THE WORLD FOOD PRIZE
2008 NORMAN E. BORLAUG INTERNATIONAL SYMPOSIUM
Confronting Crisis: Agriculture and Global Development in the Next Fifty Years
October 15-17, 2008 - Des Moines, Iowa

PROMISES AND CHALLENGES OF NEXT-GENERATION SCIENCE AND TECHNOLOGY
October 15, 2008 – 3:30 to 4:45 p.m.
Moderator: **Scott Kilman –** Senior Writier, *The Wall Street Journal*
***Participants*: Martin Fisher –** Founding Director/CEO, KickStart
Bernadene Magnuson – Senior Scientific and Regulatory Consultant, Cantox International
Clay Mitchell – Saltonstall Fellow, Cornell University; Owner, the Mitchell Farm
Roberto Rodrigues – Co-chair, Interamerican Biofuel Coalition
Paul Schickler – President, Pioneer Hi-Bred International, Inc.
Judi Wakhungu – Co-chair, International Assessment of Agricultural Knowledge, Science, and Technology for Development

INTRODUCTION
Gordon Conway
Chief Scientific Advisor, UK DFID

We're turning now to a new conversation, basically about technology. We know that technology has a lot of promise. We also know that technology doesn't necessarily deliver on its promise.

I'm really delighted to introduce the moderator here, is Scott Kilman. Scott was the person who was responsible for me reading *The Wall Street Journal* pretty regularly when I lived in New York for seven years. It wasn't *The Journal* I naturally turned towards, but as soon as I discovered his articles, then I did. He's a senior writer of *The Journal*. He's written for years on a whole range of agriculture and food issues, covering things like genetic engineering, price fixing in the agribusiness industry, recent upheavals in the commodity and food price markets.

He was recently an adjunct fellow at the Chicago Council for Global Affairs. And he and his colleague, Roger Thurow, are in the process – I thought you were writing the book when I was there at Rockefeller five years ago. Huh? Oh, it's "Big Energy." I just thought that's a rather long book for journalists.

Anyway, Scott, it's going to be called *Global Hunger*, and it'll be out soon – right? Scott, please come to the platform. Thank you very much.

CONVERSATION
Scott Kilman
Senior Writer, *The Wall Street Journal*

Well, it's nice to be in a room full of people who don't want to talk about the stock market. My cell phone is set to go off – if it goes below 7000, you'll know, because my suit will start to vibrate, and I'll have to go do another story.

If we could have the panelist members come on up. We're going to try to keep this very informal. You know, it's billed as a dialogue, so what I hope to have happen is that the members of the panel will ask questions of each other, and we'll have questions from the audience. And my job is to ask questions and try to keep the conversation going.

And so after we talk for a while, I'll look out in the audience, and just raise your hands, and we have mics in the front. I was at the U.N. a couple of weeks ago and was doing something similar to this, and I caused a minor problem because I didn't realize that at the U.N. you don't raise your hands, you take your nameplate and you turn it at an angle. So I kept seeing these people with their placards changed. I didn't know what it meant, and finally somebody – I think it was one of the presidents of an African country – reached over and explained to me what I needed to be doing.

And I think several of the folks here I know, some I've met before, not everybody that I've met, but the way I want to do this if possible is I'll introduce each of you. If you could just talk for a minute or two about what your group or what your company does, you know. The theme that we're talking about – and it's very broad – just what science and technology is there that could make a difference to fighting hunger and improving food security. And clearly you can tell by the size of the panel that there's many different paths and tactics that we can take.

And I'm actually reminded of the story – it's part of the book – about how, I guess it's like the butterfly-wing example. You know, one thing starts something else in motion and it snowballs. And I was thinking of the story of Henry Wallace, the founder of Pioneer, when he ran with Roosevelt and the ticket won – Roosevelt had a way of doing that. And Henry Wallace was going to be the incoming vice president.

He had some time to kill, and Henry Wallace decided he was going to take some time to improve his Spanish. Not too many vice presidents you can think of who would do that anymore. And so he asked Roosevelt, "Where can I go where I can practice my Spanish? I want to go practice my Spanish. Where do you suggest I go?" And Roosevelt sent him to Mexico. And it was an interesting place for him to go, because the Mexicans and Wallace had something in common, which was a passion for corn, or maize. And when Wallace was there, he was astounded at how poorly the farmers of Mexico were doing in a place that was the birthplace of corn.

So he came back to the United States, and one of the first things he did when he was vice president was ask the Rockefeller Foundation to look at whether they could start doing agricultural development programs in Mexico. The Rockefeller Foundation had been doing work with medicine and vaccines overseas. The Rockefeller Foundation got interested. A group was started. Norman Borlaug was hired as a young man, from DuPont. He came across the idea of shuttle breeding, which led to semi-dwarf wheat, and eventually rice, and here we are today.

But it was all because – I wonder when it would have started, or how soon it would have started, if Henry Wallace hadn't decided he wanted to brush up on his Spanish.

So let's start first with Martin Fisher. He's the CEO – and you can just sit where you are and talk; I think there's mics by you, right? – Martin Fisher is the CEO of KickStart, which I've actually seen his products on the road. I was in western Africa last year, and you'd see people walking down the street or trying to drive their bike down the road with one of these metal water pumps on their

backs. And it's clear to me that it's made quite a difference to a lot of people's lives. So if, Martin, you could just explain a little bit about what your company does.

Martin Fisher
Founding Director and CEO, KickStart

Great. So KickStart is really trying to solve the problem not only of food security but of income security. Because as any poor farmer will tell you, they actually need money as much as they need food, they need to buy farm inputs and everything else, education, and healthcare.

And of course the best way to get income security as a farmer is to grow a high-value crop that you can both eat and sell for a high price in the local market. And unfortunately, simply growing a lot more of the same staple crop with better seeds and fertilizer very often doesn't work because the price at the rain-fed harvest is very low and you can't sell your crop, and you can't store it because you don't have storage, and there's no transport to take it away.

And so in Africa, 40 percent of the crops actually go to waste. So it's not clear that just growing more crops with rain-fed harvest is the solution. And this is where irrigation comes in, because with irrigation, of course, you can grow crops throughout the year. You can grow high-value crops, and you can especially sell them during that long period when no other crops are available on the market.

And in Africa there's very little irrigation. We've heard the number; less than 4 percent of the land is irrigated compared to about 42 percent in Asia, or if you just look at China alone it's over 50 percent of the land irrigated.

But there's really no good technology for irrigation in Africa. Large-scale schemes, I think we all know the problems with them, and not only environmental ones but the management issues. And there's good evidence that small-scale schemes work a lot better, or even individual schemes. But, of course, there's no technology for the farmers. Petrol pumps are too expensive for irrigation, and there's no electricity.

So at KickStart – which we set up to solve this problem – we've designed a line of human-operated irrigation pumps. And I'll just jump on the pump very quickly here and show you what it does. This is what we call our Super MoneyMaker Pump, because as I said, a poor person really is concerned about making money.

You walk back and forth like this. You have a hose pipe that can go into a water source, into a well as deep as 25 feet, or into a pond. And there's another hose pipe on the other side. You can pressurize the water here to the top of a hill, 200 meters along a flat, and irrigate 2.5 acres. This pump retails at $100. This little pump here will irrigate 1.25 acres. You simply operate it like this – we call it the hip pump. Again, it can pull water from 25 feet deep and a couple hundred meters of hose on a flat or up a hill.

To date we've sold over 100,000 of these pumps, and we do very careful impact monitoring. And over 70,000 families are using these and have used them to generate substantial incomes from the irrigation – over 50,000 under irrigation with these small technologies.

But the potential in Africa alone for these is something like 20 million farmers who could use these technologies. We're clearly just scratching the surface. And what one has to do, of course, is one has to not only have a great technology which is affordable – like I said, $100 and $35. But you also have to get it to the farmer.

And so we have a network of over 450 retail shops – every village, market, town where people can go and buy these pumps. And then we have to make the farmers aware of these technologies, and we do mass-marketing campaigns, everything from live farm demos, billboards, radio, and newspaper – huge mass-marketing campaigns to tell farmers, "Okay, you want to make money? Go down to your local shop, buy a pump and get out of poverty."

Now, we use our donor funds to subsidize those market campaigns, because there's a fundamental market failure. Private companies will not design equipment like this for very poor farmers in Africa. It's simply too expensive to get the equipment to them. And this is why farmers in Africa still use that wooden-handled hoe and the machete – and those are the only two tools most of them have, because the private companies won't do this.

We use donor funds to overcome that market failure. You get to a tipping point where everybody knows about this technology, and then just like bicycles, they become profitable to sell in Africa, and it's only that way, through the private sector, using private-sector players, that we can actually enable farmers in Africa to access better technologies.

Thanks.

Scott Kilman

Thank you. Clay Mitchell is a farmer near my hometown. He lives and farms south of Waterloo. He's a corn and soybean farmer of, I think he said, 2,500 acres. And in many ways you're seeing what the future of farming could well look like. Maybe in about 10 years there'll be more farmers farming the way Clay does. So if you can explain a little bit about how your farm operates.

Clay Mitchell
Cornell University/The Mitchell Farm

My family has been farming near Waterloo for about five generations. And first I'd like us just to think for a moment about how much farming has changed in the United States in that time. Clearly, even if I was farming using the methods from a few generations ago, I wouldn't be able to be in business now. Technology is having a much greater impact on farming in the U.S. than policy has, to the point of making policy seem puny, even.

And a lot of what I talk about leads to an obvious question: How can these technologies be transferred to the developing world? How can we get them there now? And I don't have a clear answer for that. But one thing that we do know about technology trends is that successful technologies do spread eventually. And even if we're out of phase, I think that a lot of these lessons from the U.S. will apply in other parts of the world in time.

And some of these are failures. One of the examples of that would be precision-farming technology in the U.S. So this is what really academia has focused on in the last two decades –

variable rate application of fertilizers and seeds and chemicals to match variable needs throughout the field, due to different soil types and different topography. And the adoption of these technologies has really been negligible in the developing world.

And there are various reasons for that, including the difficulty of the technologies and the dependence upon massive amounts of information. But the biggest reason for the failure is because it's not the most important thing on the farm. It's not the most important thing for the farm productivity. And on the farm, if a person is not working on what is the biggest limitation to productivity, there's an opportunity cost to that.

And the most important things still in the U.S. and most parts of the world tend to be timeliness of applications, water-management issues, and the quality of the application. And we're still doing a very poor job on all of those basic things. And the technologies that have become adopted readily in recent years address those with large, out-of-the-box gains.

And those depend largely on automation, particularly the merging of automation with survey-quality GPS for sub-inch-accurate application of chemicals and fertilizers and seed. And this also enables novel and otherwise impractical farming systems like controlled traffic farming, intercropping, and things like this.

I think that in the future it also creates a new opportunity for bringing more information about what's happening on the farm into the public domain. Right now there are a lot of environmental models built on very thin-air assumptions that the models are highly sensitive to. USDA reports about crop productivity, planting intentions, and harvest come out once a month. The market still reacts to them, but it is known that the quality is not very good on these reports; they're certainly not quite as good as some of the private reports.

The controllers that are used in today's automation are capable of recording and uploading in real time what the status is of what's actually going on on the farm. And that's part of what I see for the future.

The trends in technology are some of the most predictable trends in agriculture that we have. Yield increases are as predictable in the U.S. as Moore's Law is to computer hardware. It's almost certain that we will have fewer people in farming, yields will increase, and that successful technologies will transfer to parts of the developing world.

Scott Kilman

Thank you. Our next speaker reminds me of – journalists are supposed to be able to know a little about a lot of things. And Berna Magnuson knows a lot about little things; she's our expert on nanotechnology.

Bernadene Magnuson
Senior Scientific/Regulatory Consultant, Cantox Health Sciences International

Hi. I'm Berna Magnuson. I was asked to mention what company I represent. I'm with Cantox Health Sciences International. We're a consulting firm for the food and agricultural industries, providing expertise in food toxicology, food safety, and regulatory compliance.

I am here today, though, representing IFT, the Institute for Food Technologists, as I am one of the lead people involved in promoting and increasing our understanding of the use of nanotechnology in food and food-related industries. So I'm going to just explain a little bit about what is nanotechnology and just how small is "small."

Nanotechnology is defined as science and technology at the atomic or molecular level with at least one dimension being within the scale of 1 and 100 nanometers. So what does that really mean? How big is a nanometer? And the best way to probably try to describe it is something that you're familiar with – that is a human hair. A nanometer is $1/100{,}000^{th}$ of the width (not the length), the width of your human hair – so it's really, really teeny. It's $1/1000^{th}$ the size of bacteria.

So you cannot actually see nanometer with a regular light microscope; you need to go to much more accurate and highly technical imaging-detection systems.

So what does that have to do with anything? The importance is that once you get down into that level of a nanoscale, properties of very familiar things actually change quite dramatically. So our chemical properties, physical properties, and biological properties of familiar materials change.

So for again, example, the gold that many of us would be wearing on our finger or in our ears or wherever would have very different properties. Instead of actually being colored gold, at the nanoscale it looks blue. Instead of being very stable and something you don't worry about having on your finger, it is highly catalytic and reactive. Also the melting point changes very dramatically.

So a very exciting aspect of nanotechnology is that we can create new properties, and discover new properties of current materials, which then provide very new and exciting applications. And there is a great excitement and a great deal of investment in the use of nanotechnology in pretty much every industry in developed countries. And it is only now really starting to move into the food industry. And we can kind of talk about why the food industry is last out of the chute there, as our conversation goes on, just in terms of where are the developments in terms of potential impacts of nanotechnology in food science.

This includes, for example, one of the greatest areas, [which] is improvements in food safety. This is in terms of pathogen detection. And I'm from Canada, and of course we just had the whole hysteria, problems with the meat recall, there. There are also issues in terms of toxin detection, so that affects bioterrorism in the food industry. And a very important one in terms of global issues is water purification, great opportunities there. It also has impacts in terms of food packaging and dramatically altering our ability for long-term food storage.

Nutritional qualities can be dramatically affected as well, and a great deal of research is going on in terms of improvement of nutrient qualities of food and improvement of bioavailability, or the effectiveness, of those nutrients that we do have.

Also one area is improved development of new food ingredients. And again I don't want to take so much time, but we can talk a little bit about how that may actually impact the whole question of need for increased meat products and how there's a lot of developments being done now in terms of design of new ingredients that very accurately simulate meat products.

And lastly, food processing can be greatly impacted as well. An area I'm not as familiar with, but I know there is a great deal of work as well, is in the area of food production and similar to what

was just mentioned, improvement in the ability of fertilizers to be targeted, sustained release, and so on. And now technology is being used in that way.

Just want to mention that it is, of course, very much at the developmental stage for the food industry. For many other industries, it's already in the marketplace, and I would be able to probably identify at least every one of you have nanotechnology impacting you in some way now as we sit in this room, by some different product that you're using, from a cell phone to a water-resistant or stain-resistant shirt, or we can go on and on.

But the problem for the food industry is that there's many challenges to be addressed, many hurdles to overcome. And these will be especially important to address if they ever were to get to the point to be able to be used by underdeveloped countries and be of economic and viable use in those areas. But I think it is a huge potential and definitely making major impacts in other industries, I think, that we will see it in the future.

Scott Kilman

Thank you. Paul Schickler is the president of Pioneer Hi-Bred, one of the nation's biggest seed companies. And we've already mentioned the role with Henry Wallace, and Pioneer already has a presence in Africa and has had a presence for quite some time, selling anything from a corn seed, I think we talked about, on the eastern side of Africa. Paul.

Paul Schickler
President – Pioneer Hi-Bred International

Thanks, Scott. As Scott mentioned, I'm with Pioneer Hi-Bred. Pioneer Hi-Bred has been in the plant genetics business for 86 years, and our start was with our founder, Henry Wallace, in our early days. Today we're part of the DuPont Corporation. DuPont has been in business 206 years, so we have a tremendous history between the two organizations that have come together.

And the interesting thing about the way in which Pioneer and DuPont have come together is that we do have great fit. DuPont has built its history upon being an excellent developer of chemistry and being expert in material science. And the transformation that we're going through now is to add to those two areas of expertise the science of biology; and, of course, that's what Pioneer can bring to DuPont. So it's a great fit that has been accomplished over the last 10 years.

Pioneer's business, over the more than 80 years that we've been conducting business, has been to focus on genetics, improve those genetics so that we can bring improved productivity to farmers throughout the world. And we combine those improved genetics with a system that enables the farmers who use our products to also match those genetics with improved production practices, so that they can get the best out of those genetics on their farm.

And the great theme of that focus of increased productivity through the use of genetics is that it is scale-neutral. It works as well for small farmers in Thailand as well as large farmers in the United States – it is scale-neutral. And as Scott mentioned, we've got some great examples. Scott is very familiar with our work in Ethiopia, where the use of genetics has really made a difference with the customers and farmers that we work with in Ethiopia.

And then over the last decade we've added to those practices – focusing on genetics and on improving production practices – we've added to that the science of biotechnology. And that is giving us another leap forward in our ability to improve productivity and improve the livelihood of farmers everywhere in the world.

And what we can do with biotechnology is not only continue to increase the productivity but then also add to that, improve the protection that the plant can have against other environmental factors that the plant has to compete against as it grows. And then we can also bring additional characteristics, whether they be improved nutrition or other uses of the plant through biotechnology. So that is a great, what I would say, new science that we're bring to the science of plant genetics.

And again, just like giving or making available genetic improvements to farmers worldwide, being scale-neutral, so is biotechnology. Throughout the world, biotechnology now is being accepted and adopted at a faster rate in developing countries than it is in the developing world. And we've got some great stories in a market like Philippines that has accepted biotechnology very rapidly and is seeing the benefit of that through improved productivities.

Finally, I'll close with two thoughts on DuPont's position as we look to the issues of the world today and as we look to the future. And that is: We are continuing to be committed to improve the productivity and livelihoods of farmers everywhere through the use of genetics and biotechnology, and again as Scott indicated, with particular focus on improving livelihoods on the continent of Africa as well as southern Asia.

We want to do that, this focus in Africa and southern Asia, in collaboration with public organizations, foundations, NGOs, academia so that we can bring together a more robust effort across the private and public sector. We think that can make a long-term impact toward solving some of the production problems, particularly in Africa and southern Asia.

And then the second point is to use biology to address both the food-availability issue as well as making a meaningful impact on our dependence on petroleum-based products. We can continue to serve the food and feed availability through improved productivity, again combining the improved practices with genetics and biotechnology, and at the same time make a meaningful effort into reducing the petroleum-based dependence that we have.

And we can do that through a number of sciences that are not only in the market today but additional generations of those practices will be in the market in the days ahead.

Scott Kilman

Thank you. And I have to apologize to Judi. I didn't get a chance to meet her ahead of time, so I don't know if the "K" in your last name is silent or not – is it "Wakhungu"? Good, all right. Judi Wakhungu wears several hats. She is a geologist, which is interesting for this panel. She is also the executive director of the African Center for Technology Studies.

And she was co-chair of the International – I guess what I have come to know as the "assessment report," the International Assessment of Agriculture, Science and Technology for Development. You can tell the FAO or the World Bank financed it, because it has such a long, long

title. But it was a very interesting report. There were hundreds of scientists who were involved in looking at what is the technology that will most help poor farmers in the world.

Judi, if you could explain a little bit about your work.

Judi Wakhungu
Co-chair, IAASTD

Thank you very much, Scott. As you mentioned, I wear several hats, but I'm very lucky at this meeting, because I'm only wearing two. So that is very easy for me. I'll start with the main hat I wear, and that's the executive director of the African Center for Technology Studies.

For those of you who may not be familiar with us, the African Center for Technology Studies is a science and technology think tank that strives to advise African governments and regional bodies on the importance of science and technology for development.

As many of you are aware, if you look at the policy environment in sub-Saharan Africa, it's mostly dominated by the politics of the day, the economics of the day, and the legalities of the day. But we're living in a world that's much more dynamic in terms of science and technology. And so we work very closely with our leaders and our parliamentarians, many of them who are not scientists and technologists or engineers in their training, to try to underscore to them the importance of science and technology for development and particularly making sure that our policies are also based on science and technology.

The African Center for Technology Studies works in three main areas, and this is agriculture and food security, energy and water security, and science and technology literacy. And this is where we also have our capacity-building programs where we train policymakers in governments, in civil society, but also parliamentarians as well, particularly those who work on the agriculture committee or those that work, say on the biotechnology and biosafety committees.

Having said that, let me then segue into what Scott mentioned, which is the other hat I'm wearing here. And this is that I have served for the last few years as the co-chair of the International Assessment of Agriculture, Science and Technology for Development, popularly known as the IAASTD.

And this is an assessment – and you're correct, Scott – that was funded by a number of U.N. bodies, including UNEF, GEF, FAO, UNESCO and WHO, and also the World Bank, where we had our main secretariat. But we also had secretariats in other areas. For instance, I had the privilege of at ACTS hosting the sub-Saharan Africa secretariat.

The IAASTD had a number of goals. First of all, in terms of the structure it is an intergovernmental process, so it's an IGO process, with a multi-stakeholder bureau. And the multi-stakeholder bureau consisted of governments and civil-society organizations. Because time is of the essence here, I will just briefly explain to you what the assessment strove to do.

The IAASTD had four major questions in mind in order to address four specific Development Goals. And briefly it's simply: If you look at the state-of-the-art in agricultural science

and technology, and if you look at the efficacy and what we know today in terms of agricultural science and technology, how can we address four major Development Goals?

And these are: How can we reduce hunger and poverty? How can we improve rural livelihoods? How can we improve nutrition and health? With a major challenge of striving to do so in an environmentally sustainable manner, and also in a manner that promotes socioeconomic justice and equity.

There are a number of findings of the IAASTD, which I can address later in our conversation this afternoon. But the main one really was that we need to look at small-scale farmers once again and that the critical role of small-scale farmers now in the future (and the future for us we addressed as 50 years from now) is more critical than ever.

Secondly, if the science and technology in agriculture is sufficient to address the questions that I just posed earlier, we will therefore need to have policies that are pro-poor. We will also need to have policies that very directly address women farmers, since most of the families are actually led nowadays in rural areas by women and women farmers.

I'll stop there, Scott, and hope that I can address these questions further.

Scott Kilman

And then Robert Rodrigues is the co-chair of the Interamerican Biofuel Coalition, which basically means that he's the Mr. Ethanol of Brazil. He's been a leading advocate of developing the ethanol industry in Brazil, which many of you know primarily runs on sugarcane. And Roberto wanted to talk for a minute about how Brazil has used technology, presenting agriculture as using technology. Do you want to sit there, or do you want to come up here? There?

Roberto Rodrigues
Co-chair, Interamerican Biofuel Coalition

Thank you, Scott. But first of all I have to ask you please to forgive me for my mistakes in English. I say that I speak English like Tarzan used to do, so please. And obviously I miss Jane – Jane is not here.

Well, you have in your packet some figures about what Scott has said here, and I would like to tell you that it's not a question <u>if</u> technology is going to guarantee the supply of food for the world. It's not <u>if</u> – <u>must</u>, has to. So there is no other answer. We must do that, because population is going to increase 2.0 billion people from the year 2000 to the year 2025, according to United Nations information. So we are trying to do something in Brazil that is interesting. I would like to show you these figures.

In the last 17 years, the cultivated area in Brazil with grains has increased 27 percent, 27 percent area cultivated. But the production has improved 147 percent. This is pure agronomics technology, given to some enterprises like EMBRAPA, which is our national enterprise for research in agriculture. It means more or less 99 percent bigger in 17 years, the producing area.

But it is not only in grains. It is also in meat production. For instance, chicken broiler – in the last 13 years the production of broilers has increased 200 percent; pork production, 113 percent;

and beef, 77 percent. But beef is increasing very quickly in the last 5-6 years, because 15 years ago a cow went to the slaughterhouse at 4 years old; now it goes 18 months old. So we are producing much more beef per hectare than before.

And of course the issue of sugarcane. When you talk about biofuels, ethanol from sugarcane, you have to figure that in the beginning of the Brazilian program for biofuels, named PROALCOOL, if you had today this same productivity area that we had at the time, we should need now the double of cultivated area with sugarcane to get the same production. That means it was also 100 percent increasing of producing area in sugarcane.

And I think there is something; nobody pays attention to that. This biggest productivity and more production in less areas means sustainability, because we don't need more rain forest or savannahs or Cerrados to get the same production that you have today. Otherwise, we should destroy much more than has been announced worldwide.

And the last figure that you have, that is very important for me to tell you about, is this issue of biofuels. That's different from food that any country can produce, even in greenhouses, in Siberia, for instance. Different from food. Biofuels or agroenergy depend enormously on the sun. And that means that the production of biofuels, bioelectricity and agroenergy will happen between the two tropics – the Tropic of Cancer and the Tropic of Capricorn. And the countries that are there are Latin American countries, African countries, and the poorest, poor Asian countries.

So what's going to happen through agroenergy is a big change, not only in agricultural paradigm in the world, but much more than that – it will be a change of geopolitics. Because these poor countries will have produced the most important quality for the 21st and 22nd century, which is energy.

So the example that Brazil has in biofuels, in terms of ethanol from sugarcane, is absolutely perfect to being applied in other Latin American countries, as it will be in African countries and Asian countries – mainly because sugarcane comes originally from Asia.

So I am telling you these figures to give you my vision that absolutely we are going to improve new technologies. We will get much more production per area, and we are able to feed humankind, and we are able to produce biofuels also, all together. Even sugarcane, as a grass, as you know, in the rotation of – 20 percent of the complete area of sugarcane has to be renewed annually. And it is renewed through plantation of legumes and others like soybeans, beans, or peanuts. Then sugarcane is now increasing its area in Brazil, conquering pastures area, because we need less pasture area because the technology of cattle is improving also.

So we are producing food and grains where before there was never production of grains. Sugarcane allows us to do that. So it is something that I think should be spread or tried in order to give you some information of what we are doing. There are some myths that in Brazil sugarcane production is going to reduce the production of food. That's not correct, and the proof of that is that this year we have a record of production of grains, a record, historic record this year, 2008. But we also have record of production of sugarcane. We also have record of production of meat, and we also have record of production of dairy products.

So there is no competition between sugarcane and food in Brazil. And we can replicate that in African countries, in other Latin American countries, in a lot of Asian countries.

Just to finish, I think that in the technology, we represent the victory, because we are going to get that. And in Brazil there are some new technology solutions that are fantastic for the new future. One of that developed by EMBRAPA is what we call the integration, agricultural pastures. And it's like Columbus's egg – you seed the grass, the pastures before seeding the food, like soybean or maize or whatever. And then when you harvest the food, then the pasture is able to receive cattle during the dry season. So we've got two crops in the same year, and it's developing fantastically, even saving water through conservation of the soil and the land.

Another important thing that we are doing in Brazil, and there are a lot of governments worldwide that are working with this, is biofortification. Which is, through genetics and even biotech, we can make the foods and the products in agriculture much more rich in vitamins, in carotenes and other issues that can get much more capacity to sustain people than before.

Technology in agroenergy is increasing enormously in Brazil, enormously. Sugarcane, new varieties, and new use of the leaves and the bagasse will give us a chance to double the productive area of ethanol in 10 years. Currently we produce 8,000 liters per hectare, but in 10 years we will go to 15,000 liters. So it will be very much cheaper than today, in competition with gasoline.

So we have a lot of things to show you about technology. But I'd like to say three more things to finish my short presentation.

First, small farmers – there is a vicious cycle. A small farm is not profitable; they cannot buy technology; they have not good production; they are not profitable. We have to cut that in someplace. And I think that the only solution for that is cooperatives, cooperative movements, because cooperatives can spread technology, can give credit, and can add value in the… of small farmers. The big farmers can do it alone by themselves, but small farmers without cooperatives cannot resist. And I think that in Africa, Asia, in Latin American countries, the cooperative movement can represent an important role for that.

And even to develop new technologies, because as was said during the presentation, the keynote speakers' presentations, it was showed that there are less and less governmental resources for research in the countries. But we are developing in Brazil, together with EMBRAPA, under a new legislation a kind of special society between the enterprise, the governmental department offices, and private sector, through which private sector puts money and gets results, not only through the research but also in the rights to sell later on what has been developed through this partnership. And it's working interestingly. It's a very new issue that's going on, and it's interesting.

And now to finalize – in the last panel, Scott – excuse for me, just one – somebody asked why young people are not coming to agriculture and going to other activities. I teach agronomics in my country since 1967, and indeed the interest is being reduced in terms of agriculture. Why? Because, as Graham said, the other sectors receive more; they are more well paid. The financial sector, the stock options, are paying so much that – you know, I am an agronomist.

My father was an agronomist and had one brother agronomist and a brother-in-law agronomist. My mother is daughter of an agronomist; she has three brothers, the three are

agronomists. I have just one sister; she is married to an agronomist. They have two children, both are agronomists. I have just one wife; she is an agronomist. We have four children, the two boys are agronomists; one girl is psychologist, the other one is a lawyer because somebody must take care of our back, of course. And I have a daughter-in-law who is an agronomist also. And my eight grandchildren look at us and say, "How stupid you are. We'll work for the finance sector."

So something must be done, because what we are seeing now is a crisis in the financial sector. Why? Because there is not a product to guarantee this money flying over the countries. So we must produce more.

But I go to Europe very often, to discuss biofuels mainly, and I have friends in what they call CEJA – le Conseil Européen des Jeunes Agriculteurs; it's a council for young farmers. And the members are disappearing. I said, "Why your members are disappearing." They said for two reasons: First, because it's clear that our profit is diminishing. And second, because of that, we don't find fiancés. Ladies don't want to marry us because we're poor." So imagine – without profit, without wife; let's go to the other sector.

Scott Kilman

Thank you – you know a lot more words than Tarzan.

The general question I wanted to start with – for everybody on the panel if they want to weigh in – is: This decade is interesting because most of the years of this decade the world has consumed more food than it's produced. And we're now seeing – if you look at the FAO data and the USDA data, they're now projecting that the number of hungry people in the world is climbing back towards a billion, which is a level we haven't seen since the last food crisis of the early 1970s.

And, of course, the recent gyrations in the commodity markets, it's hard to tell what's going to happen next year, but the fundamentals are still in place. You know, the commodity prices – this is not a prediction – the commodity prices could be just as wild next year.

So my question is: How optimistic are you folks, from the areas that you work in, how optimistic are you that the world can meet the Millennium Development Goals? Do you have any optimism at all that the world will be able to reduce hunger by half by 2015? Paul, and Martin, and Judi – whoever wants to talk about it. Paul, why don't you start.

Paul Schickler

I'm very confident. One indicator would be to look at history. And if you go back to – and I'll use it as an example – hybrid corn. If you look back over history throughout the development of hybrid corn, productivity has improved at about 1.5 percent per year. And that is a trend line that is very, very proven and predictable.

As we look to the future, we think that we can more than double that. And that has already started to show up in the last 8-10 years through the use of biotechnology, as that's been added to plant genetics and improved agronomic practices. So we're starting to see that curve change, and in our products and in our labs, we can directly associate the 1.5 percent per year improvement in corn, we can translate that over the next 10 years to a 40 percent improvement in productivity over that 10-year period.

So to put that in terms in the United States. 2007, the average yield was 155 bushels to the acre; a 40-percent increase over the next 10 years would put that at 210 bushels to the acre. That same kind of improvement can be done everywhere in the world where those same combination of agronomics, genetics, and biotechnology are used.

Roberto made the comment about sustainability. It can also be done in a sustainable fashion. Over the last 20 years – the productivity just on a historical trend line, not including what we think we can deliver in an improved trend line over the next 10 years – over the last 20 years the 1.5 percent per year improvement in corn has resulted in a virtual increase of acres of 150 million acres worldwide.

To say it another way, 150 million acres went unplanted due to the productivity improvements in the last 20 years. And to give you some sense of scale to that, I think that is about the size of the Cerrados in Brazil. So we have through, in the last 20 years, brought into productivity, and not required the additional land, 150 million virtual acres or the equivalent about the Cerrados in Brazil.

So it can be done through productivity, agronomic practices, genetics, and technology in a sustainable fashion that avoids bringing additional land into production. And when you talk about additional land, most of that would be fragile land.

Scott Kilman

Let me ask Judi first, and then we can get to – Judi, one of the issues that the International Assessment raised is whether generally modified crops can deliver as much to poor farmers around the world as is often advertised. I mean, do you agree with Paul's assessment, that yields are able to grow fast enough to prevent hunger from getting worse, using, I mean, using the modern technologies that we have? Or do you think it will have to come from somewhere else?

Judi Wakhungu

In terms of the IAASTD, this was a very controversial issue, as you know. Given the assembly of experts that we had, they came from across the board. And we faced a situation where, when it came to how GMOs or transgenics were handled, it was difficult to get agreement from the experts that were actually assembled in the room.

And it wasn't really, from my perspective, sitting there as co-chair trying to moderate and facilitate, it was necessarily questioning, say, the science, per se, but it was to do with the milieu in which the science was embedded. And that the experts that had reservations about the efficacy of GMOs were more concerned with, first of all, looking at the yields and saying that, over the past 20 years if you look at the performance, that the yields were not as high as expected, or on the other hand that they were very uneven. So certain agroecological zones had fared well, but others had not. And so they were lukewarm in terms of what the potential was for transgenics, GMOs, given the current arrangement that is dominated by the corporate sector. So that was one perspective.

On the other hand, just looking at the potential for these technologies themselves, there was a strong feeling, in many of the sub-global assessments, that there was potential for abiotic stresses – that as we continue to face erratic climate, with some areas, as was mentioned earlier this morning, with the same areas from one season facing excessive floods and then a few years down the road

also facing excessive drought – that we need to look specifically at the potential of recombinant DNA to address local issues, issues that are specific to the community.

So it was controversial, and I've tried to summarize it as best as I can.

Scott Kilman

It seems to me that one of the questions is: Do you use molecular breeding and biotechnology, gene transfer, do you use that to increase yields in the developed world, and that helps keep crop prices down so food is more affordable? Is that the way you attack hunger, using this technology? Or is it reasonable to assume that you can get biotechnology right into the hands of poor farmers?

And that's something that stumps me, because I can't figure out how you can do that economically, because generally modified crops cost more. There's a premium that's involved. And these are farmers who can't afford much of anything, let alone a premium. So where do you think – how will biotechnology help poor farmers? Is it to help to develop, to grow more food, or do you have any hope, Paul or Judi, that generally modified seeds will actually be somehow put into the hands of poor farmers?

Paul Schickler

Well, the answer is both, because I think we need the opportunity to address the food security and productive requirements of the world from both directions – the developed world, using biotechnology to continue to improve productivity, but also to apply it to the underdeveloped world and small farmers so that they can, too, as well improve their livelihoods.

We have examples: Philippines is one of the fastest adopters of technology, biotechnology, in the world. The farmers there are small. But you need to think of it as sort of cycle.

Whether it is the Philippines or other areas of the world, the first thing that we do is bring improved agronomic practices to our customers. As they manage their crop better, then they can make the step to improved genetics. And as they work through that opportunity to improve their productivity, then bring biotechnology to them as the next step in productivity.

So we have that, what I would say, model clearly in place, like I said, in the Philippines, in South Africa, in Spain, in Portugal, in those countries that have deregulated biotechnology.

I am convinced, as I said during my opening remarks, that, just like plant genetics, the use of improved plant genetics is scale-neutral; so is biotechnology. But it needs to develop that cycle of repetitiveness.

Scott Kilman

By scale-neutral, you mean that it has as much benefit for the small farmer as for the large farmer.

Paul Schickler

Right.

Scott Kilman

And, Judi, did you want to add anything?

Judi Wakhungu

I concur. It's just that we need to look at food production over the next 25-50 years, and in order to feed the world, we'll need to double food production. And so a variety of tools will be needed. And we need to look at the array of tools and the suitability for each local area.

Scott Kilman

And, Paul, do you want to… I'm sorry. I apologize. Martin, did you want to weigh in?

Martin Fisher

Yeah, but I'm personally an optimist when it comes to the technology because, as you point out, we can continue to develop this technology. And in the developed world, unless climate change has huge impacts in the developed world, I think we can produce a lot more food. But I'm much more skeptical about ending the hunger, because it's really going to get down to those smallholder farmers.

And I always think of that in terms of three things to get to the smallholder farmers. First of all, it's got to be affordable. (You could call it the three A's.) It's got to be affordable to the farmers; it's got to be locally available in their local marketplace where they are, if we're talking about any kind of technology, whether it's seeds, fertilizer, or an irrigation pump; and they have to be aware of their benefits. That's the whole knowledge side.

And those things, because generally when we're talking about where the really, most hungry people are, certainly in Africa, there's a fundamental market failure. It's that the big, private-sector companies find that they can't go into those places and make money selling to these extremely poor, extremely risk-adverse, extremely hard-to-reach customers who have very limited access to any kind of marketing or information. And that's where this breaks down.

Now, in my mind you need to put in place smart subsidies to overcome that market failure in terms of establishing private-sector supply chains and in terms of doing that massive amount of promotion to get that awareness. And if we have the political will to do those things, then I think these technologies can get down. And the only big question mark, of course, is climate change and, Can we modify technology quickly enough and adapt it quickly enough to adapt to the climate change?

Scott Kilman

And by "smart subsidies," I think what you mean are subsidies like in Malawi where they're tied to fertilizer – they help farmers buy fertilizer as opposed to a target-price system that we're used to in the United States?

Martin Fisher

Well, by smart subsidies, I'm talking about a subsidy that tries not to distort the market too much and that supports the private-sector distribution network. Because the only thing that's sustainable is the private sector when it comes to distribution in the long-term – those little retail shops that are selling the seeds and fertilizer and the equipment.

And so the smart subsidy has to try not to disrupt that, and it has to have a time when it's going to be taken away. So if you can do it without disrupting the markets – as what we do in case of our irrigation pumps, is we have a supply chain that's purely profitable where the manufacturers, wholesalers, and retailers all make money selling the irrigation pumps.

But we use the smart subsidies, which in our case is donor funds, to do the market development, do all the awareness, all the marketing, all the promotion, to get people to know that these things really can help them. Because actually even very poor farmers can scrape together enough money to buy these things if they are really convinced about the impact. So I really think that it's that awareness and that convincing and putting in place that supply chain, which the subsidies have to be used for.

Scott Kilman

And, Berna, you wanted to say something?

Bernadene Magnuson

Yeah. While I agree in terms of comments being made for underdeveloped worlds, I just kind of wanted to make a comment in terms of hunger and issues in terms of food scarcity and within even our developed countries.

And I think that, in these situations, it is not a matter of trying to produce more food. In actuality we are having such a tremendous increase in terms of obesity and increased health costs due to obesity, and increased food wastage, increased food spoilage. And I think that actually just better utilization and distribution of the food currently in many of our developed countries – I was just to Australia and New Zealand; the trends are happening everywhere.

So although I think increased food production in some areas of the world is it, I think even awareness and social conscience in some… I don't have the answers, but I think that's definitely something that has to be considered, even within developed countries, like U.S., Canada.

Scott Kilman

And we're already starting to run out of time, believe it or not. So if you have any questions, just go over to the mic. Unfortunately I have my reading glasses on, so you've got to wave your arms so I can see.

But, Clay, you had raised a question earlier with me when we were talking that you wanted to bring up about whether some of these technologies that are being talked about – genetic modification, molecular breeding, nanotechnology – wouldn't be considered natural. So is there…?

Clay Mitchell

Yes. As we look at obstacles to the technology option, we expressed a lot of optimism here about the ability of agriculture to follow the trend line, which is so distinct, and we haven't had these plateaus yet; but new technology is clearly needed.

And we know, as we look at technologies, that there's often a double-edged sword, that there are often costs, sometimes environmental costs and other costs. I've been fortunate on my farm to discover a lot of technologies that seem unambiguously good, things that allow me to save fuel, save soil, increase productivity. And stewardship is really important to me, so I'm really proud of those things.

But the first question that people ask me when I say that I'm a farmer is, Are you organic? This concept of what is natural is so strong in a lot of cultures, and in the U.S. today, it's really kind of a trump card. It is a real touchstone for whether something is true or valuable.

And as we're talking about, particularly biotechnology, and with Berna talking about nanotechnology, I'm wondering, will that need from the non-farming public, which is an increasing part of the population and an important trend that we need to deal with, that desire, that need, that value to see something as natural – will that be an obstacle? Do you find the need to couch your technologies in a natural paradigm?

Bernadene Magnuson

Well, absolutely. I think that definitely is one of the hurdles. And for fear of offending anybody here, one of the common comments in terms of nanotechnology is we have to make sure we don't do what was done with biotechnology of food. So in terms of – really, because of the misunderstanding, I think, and lack of knowledge of how food is produced, there has been a lot of misinformation that has perpetuated undue fear both, I think, of GM foods and is likely to also occur again with any use of new technology in general in food.

And, I think, food we consider to be one of the areas where people are absolutely most risk-adverse. They will accept levels of risk in pretty much every other aspect of their lives, but food for some reason – well, there's lots of reasons, but they will not accept it.

And really, unfortunately, I think many times this is taken advantage of and that organic and so on has a premium price, and there are a lot of reasons why there would be encouragement of trying to promote organic, perhaps based on information which isn't exactly what, as scientists, we would accept. I hope you can appreciate – I'm trying to say this very politically correct.

Scott Kilman

You don't need to; that's fine.

Bernadene Magnuson

So the short answer is, yes, it's definitely a problem, as was food irradiation. It got killed by misinformation.

Scott Kilman

If I can turn the question a little bit – one thing I've wondered about is that – You know, biotechnology is expensive, so companies who engage in it and spend a lot of money, they need to protect their investments, so they get patent rights. One of the differences between now and when Dr. Borlaug was doing his work was that he had a lot of flexibility. I mean, breeders would share their plants and share their information and they'd give each other credit. But, you know, there weren't many patent disputes.

Today, if you talk to an academic breeder, those that are still around, they feel a lot more constrained by what they can do. Because if there's an interesting gene, you know, Monsanto or DuPont or somebody else might have it or a promoter for it.

So how do you keep biotechnology moving forward and but also do it in a way… Is there a way that would allow academic breeders to have more freedom to do the work that they used to do?

Paul Schickler

Well, I think the first thing to understand is that, as you say, it is very expensive science, it's very expensive research. But the way you overcome that is through collaboration. We clearly are not going to invent everything that we need now in the next 5 or 10 years. We have to do it in partnerships, whether that's with other companies – in partnership for discovery, or in licensing it from other companies – or from academia in other institutes.

We source technology everywhere in the world through partnerships and collaborations, and I think that's going to continue on into the future and even become a greater component of where we get technology from.

Having said that, we do provide technology going out as well, not only in license arrangements but, for instance, with the Gates Foundation. We've donated technology to a project that we're working with the Gates Foundation and Africa Harvest to make a technology that we developed more broadly adapted for farmers in Africa.

Scott Kilman

Roberto, you wanted to say something?

Roberto Rodrigues

Fifty-five years ago, 60 years ago, some teachers in my University of Agronomics in Brazil were very afraid about hybrid corn, [that it] could be a disaster for our natural corn. Biotech is a science, and we must believe in science. I think that scientists are doing what they must do.

Of course, we need three points: First, security; protection for environment, health – but they do that. Second, the market; we will say, "What's going to happen with biotechs?" But the market depends on the demand of consumers. And then what is absolutely important – I said it, and Bernadene said it – is information, the correct and pure information.

QUESTION AND ANSWER SESSION

Kilman Any questions? Go ahead.

Question Charlotte Hebebrand from the IPC. I think it was Clay Mitchell who said…

Kilman Can you say what the IPC…

Question I'm sorry. The International Food and Agricultural Trade Policy Council, IPC for short. Clay Mitchell, I think, said in the beginning that technology has a much greater impact on your business than policy. And I would think that's true, but it seems to me that when you're talking about the spread of technology, policy is actually very crucial.

And I think in some of the examples that we've talked about here, policy has been a hindrance to the spread of technology, whether it's biotechnology, or, I imagine nanotechnology will be the next place where we see real differences in policy and regulatory frameworks. [For] ethanol, I think, one can argue, policy plays an important role, whether you're talking about high tariffs in the U.S. and the EU on ethanol.

So how much thought do you all give to policy, and can we really separate technology from policy questions? Thank you.

Mitchell When I said that statement, it was kind of brutish, because obviously we're comparing apples and oranges. They're obviously very related, interrelated.

But if we go back to the 1930s where corn yields were 30 bushels an acre in the United States and over 6 million people farmed, we were not prepared, or there was no way to forecast or be deliberate about the change that technology would bring about. Policy is inherently something more deliberate. Technology in some ways comes as a surprise; certainly the impacts do.

So I think there are a lot of other nontechnology issues that we often deal with, issues of the fairness and equity in agriculture policy, and ignore incredible impacts of technology.

Kilman Berna, I think, will – we've got, what, two more minutes left. So, Berna, and then we'll take one question.

Magnuson Okay. I'll try to be quick. Just I think definitely that in terms of food nanotechnology, those of us involved in this area are realizing that is a critical question. And actually we are – the Institute for Food Technologists is working together with and developing collaborations in cooperation with FDA, the National Science Foundation, National Health Institute in order to address very early on what would likely be – I mean, the biggest question, of course, is going to be safety, health impacts, safety impacts, and environmental impacts.

So very early on, in the early stages, we're working with them in order to be able to make sure that, as we're developing these technologies, we're also developing the techniques and the science to support the policy that is likely to come.

Kilman Well, thank you very much. We've run out of time. This is such a broad panel. We could spend an hour drilling down for each person. But I appreciate your patience and your questions. Thank you very much.