, our embassies have been doing this same type of activity, working with opinion leaders actively to try to generate greater understanding of this topic.

Another important element of our work is scientific cooperation. We have done that diplomatically through the Department of State as well as through USDA and elsewhere. This is a big project and it is a long-term project. I think it is imperative that we approach

this on a bipartisan basis and that we work together with the rest of the world to have reasoned and sound dialog on this topic.

I think we have a real opportunity in this country. It is an opportunity to have a more reasoned and rational debate than has occurred elsewhere. I welcome this hearing, Mr. Chairman, as part of that process and I hope that we can spread the message around the world.

Senator HAGEL. What role, if any, does the EPA play in this?

Mr. SANDALOW. EPA has an important regulatory function, particularly on some of the pesticide issues related to agricultural biotechnology. I am not aware of specific efforts with respect to EPA's activities in the developing world, but would be happy to ask them and submit that information for the record, Mr. Chairman.

Senator HAGEL. Thank you.

[The following response was subsequently supplied:]

RESPONSE OF HON. DAVID B. SANDALOW

I am informed that EPA does not have a specific program regarding biotechnology in developing countries, although it has assisted developing countries in the creation of effective domestic regulations on certain products of biotechnology.

Senator HAGEL. I suspect you have had an opportunity to at least see the Washington Post story yesterday that I referred to in my comments. I do not know how deeply you have gotten into the report and what the National Academy of Science has said, but I would be interested in your reflection on what that story was about and the potential of what the National Academy of Sciences, along with its brother and sister agencies from other countries, had to say.

Mr. SANDALOW. I have had a chance to look at the report quickly and I think the report emphasizes the important opportunities in biotechnology in the developing world. Its conclusions, which are stated right up front, emphasize that biotechnology can make a big difference and that we need to pursue biotechnology in the developing world. I think it is particularly important that this report comes not just from the American National Academy of Sciences, which is of course an esteemed body, but also from national academies from about six or seven other countries, including developing countries. So it represents a broad-based consensus on this important topic.

Some of the issues in the article you referred to are important. They are ones that need to be addressed. The intellectual property issues in particular are ones that are going to have to be worked on over time. But I have not had the chance to review the report closely or to gather together my colleagues in the government to do a more comprehensive assessment. But based upon a quick review of the report itself, I think it sends a very strong message that this is a technology with tremendous potential that we should be working to pursue in the years ahead.

Senator HAGEL. What can we do that we are not now doing to harness the resources of both government and the private sector to work more closely together on this issue?

Mr. SANDALOW. I think I said this a moment ago, but perhaps the most important piece is having rational, reasoned discussions like the one we are having right now. I think another important

piece, Mr. Chairman, is passing Senator Ashcroft's very important piece of legislation once we have had our technical discussions on them. I think that type of effort can really help in the developing world.

Fully funding the President's international affairs budget would help as well. It would help us get the message out around the world. There is a variety of activities we can do that can make a difference, Senator.

Senator HAGEL. Thank you.

Senator Lugar.

Senator LUGAR. Thank you very much, Mr. Chairman. Just following along your line of questioning, I was intrigued by your written testimony, Secretary Sandalow, on how the United States is addressing the issue. You have pointed out the money is being spent by USAID, by USDA, and the trade agencies having an interest in this.

I suppose the question that keeps coming back to me, however, is how the administration is coordinating an effective strategy, given all of these disparate elements. Harking back to the Agriculture Committee experience, we had USDA, EPA, FDA sort of shoulder to shoulder at the table, because these are all elements trying to think through both the production, the safety, and the trade aspects, and to testify on the efficacy of biotech, which they all did and it was helpful.

Interestingly enough, industry people who were witnesses that day wanted to do more. This is almost counterintuitive, that people who feel they are often overregulated on this occasion want government officials who were giving testimony perceived as credible on the basis of their scientific studies, the hundreds of hearings, regulatory tests, and what have you, to do more in safe and healthy.

Now, the point was made that other countries do not have an FDA, or may have something equivalent to an EPA, but they may or may not. There may not have, in other words, credible government agencies, officials, or inspections, so that myths can abide for a long time. There may be no touchstone with a degree of credibility in the government.

Now, our problem it seems to me is huge in this respect, and I do not fault this administration or anybody else. I am just trying to think it through. Who is to be the spear-carrier for all of this? For example, the Secretary of State may visit with her counterpart, Mr. Fischer in Germany, and talk about this, and he is very knowledgeable about the issue. Likewise, Charlene Barshefsky with the trade people. Secretary Glickman routinely goes to Europe to talk about this to the EU people.

I would say they have made virtually no headway. When I follow along in a much more modest way and talk to the same people, not only has the ball not moved, but the so-called Montreal Protocol adopted last year made it virtually impossible for the United States even to export a bushel of seed corn. We have had protectionist problems with Europe for a long time with regard to corn generally. But in the past, we exported a few bushels of seed corn and, given the warning and efficacy labels and so forth, they can keep that at the dock here.

So we are dead in the water. Some would say, well, you cannot mix together foreign policy problems, science problems, economic problems. These all ought to be conveniently separated. Certainly you would not ever want to mention NATO and anything we do with European countries that has to do with security and sort of fundamental relationships with Europe.

But at some level somebody has to do this. I am just thinking aloud with you, but I wonder in the administration have people tried to think this problem through, despite the fact that you are doing some good things with a little money here, a little money there, a dab of this or that? The fact is after the Seattle events or the events here in Washington at the time of the IMF and the World Bank meetings, there are a great number of people in the streets that do not like this subject at all. As a matter of fact they are a rather volatile demonstration of what appears in much more gentile language in the New York Times ad.

I saw one ad, for example, in February. It was the sixth of a series. I had missed the first five. It suggested seriously that agriculture, food and safety have gotten out of hand in this world; we would be better off, rather than having 100-acre farms, to have 30-acre farms, to deliver food to the doorstep, to get rid of all chemicals, to get rid of all exports and, therefore, end the spread of difficulties that might come from whatever experiments we have been doing.

This is being seriously argued with a whole host of foundations and very reputable Americans signing their names to this. This is serious. This is in our own country. This is not the Europeans, whether they are theologically disposed or simply protectionist, or Third World countries saying you have left us behind, you have been so worried about your own commerce and your own profits that you really did not think about us at all, and therefore we really want some attention.

This is, I think, a very big issue, which is being met I think superficially. What has happened in the administration? What sort of talks have you had with Secretary Albright or Secretary Glickman or Ms. Barshefsky or the President or anybody to address this issue. If allowed to continue, it could have debilitating effects not only on our trade with Europe, but on the feelings of many Americans toward Europeans, many of them my constituents, who as a matter of fact are more worried right now about the fact that there is no trade in beans and in corn than they are with whether NATO subsists or survives. They have changed their focus, and this is a serious issue.

Mr. SANDALOW. Thank you, Senator. You made a comment that I want to be sure to highlight because it is so important. You noted that there are many countries that do not have food regulatory agencies that have the public confidence that our FDA has here in the United States and that that plays a role in this issue. From my travels in Europe, I would underscore that that is a central factor in the issue of biotechnology in Europe.

Unfortunately for American farmers, unfortunately for Europeans, I believe unfortunately for the rest of the world, in Europe this issue has gotten caught up in an entirely unrelated set of

issues involving food safety, and that is unfortunate. It is something that we are working on on a hard and sustained basis.

You asked about coordination and I want to strongly agree with and underline the premise of your question, which is that this is a remarkably cross-cutting issue, the issue of biotechnology. And I think that is in part because biotechnology has so many potential impacts across so many corners of our lives. Biotechnology can help improve crop productivity, biotechnology can help with medicine, biotechnology has trade impacts, biotechnology raises issues domestically, biotechnology raises foreign policy issues.

As a result of that, we find biotech issues arising across the Government. As a result of that fact, the White House has pulled together a team which is helping to coordinate that and the different policy councils in the White House coordinate work on this issue as they do work on other issues. That is one of their classic functions. It is critically important that they do that.

You asked about Secretary Albright and the President's activities. I have had the privilege to talk to each of them on this topic. Secretary Albright, most recently has been deeply engaged on this topic, and has hosted lunches. The State Department makes this a regular part of her diplomacy and a priority, I might say.

In closing, Senator Lugar, you mentioned the so-called Biosafety Protocol that was adopted up in Montreal. That is not the topic of this hearing, but I would ask you just to keep an open mind on this agreement and I would like to make two points about it. It has, first, an unambiguous savings clause with respect to the World Trade Organization, so nothing in that agreement will in any way compromise any trade rights that we have.

Second, I believe it is an important part of the long-term confidence-building around the world about biosafety. In the long run this issue is not solved by only opening markets. This issue is only solved when markets are open and there is public acceptance of this product around the world, and part of the public acceptance process I think is this type of international regulatory structure.

Senator LUGAR. Thank you.

Senator HAGEL. Senator Lugar, thank you.

We have been joined by the distinguished senior Senator from Missouri, Senator Bond. I think on our second panel you are going to introduce Dr. Beachy, and if it is appropriate I am going to ask your friend and colleague Senator Ashcroft to go ahead and present his questions to Secretary Sandalow. Nice to have you with us.

Senator BOND. I appreciate being invited as an officious intermeddler and I am delighted to be here and follow something on which I have been working. I just want to compliment the Assistant Secretary on the work that has been going on. We were in Thailand earlier this year and one of the key concerns there was making sure that the people of Thailand had the ability to assure for themselves that the food was safe. We have asked the very fine Ambassador, Ambassador Richard Hechlinger, to work with you to build the capacity in Thailand so Thailand's scientists can assure the people of Thailand that the food is safe. Very exciting, and I will talk more later.

Thank you, Mr. Chairman.

Mr. SANDALOW. Thank you, Senator.

Senator HAGEL. Senator Bond, thank you. You always bring a certain amount of stature with you and we are grateful for that at this humble committee.

Senator Ashcroft.

Senator ASHCROFT. Thank you, Mr. Chairman. I would stipulate that it is a high degree of stature.

May I inquire—Secretary Sandalow mentioned the item from the Washington Post and you had mentioned it earlier. I think we were all focused on that. Has anyone submitted that for the record?

Senator HAGEL. I think you are doing so and it will be included.

[The Washington Post article follows:]

[From the Washington Post, Tuesday, July 11, 2000]

REPORT SAYS BIOTECH FAILS TO HELP NEEDIEST FARMERS

PANEL CALLS FOR ALLOWING SEED SAVING, OTHER STEPS TO ELIMINATE BARRIERS TO TECHNOLOGY SHARING

(By Marc Kaufman)

Commercial considerations are keeping advances in biotechnology from the poor farmers in developing countries who need them the most, according to a joint report, by the National Academy of Sciences and seven other academies around the world.

In addition, contentious issues regarding who owns modified plant genes, and whether biotech seeds can be re-used, are slowing the process of making genetically improved forms of staples such as rice, and cassava available to the 800 million people worldwide who don't have enough to eat, according to the report.

"This is a situation where major change and a lot more energy are needed," said president Alberts, of the U.S. Academy. "The new plant technologies are not being used in many parts of the developing world where the needs are greatest."

The "white paper"—prepared by a working group from the academy, the Royal Society of London, the national academies of science of Brazil, China, India, Mexico and the Third World Academy of Sciences—will be released today, in London. The report generally embraces biotechnology and rues the "backlash" against the technology in Europe and elsewhere. Without gene modification technnology, the report concludes, it will be impossible to feed the world's poor in the future without destroying the environment.

But so far, most genetically modified crops have been grown in North America and other developed areas where private companies selling high-tech, high-yield seeds can earn profits, but where widespread hunger is not a problem.

To change that dynamic, the report strongly encourages private corporations to share their technologies with scientists and farmers in developing countries. It specifically calls for loosening some patent and intellectual property restrictions, and for farmers in developing nations to be allowed to re-use biotech seeds—a practice that is sometimes forbidden now.

And the report calls on wealthy nations to substantially increase funding to the Consultative Group for International Agricultural Research, a World Bank-sponsored group that supports 16 international agricultural research centers that have been losing financial aid steadily for years. While the "Green Revolution" that increased crop yields greatly in the postwar period was largely engineered by the public sector, most agricultural biotechnology today is funded and controlled by private companies.

"I think the [biotech] companies are ready to share some technologies as long, as it doesn't backfire on them commercially," said Alberts. "They are suffering from public pressure now and want to do some things that are a public service."

Val Giddings, vice president of the Biotechnology Industry Organization, which represents 900 companies and academic centers, agreed that "the technology is not being used as it could and should be, and that's a very real problem."

But he said it is "not fair to look to the private sector to solve problems, of international assistance" and that governments need to increase their own funding of agricultural biotechnology. He said that many international biotech sharing programs are already underway, including some involving "golden" rice high in vitamin A, and virus-resistant papaya and sweet potatoes.

Regarding the intellectual property issues that the report stresses, Giddings said they were a "red herring" that has generated much theoretical concern but little on-

the-ground difficulty "The argument that they present some kind of barrier has been way overblown," he said.

Scientists now routinely splice genes from different species into crops to help them grow faster and ward off pests and diseases. These engineered crops at first were embraced by U.S. farmers, who planted them on 70 million acres in 1999.

But the crops have also become increasingly controversial, especially in Europe. Opponents fear crops that produce their own pesticides might cause insects to become more resistant, creating a need for more or stronger chemicals in the future. One recent study suggested that such crops could kill Monarch butterflies. To address enviromnental and public health concerns, the report said that every nation should have a regulatory system in place to watch for any adverse effects.

The European concerns are definitely effecting the spread of biotechnology to the developing world, Alberts said. European Governments have been generous donors to international agricultural research programs, but they have grown reluctant to finance biotechnology projects they would not undertake themselves.

According to the report, researchers are working on new crops useful to developing nations, including salt-resistant corn modified with a gene from mangrove trees, potatoes and bananas produced with vaccines against infectious diseases, and a variety of dwarf crops that increase the edible parts of plants while reducing the vegetative parts.

The U.S. National Academy of Sciences is a private, nonprofit organization chartered by Congress with a mandate to advise the federal government on scientific and technical issues.

Senator ASHCROFT. I am grateful to Ambassador Young for having brought me a copy, although all of us have been focused on this. I am very pleased to see this kind of reporting. It is of note that this is not just from seven different countries. There are seven other academies, including the Third World Academy of Sciences, which I think helps us a lot.

Let me thank Secretary Sandalow for appearing before the committee. As an individual that has been a proponent for biotech issues for the administration, you are very aware of the need to help developing countries set up science-based regulatory systems and obtain adequate education on the uses and potential of biotechnology. I do believe your statement, that it is important for us to have discussions that are science-based and that emphasize the rational, and to have opportunities such as the one you described with the USAID, Monsanto, and Kenya relating to the consortium to develop disease-resistant sweet potatoes.

It seems to me that those are the kinds of—are likely to create the stubborn facts that will be the friends of hungry people, of people who need help. I thank you for that.

I once, not long ago, had a meeting with a delegation from Nigeria. I met with the Nigerian Ambassador, Ambassador Aminu, the Federal Minister of Science and Technology, and the Senate chairman of Commerce, Science, and Technology Committee, and their main point was yield. They said that enhanced crop yields resulting from the use of agricultural biotechnology could help feed a growing population and bolster economic development that is so very promising.

They also recognized that bio-enhanced foods could assist in combating diseases specific to developing countries. I am very pleased with that.

I want to thank you very much for your statements about S. 2106. You joined the Nigerian delegation in saying that they welcome a science-based approach and that we should encourage science-based approaches in developing countries. I appreciate the

administration's strong endorsement of the measure. We look forward to working toward its implementation as quickly as possible.

I would just like to say that if you could comment on what you think would—how this would likely be implemented, comment on the goals to encourage more educational and technical assistance to developing countries on genetically enhanced sustainable agriculture, and particularly I would suggest that I would like to work as expeditiously as possible. I would like to try and work to get something done this year. Do you feel like a timeframe that includes our efforts this year is within the expectation of the administration?

Mr. SANDALOW. Thank you, Senator. I hope so. The need is so great, the opportunities for implementation are enormous. They would include working in developing countries with experts on the ground. They would include scientific cooperation. They would include funding for additional research, the building of regulatory programs. The list is lengthy, and I hope this is something that we can work together on very, very quickly.

Senator ASHCROFT. One other insight, and I do not mean to consume all my time. You said that we have a greater opportunity for a reasoned understanding of this issue than has been made in other settings. This is certainly a place where we must have reason to prevail. So not only should we have these discussions here, but I think the legislation is designed to go to those other settings and provide a reasonable and rational scientific base.

I think what we have seen is, in the absence of science-based reasons, these other discussions fill what otherwise would be a void, and the light of the truth and the light of fact and reason and science must dispel an environment which allows the panic and unreasonable to be propagated.

So I thank you very much.

Mr. Chairman, I am deeply grateful for your willingness to participate in this issue in this way. I do not want to underestimate it. This really is not about science; this is about human beings who are suffering because we have not had an adequate understanding of science. The real bottom line here are countries and communities and families and individual human beings who are in serious difficulty, absent health, absent nutrition. And we can help correct this by just making sure that the truth of reason and science is the basis for decisionmaking.

Thank you very much.

[A press release from Senator Ashcroft follows:]

[Wednesday, July 12, 2000]

PRESS RELEASE FROM SENATOR JOHN ASHCROFT

STATE DEPARTMENT ENDORSES ASHCROFT BILL TO EXPAND FOOD PRODUCTION IN DEVELOPING NATIONS

State Department, Ambassador Young, Danforth Center's Dr. Beachy Testify about Importance of Ashcroft Legislation

WASHINGTON, DC.—U.S. Senator John Ashcroft's efforts to help developing nations expand food production and combat global hunger today won the endorsement of the U.S. State Department.

Testifying in Congress today, David Sandalow, Assistant Secretary of State for Oceans and International Environmental and Scientific Affairs, announced the Administration's strong support for legislation sponsored by Ashcroft. Ashcroft's bill

will encourage developing nations to make appropriate use of American biotechnology products, a field in which Missouri-based Monsanto is a world leader.

Ashcroft, a member of the Senate Foreign Relations Committee, said: "U.S. agriculture biotechnology holds the prospect for substantial benefits to the world in a number of critical areas. Enhanced crop yields resulting from the use of agricultural biotechnology will help feed a growing global population and help fight world hunger. Healthier bio-enhanced foods also will assist in combating diseases specific to the developing world that arise from vitamin and other nutritional deficiencies. I'm pleased that the Administration is behind our efforts to help developing nations see the benefits of biotech."

The Ashcroft-sponsored "Advancing the Global Opportunities for Biotechnology in Agriculture Act" (S. 2106) assists developing countries in setting up regulatory systems to review the benefits and potential risks of genetically-enhanced agriculture. Such systems will allow third world countries to establish standards that judge new products based on objective scientific principles, and not on the protectionist approach of the European Union. To accomplish this, the Ashcroft bill sets aside $6 million (FY2001) in U.S. AID's budget for agricultural development.

In addition to Sandalow, former UN Ambassador Andrew Young, now of GoodWorks International, and Dr. Roger Beachy of the Danforth Plant Science Center in St. Louis testified today before the Senate Foreign Relations Subcommittee on International Economic Policy, Export and Trade Promotion. Young has discussed with Ashcroft the need to assist African nations with biotech products to help combat debilitating illnesses such as river blindness and HIV/AIDS.

Along with fighting world hunger and combating diseases, agriculture biotechnology in third world countries will have environmental benefits. Pest and disease resistant crops developed through biotech will reduce the need for herbicides and pesticides. Plus, greater agricultural yields will minimize the need for additional farmland to feed and clothe the world's growing population.

The Senate Foreign Relations Committee in March approved the Ashcrofi bill as an amendment to the Technical Assistance, Trade Promotion, and Anti-Corruption Act (S. 2382), which has since been referred to the Senate Banking Committee.

Senator HAGEL. Senator Ashcroft, thank you.

Unless any of my colleagues have further questions for Secretary Sandalow, we will allow you to escape with the caveat that we might have some additional questions for the record. Mr. Secretary, thank you.

Mr. SANDALOW. Thank you very much, Mr. Chairman.

Senator HAGEL. We appreciate your good work.

If the second panel would come forward, we will get started. Thank you.

Gentlemen, thank you and again welcome. We are grateful that you would take time to come up and share with us some of your thoughts. Ambassador Young, please proceed.

STATEMENT OF HON. ANDREW YOUNG, CHAIRMAN, GOODWORKS INTERNATIONAL, ATLANTA, GA

Ambassador YOUNG. Mr. Chairman, I am really grateful for your invitation to convene these hearings and to this distinguished committee. I come not as a scientist or a technology expert. I am basically a preacher, and I hope you will forgive me if I try to put this in the kind of context that I think I see evidence of already in this hearing.

Our mandate is to feed the hungry, clothe the naked, heal the sick. As I tried to do that, I ended up in first civil rights, then in politics, only to realize that when I was in Congress we were very short of money. So that when I went to be mayor of a city I realized that the private sector was the source of much of the money, much of the technology, and that only by working together, the non-

governmental agencies, the political process, and the private sector, could we really make any headway.

We have had a tremendous success of that. In the South dealing with civil rights, it was the business community long before the government that was responsive, and religious nongovernmental agencies far more sensitive. I end up applying the same social strategy to dealing with the problems of the developing world. I read that there is a crisis brought on essentially by the health of the African Continent, and we tend to be somewhat removed from that. Last Christmas the Minister of Health from Senegal came by to visit me in Atlanta and asked for help. I said: I do not know what I can do, but if you have a few of the Ministers of Health from African countries that would like to come visit with us in Atlanta, we can probably host you and get the Center for Disease Control and some others to sit with you.

We ended up with 32 Ministers of Health from the African Continent coming, and we ended up as we sent out invitations, we got responses not only from the governmental agencies dealing with health and nutrition and CARE and the Red Cross and the Carter Center, but we also got a very good response from the corporations that are involved on the African Continent.

One of the reasons was that poverty, nutrition, disease are becoming increasingly workplace security issues. So we have found that with some of these ad hoc coalitions, including particularly the biotechnology area, that we have American businesses, American universities, American religious institutions, trying things together.

There are no guarantees, but it was a situation of desperation. So the missionaries from Church World Service came and said they had discovered a tree that was indigenous to the African Continent—they happened to be located there in Elkhart, Indiana, Senator—and that this tree has amazing properties of iron and vitamin A and C. So they are planting tree forests and planting trees near people's homes, where they might use these leaves and the roots and the flowers in their diet.

The representative from Monsanto, I think it was, came from Johns Hopkins and said that one tablet of vitamin A would probably cut the death rate of malaria by 30 percent. So that the efforts to put vitamin A into rice or into cassava or into corn become both nutritional and medical. We found that African Ministers of Health and their science and technology divisions were very interested in being involved and getting some of their scientists involved in looking at things that they can do with their crops and looking for our help.

We also found that the disease factors could be a national security issue, that much of our oil security now is, our backup is West Africa, from Nigeria down to Angola. Ninety percent of the workers in those oil fields are Africans, are trained by mostly American and British and French companies. They are not immune to the diseases of the region. But if you think of the economic problem that oil companies that are 90 percent indigenous Africans with the other 10 percent coming from my home State of Louisiana and East Texas, down in the Gulf, that if they had to bring another 10 percent of the work force from the United States what would it do to the price of oil?

The American companies that are involved on the African Continent in development with some success all see a pending crisis and are beginning to work together in some ways to address the questions of disease. But in the absence of a cure, what can you do to keep people healthy? We have found that nutrition is secondary prevention in AIDS, that when you are involving people who are HIV-positive in good nutrition, even when there is not yet a cure, it makes them responsible for their disease, it encourages them, it involves them in units not unlike our experience with Alcoholics Anonymous, where people who are victims of a disease, instead of giving in in despair, decide to take on the challenge of preventing the disease in others.

So that creating that kind of consortium between our scientists, our churches, our universities, and our politics is one of the things that we have been engaged in at GoodWorks. We do not have any results to report, except that everybody is interested and anywhere we get together to try anything almost, it works, in terms of the kinds of crops that we have been experimenting with.

Before the awful war between Ethiopia and Eritrea I was there and, in spite of the fact that the Ethiopians were leading the assault on biotechnology in the Montreal Protocol, there were 11 million farm families that had been organized by Norman Borlaug and Jimmy Carter and the Ethiopian Government. Agriculture in Ethiopia was largely involving genetically enhanced seeds and crops and doing it quite successfully.

So that we have in the real world people dealing with real problems coming together, trying to find something that could work, that works, in a sense of desperation. On the other side, I think there are theoretical fears and hearings like this I think come together and help us have some clarification of those.

[The prepared statement of Ambassador Young follows:]

PREPARED STATEMENT OF HON. ANDREW YOUNG

Good afternoon. First, let me thank Senator Chuck Hagel and members of the Senate Foreign Relations Subcommittee on International Economic Policy, Export and Trade Promotion for inviting me here today to speak about the role of biotechnology in combating poverty and hunger in the developing world.

I am not here as a scientist, a technology expert or a farmer, but as a concerned citizen who has spent a great deal of his life devoted to work in Africa. As the world population continues to increase and infectious diseases pose a growing threat to Africa and other developing nations, I believe that we in the industrialized world have a responsibility to help. We have a responsibility to harness all the tools and resources that modern technology can offer to combat the plight of the world's hungry and sick populations—for their sake and for the sake of global stability.

I am sure that most of you here read some or all of last week's Washington Post series on HIV/AIDS in Africa. By any account, the figures are shocking, and a solution to this pandemic seems a distant reality.

Of the more than 34 million people in the world living with HIV/AIDS, almost 25 million are in sub-Saharan Africa—that is almost 74% of the global HIV/AIDS population. To-date, Africa has suffered 83 percent of all deaths due to HIV/AIDS, and is subject to nine out of ten new infections.[1] What does this mean in terms of practical realities? It means that every day in sub-Saharan Africa, 5,500 people die from the AIDS virus.[2] It means that health care costs for AIDS in struggling democracies are consuming budgets that could otherwise be used for preventative care, or to combat other curable illnesses and disease. It also means that food security in

[1] Food and Agriculture Organization of the United Nations.
[2] The Washington Post, July 5, 2000.

these countries is further threatened as adults fall sick and die—resulting in a decline in agricultural productivity due to the loss of farm labor.

In Nigeria, for example, President Obasanjo is fighting for democratic reform after years of military dictatorship. But the country he has been elected to lead includes 2.7 million people infected with the AIDS virus. Likewise, South Africa is home to 4.2 million people with HIV/AIDS—more than any other nation in the world.[3] The impact of this disease on the most productive segments of these societies, many of whom are largely engaged in agriculture and represent the mainstay of many African economies, requires further attention and consideration. Thus, in addition to preventing the spread of the disease and caring for those already infected, African leaders must rapidly look past conventional approaches to agriculture, which may soon become obsolete in the face of declining rural populations.

Why has this pandemic exacted such a high toll in Africa and other developing countries? Much of it is related to poverty, the primary threat to development. It makes people more vulnerable to infectious disease through malnutrition, family break-ups, and homelessness—all of which are high-risk factors. Furthermore, when you are struggling with daily survival, your immune system is weakened, access to medical care is scarce, and education and awareness are low.

Clearly, poverty, malnutrition and disease go hand-in-hand. Poverty remains the root cause of hunger and malnutrition throughout the developing world. For example, in sub-Saharan Africa—one of the world's poorest regions—nearly one-third of all children are malnourished and about 20% of women are underweight.[4] A dangerous consequence of malnutrition is that it weakens the immune system and leaves populations more susceptible to infectious diseases, such as HIV/AIDS, malaria, and other forms of illness. Without access to nutritious foods and much-needed cash crops, Africa has little hope of battling the poverty and malnutrition fueling the spread of HIV/AIDS throughout the continent.

Now let me get to the point of this testimony—the role of biotechnology in combating hunger, poverty and disease in the developing world. At hand is the question of how new technologies can empower Africa and other developing countries to engage in sustainable agricultural practices that will feed their growing populations, while also helping protect against disease.

I contend that the answer to this question requires a three-fold approach: (1) improving agricultural production, resulting in higher yields of food and cash crops; (2) enhancing the nutritional content of staple foods; and (3) introducing new pharmaceutical products, such as oral vaccines, to developing nations. Biotechnology can make a critical difference for developing nations in all of these areas.

It is indisputable that steps must be taken to improve agricultural production in the developing world. As populations in the world's poorest regions continue to grow by nearly 90 million per year, the International Food Policy Research Institute estimates that farmers will have to produce 40% more grain globally by 2020 to keep up with rising food demands. Furthermore, the United Nations predicts that by 2020 more than half the people in the developing world will live in cities. While today up to 80% of the people in sub-Saharan Africa and South Asia grow the food they eat, in 25 years, up to 60% of that food will have to be supplied through market channels.[5]

These truths come to us at a time when we are running out of new fertile lands to cultivate, and a history of poor farming practices have damaged arable lands in much of the developing world. We are also at a time in which staple crops are being decimated by viruses and pests before they can be harvested for hungry populations. Throughout Africa, for example, approximately 60% of the cassava crop—an important staple and source of calories—was lost to the cassava mosaic virus in 1998.[6] In Kenya alone, it is estimated that 40%-60% of crop yields are lost to pests annually. And, as I mentioned earlier, countries stricken with AIDS are rapidly losing much of their rural farm labor—the backbone of traditional farming.

Faced with these truths, the answer cannot be for farmers in the developing world to continue traditional practices, such as clear-cutting temperate and tropical forests or boosting the use of chemicals which can contaminate groundwater supplies. The answer can be found in new technologies that increase crop productivity in the poorest countries by up to 25% without increasing labor, while also reducing the use of pesticides and insecticides. The answer can also be found in the development of new crops, which resist other natural challenges such as drought and changing weather patterns, or which offer novel nutritional benefits.

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[3] UNAIDS Region Fact Sheet 2000.
[4] UNICEF, 1998 *State of the World's Children.*
[5] Daleep Mukarji, Christian Aid.
[6] Council for Biotechnology Information.

Let me give you two examples of concrete successes in Africa of biotechnology applications that are already making improvements to agricultural production possible.

- In the Makathini Flats area of KwaZulu Natal, South Africa, the improvements to production by small landholders using a genetically enhanced cotton variety have been significant, with economic savings on average of $140 U.S. per hectare. Farmers are capturing these savings by reducing agricultural inputs such as pesticides, and through higher yields. As a result, the adoption rate of this cotton variety among farmers growing *on just one to five hectares of land* has increased dramatically—from 60 during the 1998-99 growing season to more than 600 during the 1999-2000 season.[7] Enhancing production of such an important cash crop helps alleviate poverty among these small landholders, many of whom are women, which can be directly linked to improved nutrition and a better quality of life for the community.
- In Kenya, the Monsanto Company partnered with the Kenya Agriculture Research Institute and the U.S. Agency for International Development to develop genetically improved varieties of sweet potato resistant to virus infections (these viruses have traditionally destroyed 50%-80% of the continent's sweet potato production). As a result of this collaborative effort, a Kenyan variety of sweet potato was recently approved by the Kenya Biosafety Committee for import, and field trials will soon be underway to ensure that the new variety is properly evaluated under local conditions and local regulations.

While improved agricultural production is essential to ensure an increased and sustainable source of food for the developing world, biotechnology also has the potential to make crops more nutritious. This is critically important when vitamin A deficiency affects 125 million children globally, and causes irreversible eye damage in 14 million children everyday.[8]

Many of you may already have heard about "Golden Rice," a strain of rice that contains more iron and beta-carotene, a precursor of vitamin A. AstraZeneca, the maker of Golden Rice, has approached more than 80 developing nations across Asia, Africa and Latin America with regard to donations of the Golden Rice seeds, and has received a strong welcome for this new technology.[9] For countries in which rice is a staple, families will have a source of vitamin A provided to them in their daily meals, which can reduce the staggering rate of river blindness among children, or the high-risk factors facing children of iron-deficient mothers, such as physical and mental retardation, premature births and infant mortality.

In the pipeline is technology to enrich African maize varieties with beta-carotene, much like the technology which has been successfully employed in the development of high beta-carotene canola and Golden Rice. Approaches such as these will enable African governments to employ food-based nutritional strategies which can help in the fight against infectious diseases such as AIDS and malaria, in addition the chronic problems of river blindness and malnutrition generally.

One of the most amazing breakthroughs in biotechnology, though, is the oral vaccine, which will allow consumers in the developing world to become inoculated against deadly diseases through locally-grown food crops for a small fraction of the cost of traditional vaccines. For example, Professor Charles Arntzen of Cornell University is currently developing a hepatitis vaccine in bananas. Just imagine . . . bananas are foods that are eaten by infants and children, as well as adults. They can be eaten raw, and they are widely available throughout the developing world.

If Dr. Arntzen's project is successful, the banana could deliver the vaccine at two cents a dose, compared to about $125 for a traditional vaccine injection.[10] Right now, an estimated 300 million people globally carry the hepatitis virus and as many as one third of them will die from its effects within the year. Furthermore, by using biotechnology to develop edible vaccines, you bypass the needs for distribution, refrigeration, or the sterilization of needles that are ongoing hurdles to traditional vaccination programs in much of the developing world.

For those of us fortunate to live in the United States or Europe, it is difficult to comprehend the realities of daily life for the people of sub-Saharan Africa and other developing regions. While we grow an abundance of food for consumption and enjoy three meals a day, there are more than one billion who currently live on less than

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[7] The Monsanto Company.
[8] Ismail Serageldin, CGIAR Vice President, The World Bank, March 29, 2000.
[9] Zeneca Ag Products.
[10] Dr. Charles Arntzen, President, Boyce Thompson Institute for Plant Research.

a dollar a day, and between two and three billion who live on less than two dollars a day.[11]

Poverty, malnutrition and disease go hand-in-hand, and we must fight it head-on with all the tools at our disposal.

With 800 million people—mostly women and children—chronically malnourished,[12] we have a responsibility to share technologies that will empower the small landholder to grow higher yields of more nutritious foods through sustainable practices. That is what biotechnology can offer, and that is the reality that we must embrace.

Thank you.

Senator HAGEL. Mr. Ambassador, thank you, and we will come back around with a series of questions.

Senator Bond.

STATEMENT OF HON. CHRISTOPHER S. BOND, U.S. SENATOR FROM MISSOURI

Senator BOND. Thank you, Mr. Chairman. Thank you first of all for holding this hearing, because I can think of no more important subject to deal with in this committee or in this body, in this Congress, than how we can do something that would be of significant assistance to the people in the developing parts of this world who live in grinding poverty, experience malnutrition, experience the impact of diseases, and a whole series of programs, problems, that are very difficult to deal with.

I believe that biotechnology has, plant biotechnology, has the opportunity to do things. What Ambassador Young talked about really was laid out very well. I do not know if you all have looked at it, but I sat down and watched a four-part series by the BBC talking about biotechnology. It presented the negative side, the opposition on BBC, the opposition to plant biotechnology, people saying: We do not want to disrupt the lives of the indigenous farmers in Africa. And the camera crew went out to look at the farmers who were trying to eke out a subsistence living in Africa, one family where the grandchild had not eaten for 3 days, and they fed them before they could even interview them, and they showed the impact of diseases, of invasive weeds, the problems that they have with those crops.

We know the statistics around the world, the tremendous number of people who are suffering from malnutrition, can be helped significantly, and the first and probably the most exciting one is the Golden Rice, the beta carotene-enriched rice which provides the vitamin A that can reduce significantly the five million deaths of infants from malnutrition, the half a million cases of blindness every year that are caused by malnutrition, lack of vitamin A in the diets.

I always travel with a number of very thoughtful articles and, Mr. Chairman, one that is particularly compelling is from Progressive Farmer, written by our distinguished colleague from Indiana. I would offer these to see if you want to include these, and an article by former President Jimmy Carter, that I think outline some of the challenges and the tremendous opportunities that biotechnology offers.

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[11] Ismail Serageldin, CGIAR Vice President, The World Bank, March 29, 2000.
[12] Food and Agriculture Organization of the United Nations.

Senator HAGEL. We will first check the authenticity of this, of course, with Chairman Lugar, but they will be included in the record.

[The material referred to follows:]

[From the Progressive Farmer/February 2000]

MY THOUGHTS—A PAGE OF OPINION

LET'S NOT IGNORE SOUND SCIENCE

(By Senator Richard G. Lugar)

Galileo, if he is looking down from the heavens as he once gazed up at them, must find the current public discussion of the emerging science of biotechnology uncomfortably familiar. Myth, rather than scientific fact, has come to predominate the debate.

The European press refers to genetically engineered grains as "Frankenstein food," and respected research scientists are accused of "playing God."

Galileo's crime was that he challenged the popular but mistaken belief that Earth was the center of the universe. It was a myth firmly ingrained in the societal values and institutions of his time. Eventually and inevitably, Galileo's science triumphed over myth. It offered an incalculable benefit to society.

I recently held two days of hearings of the Senate Committee on Agriculture, Nutrition and Forestry to begin sorting the facts about biotechnology from the myths.

The testimony the committee received suggests, in sharp contrast to what has been written in the popular press in Europe, that biotechnology holds in its logic and ingenuity enormous potential to improve the human condition. Some of the country's leading scientists and the three federal agencies charged with the oversight of biotechnology spoke of the tremendous potential benefits that could result from the genetic engineering of crops.

They detailed the approval and regulatory oversight processes, which evaluate new products in terms of food and environmental safety. They spoke of the hope that biotechnology offers to developing nations of the world.

Dr. Bob Buchanan of the University of California-Berkeley believes the research he has been conducting could, in the not-too-distant future, result in nonallergenic forms of wheat. This could unburden millions of people who currently cannot eat this common food. Dr. Dean Della Penna of the University of Nevada-Reno is doing groundbreaking research on using bioengineering techniques to enhance basic foodstuffs with vitamins.

Increased vitamin E in vegetable oil could potentially reduce the risk of heart disease or of certain cancers by significant amounts. Increased vitamin A in basic foods such as rice, corn and casava could help address serious diet deficiencies in the Third World that result annually in 500,000 children going irreparably blind.

Witnesses also spoke of environmental benefits. Dr. Roger Beachy of the Danforth Plant Science Center in Missouri, told how insect-resistant potatoes, cotton and corn are removing millions of pounds of chemical insecticides from the environment. Dr. Ray Bressan of Purdue University discussed his research on making crops more drought resistant, which would help prevent human incursion on marginal and environmentally sensitive lands.

I only wish there had been greater media coverage of our hearings, because the public deserves to hear both sides and to understand the promise of biotechnology. The hallmark of a progressive society is the ability to engage in an informed, logical and balanced discussion. It has been written that the greatest enemy of the truth is not the intentional falsehood, but rather the pervasive and enduring myth.

Myth has, heretofore, characterized the European debate over biotechnology, and we must take great care that it does not prevent a truly informed discussion here.

[From the New York Times, August 26, 1998]

WHO'S AFRAID OF GENETIC ENGINEERING?

(By President Jimmy Carter)

ATLANTA.—Imagine a country placing such rigid restrictions on imports that people could not get vaccines and insulin. And imagine those same restrictions being placed on food products as well as on laundry detergent and paper.

As far-fetched as it sounds, many developing countries and some industrialized ones may do just that early next year. They are being misled into thinking that genetically modified organisms, everything from seeds to livestock, and products made from them are potential threats to the public health and the environment.

The new import proposals are being drafted under the auspices of the biodiversity treaty, an agreement signed by 168 nations at the 1992 Earth Summit in Rio de Janeiro. The treaty's main goal is to protect plants and animals from extinction.

In 1996, nations ratifying the treaty asked an ad hoc team to determine whether genetically modified organisms could threaten biodiversity. Under pressure from environmentalists, and with no-supporting data, the team decided that any such organism could potentially eliminate native plants and animals.

The team, whose members mainly come from environmental agencies in more than 100 different governments, should complete its work within six months and present its final recommendation to all the nations (the United States is not among them) that ratified the treaty. If approved, these regulations would be included in a binding international agreement early next year.

But the team has exceeded its mandate. Instead of limiting the agreement to genetic modifications that might threaten biodiversity, the members are also pushing to regulate shipments of all genetically modified organisms and the products made from them.

This means that grain, fresh produce, vaccines, medicines, breakfast cereals, wine, vitamins—the list is endless—would require written approval by the importing nation before they could leave the dock. This approval could take months. Meanwhile, barge costs would mount and vaccines and food would spoil.

How could regulations intended to protect species and conserve their genes have gotten so far off track? The main cause is anti-biotechnology environmental groups that exaggerate the risks of genetically modified organisms and ignore their benefits.

Anti-biotechnology activists argue that genetic engineering is so new that its effects on the environment can't be predicted. This is misleading. In fact, for hundreds of years virtually all food has been improved genetically by plant breeders. Genetically altered antibiotics, vaccines and vitamins have improved our health, while enzyme-containing detergents and oil-eating bacteria have helped to protect the environment.

In the past 40 years, farmers worldwide have genetically modified crops to be more nutritious as well as resistant to insects, diseases and herbicides. Scientific techniques developed in the 1980's and commonly referred to as genetic engineering allow us to give plants additional useful genes. Genetically engineered cotton, corn and soybean seeds became available in the United States in 1996, including those planted on my family farm. This growing season, more than one-third of American soybeans and one-fourth of our corn will be genetically modified. The number of acres devoted to genetically engineered crops in Argentina, Canada, Mexico and Australia increased tenfold from 1996 to 1997.

The risks of modern genetic engineering have been studied by technical experts at the National Academy of Sciences and World Bank. They concluded that we can predict the environmental effects by reviewing past experiences with those plants and animals produced through selective breeding. None of these products of selective breeding have harmed either the environment or biodiversity.

And their benefits are legion. By increasing crop yields, genetically modified organisms reduce the constant need to clear more land for growing food. Seeds designed to resist drought and pests are especially useful in tropical countries, where crop losses are often severe. Already, scientists in industrialized nations are working with individuals in developing countries to increase yields of staple crops, to improve the quality of current exports and to diversify economies by creating exports like genetically improved palm oil, which may someday replace gasoline.

Other genetically modified organisms covered by the proposed regulations are essential research tools in medical, agricultural and environmental science.

If imports like these are regulated unnecessarily, the real losers will be the developing nations. Instead of reaping the benefits of decades of discovery and research, people from Africa and Southeast Asia will remain prisoners of outdated technology. Their countries could suffer greatly for years to come. It is crucial that they reject the propaganda of extremist groups before it is too late.

Senator BOND. Let me make just a couple of comments about Roger Beachy. His record and his credentials and his works will speak for themselves, but I had the pleasure of traveling to Southeast Asia with Dr. Beachy, who is now heading our very promising

Danforth Plant Science Center in St. Louis. When we were there it was obvious that we did not need to have a biographical sketch, because the scientific leaders in Singapore and in Bangkok knew of Dr. Beachy. He has already worked with them and trained many of the scientists. The hope and the promise that he brings, along with all of his colleagues in this field, are really very significant and exciting.

I want to mention to my colleagues that, at my request, the Senate Foreign Operations Appropriations Subcommittee has included $30 million for funding biotech research and development initiatives to combat the maladies that plague the world—hunger, malnutrition, and drought. We specifically designated $5 million for the International Rice Research Institute in the Philippines to bring this development into full production. We put in, included a designation for University of California at Davis for control of parasitic weeds in Africa, to Tuskegee University to identify gene technology applications for combating hunger and malnutrition, the International Laboratory for Tropical Agriculture Biotechnology at the University of Missouri in St. Louis to work on diseases threatening rice, tomatoes, cassava, and a million dollars for the Danforth Plant Science Center to work with researchers from Thailand and elsewhere to help them develop genetically engineered products which can resist diseases.

Dr. Beachy with his team have, I believe it was, tomatoes that could be resistant to the viruses destroying the crop in Thailand, and he has a tremendous story to tell. I believe that this technology is not recreational. It is to solve the world's health, humanitarian, environmental challenges.

I thank this committee for holding the hearing and I am very proud to present a man who is well known throughout the world in plant biotechnology, Dr. Roger Beachy, to address the committee.

Senator HAGEL. Senator Bond, thank you.

Dr. Beachy.

STATEMENT OF ROGER N. BEACHY, PH.D., DIRECTOR, DONALD DANFORTH PLANT SCIENCE CENTER, ST. LOUIS, MO

Dr. BEACHY. That is a hard one to follow, Senator Bond. Thank you for the introduction.

Senator Hagel, thank you for calling this subcommittee hearing and for allowing me to make a few remarks to Senator Lugar and Senator Ashcroft and others that are here today.

The Danforth Center was established in 1998 and is formatted on the model of the great independent biomedical research institutions that have come to drive the biomedical research community. The Danforth Center is devoted to research in plant biology to improve human nutrition and sustainable agriculture production.

In many ways the Danforth Plant Science Center is unique in its mission because it has dedicated 10 percent of resources as well as 10 percent of the physical facility to conduct research specifically related to the needs of agriculture in developing countries. This effort includes training scientists to increase intellectual and technical capabilities that are relevant to their home countries. Train-

ing is provided in plant science and biotechnology in areas which they request.

I welcome the opportunity to present testimony on the importance of research in plant sciences, agriculture, food, and nutrition. In particular, my focus today will be on the areas related to the importance for the benefit of the poor and developing countries and as an essential step in the fight against hunger and disease.

Few of us in this room will deny that there are tremendous needs around the world for adequate amounts of nutritious food. Adequate food and nutrition are essential to ensure the physical and intellectual growth and development of children that eventually lead to healthy and productive adults, as Ambassador Young has indicated. It is well known that malnutrition in utero leads to increased diabetes, hypertension, and heart disease. Malnutrition in utero can cause deleterious effects two generations subsequent to a poorly fed mother, with impacts on intelligence and on learning. Two generations. We must get started on addressing the needs.

Low intake of calories leads to kwashiorkor, marasmus, edema, and other conditions. Vitamin A deficiencies have already been discussed today. Deficiencies in dietary folic acid, a B vitamin, leads to reduced intelligence because it is important for the development of neuronal cells.

It is estimated that 850 million people currently are undernourished or malnourished in the world. Sixty percent of the undernourished are in marginal environments where intensive agriculture is not likely to be established or successful. The challenge is to meet the current needs. But, think of the needs that are in front of us for the eventuality of a world whose population may be as great as 9 billion in 2040. Yet, there is limited land on which to produce food without further destroying the important forest and wilderness areas that produce life-giving oxygen, that cleanse our air, to protect and sustain biodiversity, and assure that underground stores of water are sufficiently purified to be suitable for human consumption.

Agriculture producers in the United States have a growing awareness of their duties as keepers of the environment. Many are actively reducing the use of harmful agrichemicals while maintaining highly efficient production of safe foods. Plant scientists and agriculturalists have developed better crops and improved production methods that have enabled farmers to reduce the use of insecticides and chemicals that control certain diseases. Methods such as integrated pest management and no-till and low-till agriculture have been tremendously important in this regard.

Some of the success has come through the judicious application of biotechnology to develop new crops that resist insects and can tolerate certain herbicides. You have heard of the work of biotechnology to develop cotton varieties and corn that resist the cotton boll worm and the corn borer. These varieties of crops have allowed farmers to reduce the use of chemical insecticides by between 1.5 and 2 million gallons since 1996 while retaining or increasing crop yields.

Crops that tolerate certain friendly herbicides have increased no-till or low-till agriculture tremendously, saving valuable topsoil that we are going to rely on for the next 100 years.

Although biotechnology has increased productivity for American and Canadian farmers, the technologies are not widely available or more importantly are not adapted, for applications in parts of the world that could benefit the most. Those peoples who require more food and better nutrition are amongst those who are not seeing the rewards of scientific discovery. In Asia and Africa, where rice is the main food, stem borers and other insects and viruses and fungal diseases continue to suppress crop yields. Diseases caused by fungi and viruses decrease yields of crops such as groundnut, chickpeas, papaya, sweet potatoes, yams, cucumbers, melons.

However, modern methods of crop improvement, coupled with better farming practices, can make a real and significant difference in crop production in all areas of the world. Biotechnology can be used to reduce crop losses due to disease, to insects, and post-harvest deterioration and rotting of foods. This is perhaps best demonstrated by several examples. Start with the virus that causes a severe disease in papaya, a ring spot disease. It reduces papaya production and kills trees in Asia and in parts of Latin America and in Africa. In northern Thailand papaya is a major staple vegetable, and is used in green salads. Consider the leaf curl disease of white potatoes in all producing areas, and the virus that causes yellowing of leaves in sweet potatoes throughout East and Central Africa. Consider the virus that causes stunting and yellowing in rice, a disease that is known as tungro, throughout Central Asia. Each of these important diseases can be controlled through biotechnology.

Consider also the production of cotton in India, Pakistan, and Egypt and other countries where the boll worm and boll weevil can reduce yields and farmers' profits. We have learned that in some parts of India farmers commit suicide rather than face the consequences that come with financial losses that are caused by insect attack. When smallholder farmers in China and South Africa grew native cotton varieties that contain the B.t. gene for insect resistance that was introduced via biotechnology farmers realized between $150 and $200 per hectare increased profits. It is estimated that more than a million farmers in those two countries have benefited from the use of the B.t. gene in cotton. The increased profits come because the farmers did not need to purchase insecticides to control the pests.

An important preliminary study that came out of China found that farmers that used fewer pesticides also had fewer medical problems and required fewer trips to doctors' offices—not often considered in the savings that biotechnology brings.

Perhaps the most striking examples of biotechnology are yet to come. We have heard of the benefits of beta-carotene enriched rice. There is great hope and expectation that consumption of foods that have higher levels of vitamins, whether in improved canola oil or rice or other crops, will have the benefits that have been mentioned in various presentations today.

Researchers have also developed foods that can deliver certain types of therapeutic substances, such as vaccines, that can stimulate the body's defense against diseases.

During the past 20 years I have been privileged to participate in the development of knowledge that contributed to certain biotechnologies. In the early eighties my lab at Washington University in St. Louis, in collaboration with scientists at Monsanto Company, developed methods to produce virus-resistant crops. Later my labs at the Scripps Institute made relevant discoveries in gene regulation, disease resistance, and vaccine development.

From the mid-1980's I made a committed effort to apply those technologies to improve agriculture for peoples in developing countries. The reasons I made that decision are several: First, there was a growing need to improve the efficiency of food production while decreasing reliance on agrichemicals worldwide

Second, there was a need to increase the nutrition and healthiness of people around the world.

Third, there was a great need for more well-trained scientists in developing countries to use modern methods to improve food production.

All of us recognize that there are many challenges to the production, preservation, distribution of adequate foods of high nutrition. And science can only be part of the solution. Nevertheless, we determined to use our technology to benefit agriculture in Africa, Asia, and Latin America.

In 1988, with a small grant from the Rockefeller Foundation and the agreement of the French Government's organization known as ORSTOM—now known as IRD—one of their scientists, Dr. Claude Fouquet, joined my group at Washington University. Fouquet had spent 13 years working in agriculture in Africa before coming to us. In 1991, Fouquet and I then established a program called the International Laboratory for Tropical Agriculture Biotechnology. Between 1991 and today we have trained more than 130 scientists from 19 countries. More than 80 percent have been repatriated to their home institutions where they are working hard to develop indigenous science to apply to local crop production.

The last thing I want to leave you with is my opinion that the United States has not kept apace with the rapid growth of science and technology that is needed to ensure its utility and its acceptance. We have not looked ahead to address the issues of acceptance of transgenic crops. Many of us in the scientific community stand ready to participate in whatever manner we can to provide the expertise and technologies necessary to improve food production, nutrition, and food safety, in developing countries. We are anxious to provide training environments, and to communicate electronically and otherwise, to send the information where it can be best used. In short, we want to be relevant to agriculture outside of the United States as well as to agriculture within the United States.

What is in short supply—and we are very grateful to the efforts of Senator Ashcroft and Senator Bond in this regard—is a commitment from our Government to provide the training and modest infrastructure that allows scientists to create knowledge, and to develop crops that enable them to feed themselves. We cannot simply send the wheat from which those that are hugry can make bread.

What we must do is create an atmosphere for collaboration, as opposed to colonialization, in science. We must work together to further the production of sufficient food of high nutritional content to meet the needs of those that request our help.

Only when food needs are met will people be prepared to face the health issues. Only then will vaccines be successful and anti-HIV drugs and other pharmaceutical treatments reach their full potential. Make no mistake about it, food and nutrition are absolute keys to health, productivity, and social stability.

It is not too late for the United States to recognize the issues and to chart the way to collaboration and to be the world leader in implementing important and meaningful solutions to the challenges of a growing world population.

Again, thanks for your attention and your dedication to make this happen.

[The prepared statement of Dr. Beachy follows:]

PREPARED STATEMENT OF ROGER N. BEACHY, PH.D.

Senator Hagel, members of the subcommittee, and others in attendance, thank you for the invitation to appear before the Subcommittee on International Economic Policy, Export and Trade Promotion. I am Roger N. Beachy, Ph.D., President of the Donald Danforth Plant Science Center, St. Louis, Missouri. The Danforth Center was established in 1998 as an independent, not for profit institution, formatted on the model of the great independent biomedical research institutes in the U.S. The goal of the Danforth Center is the discovery of new knowledge in plant biology and applications of that knowledge to develop more sustainable agriculture, to improve human nutrition and human health, and to encourage commercial development of research discoveries. In many ways the Danforth Center is unique in its mission, as it has dedicated 10% of its resources and facilities to conduct research specifically related to the needs of agriculture in developing countries. This effort includes training scientists in the development of intellectual and technical capacities that are relevant to their home countries in the areas of plant science and biotechnology. The website of the Center, www.danforthcenter.org provides current information about our charter and mission statement, and the status of current research faculty and research programs.

I welcome the opportunity to present testimony on the importance of research on plant sciences, agriculture, food and nutrition. The particular focus of my remarks relates to the importance of research for the benefit of the poor in developing countries and as an essential step in fighting hunger and disease. Few of us deny that there are tremendous needs around the world for adequate amounts of food. Adequate food and nutrition are essential to ensure the physical and intellectual growth and development of children, and leading to healthy and productive adults. For example, it in known that:

- Malnutrition *in utero* leads to increased diabetes, hypertension, and heart disease.
- Malnutrition *in utero* can cause effects two generations subsequent to the mother, with probable impacts on intelligence and learning.
- Low calorie intake leads to kwashiorkor, marasmus, edema and other conditions.
- Vitamin A deficiencies can lead to blindness; Folic acid (a B vitamin) deficiencies reduce intelligence.

It is estimated that 850 million people currently are undernourished or malnourished worldwide. Seventy percent of the world's poor are in rural areas, 60% of which are in marginal environments where intensive agriculture is not likely to be established. The challenge is to meet the current needs, and to prepare for the eventuality that by 2040 the world's population will reach 9 billion. Yet, there is limited land on which to produce food without further destroying the important forests and wilderness areas that produce life-giving oxygen, cleanse our air, protect and sustain biodiversity, and assure that groundwater enters the underground stores sufficiently purified to be suitable for human consumption.

Agricultural producers in the U.S. have a growing awareness of their duties as keepers of the environment; many are actively reducing the use of harmful

agrichemicals while maintaining highly efficient production of safe foods. Plant scientists and agriculturists have developed better crops and improved production methods that have enabled farmers to reduce insecticides and chemicals that control certain diseases. Methods such as integrated pest management, no-till or low-till agriculture have been tremendously important in this regard. Some of the success has come through the judicious application of biotechnology to develop new varieties of crops that resist insects and that tolerate certain herbicides. For example, biotechnology was used to develop varieties of cotton and corn that are resistant to attack by cotton bollworm and corn borer. These varieties have allowed farmers to reduce the use of chemical insecticides by between 1.5 and 2 mil gallons, while retaining or increasing crop yields. Crops that are tolerant to certain "friendly" herbicides have increased no-till and low-till agriculture, reducing soil erosion and building valuable topsoil to ensure the continued productivity of our valuable agricultural lands.

Although biotechnology has increased productivity for American and Canadian farmers, the technologies are not widely available or not adapted for application in parts of the world that could benefit most. Those peoples who most require more food and better nutrition are amongst those that are not seeing the rewards of scientific discovery. In Asia and Africa where rice is the main food, stem borers and other insects, and virus and fungal diseases continue to suppress crop yields. Diseases caused by fungi and viruses destroy crops and decrease yields of crops such as groundnut, chickpeas, papaya, sweet potato, yams, cucumbers, melons, and a host of other fruits and vegetables. However, modern methods of crop improvement, coupled with better farming practices, can make a real and significant difference in crop production in the tropical, poor regions of the world. Biotechnology can be used to reduce crop losses due to disease, insect attack, and post-harvest deterioration and rotting.

This is best demonstrated by several examples. Consider the virus disease that causes a severe ringspot disease in papaya—the disease reduces papaya production and kills the trees in Asia, in parts of Latin America, and in Africa. Consider the virus leaf curl disease on white potatoes, the virus that causes leaf yellowing in sweet potatoes throughout each and central Africa. Consider the virus that causes stunting and yellowing in rice, a disease referred to as tungro, throughout central Asia. Each of these important diseases can be controlled through biotechnologies that increase the resistance of these plants to the viruses.

Consider the production of cotton in India, Pakistan, Egypt and other countries wherethe boll worm, boll weevil and other insect pests can reduce yields and farmer profits, to the point where farmers in some parts of India commit suicide rather than face the effects that come with financial losses. When smallholder farmers in China and South Africa grew their native cotton varieties that contain the B.t. gene for insect resistance that was introduced by biotechnology, farmers realized between $150 and $200 per hectare increased profits. It is estimated that more that a million farmers (combined) in these two countries have benefited from insect resistant varieties of cotton. The increased profit came because the farmer did not need to purchase or apply insecticides to control the pests. A related study implies that farmers that used fewer pesticides also had fewer medical problems and required fewer trips to doctor's offices. These are real and tangible benefits of biotechnology.

Perhaps the most striking examples of how biotechnology can improve human nutrition are found in rice varieties, and varieties of canola that have been improved by biotechnology to increase the amounts of beta-carotene. This precursor of Vitamin A is in short supply in diets in many parts of the world. There is great hope and expectation that consumption of foods from these crops will alleviate or reduce the chronic Vitamin A deficiencies in the diets of many of the poor in Asia and Africa. Other research is underway to use similar types of biotechnologies to increase the levels of other vitamins, and to improve the amount of proteins in crops that have low levels of protein, such as potatoes and cassava. Researchers are also developing foods that can deliver certain types of therapeutic substances, such as vaccines, that stimulate the body's defense against certain endemic diseases.

During the past 20 years I have been privileged to participate in the development of knowledge that contributed to establishment of certain agricultural biotechnologies. For example, in the early 1980s my laboratory at Washington University in St. Louis, in collaboration with scientists at Monsanto Company, developed a method to produce plants that resist infection by certain types of virus diseases, using biotechnology. My labs at Washington University and later at The Scripps Research Institute (La Jolla, CA) also made relevant discoveries in the areas of gene regulation, disease resistance, and vaccine development.

From the mid-1980s, when we made some of the early discoveries in biotechnology, I have made a committed effort to apply them to improve agriculture and human health of peoples in developing countries. The reasons for this decision

are obvious: First, there is a growing need to improve the efficiency of food production worldwide, while decreasing reliance on agrichemicals. Second, there is a need to increase the nutrition and healthiness of peoples around the world. Third, there is a great need for more well trained scientists in developing countries that can develop and use modern methods to improve food production and quality in developing countries. All of us here recognize that there are many challenges to the production, preservation and distribution of adequate food of high nutrition, and to ensure food security for all peoples. Science can provide only part of the solution, but nevertheless, we determined to do what we could to address the needs of agriculture in Africa, Asia and Latin America.

In 1988, with the aid of a small grant from the Rockefeller Foundation and the agreement of the French government's public research organization ORSTOM (now known as IRD) an ORSTOM scientist joined my group at Washington University and we initiated a research project on rice tungro virus disease. This project expanded to include developing efficient methods for transgenic rice, and methods for tissue culture and transformation in cassava, also known as manioc. In 1991 the project was relocated with me to The Scripps Research Institute. Through the increased support of ORSTOM, the Rockefeller Foundation and a modest amount of support from USAID provided via a project at Michigan State University we built a strong research group: it was designated the "International Laboratory for Tropical Agricultural Biotechnology" (ILTAB). ILTAB was relocated to the Danforth Center early in 1999. Between 1991 and today, ILTAB has trained more that 130 scientists from 19 countries, including from Africa, Asia, and Latin America; more than 70% have returned to their home institutions and maintain contact with the Center. Trainees have participated in research programs that are directly related to the research needs of their home institutions.

Research at ILTAB has produced a number of successes, including:

- DNA diagnostic tools to detect plant geminiviruses.
- Worldwide database for geminiviruses and potyviruses.
- Convenient techniques for developing transgenic rice plants.
- Transgenic varieties of rice that are tolerant to rice tungro disease.
- Transgenic varieties of rice that are resistant to bacterial blight.
- First transgenic cassava plants.
- Transgenic varieties of cassava that exhibit resistant to African cassava mosaic virus and east African cassava mosaic virus.
- Collaborations with scientists from around the world on research projects on crops such as sweet potato, yams, banana, tomato, sugar cane.

These projects have been successful because of support, largely from the French government and the Rockefeller Foundation, and because of excellent colleagues in other countries. For example, greenhouse and field studies being conducted in China and other countries in Asia are made possible because regulatory approval for tests has been given by local governmental agencies, most of which have adapted U.S. guidelines and superimposed local scientific oversight. In other countries regulations are not yet in place and testing cannot be conducted. Many countries in Asia and Africa simply do not have the scientific infrastructure in place to judge the safety issues that have come to be associated with the use of biotechnology in food production. We, the U.S., have not kept apace with the rapid growth of science and technology. We have not looked ahead to address the issues of acceptance of transgenic crops and foods derived therefrom, or to the acceptance of biotechnology in general. We, the scientific community, stand ready to participate in whatever manner we can to provide the scientific expertise and technologies that are relevant to improve food production, nutrition, and food safety to those from developing, poor countries. We are anxious to provide training environments, to conduct research on tropical crops, to participate in electronic communications that can build bridges and transfer much needed information. In short, we want to be relevant to agriculture outside of the U.S. as well as within the U.S. What is in short supply, however, are the funds that can make this happen. We need the commitment from our government to provide the training, and modest infrastructure, that allows scientists to create knowledge to feed themselves bread, rather than sending only wheat from which to make bread. What we must do is create the atmosphere of collaboration in science, as opposed to colonialization in science, and work together to further the production of sufficient food of high nutritional content to meet the needs of those that request our help. Only when such needs are met will they be prepared to face their health needs. Only then will vaccines be successful, and anti-HIV drugs and other pharmaceutical treatments reach their full potential. Make no mistake about it; food and nutrition are absolute keys to health, productivity, and social stability. It is not too

late for the U.S. to recognize the issues, to chart the way to collaboration, and to be the world leader to implement meaningful solutions.

Thank you for your attention and your dedication.

Senator HAGEL. Dr. Beachy, thank you.

Mr. Halweil—is it "HAL-well" or "HALL-weil"?

STATEMENT OF BRIAN HALWEIL, STAFF RESEARCHER, WORLDWATCH INSTITUTE, WASHINGTON, DC

Mr. HALWEIL. "HALL-wile."

Senator HAGEL. Well, please proceed, Mr. Halweil.

Mr. HALWEIL. Thank you, Mr. Hagel, Mr. Chairman. Good afternoon and good afternoon, Senator Lugar and other members of the subcommittee. Thank you very much for this opportunity to testify on the role of biotechnology in combating poverty and hunger in developing nations, a subject that I consider central to the broader debate on the use of agricultural biotechnology.

In searching for a biotech fix for hunger, we are pursuing an agricultural will-'o-the-wisp, a seemingly attractive-sounding goal that is simply not well connected to the products which the biotech industry has brought to market. Instead of looking to as yet unproven and nonexistent biotech breakthroughs, we should be looking at the extremely full body of research that shows quite clearly those policies and agricultural interventions that will help to reduce poverty and eliminate hunger.

There are four points that I wish to make in my presentation. First, the dominant causes of hunger around the world are not technological in nature. They are rooted in basic socioeconomic realities. Development economists have persuasively argued that poverty, rather than food shortages, is frequently the underlying cause of hunger, and that point has already been made here today.

In a report released on World Food Day last year, the United Nations showed that nearly 80 percent of all malnourished children in the developing world live in countries with food surpluses. In other words, people often go hungry even where food is readily available. Poverty limits people's access to food or to the land, credit, and other resources needed to produce it. Poverty also means poor access to health care, education, and a clean living environment, which increases the likelihood of hunger. Medical conditions like diarrhea, for example, which is usually the result of an unclean water supply, prevent a child from absorbing available nutrients.

Poverty often strikes hardest among women, the nutritional gatekeepers in many families and the primary food producers in the Third World. Yet, because women have little or no access to land ownership, credit, agricultural training, and social privileges in general, their ability to provide adequate nutrition for their families is handicapped. A 1999 study of malnutrition in 63 developing countries by the International Food Policy Research Institute, the World Bank's agricultural policy arm, found that improvements in social factors—health environment, women's education, and women's status—accounted for nearly three-quarters of the reduction in malnutrition in these countries since 1970.

This is not to say that technology, including biotechnology, plays no role in the alleviation of malnutrition. But there are clearly

more immediate forces keeping people poor and keeping people hungry.

My second point: The global biotechnology industry has funneled the vast majority of its investment into a limited range of products, for which there are large, secured markets within the capital-intensive farms of the first world, products which are of little relevance to the needs of the world's hungry. Despite tremendous growth, 99 percent of the global area planted to genetically engineered crops is still found in just three nations: the United States, Argentina, and Canada. And 72 percent is in the United States alone.

The transgenic crops that currently dominate the global acreage are those that have been engineered to resist spraying of herbicides, those that have been engineered to turn out the B.t. insecticide, or crops that have been engineered to do both. In 1999, herbicide-resistant crops were planted on 71 percent of the global transgenic area, B.t. crops were sown on 22 percent, while crops with both these traits were planted on the remaining 7 percent.

These crops offer large-scale industrial farmers reduced production costs or increased ease of crop management, which explains the exceptionally rapid adoption of transgenics in a few nations. But there is a basic disconnect between these sorts of research priorities and the alleged beneficiaries of genetically engineered crops, the world's hungry. Compare, for example, the $4 million that has been spent on developing a beta-carotene-enhanced rice for use in vitamin A-deficient populations with the $500 million spent on developing Roundup Ready soybeans, the dominant variety of herbicide-resistant crops.

In addition, a joint report released yesterday, which has been referenced here today, by the National Academy of Sciences and seven other academies around the world concluded that transgenic plants are not being used in many parts of the developing world where the needs are greatest.

There are other concerns associated with the technological landscape that is controlled almost exclusively by the private sector and defined by patent protection. Patents and similar legal mechanisms are giving a declining number of large firms substantial control over crop genetics, with worrisome implications for seed saving, farm incomes, and food security. And although Monsanto and AstraZeneca recently announced that they would not commercialize the so-called Terminator technology or other seed sterilization technologies, the biotech industry collectively owns at least three dozen patents that control either seed germination or other essential life functions.

Without addressing inequitable land distribution, differential access to credit, and any other socioeconomic realities in the developing world, the consequences of introducing even the most promising biotechnology are likely to be less than desirable, and this is the lesson that we have learned from the Green Revolution.

Third, if we are interested in eradicating hunger and poverty in the developing world, there are approaches other than investment in biotechnology that are better understood, less risky, and which may ultimately prove more cost effective. As mentioned earlier, land reform, improved access to reproductive health services, and improved educational opportunities for women are among those

policies that have had a sizable impact on reducing poverty and hunger in the past and are likely to do so in the future. These same policies, I might add, are also the most effective ways to reduce birth rates and slow population growth, a problem that has been addressed many times here today.

Investments in agriculture are clearly key to boosting incomes and ultimately reducing malnutrition, and this is particularly true in the poorest regions of the world—sub-Saharan Africa and South Asia, where the majority of the people still make their living from agriculture and where the economies are still heavily dependent on agriculture. But many agricultural researchers in the developing world, including Pedro Sanchez, the director general of the International Center for Research in Agro-Forestry, one of the World Bank's CGIAR centers, in Nairobi, argues that the most investments are not in improved seeds, but rather improved natural resource management, including soil and water conservation, crop rotations, and nitrogen-fixing crops.

Pedro notes that until these resource management issues are addressed, farmers in Africa, Asia, and Latin America cannot take full advantage of any potential offered by improved seeds, whether they were improved through genetic engineering or traditional crop breeding.

In my testimony I have assembled a short list of agricultural interventions in the developing world that focus on improved resource management and that have all resulted in yield increases of 100 to 300 percent. These sorts of yield increases are considerably higher than any present results with biotech seeds and these interventions, in contrast to biotech interventions, depend on resources and know-how that is already available to resource-poor farmers. I offer these examples to demonstrate that there are alternatives to biotechnology for combating poverty and hunger.

My final point: As an ecologist by training, I would like to make a brief statement about the ecological risks of genetically engineered crops. Once genetically engineered crops are planted in close proximity to sexually compatible wild relatives, the spread of genes from one plant to the other through cross-pollination is inevitable. This sort of gene spread has already been reported for transgenic canola in Europe and Canada. Must of the research needed to assess the potential impacts of such cross-pollination has simply not been done, so it is not entirely clear what will happen when a wild plant acquires the ability to produce the B.t. toxin or to do any number of things that transgenic crops are being designed to do.

But whatever the short- or long-term impacts, one thing is clear: Because developing nations are home to the majority of the world's plant and crop biodiversity and because crops in the developing world often exist in close proximity to wild relatives, the risk of cross-pollination is greatest there.

Mr. Chairman, taking a global perspective in my research, I have come across several publications on the subject of biotechnology and hunger from colleagues working in the developing world and I respectfully request that, in addition to my own testimony, two of these documents be submitted as part of the hearing record to complement my own brief statements.

Senator HAGEL. They will be included.

Mr. HALWEIL. I would also like to bring to the attention of the committee members a forum sponsored by Representative Tony Hall on June 29 of this year entitled "Can Biotechnology Help Fight World Hunger," and I have a program from that forum if you would also like that included in the hearing records.

Senator HAGEL. That will be included as well.

Mr. HALWEIL. Thank you very much for this opportunity to testify. I would be happy to entertain any questions.

[The prepared statement of Mr. Halweil with attachments follow:]

PREPARED STATEMENT OF BRIAN HALWEIL

THE ROLE OF BIOTECHNOLOGY IN COMBATING POVERTY AND HUNGER IN DEVELOPING NATIONS

Good afternoon, Mr. Chairman and other members of the Subcommittee.

My name is Brian Halweil, and I am a staff researcher at the Worldwatch Institute. Worldwatch is an independent, nonprofit environmental research organization based here in Washington, DC. Our mission is to foster a sustainable society in which human needs are met in ways that do not threaten the health of the natural environment or future generations. To this end, Worldwatch conducts interdisciplinary research on emerging global issues, the results of which are published and disseminated to decision-makers and the media.

At the Institute, I work primarily on issues related to food and agriculture, including the topics of malnutrition and biotechnology. Thank you for this opportunity to testify on the role of biotechnology in combating poverty and hunger in developing nations—a subject that I consider central to the broader debate on the use of agricultural biotechnology.

In searching for a biotech fix for hunger, we are pursuing an agricultural will-o'-the-wisp, a seemingly attractive sounding goal that is simply not well connected to the products which the biotech industry has brought to market. Instead of looking to as yet unproven and nonexistent biotech breakthroughs, we should be looking at the extremely full body of research that shows quite clearly those policies and agricultural interventions that will help to reduce poverty and eliminate hunger.

There are four basic points that I wish to make in my presentation. First, the dominant causes of poverty and hunger around the world are not technological in nature, but rooted in basic socioeconomic realities. This is not to say that technology—including biotechnology—plays no role in the alleviation of malnutrition, but there is no technology that can override the immediate forces keeping people poor and hungry.

Second, the global biotechnology industry has funneled the vast majority of its investment into a limited range of products for which there are large, secured markets within the capital-intensive production systems of the First World—products which are of little relevance to the needs of the world's hungry.

Third, if we are interested in eradicating hunger and poverty in the developing world, there are approaches other than investment in biotechnology that are better understood, less risky, and which may ultimately prove more effective.

Fourth, because developing nations are home to the majority of the world's plant biodiversity, and because crops in the developing world often exist in close proximity to wild relatives, the risk of cross-pollination between genetically engineered crops and wild relatives is greatest there.

Development economists, including Nobel Laureate Amartya Sen, have persuasively argued that poverty—rather than food shortages—is frequently the underlying cause of hunger. In a report released on World Food Day last year, the United Nations showed that nearly 80 percent of all malnourished children in the developing world in the early 1990s lived in countries that boasted food surpluses. In other words, people often go hungry even where food is readily available.

The more important feature common to these hungry countries is pervasive poverty, which limits people's access to food in the market or to land, credit, and other resources needed to produce food. Poverty also means poor access to non-food services, including health care, education, and a clean living environment, which increases the likelihood of hunger. Medical conditions like diarrhea, for instance, which is usually the result of an unclean water supply, prevent a child from absorbing available nutrients.

Poverty often strikes hardest among women, the nutritional gatekeepers in many families. The United Nations Food and Agriculture Organization estimates that more than half of the world's food is raised by women, and in rural areas of Africa, Latin America, and Asia, the figure soars to 80 percent. Yet, because women have little or no access to land ownership, credit, agricultural training, education, and social privileges in general, their ability to provide adequate nutrition for their families is handicapped.

Eradicating hunger requires elimination of its root causes, including gender discrimination and desperate poverty which prevents access to food or the resources to produce it. A 1999 study of malnutrition in 63 countries by the International Food Policy Research Institute (IFPRI), the World Bank's agricultural policy arm, found that improvements in social factors—health environment, women's education, and women's status—accounted for nearly three quarters of the reduction in malnutrition in these countries since 1970. (This study noted that increased food availability was an important fourth factor, responsible for roughly one quarter of the reduction in malnutrition in these countries.)

This having been said, consider where the majority of investment in agricultural biotechnology is going. The global area planted to genetically engineered crops has grown 23-fold since 1996, the first year of large-scale commercialization. Global area now stands at 39.9 million hectares compared to 1.7 million hectares in 1996. Despite this tremendous growth, 99 percent of the current area is found in just three nations—the United States, Argentina, and Canada; 72 percent is in the United States alone.

Dozens of crops—from apples to lettuce to wheat—have been genetically modified and are near commercialization, though only transgenic varieties of soybean, corn, cotton, canola, squash, and papaya are currently grown commercially. Of these seven crops, soybeans and corn account for 54 percent and 28 percent of the global transgenic area, respectively, while cotton and canola share most of the remainder with nearly 9 percent each.

The transgenic crops currently being grown around the world have been engineered either to resist spraying of herbicides (herbicide-resistant crops), to churn out the insecticide produced by the soil bacterium *Bacillus thuringiensis* (Bt) (Bt-crops), or to do both. In 1999, herbicide-resistant varieties of soy, corn, cotton, and canola were planted on 71 percent of the global transgenic area, while Bt-corn and Bt-cotton were sown on 22 percent. Corn and cotton varieties that both produce Bt and resist herbicides were planted on the remaining 7 percent. These traits offer large-scale industrial farmers reduced production costs or increased ease of crop management by lowering the need to scout for pests, cutting labor costs, allowing a shift to cheaper chemicals, and generally simplifying pest control—which explains the exceptionally rapid adoption of transgenics in a few nations.

For the foreseeable future, these are the sorts of crops and traits that will dominate the global area planted to genetically engineered crops. There is very little connection between these applications and the needs of the world's hungry—modified soy and corn are mainly used in livestock production and processed foods; modified canola is pressed into oil and used in processed foods; and cotton is used for its fiber and oil. Herbicide-resistant crops, for example, are not helpful to poor farmers who rely on manual labor to pull weeds because they couldn't possibly afford herbicides. As a result, the immediate markets for biotech in the developing world are not the subsistence farmers, but the larger operations, which are often producing for export rather than for local consumption. The adoption of genetically engineered soybeans by Argentina's industrial export producers illustrates this point well.

There is a basic disconnect between these research priorities and the alleged beneficiaries of genetically engineered crops—the world's hungry. Compare, for example, the $4 million that has been spent on developing a Beta-carotene enhanced rice for use in Vitamin A deficient populations with the $500 million spent on developing Roundup-Ready soybeans, the dominant herbicide-resistant variety. This $500 million spent on developing Roundup-Ready soybeans also compares with the $400 million annual budget of the Consultative Group for International Agricultural Research (CGIAR), a consortium of international research centers that form the world's largest public-sector breeding effort. In addition, a joint report released yesterday by the National Academy of Sciences and seven other academies around the world concluded that transgenic plants are not being used in many parts of the developing world where the needs are greatest.

There are other concerns associated with a technological landscape that is controlled almost exclusively by the private sector and defined by patent protection. Patents and similar legal mechanisms are giving a declining number of large private firms substantial control over crop genetics and farmers, with worrisome implications for seed saving, farm incomes, and food security. Although Monsanto and

AstraZeneca recently announced that they would not commercialize the so-called "Terminator" technology or other seed sterilization technologies, the biotech industry collectively owns at least three dozen patents that control either seed germination or other essential plant processes. This privatization of germplasm is already putting public sector agricultural research at a disadvantage, and might ultimately prove life-threatening to the majority of small farmers in Africa, Latin America, and Asia who depend on saved seed from year to year.

In addition to this financial obstacle, there is a biological obstacle that may limit the potential of biotech to combat poverty and hunger. The crop traits that would be most useful to subsistence farmers tend to be very complex. The kinds of products that would make sense in a subsistence context include crop varieties responsive to low levels of soil fertility, crops tolerant of saline or drought conditions and other stresses of marginal lands, improved varieties that are not dependent on agrochemical inputs for increased yields, varieties that are compatible with small, diverse, capital-poor farm settings. In herbicide-resistant crops and Bt crops, the engineering involves the insertion of a single gene. Most of the more complex traits mentioned above are probably governed by many genes, and for the present at least, that kind of complexity is beyond the technology's reach.

The experience of the Green Revolution has shown that if the introduction of agricultural technology is not sensitive to social and economic inequalities, then it can actually exacerbate existing inequalities, poverty and hunger, as the better off farmers grab the majority of the technology's benefits. Today, the majority of the world's hungry are those farmers in Africa, Asia, and Latin America who were bypassed, or even marginalized, by the Green Revolution package of seeds that were highly dependent on fertilizer and irrigation inputs. Without addressing inequitable land distribution or differential access to credit, for example, the consequences of introducing even the most promising biotechnology are likely to be less than desirable.

I would like to point to some interventions other than biotechnology that may prove more effective at reducing poverty and hunger in the developing world. As mentioned earlier, land reform, improved access to reproductive health services, and improved educational opportunities for women are among those policies that have had a sizable impact on reducing poverty and malnutrition in the past and are likely to do so in the future. (These same policies are also the most effective ways to reduce birth rates and slow population growth.)

Investments in agriculture are key to boosting incomes and ultimately reducing malnutrition. This is particularly true in the poorest regions of the world, Sub-Saharan Africa and South Asia, where the majority of people make their living from agriculture and where the gross national products are still heavily dependent on agriculture. Pedro Sanchez, the Director-General of the International Centre for Research in Agroforestry (ICRAF), one of the CGIAR centers based in Nairobi, argues that "Third World farmers don't need improved seeds, but rather improved natural resource management, including soil and water conversation, crop rotations, and nitrogen-fixing crops." Sanchez notes that until these resource management issues are addressed, farmers in Africa, Asia, and Latin America will not be able to take full advantage of any potential offered by improved seeds, whether genetically engineered or traditionally bred.

Below, I have assembled a short list of agricultural interventions in the developing world that focus on improved resource management and that have all resulted in large yield increases. These interventions are often characterized as ecological or agroecological, because they depend on building or harnessing the ecological processes—including crop diversity, nutrient cycling, plant and pest interactions, competition, and symbiosis—occurring in the field rather than on external chemical inputs.

- A recent survey of agro ecological interventions in Latin America revealed that yield increases of 100 to 300 percent are not uncommon for a range of staple crops, including beans, corn, rice, potato, and cassava.
- A separate set of projects in Latin America that emphasized locally adapted green manures and cover cropping have increased maize yields from 1-1.5 tons/hectare to 3-4 tons/hectare.
- More than 300,000 farmers in southern and western India farming in dryland conditions, and now using a range of water and soil management technologies, have tripled sorghum and millet yields to some 2-2.5 tons/hectare.
- Some 200,000 farmers across Kenya who as part of various government and non-government soil and water conservation and agroecology programs have more than doubled their maize yields to about 2.5 to 3.3 tons/hectare. (Simultaneously, these Kenyan farmers have substantially improved vegetable produc-

tion through the dry seasons, improving income generation and household nutrition.)

These sorts of yield increases are considerably higher than any present results with biotech seeds. And these interventions, in contrast to biotech interventions, depend on resources and know-how that is already available to resource-poor farmers, working in ecologically sensitive areas. I offer these examples to demonstrate that there are alternatives to biotechnology for combating poverty and hunger in developing nations.

Finally, as a representative of an environmental research group and as an ecologist by training, I would like to make a brief point about the potential ecological risks of genetically engineered crops and how that might affect poor and hungry populations in developing nations. Once genetically engineered crops are planted in close proximity to sexually compatible wild relatives, the spread of genes from one plant to the other through cross-pollination is inevitable. This sort of gene spread has already been reported for transgenic canola in Europe and Canada. Much of the research needed to assess the potential impacts of such cross-pollination has simply not been done, so it is not entirely clear what the likely impact on an ecosystem will be when a wild plant acquires the ability to churn out the Bt toxin or to resist an herbicide or to do any number of things that transgenic crops are being designed to do. Whatever the short- or long-term impacts, one thing is clear: because developing nations are home to the majority of the world's plant biodiversity, and because crops in the developing world often exist in close proximity to wild relatives, the risk of cross-pollination is greatest there. In other words, developing nations are likely to bear the brunt of any ecological impact because of the greater likelihood of gene spread.

Mr. Chairman, in taking a global perspective in my research, I have come across publications on the subject of biotechnology and hunger from colleagues working in the developing world. I respectfully request that two of these documents be submitted as part of the hearing record to complement my own brief statements. In addition, I would also like to bring to the attention of the committee members a forum sponsored by Representative Tony Hall on June 29th of this year entitled, "Can Biotechnology Help Fight World Hunger?" I respectfully request that the program for this event be submitted as part of the hearing record.

I would be happy to answer any questions. Thank you again for this opportunity to testify.

[Attachments.]

CAN BIOTECHNOLOGY HELP FIGHT WORLD HUNGER?

June 29, 2000

Date

Thursday, June 29, 2000

Time

9 a.m.–12 noon

Place

The Gold Room, 2168 Rayburn House Office Building, Capitol Hill

Program	*Introduction*
9:00–9:30	Rev. David Beckmann, Moderator
	Opening Remarks
	(Each Member of Congress will speak for 5 minutes.)
	Rep. Tony P. Hall
	Sen. Richard G. Lugar
	Rep. Dennis J. Kucinich
	Rep. Robert L. Ehrlich, Jr.
9:30–10:20	*Presenters*
	(Each presenter will speak for 10 minutes.)
	Dr. Martina McGloughlin
	Dr. Vandana Shiva
	Dr. C.S. Prakash
	Dr. Mae-Wan Ho

10:20–10:30	*Questions & Answers Session I*
10:30–11:40	*Challengers* (Challengers will speak for up to 3-4 minutes.) Ms. Therese St. Peter Dr. Michael Hansen Dr. Per Pinstrup-Andersen Mr. Arthur Getz Dr. Peggy Lemaux Mr. Michael Pollan
11:40–11:50	*Questions & Answers Session II*
11:50–12:00	*Concluding Remarks* Rev. David Beckmann

Participants (listed in alphabetical order):

Rev. David Beckmann-President, Bread for the World
Mr. Arthur Getz—Specialist, World Resources Institute
Dr. Michael Hansen—Research Associate, Consumers Union's Consumer Policy Institute
Dr. Mae-Wan Ho—Science Advisor, Third World Network
Dr. Peggy Lemaux—Professor, University of California at Berkeley
Dr. Martina McGloughlin—Professor, University of California at Davis
Dr. Per Pinstrup-Andersen—Director General, International Food Policy Research Institute
Mr. Michael Pollan—Contributing Writer, The New York Times Magazine
Dr. C.S. Prakash—Professor, Tuskegee University
Dr. Vandana Shiva—Director, Research Foundation for Science, Technology & Ecology
Ms. Therese St. Peter—Specialist, Zeneca Ag Products, Inc.

POTENTIALS AND THREATS OF THE GENETIC ENGINEERING TECHNOLOGY: QUEST FOR AN AFRICAN STRATEGY AT THE DAWN OF A NEW MILLENNIUM

Hans R. Herren

Director General, The International Centre of Insect Physiology and Ecology (ICIPE), P.O. Box 30772, Nairobi, Kenya

BACKGROUND

Do we need genetically engineered crops to feed the world? This question is at the centre of several major controversies, ranging from intellectual property rights to biodiversity conservation via social and economic considerations. The major question really lies in what choices are science, industry and governments proposing to the farmers and the consumers? In Africa's special case, what solutions to food security makes sense in this particular socio-economic and environmental setting? The scepter of a new fiasco lies very near, as the farmers are likely to be simply weaned from pesticides to be force fed biotech seeds, in other words, taken off one treadmill and set on a new one!

According to a Monsanto-initiated publicity campaign, which seeks endorsement from African heads of state, the solutions to the elusive developing world food security problem are to be found in genetically engineered food crops. It claims the following: "Biotechnology is one of tomorrow's tools in our hands today. Slowing its acceptance is a luxury our hungry world cannot afford."

What is really meant is that these biotechnology[1] products—in this case seeds from genetically modified crops—will cater for the needs of an increased global pop-

[1] "Biotechnology" relates to the use of tissue culture for the rapid multiplication of improved varieties, through cell culture or the like. It also includes the use of naturally occurring microorganisms such as Bt (*Bacillus thuringiensis*), viruses, endophytes and others which may have been selected for their activity against certain plant pests and diseases, but which have not been

Continued

ulation. The public sector has also joined the bandwagon, which reinforces my personal concern about the dangers of such a limited approach to food security issues. The trend towards a quasi-monopolization of funding in agricultural development into a narrow set of technologies is dangerous and irresponsible. Also, too many hopes and expectations are being entrusted in these technologies, to the detriment of more conventional and proven technologies and approaches that have been very successful.

It is only too obvious to concerned scientists, farmers and citizens alike that we are about to repeat, step by step, the mistakes of the insecticide era, even before it is behind us. I would even argue that these new miracle technologies are mostly not necessary, let alone desirable, to solve the world's food security problem. I am not denying that in some instances they may be of use in increasing the *qualities* of food crop varieties, but this aspect has relevance only once *abundance* has been achieved. Africa needs a homegrown food security research, capacity and institution building and implementation strategy that is tuned to its economic and social constraints and is in harmony with its diverse environment.

THE PROBLEMS AND POSSIBLE SOLUTIONS

Despite the enormous investments to date, the progress in developing new crop varieties and livestock breeds and clones, although quite dramatic in scientific terms, has so far lagged behind expectations and promises, particularly in the genetic engineering sector. Transgenic crop varieties (tgvs) are already being used on rather wide areas in the developed countries and are here to stay and will certainly also be deployed by some farmers in Africa. We need, therefore, to deal with at least two major issues which have been neglected by the promoters of genetically modified organisms (GMOs), and unfortunately also by most donors: (i) the potentially negative impact of widespread use of these GMOs on health, the environment, food security and the economy, and (ii) the modalities of their utilization. This is what I would call, "the other side of the coin."

When considering the many different products arising from biotechnology and genetic engineering, of particular concern are the newly developed transgenic varieties of common crops. We have here a typical example of a technology (genetic engineering) that is "looking for an application," in other words, a stockholder/technology-driven rather than a problem-driven approach. The fact that there are many more efficient and sustainable, yet under-exploited, approaches readily available or easily researchable seems not to amount to much in the eyes of policymakers and many donor agencies.

A good example could be the cassava mealybug, if the problem were to occur today. The solution of today's genetic engineers would be to insert some mealybug resistance genes into the cassava plant. I doubt that I would be able to sell the biological control approach today as I did 20 years ago. Note that through biocontrol, the mealybug problem has been eliminated once and for all. This environmentally "soft" biotech solution was applied over a period of 15 years, which included research and implementation across all of Africa. The latest reported cost-to-benefit ratio is 1:200. Hard to beat, even with the best tgvs!

But why this shift in interest away from natural, sustainable solutions which reemerged some 15 years ago, but which are now on the way out? My explanation is that most of these solutions are not considered marketable, by virtue of the very definition of the term "sustainable." The agro-industry obviously has in mind its shareholders, who are more interested in the short-term profitability than in the long-term sustainability of any given production system, even for their own food. Thus, if industry can sell a package that has to be bought over and over again, perhaps at an increasing number and cost per application, the better. This trend can be illustrated by the packaging of herbicide-resistant seeds and complementary herbicide. The latest development in this profit-to-use treadmill direction is the "terminator" gene, which will ensure that a given transgenic crop variety will not germinate in the second season, forcing the farmer to buy new seeds every season. On the one hand this may assure better quality seeds, but on the other, what does it do for the sustainability of the African farming system, for the evolution of land races, and for the economics of the small farm and the ever poorer rural and urban populations.

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genetically modified. Biotechnology may also include vaccines against parasites or vectors of animal and human diseases, diagnostic tests and gene marking tools for classical breeding. "Genetic engineering" refers to the creation of new plant types or transgenic varieties (tgvs) through genetic manipulation of the organism's gene pool by introducing non-species-specific genes, often from other taxa/phyla.

Most of the genetic material now being exploited by the agro-industry came from those very land races that this same industry is now likely to bring to extinction with its plans to widely disseminate tgvs. It may be true that there are seed specimens of land races in freezers, which may serve as a potential gene source for some years to come, but can we tolerate mortgaging the food security of future generations without raising the red flag? The turf battles between the seed/agro-chemical giants and the intellectual property rights proponents are making it clear that sharing nature's wealth for the benefit of the poor is not around the corner. When it comes to utilization, conservation and equitable sharing of genetic resources, Dr. M.S. Swaminathan stresses that, "What's important is not to clog the channel of cooperation, but to keep alive the very principle of evolution of agriculture of the past 10,000 years."

The narrow genetic base of the tgvs is another factor that speaks against them. Given the wide variety of agro-ecologies found in the tropics, Africa in particular, there is therefore a need for a broad range of ecologically suited varieties. Sufficient evidence already exists of past crop failures due to genetic uniformity to be worried: five in the last 25 years. It seems that here, also, there is a problem in learning from past experience.

The use of new, high yielding and possibly pest- and disease-resistant tgvs will bring with it the need to invest in extra inputs, as shown during the Green Revolution in Asia. With or without the tgvs, there will be a need for extra inputs, but the seed costs alone for high-yielding varieties—and more so for the transformed ones—is likely to be above the means of most African farmers. As it is, most Third World farmers can scarcely afford the regular hybrid or improved open-pollinated seeds.

It is well documented that yield can be increased two- or three-fold in most of sub-Saharan Africa and other tropical areas through increased use of fertilizers (both organic and inorganic), weed control, IPM and utilization of already developed and available varieties, in other words, many of the "soft," or "old," biotechnologies. The black bean example in Mexico is proof that sustainable agriculture can also be productive.

You may say that we need to prime the pump, and get the farmers out of the vicious circle. Yes, that could have been done 25 years ago, if it were feasible. The problem is the lack of policies and will, at government level, to put agriculture at the top of the agenda. Tgvs will not change that. The tgv concept is based on the profit motive of seed and agrochemical companies, not on the welfare of farmers and consumers and the need to develop a sustainable and self-reliant production strategy. Tgvs will *not* feed the hungry, they will make them poorer, if the Green Revolution is an indicator of what we can expect.

What Africa needs now is not tgvs, it is a progressive policy environment, in which farmers are given the necessary credit facilities, a tool box with manageable solutions to their agronomic problems and access to markets. They must be given the chance to purchase, through micro-credit schemes, the right inputs at reasonable prices, and on time! Without micro-credit, no technology, either traditional or biotech-based, can be introduced.

There is, however, little indication that governments in the South are revising their budget allocations and giving agriculture in concert with health the importance they merit. Agriculture and health need to go hand in hand if there is to be any hope of achieving the growth in productivity necessary to keep pace with population increase.

The solution lies not with tgvs, but in a different approach, an approach which developing countries and their farmers alike can afford. Such an approach would give priority to training farmers in the basics of plant growth; nutrient uptake and application; organic fertilizer production and application; pre- and post-harvest pest management; farm management; and farmers' cooperative development, among others. It is essential that a holistic approach to training in the farmers' field schools (FFS) be implemented. Farmers' training and credit facilities may indeed be the fastest way forward towards the goal of food security. If an example is needed, the programme pioneered by Sasakawa-Global 2000 may well fit, even though it is not yet perfect (it lacks an integrated production approach).

The funds now being invested by the public sector in developing and deploying new tgvs would go a long way towards educating farmers in the application of presently available and under-utilised technologies, and could fund research and development of truly sustainable and affordable solutions to crop production. Some promising solutions to achieving food security without incurring heavy financial burdens and the uncertain negative ecological impact of tgvs have been identified by the Conference of the Parties of the CBD. They lie in increasing our knowledge of the

dynamics of soil microorganisms, their roles in fertility conservation and restoration, and of the impact of pollinators on the yield of food and horticultural crops.

Africa in particular needs investment and technical know-how in the production of natural, or soft-biotech, integrated pest management (IPM) products such as pathogens, predators and parasitoids, semiochemicals and botanicals. Many of these technologies are currently available in China, India and Brazil, and should be transferred under South-South cooperation schemes.

There is also a mounting body of research and evidence that shows all is not well with the use of tgvs (see a few emerging issues in Annex 1) when it comes to side effects and threats to biodiversity. I have been lobbying over the last several years for increased research support for environmental impact studies in Africa, but have found only deaf ears! I am wondering what the donors expect from the small sums of money (a few tens of millions of dollars) they now spend on research on tgvs, compared to the hundreds of millions of dollars spent by industry! I am trying to promote the idea that public money, i.e. taxpayers' money, should be spent on assessing the impact of tgvs on the environment, on the wild relatives of genetically engineered crops, on the general ecosystem functioning, as well as their effects on human health. At present, these aspects are looked at only marginally or to fulfil the regulatory process, but do not address the long-term implications of tgv use, as ought to be the case. Such research would also help the biotech industry, by providing solutions for a more efficient deployment of tgvs, thus increasing the "life span" of such products! For instance, it has already been shown that insects will develop resistance to tgvs within a few generations, therefore negating years of research. Also, the industry is misleading the farmers by promoting insect resistance. It is noteworthy to explain, that the resistance so far available covers only lepidoptera and coleoptera pests, but not most sap sucking insects or mites, which are also major pests. In short, although the farmer may have a Bt maize, she/he may still have to spray against other pests. A famous plant breeder, Dr. N.W. Simmonds, has called the genetic engineering of food crops "a pie in the sky" or "most spectacular con trick in crop improvement," and is very critical of what he calls the collapse of decent science in the face of biotechnology.

On the critical biosafety issue, who will develop the necessary regulations, not so much from the developed nations' point of view, but from the developing countries' vantage point? There may well be differences between the two, given their different ecological, social and economic environments. In many developing countries, steps are being undertaken to formulate such regulations based on those already available from developed countries. The costs for these activities in terms of scarce human and financial resources is a matter for concern. There are many other more important tasks at hand for African scientists and other professionals than these "imposed" tasks, which will primarily allow the agro-industry to get the legislation in place to test and sell their goods—goods which are of doubtful priority, unfinished as yet, and most certainly not affordable by the average farmer. The more science is driven by intellectual property rights, the more the issues being tackled will be the ones were profit can be made. Dr. Ismail Serageldin mentions as example the pharmaceutical industry, largely driven by private sector investments with proprietary science. Despite the fact that malaria is the worlds most important disease, there is hardly any investment in malaria control options (with exception for the U.S. military). So we can well imagine the private sector using the genetic material from the South, for yield improvement mostly in the developed countries. The developing ones will hardly be able to afford to pay for the technology, and furthermore, this technology may not be ecologically adapted to their needs in the first instance. In a continent with 40 to 45% of its population living in absolute poverty, and in need for a job, industrialised agriculture is not the solution. There are numerous example of very successful organic agriculture in the North. This type of agriculture requires more labor, and yields higher profits. Would that not be the better path to follow?

With the tightening of the rules on biotech activities in Europe, Africa is now being targeted by many biotech companies for the testing of tgvs under the pretense that Africa needs these solutions immediately (the EC has plans to spend 206 million Ecus on 152 projects related to biotechnology). The truth is that Africa can double, or treble its production without any tgvs, but that Africa represents an ideal, yet almost regulation free test ground.

Africa is the home (centre of origin) of several major food crops. The wild relatives of these crops are now in danger of becoming bio-contaminated with stray genes from their genetically modified cultivated relatives. This scenario is real, and represent, next to the loss or bio-contamination of land races, the most serious issue facing the deployment of gtvs. In order to asses the potential threat, there is a need to urgently undertake research one gene flow, of sorghum, cowpeas, coffee, cucurbits

etc. Unless such detailed studies are done and the results made available, no field testing nor deployment of tgv should be allowed. This research could yield on the one hand the data to make informed decisions on the way to proceed, and on the other provide the training ground for specialists to control tgv experiments. The testing of tgvs, without proper information on potential for unwanted gene flow, is yet the biggest threat to biodiversity, and in particular the diversity of our food crop relatives, from which our children will need new genes to overcome new pest and disease problems, as we did do it ourselves. Are we right in denying them this right by not acting quickly and seriously?

There is a need to change the tone of the dialogue, and to start demanding that the public sector continues to invest in research for the South. That the South also starts to invest seriously in agricultural, health and environmental research. Africa cannot afford to follow the bandwagon of the biotech lobby of the North if it want's to survive and develop a strong, ecologically and environmentally sound and sustainable food security system, that includes agriculture, health and the environment, and which it can afford. Africa wil double its population over the next 25 years, so there is no room for complacency, or mis-directed investments. Hunger is caused by poverty, and therefore any research and training programme must tackle this issue in tandem with the other three elements in sustainable development. Food security, health and environmental (water) issues are interconnected and need a holistic problem solving approach. New partnerships, serious and problem solving partnerships, need to be established and funded to bring about the solutions required to overcome the urgent problems of today and the ones looming in the years ahead.

CONCLUSIONS

In summary, I do not see the likelihood of tgvs making a major impact on food security in Africa within the next 15 to 20 years, or until such time as the general economic climate has improved, supported by new agricultural policies. However, there will still remain the questions of economic and environmental viability of the technology. Looking at the investment pattern by industry and the public sector, the chance that we are going to end up with the same mess as with the current pesticide treadmill is just around the corner. We shall have learned nothing since Rachel Carson's The Silent Spring was published over 30 years ago. What a shame!

In a recent article concerning the biosafety protocol for the management of threats posed by living modified organisms, UNEP's Director General, Dr. Klaus Topfer writes: "We need a bio-safety regime that does not hinder biotechnology innovations, but also one that can prevent misuse, escapes and accidents that could have irreversible consequences."

I fully agree, and this statement reflects my thinking and confirms my concerns. I hope my message will reach the decision-makers who can influence the allocation of public, and also private sector, funds to the "other side of the coin" and to the sustainable soft biotechnologies, this to assure that the poor also can grow crops and buy food.

As for Africa, the quest for a new strategy to assure food security at continental, regional, national and household levels at the dawn of the new millennium is and should be a matter of priority. If I can make a few suggestions on what is required, I would sum up as follows:

1. Africa needs new investment policies and means for research, capacity and institution building and development in the areas of agriculture, health and the environment as a matter of priority, in particular as they relate to alternatives to the high development and input cost technologies offered by developed countries industry.

2. The research in conventional, and advanced, technologies should focus on the needs, realistic financial means and the technical absorption capacities of the farmers and rural populations of the research outputs. It also needs to be flexible and adapted to the very diverse ecological conditions, and therefore requirements for site specific solutions.

3. Africa needs positive economic and social development, fostered through social and political reforms. Agriculture should be the area of first priority when it comes to investment, as it provide employment, generates income, and stimulate non-farm activities.

4. Africa needs to consider its available resources as a starting point for technological improvements, not only the available technologies from the developed countries.

5. Trade and fiscal policies and decisions need to be shifted from benefiting Governments to benefiting the agricultural sector, as it is agriculture which is the engine of sustainable development.

6. African Governments need to invest or support and promote private investments in farmers training via specialised schools and in-microcredit schemes.

ANNEX

"GENETICALLY ENGINEERED CROPS MAY THREATEN BENEFICIAL INSECTS"

Three recent studies point to troubling and unexpected effects of genetically engineered insect-resistant crops on beneficial insects. These studies highlight the need for testing of impacts on non-target species before genetically engineered crops are approved for widescale use.

Scientists from the Swiss Federal Research Station for Agroecology and Agriculture in Zurich, conducted two studies that looked at the effects of Bt toxin [1] on green lacewing insects. In nature, these insects feed on the (major) pest targeted by Bt corn, the European corn borer. Lacewings, which are known for their appetite for aphids and other soft bodied insects, play an important role in maintaining the equilibrium of insect populations. They are also important for organic farming pest control strategies.

In one study, recently published in the *Journal of Environmental Entomology,* researchers found that the mortality rate of lacewing larvae increased significantly after eating Bt-toxin similar to that found in genetically engineered corn produced by Novartis Green lacewing larvae fed with Bt-toxin from transgenic organisms showed a significantly higher rate of mortality (57%) than a control group of insects (30%). The larvae were fed purified Bt-toxin produced by genetically engineered *E. coli* bacteria. The bacteria produce toxin similar to that found in Novartis corn.

An earlier study produced even more disturbing results—demonstrating the potential indirect impacts of Bt crops on beneficial insects. Researchers compared the mortality and developmental rate of two groups of lacewings—one that had been fed European corn borers reared on engineered Bt corn and another reared on corn borers fed non-Bt corn (the control group). The experiments revealed that green lacewings fed corn borers that had eaten Bt corn had a higher death rate and delayed development compared to the control group.

More than 60% of the lacewings fed Bt-corn-reared corn borers died compared with fewer than 40% of the control group. The researchers suggest that the higher mortality is directly associated with [Bt]-related factors. Among surviving lacewings, those feeding on Bt-corn-reared corn borers required an average of three more days to reach adulthood than the control group.

In a third study, Scottish Crop Research Institute scientists found that ladybird beetles fed aphids reared on transgenic potatoes experienced reproductive problems and failed to live as long as ladybirds fed aphids from ordinary potatoes (the control group). The potatoes were engineered to produce insecticidal lectins—proteins from the snowdrop plant that bind to the surface of insect cells causing them to clump and stop functioning.

The researchers found that egg production of female ladybirds fed transgenic-potato-reared aphids was reduced by more than one-third, compared with the control group. Nearly three times as many fertilized eggs from fed engineered-potato-reared aphids died before hatching compared with fertilized eggs from the control group. In addition, female ladybirds fed aphids from transgenic plants lived only half as long as females from the control group.

None of these studies have been extended to field situations so it is far from clear whether these laboratory results reflect what might happen outdoors. However, if field results show similar effects, wide-scale use of some transgenic plants could diminish populations of beneficial insects or render some herbicides useless to control weeds.

Sources: "New Evidence on Bt-Corn Disputes Companies Claims of Safety". Greenpeace Press Release. August 21, 1998. The Gene Exchange, Summer 1998.

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[1] Bt (*Bacillus thuringiensis*) is a naturally occurring soil bacterium used as a biological pesticide that can be cloned and inserted into a crop plant. The plant then produces its own toxin in most if not all, parts of the plant.

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[Sustainable Science Audit #1]

THE "GOLDEN RICE"

AN EXERCISE IN HOW NOT TO DO SCIENCE

Evaluating science and technology for sustainability and social accountability

(Institute of Science in Society)

ISIS Mission Statement

To promote science responsible to civil society and the public good, independent of commercial and other special interests, or of government control.

Science is intrinsically honest, open and pluralistic, and disagreements must be openly and democratically debated.

Science should be unbiased and accessible to all, regardless of gender, age, race, religion or caste.

To ensure public participation in decision-making, accurate information should be promptly accessible to the public in unbiased and uncensored forms.

To develop a science that can help make the world sustainable, equitable and life-enhancing for all its inhabitants.

Science should be based on a holistic, ecological perspective that takes proper account of the complexity, diversity and interdependence of all nature.

It is consonant with the holistic perspectives of diverse indigenous sciences across the world.

It is in accordance with the precautionary principle: when there is reason to suspect threats of serious, irreversible damage, lack of scientific evidence or consensus must not be used to postpone preventative action.

To integrate science in society and promote its highest moral values.

Science should contribute to the physical and spiritual well-being of all societies.

It must promote equity, justice, democracy and freedom from oppression for all.

ISIS believes science as much as scientists should be socially and ecologically accountable, and has launched a sustainable science audit project jointly with the Third World Network. This is the first in the series.

EXECUTIVE SUMMARY—JUNE 2000

The "golden rice"—a GM rice engineered to produce pro-Vitamin A—is being offered to the Third World as cure for widespread vitamin A deficiency.

The audit uncovers fundamental deficiencies in all aspects, from the scientific/social rationale to the science and technology involved. It is being promoted in order to salvage a morally as well as financially bankrupt agricultural biotech industry.

The scientific/social rationalization for the project exposes a reductionist self-serving scientific paradigm that fails to see the world beyond its own narrow confines. The "golden rice" is a useless application. Some 70 patents have already been filed on the GM genes and constructs used in making the "golden rice." It is a drain on public resources and a major obstruction to the implementation of sustainable agriculture that can provide the real solutions to world hunger and malnutrition.

"Golden rice" is not a "second generation" GM crop as has been claimed. It involves standard first generation technology, and carries some of the worst features in terms of hazards to health and biodiversity. Rockefeller Foundation, the major funder of the project by far has withdrawn support from it. The project should be abandoned altogether.

Key Words: "Golden rice," vitamin A deficiency, Green Revolution, sustainable science, GM technology, gene patents, GM constructs.

A GIFT-HORSE FOR THE POOR

A report in *Financial Times* [1] states that the creators of "golden rice" have struck "a ground-breaking deal" with corporate giant AstraZeneca to give Third World farmers free access to the grain while allowing it to be commercially exploited in the developed world. The company will oversee the production of stable GM line(s) and patenting, and take the lines through field trials and commercial approval. While farmers in developed countries will have to pay royalties, those in the Third World earning less than US$10,000 will not. But will Third World farmers be allowed to save the seeds for replanting? It did not say.

This "golden rice," not yet available, is already worth its weight in diamonds. The project was funded from four sources of public finance totaling US$100 million: the philanthropic Rockefeller Foundation, whose mission is to support scientific research that specifically benefit the poor, the Swiss Federal Institute of Technology, the European Community Biotech Program and the Swiss Federal Office for Education and Science.

The announcement failed to mention that there are already 70 patent claims on the genes, DNA sequences, and gene constructs used to make the golden rice.[2] Will the cost of paying royalties for the previous 70 patent claims be added to the cost of the golden rice? Which of the royalties on the seventy-odd patents would the Third World farmers be absolved from paying? Rockefeller Foundation, the major funder by far, has reportedly abandoned the project to "shift its agricultural funding focus to support research that will have a more direct benefit to subsistence farmers" [3]

THE SCIENTIFIC/SOCIAL RATIONALE IS FALLACIOUS

Many have commented on the absurdity of offering "golden rice" as the cure for vitamin A deficiency when there are plenty of alternative, infinitely cheaper sources of vitamin A or pro-vitamin A, such as green vegetables and unpolished rice, which would be rich in other essential vitamins and minerals besides.[4] To offer the poor and malnourished a high-tech "golden rice" tied up in multiple patents, that has cost US$100 million to produce and may cost as much to develop, is worse than telling them to eat cake.

"Golden rice" was engineered to produce pro-vitamin A or beta-carotene (the substance that makes carrots orange) in the *endosperm,* i.e., the part of the rice grain that remains after it has been polished.[5] The scientific paper started with a review of the literature to rationalize why such GM rice is needed and of benefit for the Third World. The paper was accompanied by an unusually long news feature entitled, "The Green Revolution Strikes Gold," [6] which reinforced the rationalization for the project, explaining the remarkable feat of technology involved and stated that the scientists intend to make the "golden rice" "freely available to the farmers who need it most." The last sentence in this glowing report, however, gave the game away: "One can only hope that this application of plant genetic engineering to ameliorate human misery without regard to short-term profit will restore this technology to political acceptability."

What were the reasons for the scientists to embark on the project? It is important to know, as these reasons may have been used to persuade funders to support the project in the first place, and funders ought to bear as much of the responsibility.

The first reason given is that the aleurone layer (in unpolished rice) is usually removed by milling as it turns rancid on storage, especially in tropical areas; and the remaining endosperm lacks pro-vitamin A. The researchers are tacitly admitting that at least some varieties of unpolished rice will have pro-vitamin A. The reason rice is milled is to prolong storage for export, and to suit the tastes of the developed world. So why not give the poor access to unpolished rice? A proportion of every rice harvest could be kept unpolished and either given freely to the poor, or sold at the

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[1] Financial Times (London) May 16, 2000.

[2] Revealed by authoritative sources within the Rockefeller Foundation.

[3] Normile D. 1999. Rice biotechnology: Rockefeller to end network after 15 years of success. *Science* 286:1468-1469.

[4] Koechlin, F. (2000) The "golden rice"—a big illusion? Third World Resurgence #114/115, 33-35.

[5] Ye, X., Al-Babili, S., Kloti, A., Zhang, J., Lucca, P., Beyer, P. and Potrykus, I. (2000). Engineering the provitamin A (beta-carotene) biosynthetic pathway into (carotenoid-free) rice endosperm. *Science* 287, 303-305.

[6] Guerinot, M.L. (2000). The Green Revolution strikes gold. *Science* 287, 241-243.

cheapest prices. But the scientists have not considered that possibility. Unpolished rice is fact part of the traditional Asian diet until the Green Revolution when aggressive marketing of white polished rice created a stigma of unpolished rice. However, most rural communities still consume unpolished rice and now that consumers have become aware of its nutritional value, unpolished rice is becoming sought after.

"Predominant rice consumption," the researchers claim, promotes vitamin A deficiency, a serious health problem in at least 26 countries, including highly populated areas of Asia, Africa, and Latin America. Some 124 million children worldwide are estimated to be vitamin A deficient. (Actually, the latest figures quoted in a press release from the International Rice Research Institute (IRRI) is 250 million preschool children.[7]) The scientists seem to be unaware that people do not eat plain rice out of choice. The poor do not get enough to eat and are undernourished as well as malnourished. The Food and Agricultural Organization (FAO) started a project in 1985 to deal with vitamin A deficiency using a combination of food fortification, food supplements and general improvements in diets by encouraging people to grow and eat a variety of green leafy vegetables. One main discovery is that the absorption of pro-vitamin A depends on the overall nutritional status, which in turn depends on the diversity of the food consumed.[8]

"Predominant rice consumption" is most likely to be accompanied by other dietary deficiencies. A recent study by the Global Environmental Change Programme[9] concludes that predominant consumption of Green Revolution crops is responsible for iron deficiency in an estimated 1.5 billion, or a quarter of the world's population. The worst affected areas are in rice-growing regions in Asia and South-East Asia where the Green Revolution had been most successful in increasing crop yield.

Research institutions such as IRRI have played the key role in introducing Green Revolution crops to the Third World. IRRI was founded in 1959 under an agreement forged by the Rockefeller and Ford Foundations with the Philippine government, and its lease for operation expires in 2003. At its recent 40th anniversary celebration, hundreds of Filipino rice farmers protested against IRRI for introducing GM crops, blaming IRRI, among other things, for promoting the Green Revolution and causing massive loss of biological diversity in rice paddies throughout Asia.[10]

It is clear that vitamin A deficiency is accompanied by deficiencies in iron, iodine and a host of micronutrients, all of which comes from the substitution of a traditionally varied diet with one based on monoculture crops of the Green Revolution. The real cure is to re-introduce agricultural biodiversity in the many forms of sustainable agriculture already being practiced successfully by tens of millions of farmers all over the world.[11]

As the scientists know, clinical deficiency can be dealt with by prescription of vitamin A pills, which are affordable and immediately available. "Oral delivery of vitamin A is problematic," they state. Judging from the reference cited[12] they may be referring to the well-known harmful effects of vitamin A overdose. But why would high levels of pro-vitamin A rice in a staple food that people generally consume in the largest amounts in a meal not also cause problems connected with overdose? In particular, vitamin A poisoning has been known to result from excessive beta-carotene intake in food.[13]

Finally, why is it necessary to genetic engineer rice? "Because no rice cultivars produce [pro-vitamin A] in the endosperm, recombinant technologies rather than conventional breeding are required." This is the conclusion to the whole fallacious reasoning process. It amounts to this: rice is polished, which removes pro-vitamin. A, therefore a hundred million dollars (much of it tax-payers' money) are needed to put pro-vitamin A into polished rice. A more likely explanation is that the geneticists are looking for funding to do their research, and have constructed, as best they could, a series of rationalizations for why they should be supported. Neither the scientists nor the funders have looked further beyond the technology to people's needs and aspirations, or to what the real solutions are.

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[7] IRRI press release 22 May, "Human health and food that feeds half the world."

[8] See Koechlin, 2000 (note 1).

[9] Geoffrey Lean, Independent, April 23, 2000.

[10] Press release 4 April, Los Banos, Philippines, MASIPAG/Farmer-Scientist Partnership for Development.

[11] See Altieri, M., Rosset, P. and Trupp, L.A. (1998). *The Potential of Agroecology to Combat Hunger in the Developing World,* Institute for Food and Development Policy Report, Oakland, California.

[12] Walter, P., Brubacher, G., and Stahelin, H. eds. (1989). Elevated Dosages of Vitamins: Benefits and Hazards, Hans Huber, Toronto, Canada

[13] Nagai, K., Hosaka, H., Kubo, S., Nakabayashi, T., Amagasaki, Y. and Nakamura, N. (1999). Vitamin A toxicity secondary to excessive intake of yellow-green vegetables, liver and layer. *J. Hepatol* 31,142-148.

It took ten years to engineer beta-carotene into polished rice because rice naturally does not have the metabolic pathway to make it in the endosperm, perhaps for good biological reasons. Immature rice endosperm makes the early precursor, geranylgeranyl-diphosphate (GGPP). In order to turn GGPP into beta-carotene, four metabolic reactions are needed, each catalyzed by a different enzyme. Enzyme 1, phytoene synthase converts GGPP to phytoene, which is colorless. Enzymes 2 and 3, phytoene desaturase and xi-carotene desaturase, each catalyzes the introduction of two double-bonds into the phytoene molecule to make lycopene, which is red in colour. Finally, Enzyme 4, lycopene beta-cyclase turns lycopene into beta-carotene. Hereafter, the enzymes will be referred to by numbers only. Thus, a total of four enzymes have to be engineered into the rice in such a way that the enzymes are expressed in the endosperm. Some very complicated artificial gene constructs have to be made. The gene constructs are made in units called expression cassettes (see Box 1).

In order to select for the plant cells that have taken up the foreign genes and gene-constructs, "golden rice" makes use of a standard antibiotic resistance gene coding for hygromycin resistance, also equipped with its own promoter and terminator. All these expression cassettes have to be introduced into the rice plant cells. One simplification available is that the reactions catalyzed by two of the enzymes, 2 and 3, could be done by a single bacterial enzyme, let's call it enzyme 2-3, so a total of four expression cassettes have to be introduced, one for each of three enzymes and the fourth for the antibiotic resistance marker.

BOX 1

The "gene expression cassette"—a unit of transgenic construct

The gene for each enzyme never goes in alone. It has to be accompanied by a special piece of genetic material (DNA), the *promoter,* which signals the cell to turn the gene on, i.e., to transcribe the DNA gene sequence into RNA. At the end of the gene, there has to be another signal, a *terminator,* to mark the RNA so it can be translated into protein. To target the protein to the endosperm, an extra bit of DNA, a transit sequence, is required. The resulting expression cassette for each gene is as follows:

promoter — transit sequence — gene — terminator

Typically, each bit of the construct: promoter, transit sequence, gene and terminator is from a different source. Several expression cassettes are usually linked in series, or "stacked" in the final construct.

Unlike natural genetic material which consists of stable combinations of genes that have co-existed for billions of years, artificial constructs consist of combinations that have never existed, not in billions of years of evolution. Artificial gene-constructs are well-known to be structurally unstable, which means they tend to break and join up incorrectly, and with other bits of genetic material, resulting in new unpredictable combinations. This process of breaking and joining of genetic material is referred to as *recombination.* The more complicated the construct, the more it tends to break and rearrange or form new combinations. The instability of the construct means that it is seldom inserted into the plant genome in its intended form. The inserts are generally rearranged, with parts deleted, or repeated.

In order to make many copies of the construct and to facilitate entry into plant cells, the construct is spliced into an artificial vector, which is generally made from genetic parasites that live inside cells. The artificial vector also enables the construct to be efficiently smuggled into the plant cell and to jump into the genome of the plant cell. The vector used in the case of the "golden rice" is the one most widely used since the beginning of plant genetic engineering. It is derived from the "*T*-DNA," part of the tumor-inducing (*Ti*) plasmid (a genetic parasite) of the soil bacterium, *Agrobacterium.* The *Ti* plasmid naturally invades plant cells, inserting the *T*-DNA into the plant cell genome, and causing the cell to develop into a plant tumor or gall. The artificial gene construct is spliced in between the left and right borders of the *T*-DNA vector. The borders of the *T*-DNA are "hotspots" for recombination, i.e., they have a pronounced tendency to break and join up, which is ulti-

mately why the vector can invade the plant's genome and carry its hitch-hiker gene construct along with it.

Three different constructs were made. The first consists of the expression cassettes of enzyme 1 from daffodils and enzyme 2-3 from the plant bacterial pathogen, *Erwinia uredovora,* together with the expression cassette of an antibiotic resistance marker gene that codes for hygromycin resistance. Another antibiotic resistance gene (coding for kanamycin resistance) is also present, albeit lacking a promoter. Hygromycin and kanamycin are both aminoglycoside antibiotics that inhibit protein synthesis. The resistance genes originate from bacteria and generally have specificities for more than one aminoglycoside antibiotic. This first construct is the most complicated, but it still does not have all the required enzymes. Enzyme 1 and the hygromycin resistance gene are both equipped with a promoter from the cauliflower mosaic virus (CaMV), which is especially hazardous (see below).[14]

The second construct consists of the expression cassettes of enzyme 1 and enzyme 2-3 as in the first, but without any antibiotic resistance marker genes. The third construct consists of the expression cassette of enzyme 4, again from daffodil, stacked with the hygromycin-resistance marker-gene cassette. The strategy of separating the genes for the enzymes and antibiotic resistance marker into two different constructs is that it overcomes some of the problems of structural instability: the more cassettes stacked, the more unstable is the construct.

Each construct was spliced into a *T*-DNA vector, and two transformation experiments were carried out. In the first experiment, 800 immature rice embryos were inoculated with the vector containing the first construct, and hygromycin was used to select for resistant plants that have taken up the vector, resulting in 50 GM plants. In the second experiment, 500 immature embryos were inoculated with a mixture of the vectors containing the second and third construct respectively. Selection with hygromycin gave rise to 60 GM plants that have taken up the third construct, but only twelve of these had taken up the second construct as well. The transformation process is well-known to be random, as there is no way to target the foreign genes to precise locations in the genome. There could be more than one site of insertion in a single cell. Furthermore, as mentioned earlier, the actual inserts are likely to be rearranged, or subject to deletions or repetitions.[15] Hence each transformed cell will have its own distinctive pattern of insert(s), and each GM plant, which comes from the single transformed cell, will differ from all the rest.

Note that the GM plants from the first experiment will not have the full complement of enzymes required to make beta-carotene, and should give red endosperm from the lycopene present. Only the GM plants from the second experiment which have taken up *both* vectors would possess all the enzymes needed, and give orange-colored endosperm.

UNCONTROLLABLE TECHNOLOGY AND UNPREDICTABLE OUTCOMES RAISE QUESTIONS ON SAFETY

Unexpectedly, transgenic plants from both transformation experiments gave orange polished grains. Chemical analyses confirmed that only beta-carotene, in varying amounts, was found in all lines, but no lycopene. This suggests that enzyme 4 may be present in rice endosperm normally, or it could be induced by lycopene, to turn all of the lycopene into beta-carotene. Lutein and zeaxanthin, two other products derived from lycopene, were also identified in varying amounts besides beta-carotene. All of these were absent from non-GM rice.

In addition, many other uncharacterized, unidentified products were found, which differ from one line to another. What is the nutritional value of the other products? Are any of the known and unknown products harmful? Without thorough chemical analyses and toxicity tests, it is impossible to tell. This highlights the unpredictable, uncontrollable nature of the technology.

Molecular analyses of the GM inserts were not done in any detail. Nevertheless, judging from the evidence presented, there are the usual signs of deletions, rearrangements and multiple repeats of the constructs inserted due to structural instability of the constructs and the tendency for recombination. There is no guarantee that any of the plants will give stable progeny in successive generations. The

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[14] See Ho, M. W., Ryan, A. and Cummins, J. (1999). The cauliflower mosaic viral promoter—a recipe for disaster? *Microbial Ecology in Health and Disease* 11, 194-197; Ho, M. W., Ryan, A. and Cummins, J. (2000). Hazards of transgenic plants containing the cauliflower mosaic viral promoter. *Microbial Ecology in Health and Disease* (in press).

[15] Reviewed by Pawlowski, W. P. and Somers, D. A. (1996). Transgene inheritance in plants genetically engineered by microprojectile bombardment. *Molecular Biotechnology* 6, 17-30.

instability of GM lines is well-known,[16] and is a continuing problem for the industry. Inserted genes can lose their activities or become lost altogether in subsequent generations. There is nothing in "golden rice" to distinguish it from standard first generation GM plants with all the well-known defects and hazards.

"GOLDEN RICE" IS NO TECHNICAL IMPROVEMENT AND MORE UNSAFE

"Golden rice" exhibits all the undesirable, hazardous characteristics of existing GM plants, and in added measure on account of the increased complexity of the constructs and the sources of genetic material used.[17] The hazards are highlighted below.

- It is made with a combination of genes and genetic material from viruses and bacteria, associated with diseases in plants, and from other non-food species.
- The gene constructs are new, and have never existed in billions of years of evolution.
- Unpredictable by-products have been generated due to random gene insertion and functional interaction with host genes, which will differ from one plant to another.
- Over-expression of transgenes linked to viral promoters, such as that from CaMV, exacerbates unintended metabolic effects as well as instability (see below). There are at least two CaMV promoters in each transgenic plant of the "golden rice," one of which is linked to the antibiotic resistance marker gene.
- The transgenic DNA is structurally unstable, leading to instability of the GM plants in subsequent generations, multiplying unintended, random effects.
- Structural instability of transgenic DNA increases the likelihood of horizontal gene transfer and recombination.
- Instability of transgenic DNA is enhanced by the CaMV promoter, which has a recombination hotspot,[18] thereby further increasing the potential for horizontal gene transfer.
- The CaMV promoter is promicuous in function and works efficiently in all plants, in green algae, yeast and *E. coli.*[19] The spread of genes linked to this promoter by ordinary cross-pollination or by horizontal gene transfer will have enormous impacts on health and biodiversity. In particular, the hygromycin resistance gene linked to it may be able to function in bacteria associated with infectious diseases.
- Horizontal transfer of transgenic DNA from GM plants into soil fungi and bacteria has been demonstrated in laboratory experiments. Recent evidence suggests that it has also taken place in a field-trial site for GM sugar-beets, in which transgenic DNA persisted in the soil for at least two years afterwards.[20]
- Prof. Hans-Hinrich Kaatz from the University of Jena, has just presented new evidence of horizontal gene transfer within the gut of bee larvae.[21] Pollen from GM rapeseed tolerant to the herbicide glufosinate were fed to immature bee larvae. When the microorganisms were isolated from the gut of the larvae and examined for the presence of the gene conferring glufosinate resistance, it was found in some of the bacteria as well yeast cells.
- All cells including those of human beings are now known to take up genetic material.[22] While natural (unmanipulated) genetic material is simply broken down to supply energy, invasive pieces of genetic material may jump into the genome to mutate genes. Some insertions of foreign genetic material may also be associated with cancer.
- Horizontal transfer of genes and constructs from the "golden rice" will spread transgenes, including antibiotic resistance genes to bacterial pathogens, and

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[16] Reviewed by Pawlowski and Somers, 1996 (see note 15) and others.

[17] See Ho, M. W. (1998, 1999). Genetic Engineering Dream or Nightmare? Third World Network, Gateway, Gill & Macmillan, Penang and Dublin; Ho *et al,* 1999, 2000 (note 6).

[18] Kohli A, Griffiths S, Palacios N, Twyman RM, Vain P, Laurie DA, Christou P. Molecular Characterization of Transforming Plasmid Rearrangements in Transgenic Rice Reveals a Recombination Hotspot in the CaMV 35S Promoter and Confirms the Predominance of Microhomology Mediated Recombination. *The Plant Journal* 1999, 17: 591-601.

[19] See Kohli, *et al,* 1999 (note 17) also, Ho *et al,* 1999; 2000 (note 15).

[20] Gebhard, F. and Smalla, K. (1999). Monitoring field releases of genetically modified sugar beets for persistence of transgenic plant DNA and horizontal gene transfer. *FEMS Microbiology Ecology* 28, 261-272.

[21] See Barnett, A. (2000). GM genes "jump species barrier." The Observer, May 28.

[22] See Ho, M.W., Ryan, A., Cummins, J. and Traavik, T. (2000b). *Unregulated Hazards: "Naked" and "Free" Nucleic Acids,* ISIS and TWN Report, London and Penang.

also has the potential to create new viruses and bacteria associated with diseases.[23]

CONCLUSION

In conclusion, the "golden rice" project was a useless application, a drain on public finance and a threat to health and biodiversity. It is being promoted in order to salvage a morally as well as financially bankrupt agricultural biotech industry, and is obstructing the essential shift to sustainable agriculture that can truly improve the health and nutrition especially of the poor in the Third World. This project should be terminated immediately before further damage is done.

The "golden rice" possesses all the usual defects of first generation transgenic plants plus multiple copies of the CaMV promoter which we have strongly recommended withdrawing from use on the basis of scientific evidence indicating this promoter to be especially unsafe.[24] A growing number of scientists (318 scientists from 39 countries to-date) are calling for a global moratorium on the environmental releases of GMOs until and unless they can be shown to be safe.[25]

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Senator HAGEL. Mr. Halweil, thank you.

Let me begin the questioning by asking each of our other two witnesses to respond, if they would like, in any way they would like, to what Mr. Halweil said. He brings up some interesting points, asks some relevant questions, challenges much of what we have heard here today. I would ask Ambassador Young if he would like to respond to anything that he heard.

Ambassador YOUNG. First, Africa is such an enormous continent and almost everything we have tried works, and he is probably right, where there is land reform there is improved results where people are allowed to own their land. We have done some things with cotton in South Africa that worked very, very well.

We have done some land reform work under our AID, the Southern Africa Enterprise Development Fund. What we did in that instance was actually take a plantation in South Africa and turn it into an agribusiness and made the sharecroppers shareholders, and improved the housing, the school, and also built a processing plant on the land that people worked in. It works and they are shipping food all over southern Africa.

So there are lots of inexpensive things that you can do. Most of those are politically controlled. I think one of the advantages of biotechnology is that it is largely in the hands of the private sector, and if it works and pays for itself it will continue, if it does not it will be abandoned. But that is a market reality which is true in this country as it is abroad.

As soon as anybody in this country finds any negative effect to any of these seed technologies, I am sure there will not be any trouble calling in the FDA, the Congress, and everybody else. But up to now I think that the efforts that are applied to the African

[23] See Ho *et al,* 2000b (note 11).
[24] Ho *et al,* 1999, 2000b (note 9).
[25] See <www.i-sis.org>

Continent, almost anywhere there is an effort of almost any kind it has been successful.

Senator HAGEL. Thank you.

Dr. Beachy.

Dr. BEACHY. Yes, I have some differences of opinion from the presenter. If you look at the effects of the work that the Sassagawa Foundation has done in Tanzania and other places, that worked to enable—what they did was make small loans to small farmers, small shareholders. Those farmers used that money to buy fertilizer, to buy better seeds, and they repaid their loans very rapidly. Now, they used modern technology to repay the loans, got better loans and bigger loans the next year.

The Sassagawa Foundation approach has been very important. It is small farmers being successful using a modern technology and access to capital. So in part I do not disagree at all. Poverty is the issue, accessibility to capital is the issue, but to use it in the best way is to use it in combination with technology.

The second is there was a criticism raised of large corporations for not doing more. I really find that really quite remarkable when you consider that we have the impact that we have seen in the health industry for years not paying attention to the Third World. We now have an agriculture community that in less than 5 years after commercializing a technology wants to take it to the Third World. I find that really quite remarkable, that this can happen in such a short period of time in food and agriculture, which we have not been able to do in the biomedical side.

So I think, rather than criticizing the industry, we ought to encourage the industry to do more of what they have already started to do. So those are the two things I would like to make those corrections on, because in fact there has been good success started in the last couple of years in this direction. Yes, poverty is the issue, but I do not believe that there is a way that we can avoid the solutions to those without employing the best of technology and the best of science when they are applicable to the problem. And in the case of food and nutrition and agriculture, science is relevant in addition to bringing up the best of what is in those countries in terms of their agriculture and knowledge of indigenous crops.

Senator HAGEL. Thank you.

Staying on this issue for just a moment, Mr. Halweil, if I recall what you said correctly, you made the point that poverty rather than food shortage is the main cause of hunger. I guess my question to you is how do you fix poverty? Do you not get under poverty—to get people out of poverty through productive capacity? How do you fix poverty? How do you eliminate poverty?

Mr. HALWEIL. The solutions to poverty are clearly going to be very diverse and site-specific. There is no one policy, no one intervention, that is likely to eliminate poverty. As you noted, for people who are farmers, for entire nations that are agriculturally based in terms of their economies, increases in agricultural productivity are going to be essential to reducing poverty. I am not arguing against that.

All I am saying is that the vast majority of the research and applications that we have seen from biotechnology have not been designed for the developing world. Perhaps that is obvious if it is a

technology controlled by the private sector. At the same time, we know that there is an entire range of agricultural technologies, some modern, some traditional, some hybrids of the two, that are readily available, that, as Mr. Young has noted, when they are supported and funded and implemented they tend to work.

I think that the approach that I am advocating, that we do not get distracted from the many other ways to improve agricultural productivity and therefore reduce poverty, is more of a prudent or conservative approach, given that we have not seen any biotechnology creation yet that has a tremendous amount of relevance on the large scale for the developing world. Perhaps in several years we will and that is the hope, I think, of everyone in this room. But the bottom line is there are technologies, policies, interventions available now that can meet those same goals.

Senator HAGEL. Well, my time is up and I am going to hand it over to Senator Lugar. We may have time to get back to you. But I think that you are, in my opinion, off in a direction that will cause more poverty, if we would pursue your line of reasoning. But my time is up and thank you for your answer.

Senator Lugar.

Senator LUGAR. Thank you very much, Mr. Chairman. Let me just as a point of personal privilege mention that Ambassador Young came before this committee in 1985, when he was U.N. Ambassador. We had hearings from the onset then on all the problems of the world. As I recall, Jeanne Kirkpatrick was here that day and maybe others who served in that capacity.

I mention that because Ambassador Young in extraordinary ways as a preacher, as a mayor, as Ambassador, doing what you are doing now, has looked at this issue from many different perspectives, and brings an unusual wisdom to it. I appreciated your initial comment that Africa is so big that almost everything works.

We spent most of the morning listening to Dick Holbrooke and others talking about horrendous problems, monumental difficulties on that continent. I would just say, the minutia of efforts that is coming from this country, the world, anybody, that can make any difference there is worrisome—you simply have an appalling feeling of enormous suffering and futility.

So I think that a keynote that I see from this hearing, is that we should not talk past each other. Everybody at this table is of goodwill and the question is how any of us make any difference, even at the margin. In other words, to mention that somehow most of the biotech is going on in the United States, of course it is, most if it was discovered. Other people have found parts of it, but we had the capital to go ahead with it.

Frequently people make the point to us, even when other countries spy on us or take away our technology, they do not have the capital to develop it. As a result, this makes our country unique. You mentioned Australia and some other countries, and they have capital as does Canada. And it is poverty, poverty of capital. All the capital available in Africa is very, very small.

The question is how to get the world interested in this in any way or how to help some people in Africa develop more capital. One reason is through biotech. Those people who have had a chance to do some farming and make more money on what they are doing

may produce more crops. It may be very limited, but nevertheless it is more for them. It can make a difference, and, in my judgment without harm.

Believe me, Ambassador Young is right. The first one of these seeds that is found to go amiss, the fire bells will ring, the wrath of God will fall, and that will be the end of that company and that seed. This is very serious business in terms of all of our safety. But to go through all of the pyrotechnics with absolutely no evidence is very sad.

Let me just say with regard to Dr. Beachy, I had the privilege of going out to St. Louis and visiting the Monsanto laboratories. They have replicated conditions of Africa in some of their laboratories. They have got the heat and the humidity and all of the devices that will indicate precisely what is going to happen. It is remarkable. I have spliced a soybean seed and understand how you do that and what it is likely to mean on my farm.

I am one of these American farmers who would still say that it is probably useful for us to have a better crop. Unlike African farmers, we also have passed in the Senate crop insurance and risk management. If I have no crop, I get some money, because this is the way our wealth is distributed, so that we help people. Other countries could do the same.

As you said, Ambassador, these big questions are political ones. I referenced the Sudanese who are starving each other, killing each other. Of course they are poor and some are kept deliberately poor. That is a very big issue, but it is well beyond biotech. I would say even in Sudan, where Dr. Frist traveled, if he was able to get some seed to any of those folks, that would be helpful to those particular people who might eat. We have really got to fundamentally understand this.

I have become impatient with arguments that somehow, because poverty is the big issue, because there are several other things we could do—rearranging the conservation of a country, intervening in their governments and jerking them around and say, this is the way you do it. Of course things might turn out better, but it just seems to me it is very important, even with the modest efforts we are making, and they are modest, to do what we can.

Having said all that, what are the prospects—Dr. Beachy—I ask you this because you have been involved in this science, you understand this, and obviously you are worried, as I am, about the marketing of these ideas. But how in the world do we turn this thing around from something that is perceived as purely a production agriculture matter? And I think that is important to American farmers and maybe Canadian farmers. It could be important to African farmers, too, that they get better yields, that they have safer food.

But how do we begin to talk to American consumers that the products are better for them, quite apart from African consumers or anybody else?

Dr. BEACHY. I think industry has missed a tremendous opportunity to let the consumer know what he or she has benefited from. I take great offense when people say there is no consumer benefit. That is as if our two million farmers were not consumers, because they are the ones who are using less chemical insecticides. They are the ones whose children become ill. The people who pick the

tomatoes are the ones who get sick because they get residue on their clothes that come from the tomatoes. Do not tell me that consumers do not benefit.

What we have not had is the consumer realizing that what they have benefited is a cleaner environment with two million less gallons of insecticide. We have a potato—there is a potato variety that has been developed that does not require any insecticide to grow and produce large amounts of good potatoes. But no, the consumers have said, well, let us hold off and wait and still continue with our 12 to 15 spray applications per year to grow russet burbank potatoes.

The technology exists for eliminating pesticide applications in potatoes. Ask me why it has not made it to the market and I do not know the answer. I am a scientist only. All I know is I was trained to get rid of chemical pesticides out of food. That is what my Ph.D. at Michigan State was about.

At the same time, we are being told that these are not in consumer interest. I think if the consumer knew the value of the technology for the environment that would turn in some way, some small degree, a percentage of people to realizing that technology is relevant, not just the farmer to get the next 200 bushels per acre up from your 140, but also for the benefit of the air and the water and the soil.

So I think there is a consumer benefit; it is being described in a different way. There are other products that we have seen coming out of companies that are farther along than I think we realize, that will have nutritional benefit in addition to the vitamin A, and maybe that will make a difference.

But I think consumers are sensitive to the environmental issues. I think the companies have not done a good job in telling us what those benefits are, because they are real, they are substantial, and they are long-lasting.

Senator HAGEL. Senator Bond.

Senator BOND. Thank you, Mr. Chairman.

Mr. Halweil, you have said you do not know of any instance where GMO's have helped farmers in underdeveloped areas. Are you familiar with the planting of B.t. cotton in Ubay Province in China?

Mr. HALWEIL. Sure.

Senator BOND. And what was the results of the use of the B.t. genetically engineered cotton seeds in China?

Mr. HALWEIL. I think there were roughly 300,000 hectares of B.t. cotton planted in that province in China and the results for those farmers were largely the same as the results for American cotton growers, the other population of farmers that are planting B.t. cotton. You had some reductions, not total reductions, marginal reductions, in the pesticides sprayed for that complex of pests that was mentioned before, though it had no effect on other pesticides sprayed on cotton.

To the extent that there was a saving in terms of production costs from that reduced spraying, that went into the farmer's pocket. But you have to subtract out of that the additional money that the B.t. cotton seed might have cost in addition to what the traditional cotton varieties cost before.

Senator BOND. Well, my information, it increased the farmers' revenue by $200 per hectare. It seems to me that that reduces poverty. That keeps the farmer on the farm. That was the information that we learned, that farmers who are starving to death because they could not produce the cotton, because they could not afford the pesticides, with the use of B.t. cotton could make a living.

Let me just ask. You said apparently—I sense this bias against corporations and I know that a lot of NGO's do not like corporations or profits or commercialization. You said that the people using genetically engineered seeds were the large industrial farms, people like Pam and Charlie Kruse's farm. I know these people. I live in the area where they work. They are a husband and wife who farm and produce. Is there something wrong with them producing crops more efficiently, with less pesticides, cutting back on the use of pesticides? Is there something wrong with the farms that we have in Missouri because they are efficient?

Mr. HALWEIL. There is absolutely nothing wrong with that. All I thought was that this hearing was on the subject of biotechnology for combating hunger and poverty in developing nations.

I would like to maybe followup on the second part of your question on pesticide use in the environment.

Senator BOND. OK. I tell you what. I am running short of time and I am sure that the chairman would be happy to have a statement on it.

But I do want to followup in the little time I have remaining to ask Dr. Beachy—Ambassador Young, I am sorry I do not have a chance to ask you questions—if you would comment, No. 1, on the fact on the donation by corporations of, say, the information on mapping the genome of rice. I believe there has been a major donation by a corporation who made profits by selling to the farmers in Missouri to donate that technology to developing countries.

I also think it might be helpful for you to comment on the basis of the scientific regulatory scheme that we have in the United States to assure that when there is a problem such as a brazil nut gene included in a soybean which might cause an allergic reaction to someone allergic to peanuts, that the process stops that.

Finally, you might want to comment on Mr. Halweil's assertion that there is a danger, "the risky scheme" I think is the current terminology, of biotechnology in possibly carryover transposing to other plants.

Dr. BEACHY. In the short time that I have, those are each good questions and comments you have made. One, major corporations are getting involved in donating information in addition to technology. Monsanto Company several weeks ago donated the genetic map, the full genetic blueprint of rice plants, of rice genome, for everyone in the world to have. This is a multinational attempt to characterize all the genes in rice.

With the aid of the donation that Monsanto made, they will shorten by about 3 years the amount, the length of time it is going to take to put all the genes in order and all the sequences in order, much like the human genome mapping is going on now.

We are very close, similarly, to a rabidopsis, which is our model dicot plant, with rice being the model monocot for corn and wheat and others. So there is a tremendous amount of effort being made.

There is a second example of technology development or donation. I believe it is the Novartis Company that has donated some technology for their transformation technology to avoid using some of the selectable markers for antibiotic resistance and have donated another kind of technology for selection to everybody in the academic as well as in any public sector community.

The basis of regulation is one that I participated in back in the eighties and was involved with the FDA in helping to establish part of the regulatory process that they have used to assure that foods are safe. That process has gone through a lot of revisions over the years and it will continue to go through more revisions as more data are gathered. But in fact it is an incredible process that we have never before applied foods to.

You know, if somebody brings in a kiwi fruit from a new country and says that this kiwi fruit is good to eat, how do I know that? What is the regulatory process that tells me that that kiwi fruit is safe? We go back to that country and say: Has anyone gotten sick from it? How many have allergies?

In the case of the FDA and the regulatory process and oversight of these foods, produced by a slightly different technology, we now have in place an examination of foods that has never before taken place. The decision tree is so filled with cross-lines that the chance of something getting from here down to here onto the marketplace is extremely minimal. And they have looked at all the scientific evidence that is presented before they make a decision that this gene trait that is introduced into strawberries or corn or soybeans or wheat now and in the future are well regulated and well designed and well overseen.

The whole idea of risk management and how you do that has come about because of, in response to, a technology that is unique and perhaps it is necessary because it is unique. The risk management oversight by the USDA and the EPA are based on questions that are raised outside and then on the applications of good solid science to make sure the risks are minimized or eliminated.

I remind you, never before have we put any of our agricultural products to the same examination and test. So we have done so with these crops in a way that I think convinces me, I know it convinces me, to say that the foods that are out there now derived from these crops are safe and that the plantings in the fields have little or no risk, certainly no greater risk than any of the existing crops.

So it is the science that teaches me that, and I think if we diverge from the applications of the principles of evaluative science in the same way, if we diverse from that, I think we put ourselves at tremendous risk not only on the health side, but the environmental side as well. That is what we have. That is what we have done in this country, asked science to make our way for us.

Senator HAGEL. Thank you.

Senator Ashcroft.

Senator ASHCROFT. Senator Hagel, thank you very much.

The senior Senator from Missouri's humility prevented him from presenting an article he has written in Science magazine from February of this year, and I would like to submit it for its inclusion

in the record, along with of course the item from the Washington Post.

Senator HAGEL. It will be included in the record, Senator.

[The article referred to follows:]

[From Science, Vol. 287, February 18, 2000]

SCIENCE'S COMPASS—SCIENTISTS ORIENTING SCIENTISTS

POLITICS, MISINFORMATION, AND BIOTECHNOLOGY

(By Christopher S. Bond [1])

In the past half century, the number of people fed by a single U.S. farmer has grown from 19 to 129. Despite this stunning advance, intractable health and nutrition problems remain. The world's population continues to grow even as available farmland shrinks. Preventable illnesses and malnutrition still claim the lives of many children in the developing world. As the new millennium gets under way, policy-makers, health care professionals, scientists, and others are searching for the tools to meet the increasing demands of a growing and changing world. Chief among these tools is biotechnology. Leading scientists have concluded that, although still in its infancy, biotechnology has breathtaking possibilities for improving human health and nutrition and that a satisfactory regulatory system is in place to govern its development.

Despite this consensus, a vocal, aggressive—and in some cases, lawless—group of advocacy organizations seeks to discredit and eliminate biotechnology. At issue is the alleged risk that any genetically modified plant may pose to the environment. However, the issue of risk is by no means one-sided. Yes, we must understand whether transgenic corn poses more risk to the Monarch butterfly than does the existing practice of using synthetic chemicals. However, the greater risk, in my view is that without a scientific basis, the naysayers may succeed in their goal of subverting biotechnology and thus condemn the world's children to unnecessary malnutrition, blindness, sickness, and environmental degradation.

Although positive change is to the collective long-term benefit of us all, it typically results in short-term difficulties, anxiety, and fear for some. Opposition of the sort I witnessed at firsthand while at the December 1999 World Trade Organization meeting in Seattle, Washington, has been driven variously by trade-protectionist and anticorporate sentiment, by competing food marketers such as the whole-foods industry, and by scientifically unsubstantiated fears of change and technology. Some of those who seek to undermine biotechnology are not interested in seeking information or constructive dialogue. Some in Europe have adopted a constrained trade policy that consists of exporting little more than hysteria, which we can expect to energize the professional political ambulance-chasers here in the United States. Sadly, the actions of radicals such as those who recently vandalized test plots in California and set fire to research offices at Michigan State University are not harmless pranks; rather, such tactics lead to diminished public understanding of the benefits versus the risks of biotechnology.

Diminished understanding is key to obstructing biotechnology. In discussions of fact, the scientific viewpoint will prevail. However, public education will remain challenging. Given the nature of the modern media, will scientists have to start dressing up as corncobs, as some protestors have done, to get media attention? During the past 2 years, I have asked scientists to work with their local media representatives and public officials to help them separate fact from fiction. After the problems in Seattle, it is clear that much more must be done. We must work diligently to ensure that consumers, who drive food production, are adequately informed about the science supporting the uses of biotechnology. Input from the scientific community is vital, but we cannot count on the media to find scientists; scientists must actively seek to influence the media. As we work to counteract the naysayers, we should be encouraged that most Americans, and many others in developed countries, embrace technological advances and are generally receptive to the benefits that new technologies bring to their lives.

A protocol for an international agreement regarding trade of genetically engineered products has just been released. Although full understanding of the implications of the agreement will not precede its implementation, we can all hope that it will serve to better inform all citizens and depoliticize the process in favor of science-based decision-making.

[1] The author is the senior Senator from Missouri in the U.S. Senate.

The development of this technology is not recreational. Through biotechnology, scientists are attempting to solve the real-world problems of sickness, hunger, and resource depletion. The hysteria and unworkable propositions advanced by those who can afford to take their next meal for granted have little currency among those who are hungry. It will be up to the policy-makers, advocates for the needy, scientists, the media, and others to ensure that reason, not hype, prevails. <www.sciencemag.org>

Senator ASHCROFT. Dr. Beachy and Ambassador Young and members of the panel, thank you for your efforts and thank you for coming. Particularly, Dr. Beachy and Ambassador Young, I want to thank you for your efforts on sustainable agriculture and economic development. And I am pleased to have a Missourian here representing the Danforth Center and testifying before this committee, so I am grateful.

Ambassador Young, I appreciate the many years of experience you have and that you bring before the committee as one actively involved in the betterment of developing nations, most notably on the Continent of Africa, but around the world.

Both of you have been kind to send me letters of endorsement for Senate bill 2106, Advancing Global Opportunities for Biotechnology in Agriculture. Mr. Chairman, I would like to submit for the record additional letters of support from the dean of agriculture for the University of Missouri, from the president of Michigan State University from the director of Harvard Center for International Development. If you would receive those and include them in the record, I would be grateful.

Senator HAGEL. They will be included, Senator.

[The letters referred to follows:]

DONALD DANFORTH PLANT SCIENCE CENTER,
7425 FORSYTH BLVD., SUITE 3100,
St. Louis, MO, March 15, 2000.

The Honorable JOHN ASHCROFT
Hart Senate Office Building,
Room 316,
Washington, DC.

DEAR SENATOR ASHCROFT:

I am writing to offer my full support of Senate Bill 2106 and to thank you for introducing it. This bill would provide technical support to train Scientists from developing countries in the areas of agricultural biotechnology and biosafety. It is obvious that many of our potential partners in developing countries have much to gain from the application of new technologies in agriculture, including biotechnology. It is clear, however, that many countries lack the scientific skills and policy expertise to evaluate safety of new products. This bill would make it possible to provide training for those countries to allow them to better evaluate the products of American agriculture and to begin to develop their own intellectual strengths in this important area of science.

S. 2106 would help to facilitate the training of postdoctoral researchers and students at the Donald Danforth Plant Science Center. The Danforth Center has a highly successful research and training program called the International Laboratory for Tropical Agricultural Biotechnology (ILTAB). We expect that S. 2106 would help to support trainees at ILTAB and the Danforth Center, making it possible for us to reach more scientists from around the world who will play an important role in the research, development and biosafety of agricultural products in their home countries.

I urge your continued support of this bill and look forward to visiting with you in the future so that we might discuss the Danforth Center and ILTAB at greater length.

Sincerely,

ROGER N. BEACHY, PH.D., *President.*

GOODWORKS INTERNATIONAL, LLC,
Atlanta, GA, March 15, 2000.

Honorable JOHN ASHCROFT
Senate Hart Office Building,
Room 316,
Washington, DC.

DEAR SENATOR ASHCROFT:

It is with great pleasure that I write to you in support of S. 2106 which supports capacity building for agricultural biotechnology applications in Africa and other emerging markets.

As you may be aware, I have been involved in outreach to Africa in support of biotechnology for some time now, realizing the great potential for biotechnology to help solve problems of starvation, illness and environmental degradation in some of the world's poorest areas. I remain committed to biotechnology as an important tool for agricultural development, which will allow African nations to feed their growing populations through sustainable practices in the years ahead. Innovations such as Vitamin A-enriched maize will help protect future generations of Africa's children from debilitating illnesses such as river blindness, and could even work as a nutritional supplement in the fight against HIV/AIDS. Similarly, the development of virus-resistant sweet potato and cassava will increase yields for these important food security crops which are widely consumed in the developing world. These are only a few examples of how technologies developed in the U.S. can address the needs of a growing global population.

Later this year, I hope to visit KwaZulu Natal, South Africa, where small farmers in the Makathini Flats area are successfully growing genetically enhanced cotton. I understand that field trials have been so successful that the number of small growers in the Makathini area using the genetically enhanced seed has grown from 60 during the 1998-99 season to more than 600 in 1999-2000. This example of biotechnology's potential in Africa is particularly appealing to me in that small family growers make up the vast majority of producers on the continent, and any advantage to their productivity has an immediate impact on their quality of life. I believe this type of positive impact is what we want to achieve through foreign aid and scientific exchange with Africa and other emerging markets.

But for biotechnology to take root in Africa, the U.S. and other countries promoting agricultural biotechnology must make significant investments in education and training abroad. This became apparent to me over the last year through my work on the Biosafety Protocol to the Convention on Biological Diversity. The "Like Minded Group" of developing country delegates to the Protocol negotiations, led by a bloc of African nations, took a strong stance against biotechnology. The reason for their position was due, in large part, to propaganda and misinformation distributed by environmental groups that promoted irrational fears among many delegates. In the absence of scientific knowledge and understanding about biotechnology, these fears threatened to close the door on the trade of genetically enhanced goods. The type of programs, supported by S. 2106, which will promote the sharing of technologies and expertise with the developing world will be extremely effective in building a basis for acceptance and support of biotechnology in critical areas of the world. This is vitally important in our struggle to help African nations achieve sustainable agricultural practices that provide food security for their people.

Thank you for your time and consideration. Please call of me if I may be of assistance in promoting this important piece of legislation.

Sincerely,

ANDREW YOUNG.

OFFICE OF THE PRESIDENT,
MICHIGAN STATE UNIVERSITY,
East Lansing, MI, March 16, 2000.

The Honorable JOHN ASHCROFT
Hart Senate Office Building,
Room 316,
Washington, DC.

DEAR SENATOR ASHCROFT:

I am writing you in support of Senate bill 2106, the *Advancing the Global Opportunities for Biotechnology in Agriculture Act of 2000.*

Today, there are more than 840 million poople—a number exceeding the combined population of Europe, U.S., Canada and Japan—who do not have enough to eat. Every minute, some 30 people die of hunger in the developing world and half of these are infants and children. More than 170 million preschool children are undernourished. More than a half-million children go blind each year from lack of vitamin A, and iron deficiencies are responsible for anemia among many millions of women and children, making them vulnerable to a host of diseases.

Millions of farmers worldwide eke out livelihoods under poor and risky growing conditions while suffering from poverty, hunger and poor health. Food production will likely have to double to feed an additional two billion people by 2025.

To prevent a crsis, the world community must simultaneously confront the issues of poverty, food insecurity, environmental degradation, and erosion of genetic resources. The power of science, while not sufficient by itself, can assist in benefiting the world's poor. One area of science is biotechnology. Biotechnology can shorten the time and cut the costs required to develop new crop varieties. Biotechnology tools can introduce genes that counter soil toxicity, resist insect pests, and increase nutrient content in crops.

The U.S. is the world leader in agricultural biotechnology. However, very little of this research effort has been directed at developing country agriculture. This is because the private sector, which has invested most in this new technology, does not see a viable market for their products in these underdeveloped markets. In addition, public sector efforts to use biotechnology on behalf of poor farmers and consumers have been uncoordinated and under-funded. Despite this, there are a number of exciting results awaiting widespread testing and dissemination, including:

Genetically modified rice to provide more iron and vitamin A.

Genetically modified rice that provides protection against submersion in India.

Use of cotton in China with resistance to insects.

For most people in developing countries, a better standard of living depends on increasing productivity in agriculture. Modern biotechnology research, together with appropriate policies, better infrastructure and traditional research methods, can bring benefits to millions of poor farmers and consumers.

The U.S. Agency for Internatioal Development (USAID) has been bringing biotechnology to developing countries via a program managed at Michigan State University (MSU) and involving scientists from other universities such as Cornell, University of Texas (Dallas) and Ohio State University. The Agricultural Biotechnology Support Program (ABSP) takes an integrated approach, providing developing countries with an opportunity to work in collaboration with public and private sectors in the U.S. on important agricultural problems to developing countries. This "ownership" of the technology provides an important impetus to develop regulatory systems that will permit the use of technology developed, in part, "at home." ABSP provides technical assistance in the development of regulatory systems by using expert consultants from the U.S. public, private and government sector, and trains scientists, lawyers and policy makers in the drafting of regulations and in the implementation of science-based regulatory reviews.

While this program is unquestionably successfully where it has operated, with functional regulatory systems in Indonesia, Kenya and Egypt, the program has been limited by low-levels of funding. S. 2106 will help address this discrepancy, provide additional opportunities to promote biotechnology abroad, and will also provide a mandate for more coordination between the U.S. University community and the U.S. regulatory agencies.

I urge the Committee on Foreign Relations to support S. 2106 in order to increase the benefits of this technology to those who need it most, to provide a framework for enhanced collaboration between the U.S. research and business community with partners in developing countries, and to promote increased and open trade in improved agricultural goods and services.

Sincerely,

PETER MCPHERSON, *President.*

CENTER FOR INTERNATIONAL DEVELOPMENT AT HARVARD UNIVERSITY,
79 JOHN F. KENNEDY STREET,
Cambridge, MA, April 25, 2000.

Honorable JOHN ASHCROFT
U.S. Senate,
316 Senate Hart Office Building,
Washington, DC.

DEAR SENATOR ASHCROFT,

We are writing in connection with the Senate Bill 2106 on "Advancing the Global Opportunities for Biotechnology in Agriculture Act of 2000." Agricultural biotechnology offers great potential to address many of the argricultural, nutritional, and health problems of developing countries, especially in Africa. Efforts to promote the use of biotechnology in developing countries are currently being undermined by inadequate international assistance to support scientific and technical cooperation, biotechnology education and diplomatic outreach. We therefore wish to support the Senate Bill 2106.

We consider this bill to be a starting point in a more substantive effort that will bring the scientific and technological leadership of the United States to bear on global agricultural, nutritional health and environmental challenges.

Yours sincerely,

PROFESSOR JEFFREY SACHS, *Director.*

DR. CALESTOUS JUMA, *Program Director,*
Science, Technology and Innovation.

Senator ASHCROFT. I would like to call upon either Ambassador Young or Dr. Beachy to comment on how you feel that Senate bill 2106 can help developing countries in terms of making the kinds of decisions necessary for them to bring their situations into a setting where individuals are more survivable and more sustainable.

Ambassador YOUNG. If I might start, simply to say that I know it is incredible, but I view Africa as a place of tremendous opportunity. All that you say about the problems and the dangers is probably true, but I also know of literally hundreds of billions of dollars that are being invested in a variety of operations on the African Continent that very shortly are going to make Africa a center of attention.

One of the things that they are going to have very shortly is some of the resources to deal—that will enable them to deal with the specific on the ground agricultural problems. I think to have the scientists already trained, to have them working to do, to think about the government policies—we are going to remove the land mines from Angola and from Mozambique, and that is wonderful arable land. But right now there is nobody that could tell you what to do with it.

I hope that Dr. Beachy, with the help of your bill, will be training the scientists and agronomists that will be ready when Africa is ready to respond to these kinds of problems in their own way.

Dr. BEACHY. I guess the easiest way to answer your question, Senator, is to say that—is to remind us that we trained a number of people from Africa in ILTAB, our International Laboratory. We have received in the last 6 weeks or 8 weeks 12 applications with full CV's from scientists, from trainees, from Africa, from at least five different countries, who want to come to learn more about the technologies, who want to make themselves knowledgeable, who want to know about biosafety, who want to know about what the role these plants can play in sustainable agriculture.

We cannot fund them. Any of the resources that are made available we want to compete for, because I think that there is an absolute need. How do we respond and how do we do it the best and who is the best place to do it, I think that question comes after the bill is passed. But I hope that bill is awarded and I hope that it is this year, because the needs are now.

We have talked about, the needs are not—the needs were yesterday and every day that we delay is I think a miscarriage to humanity and the places of need.

Senator ASHCROFT. Mr. Chairman, I want to thank these individuals for coming. I have one other item I would relate, and this relates to the Pontifical Academy for Life and its pronouncements on biotechnology. Bishop Elio Isgreccia, Vice President of the Pontifical Academy for Life and Director of the Institute of Bioethics and the Sacred Heart, University of Rome, explained: "There are no specific indications from the magisterium of the church on biotechnology. Because of this, I have stopped all those who demand the condemnation of these products." I think he further says: "Following research in the biotechnology field could resolve enormous problems, as for example the adaptation of agriculture to arid land, thus conquering hunger. The biotechnological products must contribute to man's wellbeing, giving guarantees in the face of possible risks. Therefore, what is needed is honesty."

With that, I cease that quotation, but I think that reinforces and underscores the testimony of Secretary Sandalow and what we all know, is that we want to be involved in science-based evaluations and we want those with whom we deal to be involved in science-based evaluations. That is the underlying thrust of our assistance to these other countries, to allow them to make intelligent judgments based on facts and science.

So it is with that, I thank the members of the panel and I thank you very much for convening this hearing. I think it has been most productive.

Senator HAGEL. Senator, thank you.

Gentlemen, let me ask your indulgence for just a couple of minutes. Mr. Halweil, you kind of got left out of the last 10, 15 minutes. I would offer you a couple of minutes if you would like to just summarize a couple of points. We will give you 2 or 3 minutes if you would be interested. I just want to make this as fair as we can, and you did not get some last questions, so you have got 2 or 3 minutes.

Mr. HALWEIL. Thank you, Mr. Chairman. I appreciate the opportunity. What I think I will take my time to do is answer the question which you asked me, which I think I answered very briefly, which is what I would do if I was in control to eliminate poverty, what I think would eliminate poverty and what I think this committee could do to eliminate poverty.

The Committee on Foreign Relations has not always been so friendly to funding for international reproductive health care assistance. I think that is one place in which the committee can make a serious dent in poverty. There is very good evidence that access to reproductive health care is often the important first step in diverting attention from dealing with very large families to investing in those children that families already have. In that sense, family

planning, access to family planning, is an important step in reducing poverty.

I also think that, although many of the issues mentioned here today were described as solely political conflicts, the role in creating hunger, poverty's role in creating hunger, land distribution, that it is also a political issue to hope that some time in the future in some lab there will be research results, there will be research that results in a biotechnology that is cheap enough to mass disseminate to the world's poor and hungry populations.

So I would encourage the committee and this Subcommittee on International Economic Policy to look at what we have called political issues, including phenomena like population growth, and see what inroads we might make into those sorts of issues.

Thank you.

Senator HAGEL. Mr. Halweil, thank you.

Ambassador Young, thank you. You are one of the preeminent public servants of our time, public-private. You continue to contribute to the betterment of mankind and we are grateful. Thank you, sir.

Doctor, much success. We are grateful to you for what you have done and will continue to do.

Thank you.

[Whereupon, at 4:10 p.m., the subcommittee was adjourned.]