



CENTER FOR GLOBAL DEVELOPMENT

Presents

***The Prospects of Bringing a Green Revolution to
Africa***

by
Norman Borlaug

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[TRANSCRIPT PREPARED FROM AUDIO RECORDING]

Lawrence MacDonald: Ladies and gentlemen, on behalf of the Center for Global Development, it's my pleasure to welcome you to today's event, "The Prospects of Bringing a Green Revolution to Africa." We are honored to have Noble Laureate Dr. Norman Borlaug, the father of the first Green Revolution, to speak with us today. Dr. Borlaug, I'm really looking forward to your talk. I am Lawrence McDonald the Director of Communication and Policy at the Center for Global Development and I'm proud to say I'm actually the second person in my family to persuade Dr. Borlaug to speak at an important event.

In 1970, I was a sophomore in high school in a small town in California and my dad the director of public affairs at Cal Poly, San Louis Obispo a state agricultural college when the announcement came that Dr. Borlaug would be awarded the Noble Peace Prize. My father immediately sent a telegram inviting him to come speak at the college and Dr. Borlaug graciously accepted. He honored his commitment, but when he arrived he told my dad had he any idea how many other prestigious invitations he was going to receive, he would not have accepted. So, we're very pleased to have you with us here today.

That summer, my father took me and my brothers with him to Mexico where he made a documentary about Dr. Borlaug and his work and I recall standing in the fields at Semit, the International Center for Improvement of Corn and Wheat as Dr. Borlaug very graciously and clearly explained the basics of plant genetics to a handful of teenagers who I realize now were stand-ins for my father in his film. It was the first time that I was exposed to poverty in the developing world and it was the first time that I was exposed to the idea that research funded by the rich world could make a huge difference in poor people's lives and so in a very real sense if it were not for Dr. Borlaug, there's a good chance I wouldn't be standing here today.

But I'm not so unusual in that respect, there are probably a billion people on the planet who would not be where they are today were it not for the Green Revolution. It's now my pleasure to introduce Leon Hesser, the author of this fine book, *The Man Who Fed the World: Noble Peace Prize Laureate Norman Borlaug and his Battle to End World Hunger*. Now you expect me to tell you that Leon has written a great book. In fact, Leon has written two great books. He's also the author of "Nurture the Heart, Feed the World: The Inspiring Life Journeys of Two Vagabonds." And that is in fact the story of Leon and his wife Florence, and I'm delighted to say that she's here with us today, welcome.

It's an extraordinary story, very inspiring story. Leon and Florence were tenant farmers in Indiana with two children when they sold their business and Leon enrolled in Purdue University at the age of 30. Florence worked until she was 35 as a secretary. They eventually both went on and got their PhDs and Leon played a key role in bringing "The Green Revolution" to South Asia in particular to Pakistan. He went on to become the Director of Agriculture for USAID with global responsibilities for the success of the Green Revolution. He is part of a generation of researchers and agronomists and policy makers and practitioners that working together with Norman Borlaug literally fed the world. Please welcome Leon Hesser.

Leon Hesser: Thank you Lawrence. It's my genuine pleasure to be here to introduce the father of the first Green Revolution and the man who fed the world. I first met Norman Borlaug in Pakistan in 1966. I was director of the U.S. government's technical assistance to increase food production there. I had a dozen agriculture extension advisors on the team.

The problem was at that time we didn't have very much to extend that was relevant to the Asian southern continent, enters Norman Borlaug, what a breath of fresh air. At that time, India and Pakistan we're in dire straits so far as food was concerned. We the United States had been sending in five to six million tons a year to try to stave off starvation and hunger. Canada and Australia and a couple of other countries were also sending some in. It kept getting worse by the mid-1960's there was widespread starvation in India and Pakistan. There were two provinces in northeast India that were in famine conditions.

At that time, there were two books written that in effect said, "Let's give up on India, it's hopeless. Let them die off. Let's provide our food aid to countries that have a chance." That was the sentiment when Norman Borlaug came to our rescue in Pakistan. He briefed us on his high yielding varieties of wheat that he had developed in Mexico as a Rockefeller Foundation scientist and he said based on preliminary tests on farmers' fields in India and Pakistan; I think they'll work here. We talked about it for a while and obviously, I jumped at the chance to help introduce that marvelous technology. Within four years with that technology, we doubled the wheat production in Pakistan.

It took a little bit longer in India but the same thing happened there and neither country had to import food aid, they were self-sufficient. The same thing happened, and obviously, Dr. Borlaug was hailed as the gather of the Green Revolution and in 1970 was awarded the Nobel Peace Prize. Other countries benefited as well, not only India, Pakistan and Mexico where Dr. Borlaug had developed the varieties, but many countries in South America, in the Middle East including North Africa, other countries in Asia and especially China, which is an interesting situation. In the 1960's of course, China was in the midst of the Cultural Revolution. They were hungry. It wasn't widely known in the outside world but people were starving in China.

My good friend who was Secretary of Agriculture in Pakistan at the time flew to China with a suitcase full of Norman Borlaug's wheat varieties. They tested them and a year or two later they came back to Pakistan and bought 5,000 tons of that which started a Green Revolution in effect in China. What about Africa? At that time in the 1960's Africa was not really hurting that much food wise but let's fast-forward 20 years to the 1980's. They were beginning to hurt. Their populations were increasing faster than their food supplies and Sub-Saharan Africa. About 1986, a rich Japanese industrialist, Rawichi Sasakawa, called Dr. Borlaug and said, "Why is there no Green Revolution in Sub-Saharan Africa? What are you doing down there?" And Dr. Borlaug said, "Look, I'm retired. I'm 72; I'm too old to take on Africa." Two days later, Mr. Sasakawa called him back and said, "Look, I'm 13 years older than you are. We should have started yesterday and didn't, let's get to work!"

With that Dr. Borlaug organized a conference in Geneva and Mr. Sasakawa invited his good friend, Jimmy Carter, and about 50 specialists of various kinds were there. In short, they decided maybe we should try to do something about Africa and Mr. Sasakawa founded and funded The Sasakawa Africa Association and Dr. Borlaug accepted the presidency of that. For the past 20 years he has been making several trips each year to Africa working on the food situation there. It's my pleasure to introduce Dr. Norman E. Borlaug.

Norman Borlaug: Thank you Leon. Ladies and gentlemen, it's a pleasure for me to participate in this conference with you people today concerning the present status and future status on the food front of the African countries. I'm going to use PowerPoint to illustrate points that are most pertinent. At the outset the roots of the first international development

program from a research standpoint goes back to that program established by the Rockefeller Foundation and the Mexican government in 1943. I joined that program in early '44 and have been affiliated with international agricultural developments ever since. That program was established by the Foundation. It's first attempt to work in agriculture. It's early work was in public health and education so it was a new undertaking for the Rockefeller Foundation and it was sort of forced on them indirectly by Vice President Elect Henry Wallace who saw the great need and was in no position to get funding from the Federal Government and hence the program was started with the Rockefeller Foundation and the Mexican Government.

The objects of that program are evident above. Let me just say that at the time it was initiated, there were very few trained people in Mexico in agricultural science. There was no graduate faculty in agricultural science anywhere in Latin America. So, training people was a long and special one at that time very few people spoke English in Mexico and so also it was learning a foreign language whether they came to the U.S. or Canada or if they went to Europe learning French or German. So, it was slow and tedious, frustrating I must say at many different times. The approach was also multidisciplinary research and bringing all of those data from the different disciplines to bear on production problems.

There was not extension program in Mexico, none whatsoever, even on paper. So, we who did the research had to take the package of practices to put them in demonstration plots on farmers' fields and the job was to work ourselves out of a job as soon as possible by turning over the responsibilities to well-trained Mexican young group of scientists. I won't go into detail but this shutter breeding growing selecting nurseries, two different geologic areas, geographic areas, one with the days getting shorter, one longer, selecting for early adaptation disease resistance under those vastly different conditions lead to what we learned much later. We learned it in Mexico first. It served our purpose there.

In a mountainous country to plant these different times, depending on soil temperature and have positive results but it was 25 years later through the collective efforts of people trained in the Mexican Rockefeller Program that we found out that these were broadly adapted to many areas around the world and hence and that knowledge was verified by those many students who had been trained under the joint sponsorship of Food and Agriculture Organizations (FAO) of the United Nations and with funding from the Rockefeller Foundation to train a large number of students from the North African countries, from Egypt, Jordan, Turkey, Cyprus, Syria, Iraq, Iran, Afghanistan, Pakistan and India. They were the people that took back these materials, tested them in uniform tests so that results could be compared from one country to the other and indirectly led to the changes, which became known as the Green Revolution.

And what were these components? First of all, a high yielding, highly adapted seed resistant variety but there's no magic in a high-yielding variety alone. It's like a child who is born with a good genetic makeup for growing a strong body. If it isn't properly nourished it can't grow that strong body. It's the same way with plants. Those varieties could not express their genetic potential unless they were well nourished, unless the soil was restored to fertility. I learned a lot in Mexico because under our testing and evaluation program, we worked in one area where the land had been cultivated for untold hundreds of years before the Spanish arrived in Latin America in the 1500s. The yields were disastrously low even under irrigation. But we also had lands that had been cultivated, removed from the desert and irrigated northwest Mexico. Fifty years ago and some knew the components that you see was

not just the varieties, they were introduced experimentally in 1965 but look how rapidly they grew in millions of [inaudible] of cultivated wheat or the improved rice. But variety alone as I've already mentioned wouldn't have created much impact, very minor. They would have been adapted. They wouldn't have been accepted because if you only can increase yield 10 or 15 percent in a hungry starving nation, they will say, "This small difference was due to variation from year to year in rain fall or in temperature." There has to be a significant big jump, 50 percent, 100, 200, 300, 400 percent and this was achieved with this group of practices. Look at irrigation in that period; this is for all the developing countries of Asia. It doubled in that period of time. Growing improved wheat and rice became good business for the small farmers.

The next column is perhaps the decisive one. Look at the amount of nutrients fertilizer. It went from five million metric tons in 1965 to seventy-seven million tons in 2005. And production of course of all that's when grains went from three hundred sixty eight million to a billion seventeen million, a tremendous jump. Let me emphasize one other factor that's very often confused by people who have only a theoretical knowledge of agriculture coming to the third world countries and trying to convince the political leader and all too often they do convince them that chemical fertilizers are not necessary. You can produce all the food that's needed with organic fertilizer. This is nonsense and its cost a great deal of confusion in all of the developing countries.

China could have taken Japan but China is a master at using all organic waste. Look at those three lines, the atmosphere is deposition of causes. Its lightning breaking down the fixation of the nitrogen molecule and combining it to **** which comes down with the rain but it's not very much. Biofixation the nodules on the **** not very much. Organic cycling all the animal waste, human waste, crop residues that are fermented and returned to the soil all less than 10 percent or ten million nutrient tons. But by the year 2000, nearly thirty five million tons of nutrients were being applied and some of those importations came with **** from Japan to top dress organic and they saw these big jumps and at the height of the first petroleum crisis when Japan couldn't get petroleum for its fertilizer plants it told China, we can't supply you with the ****. Someone in China, probably Choweni, in six weeks time made the decision to install ten one thousand ton a day **** plants in **** converter.

The biggest investment ever made in chemical fertilizer. And this shows the tonnage but I had time to plot the production of food follows just about that same pattern and that's why I say don't, please don't come and misinform the political advisors in the third world that we don't need chemical fertilizer. If we want to look at historical facts, look at where the African countries are today. Five kilos per **** most of this was on a few culture or cash crops like cotton, certain food crops, etc. Had this chart been made not in 2005 but in 1960 before the Green Revolution, Vietnam, China, India would have been down in that chart where they African nations are today. So, plant nutrients restoring soil fertility is a key. Those magic varieties are not magic unless they're well fed and properly cultivated.

Of course, there are many other factors that come into the picture, control of weeds and so on. But, when you put all of these things together, this for the world cereal production, not just the developing countries, the production and I'd like to say at the outset that I'm fascinated by this PowerPoint myself. I was trained originally as a forester. I worked for the U.S. Forest Service. Twice in New England and then once in biggest primitive area, farthest removed from the road of any forest service employee in the middle fork in the Salmon River. That was my first career. I had planned to spend my life in forestry but through a

couple of accidental lectures I went to here that all changed. But looks what happened to saving land for other purposes, the production of cereals in the world in 1950, six hundred and fifty million tons. By the year 2000, a billion nine hundred million nearly three fold. And that billion nine hundred million was produced on six hundred sixty million hectares of land. Only about a ten percent increase over that fifty period of time. Had we tried to produce the harvest of the year 2000 with the technology of 1950, we would have had to have cultivated an additional land area of the same quality of 1.1 billion hectares more of land. The land saved, what's shown under the green part of that chart, so that by going into intensive agriculture rather than staying in forestry and wildlife management, I think I did a lot more to help conservation wildlife and use of basic resources than if I'd stayed in forestry, which is still to this day one of great of interest to me.

We move on to the next one and the difference, why did the Revolution take off in Asia and hasn't been able to get off the ground in Africa? We have to go back in history and even in biological history. First of all in the colonial period, an agricultural product was imported to Britain from India and the subcontinent what was it? Cotton fiber. So the railroads were built right into the ****. As soon as the railroads were there the provincial government and farmers organizations built roads to the railheads to deliver the cotton. What was the next factor? Limiting production, irrigation, water. They brought the best hydraulic engineers and **** time developed this system. Not much was known about fertilizer at that time, but when we move the improved wheat, high technology and **** all of that infrastructure was there and in addition there were still organizations from colonial times who provide certain services to agriculture.

Then we look at Africa. Where did the railroads go in colonial time in Africa? To the mines, to the mineral mines and to the diamond mines. The colonial powers were not interested in agriculture from that source. All of these things have a bearing on what happened or didn't happen in Africa. Moreover, we have to turn back and look at the handicaps that the African countries struggled under. The home of malaria, one of the oldest and most devastating diseases that takes a heavy toll even to this day on many African countries. There were animal diseases that prevented cattle and the oxen from coming into West Africa. **** the same one that causes sleeping sickness in the human being transmitted by the septic ****.

Various other diseases of animal, so west Africa because of the animal diseases is still largely in the hoe and machete agriculture. Never had oxen or horses to pull a plow. All of these things have to be taken into consideration. It's green fed agriculture they had never developed the irrigation to any extent except of course Egypt, which is completely different than the other parts of Africa. And there was no market driven demand for big quantities of food like there was mentioned five million, ten million tons of grain being imported into Pakistan and India to meet the emerging hunger and famine of the middle '60s. There wasn't that demand. Even if had there been, you couldn't begin to supply even a million. Even a few hundred thousand. How do you get it into the country and into the interior? All of these factors have been handicapped.

Now a little about the history of our involvement in African agriculture. In 1985, Mr. Sasakawa, the second Riowichi from the bottom called me and he said, "I've looked at what happened. I've followed closely what happened in agricultural development in Asia and your involvement." And he said, "Why isn't something like that being done in Africa?" I said, "I don't know. I've never worked in Africa except in the fringe north of the Sahara. And I'm retired and I'm too old to think about this monstrous problem." I hung up. He

called back a bit later and he said, “Young man, I’m 15 years older than you are. We should have started yesterday. So let’s start tomorrow.” And I got baited into coming into this. I promised him that I would try to get something going during my lifetime. He passed away about seven years ago and its now being the program is headed by his son. The photo at the bottom. Of course, President Carter has been very interested in agricultural and public health and education development in African countries.

We made a survey, five of us or four of us, in 1985 and visited university experiment stations in five different countries and we found out quite a bit of information including improved varieties of basic crop plant in these experiment stations and in the university but nothing to move them to farmers’ fields. And so our program was established to develop an extension program and we had a flexible organization. So if there was bottlenecks in research, we could, from Sasakawa funds, use of these transferring to an organization to try to unsnarl some of those bottlenecks. It’s been a very flexible organization, the Sasakawa Program, and the young staff that we have that executes it. We’re a small program.

I would like to inject also that two of our best and most effective extension leaders in Africa are two of my former wheat scientists from Mexico. It’s a kind of curious thing that Mexico, a very small producer of wheat could have had this impact in India, which is the second biggest world wheat producers today and in China. And now these wheat people being active in the other crops in Africa. This speaks well for training. Training of young people. I want to the young people right out of school who haven’t developed the bureaucratic attitudes and constraints that you can’t do something for fear of making it worse. So, when we look at the, this represents probably seven hundred thousand on farm plots from a half to a third of a hectare each with the best varieties, modest amount of fertilizer, good weed control and if there are major insect problems, insecticides.

Generally, insecticides are not used and this was also true in wheat. There was virtually no insecticides used in the wheat produced except for herbicides. Now, the red is the national average. The green is for each of those countries, the average demonstration plot yield two, three fold and in some cases even more. So there is technology available. We got to get it into production. You can’t theorize about theoretical yield. You’ve got to convert that theoretical to reality and produce food to fill empty hungry stomachs. And in the foreground you see the same variety in the photo as the one in the background with fertilizer. A blind man can see it. And we move on.

In addition when we move the improved maize varieties, which was developed jointly by the scientists in Guyana and in **** the International Maize and Wheat Center, in this case one variety became very popular and is now being grown on about seven hundred thousand hectares is the high quality protein maize. Maize has two limited factors in nutrition that’s of major importance. Two essential amino acids we can’t produce in our body, we have to take it in the form of food, lysine and tryptophan. This shows how international collaboration plays an important part. This gene opaque two soft kernel thing that probably arrived in the high mountains in Peru was identified at Purdue University as carrying much higher levels of both lysine and tryptophan. It was in soft kernels, susceptible to attack by insects both in storage.

Yield of 20 percent less per acre than the ordinary hard kernel and the farmer doesn’t get paid for quality. So, nobody would grow it even though feeding studies with experimental animals, with mice, rats, swine and later with babies and children, showed that this had

tremendous advantage ****. Two scientists, Dr. Vaso, the geneticist from India and Dr. Angelina Vega a Mexican woman biochemist, went to on this. They converted that soft start back to the normal dent hard start recovered the yield of the normal best varieties and had in addition the nutritive quality. That's what's being moved into Africa. It has defective. We're trying to improve this with hybrids. Now, when we talk about agriculture for Africa, we can't confine it to one crop. During the last weekend, we were in Onslow, Norway, where ****, which is a fertilizer from a company that was spun off from North ****, which is the biggest fertilizer company in the world. And there were presentations from the private sector.

Some of the interesting new developments that permits export of certain crops in increasing amounts, increasing incomes from foreign exchange. Among them was Mars candy bars because of the importance of cacao and their interest in developing more effective ****. Others were for certain vegetables, for flour, all of those things are important but we never need, must never forget the importance of those basic things because it will take a long time to change the African countries so that they can depend on exports for most of their income. You have to begin with the basic crops, maize or corn, ****, millet, cowpeas, casaba the root crop, which provides much of the calories. We shouldn't forget those.

The cash crops I've already mentioned, we have to hopefully get more and more support from the private sector in that field and the livestock, the protein parts of our diet whether it's meat or whether it's milk. We can't hope to increase those very much until we have grain that's beyond the human needs so it can be converted into better nutritive animal product to relieve the one source of food, two or three cereals. All of this has to come to be and I'm sure that this is beginning to move and then we have to try to improve the value of the agro products that's produced by the farmer. And in order to do this, I need to qualify this by saying, all of my early years in Mexico, India, Pakistan, China, and most south American countries were **** government agencies controlling the seed multiplication that left the researchers ****. That handled the fertilizer, that handled the other input and this is now beginning to change. The private sector is coming in.

I neglected to mention one thing when I was showing you those ingredients of the Revolution. I showed you the technological ones but I neglected to mention the policy these nations, economic policy. This rapid change in production could not have been made in India, Pakistan, China, all of those countries except for changing economic policy. The availability of the fertilizer of the right kind had to be at the village levels six weeks before planting. There had to be credit for the small farmer. Remember that they are three or four, five acre farmers most of them. They have no money. The credit had to be there to buy that fertilizer at time of planting and pay for it at harvest. And similarly the price paid to their farmers had to reflect the international price not as it was controlled in many cases, forty or fifty percent less than international market.

How could you expect an Indian or Pakistani or Chinese farmer at that time with the low yield to compete with the Canadian, U.S., Australian, Argentinean farmers with a 40 percent less price for his basic product. All of these had to be changed and the way its changed is when the grassroots are on fire. When there are hundreds of thousands of those little farmers that knows what can be done now. He has seen it on his own land or the land of neighbors and their becoming impatient and that's when you talk to the political leader not what the public press in the quiet of the officer of agriculture or prime minister or president or hopefully all three. Now the private sector has to become more and more involved in these in the handing of the agricultural chemicals, fertilizers, seed, because we nearly got wrecked on

the first import of wheat seed from Mexico and to India, Pakistan, two hundred tons. The government **** seed company said, ah this is government to government now we have to do it.

Before that all of our work was with farmers' co-ops and we ended up, there isn't time to go into all of the things that went wrong, I was sure that it was a disaster. The seed arrived six weeks too late for planting. It was shipped out on the same freighter from Los Angeles. Two days after it left Los Angeles the war was on between Pakistan and India and the seed was on the same freighter trans ship. Everything went wrong and there was no time for checking the germination, which we always did. We had to plant; it was too late already. We planted and we're digging around and something's wrong with the germination. So blindly we had to double the seeding, double the cost.

Can you imagine, we didn't look very good in the eyes of the ministers of those countries, but we babied the plants that were left? We fertilized them a little more than we would have. We irrigated them better. We controlled weeds better and at harvest they were better than any crop that the two countries had ever seen and that led to the big imports from first India, 18,000 tons. Pakistan the next year 42, Turkey 23 and big shipments to other parts of Latin America. But there's always a near miss in many of these things and it's frightening what you see the things you have to go through before you get them into production. Our hope is for water development. This has been neglected. There are many places where the water is close to the surface, one or w meters. Shallow wells and pumps can produce a lot of food. It doesn't necessarily need big dams, although there are times and places for that too. But the neglect on irrigation, look at that big Congo that winds around spills it water down to the coast, it's not used for transport to the coast because of rapids. All sorts of problems. In the U.S.A. the water transport was of vital importance in our early days. The Erie Canal, the Great Lakes, the ships on the Ohio and the Mississippi, all of this before the railroads. We forget the handicaps when you don't have water transport.

Now the roads, part of the infrastructure, the most important part has been neglected. We need a Marshal Plan for the development. The Marshal Plan came into Europe after the destruction of World War II and helped it get back on its feet surprisingly fast. Across these 30 nearly 40 Sub-Saharan African countries there's no network of roads. There's no single artery connecting main seaports to the interior. Why is it so? They don't all have to be paved roads. I went through this in Mexico. I saw roads built with a little dynamite and some wheelbarrows and people crushing stone with hatchets or with hammers.

They built and graveled those roads that was 60 years ago, 55. Today those are now paved. They served a purpose. The primitive type of roads to open the back country in Mexico and this is what's got to happen. And where there are roads there are soon schools. Not one but a whole series of primary schools and then there's the medical clinic. You won't get the teachers to move in where there's no roads. Nor the medical people. Once the road is there that begins to happen. Then small transport and even perishable crops where there are roads moves to the market like those roasting here. And this is one of the things that to me is criminal.

The lack of investment in education for adults there's nearly 150 million adult people who are illiterate or 45 million that are of school age that are not in school. There are more than twice adult women that are illiterate compared to men. And the women are the heart and soul of most of the families. Not only in Africa, in many parts of the world. I dare say in our own

in many respects. So, why don't we change this? It doesn't take that much money compared to some of the other things we spend our money on.

We move on, the last 20 years we've gone into a new stage in genetic improvement. The so called biotechnology where we're able to make crosses and obtain fertile seed from plants that were taxonomically so different that with the methods I used in my whole career, we couldn't these crops. For example, the BTG, the B stands to bacillus, T for therogenicis it's a bacteria organism they put this in the soil in many parts of the world, but this new technology that gene has been put into both cotton and into maize it controls insects, greatly reduces the amount of insecticides. These are steps forward.

But these are things some of which are achieved, the cotton thing I mentioned, herbicide ***** has put into soybeans and that's why soybean has become a high yielding good money earning crop. Not only in the U.S.A. but in Brazil and Argentina and it will become so in many others. You plant when the moisture is right. Let the weeds and the variety which carries that gene for tolerance to the herbicide and at the right stage you spray the commercial crop, the soybean is tolerant, it isn't injured, it kills the weeds. All of these are new developments. There are many others coming into being. There'll be future nutritive quality improvements.

I mentioned with the conventional, the improvement in quality of nutritive quality of corn and maize. But in addition there will be improvements in vitamin content in certain of the basic minerals that are short in the diet of many people like iron and zinc. All of these are underway in research now. And then in biotic stresses there are near commercial stage already, some more drought tolerant varieties. Some that are more tolerant to alkaline soils or to acid soil. All of these things are taking place. There's been a lot of noise against all of these but look at that BT cotton. In China and in parts of India it was common to apply 14 or 15 applications of insecticide. With the BTG in the cotton variety you apply one or two to the seedling stage where there are ***** and aphids that are not controlled by this gene. Tremendous change, saving and also from the health standpoint.

I'll move on to this one, many of those economic considerations that we've been talking about. Now enough money for schools, for roads, for helping the third world countries to get on their feet and move forward. Look at how we as in the world spend our money this last year, this last current year. More than a trillion dollars in military and armament. A trillion dollars and we are the largest country to investments in this sort. What could be done if even a small amount of this money were diverted to some of the basic issues that I've already spoken about?

And to summarize, the first year director of FAO, Lloyd Boyd Gore, way back in 1946, I believe it was, said, "You can't build peace on empty stomachs." To which I add, "And human misery." The sooner we get over this idea that we can build peace largely with armament the better off we'll be in moving in the right direction. Remember that soil and human misery and poverty are wonderful seed beds for planting seeds of terrorism.

Thank you all very much.

Lawrence MacDonald: Dr. Borlaug, thank you so much. I'm going to ask our panel to begin taking their places on the stage and I will introduce them and then kick off the discussion portion of our program today. While they're doing that, I just want to say that for

me that was such a terrific talk and I realized about halfway through that it was going to be really difficult for the panel to have anything to add because Dr. Borlaug, you covered both the technical aspects, the institutional aspects of Green Revolution, political, economic, a wonderful call to not be afraid of risk and then finally I think a stirring call for us to reexamine our priorities and a reminder if one were ever needed, that you can't build peace on empty stomachs and misery. So thank you so much for sharing your knowledge and experience with us today.

We have a terrific panel lined up to comment on the discussion. I'm going to introduce them starting with the person closest to me here, Gawain Kripke is the senior policy advisor at Oxfam International. Many of you would have seen Gawain on CNN or heard him on national public radio with the BBC. He's testified before Congress. At Oxfam he directs the policy work of the organization's Make Trade Fair Campaign. Gawain, thank you for joining us.

Next to Dwayne is Vijaya Ramachandran. I'm proud to say that Vij is a visiting fellow at the Center for Global Development. She is also an assistant professor of public policy at Georgetown University. Among other things she's an expert in surveys and surveys particular of small businesses. She was previously at the World Bank and before that she was senior economist in the executive office of the Secretary General of the United Nations. Vij, thank you for being here today.

To Vij's left is my colleague Peter Timmer, senior fellow at the Center for Global Development. Peter served most recently before coming to the Center as the vice president and chief economist at Development Alternatives, Inc. before joining DAI. He was the dean of the Graduate School of International Relations and Pacific Studies at UC San Diego. Among his many other experiences, Peter has spent a great deal of time in Indonesia. He's one of the foremost experts on Indonesia and I'm looking forward to hearing from you Peter, whether there are any lessons about the Green Revolution from Indonesia for Africa.

And then finally, to Dr. Borlaug's left, I'd like to welcome Chris Dowswell. Chris will be assisting Dr. Borlaug on the panel today. He's an agricultural economist by training and has worked with Dr. Borlaug at the Sasakawa Africa Association Global 2000 Program for the last 20 years. Chris has been living in Mexico for the last 28 years. So, I'm sure you have a lot of your own experiences to share with us.

Let me start off, Vij, I want to ask you first.

Vijaya Ramachandran: Okay.

Lawrence MacDonald: And I'm especially interested in your perspectives because you're from India and you work on Africa. So, if there was anybody who could draw some conclusions, I wonder you know, Dr. Borlaug gave us a terrific list of the impediments to the Green Revolution in Africa. And maybe my only criticism of that list is that for a lot of policymakers it might be too long. So, I'm going to ask you at the risk of oversimplifying to tell us the two or maybe three things that if you were in a position to advise African policymakers or the World Bank or the United Nations, as I know you indeed are sometimes, what would you say are the top three things that they should try to address to increase the possibility of a Green Revolution in Africa?

Vijaya Ramachandran: Thank you Lawrence and it's a pleasure to be her today and an honor to be on this panel with Dr. Borlaug. As you mentioned, he has saved many millions of lives in India and I think will do so also for Sub-Sahara in Africa as it embarks on an agricultural revolution. I think Dr. Borlaug touched on several key policy issues in his talk about why it is that Africa is lagging so far behind in an agriculture transformation. But I think something that I want to focus on particularly is the fact that in this next generation of agricultural or technological revolutions there's going to be a much, much greater role, or there is a much greater role for the private sector than there was in the '60's and the 1970's.

On the research side you know a lot of the research that was generated in the first and second Green Revolutions was generated by the public sector funded by the Rockefeller Foundation, the Ford Foundation and so on. I think if we're looking at the generation of technologies now, in agriculture a lot of it is being developed by the private sector and its being developed in collaboration with the private sector in Africa. And the dissemination of this technology I think is going to involve a very significant commitment on the part of African governments to engage with the private sector and to enable the private sector to do its job. And I think that's where there's a very critical issue or set of issues that needs to be addressed in order for this transformation to occur fully. And I think that on that front there's both sort of good and bad news.

If you look on the side of sort of policy reforms or rules reforms, there have been a number of positive steps that African governments have taken to make it easier to do business in Africa. So there's forthcoming data for example from the World Bank that shows that times to set up business, the kinds of procedures you need to go through to set up a business in the private sector. The kinds of legal environments you're operating in, all of those are showing positive signs of change. There is sort of a lot of commitment or more commitment on the part of government to reform their rules and to reform environments, legal environments and policy environments to enable the private sector to function better. So, I think on that side you know there's some good news in terms of enabling this technology, the newer technologies to be disseminated.

I think the side where we are most concerned is a set of issues that Dr. Borlaug touched upon, which is this very critical issue of the supply of adequate infrastructure. And if you look at how the private sector's doing Sub-Sahara in Africa the absence of proper roads particularly of a good and reliable supply of electricity, of a supply of telecommunications, of a supply of water, these issues seem to really be acting as a big drag on the private sector and I think that in turn is going to play a very critical role in terms of enabling the newer technologies to both be developed and to be disseminated. Dr. Borlaug mentioned that input supplies for example are transferred via private sector mechanisms to farmers. Grain marketing boards are much less important now than they were two or three decades ago. A lot of the former public sector rules are now in the hand of the private sector and the data seems to suggest that productivity lags are really driven by this very critical shortage of infrastructure.

Lawrence MacDonald: Terrific. Thank you so much. So a greater role for the private sector and the possible bottlenecks infrastructure. Gawain, I wonder if I could ask you to talk a bit about the institutional and perhaps some of the resource constraints that you see and ways to address those in bringing a Green Revolution to Africa.

Gawain Kripke: Thanks Lawrence. First, I want to also thank you for organizing the event. It's really quite an inspiration and quite an honor to be on a roster with Dr. Borlaug and also with my fellow panelists. Great people. Well, this was the rallying cry and not just a simple presentation but a presentation that has a history of success behind it. So, one of the most, I think inspiring presentations and hopeful that I've seen in a long time about the possibility of reducing hunger and doing something productive for Africa. I think Dr. Borlaug laid out sort of an agenda. He's described his own resources with his foundation but it's pretty clear that donors have been under investing radically in agriculture production, rural development, rural infrastructure and the statistics are pretty grim about that in recent years.

In the last 15 or 20 years, we've seen donors and government disinvesting in those sectors. Maybe 40 to 60 percent lower rates of donor spending in agriculture production and rural infrastructure than they were 15 or 20 years ago. This has begun to turn around and government themselves have issued a call to reinvest, to bring their own resources into it. But it's clear that donors and the World Bank, the United States, the FAO, African Union, all need to come together and sort of reprioritize this area: agriculture activity and rural infrastructure. So that's one area just to highlight the fact that we have a menu of options, a clear set of priorities but the resources haven't followed and even though I think there's growing consensus about it, we need to make sure it happens.

For the U.S. as a donor that's even more dramatic. I don't have the statistics at my fingertips but the partnership to cut hunger in Africa recently did a study that showed that U.S. support in this area is even more radically reduced. So, I think we had a challenge right here with our own Congress to put this back up on the agenda and get Congress and the Administration to reprioritize agriculture productivity, rural infrastructure in their priorities. I would say one more thing about the institutional constraints is that we tend to be reactive a lot of times in this business and there's a lot to react to, hunger has been on the increase and crisis and emergencies have been on the increase. When we talk about hunger we often respond with the tool at hand, which is food aid. But I think we need to rethink our priorities. The answer isn't to cut food aid of course but as it always that we need more. We need more resources to do the kinds of investments in productivity that have been declining even as we continue to provide the support for emergencies and responses.

Lawrence MacDonald: Gawain, thanks very much. Peter, I'm going to put you on the spot a little bit because in setting this up you've been a marvelous colleague and have been very enthusiastic about the event but I have sensed a certain element of what I would call maybe rather crudely Green Revolution skeptic and that may be unfair, but we haven't had a chance to hear from you what it is that you, what is this unspoken reservation I've been hearing. Or maybe there isn't one, but I wanted to sort of give you an opportunity while we –

Peter Timmer: Reservation?

Lawrence MacDonald: - all honor the achievements of the Green Revolution and Dr. Borlaug in particular to express what it is I've been sensing from you that I would call a Green Revolution skeptic. And please correct me if I'm wrong.

Peter Timmer: He's a sensitive guy. Thanks Lawrence, yes it does put me on the spot. I mean first of all let me join my panel member and the rest of you in honoring Dr. Borlaug for what he's done and I want to thank Leon Hesser for the book because that's the occasion

we have here at CGD to bring this forum together and to bring a lot of old friends I see out in the audience. I'm always startled when CGD does something on agriculture in Washington. It's like feeding the hungry. There's real response there people want to hear and in a sense a neutral venue for a discussion of these really critical questions. Skeptic. I'm not a skeptic of the Green Revolution as it played out in Asia.

I worked, as you indicated, worked in Indonesia in 1970, 1971 the Green Revolution transformed Indonesia's growth potential from a country that **** said, no economist holds out any hope to one of the great success stories in the following 30 years. The fastest mass reduction in poverty in history until the Chinese did the same thing some 15 or 20 years later. The Green Revolution was the foundation of growth in Asia. I think there's no question about what the contributions of Dr. Borlaug and his colleagues who used the same ideas and methodologies at Erie to transform the productivity of rice production in northern Asia, of wheat production as well.

This just totally transformed the nature of the growth process in that part of the world and we look back now and look at Asia as the great success story. There's clearly problems, Laos and Burma, **** is a really difficult case but in fact you've got the great successes of the second half of the 20th century in terms of economic growth and poverty reduction in Asia and I would argue that a huge part of that is based on the Green Revolution. So why am I –

Lawrence MacDonald: But!

Peter Timmer: So, am I a skeptic? I have in my hand a report "Africa, Growth Renewed, Hope Rekindled" it's from the U. S. Agency for International Development, 1993. It's a report on all the great things that were happening and about to happen in Africa. It hardly mentions agriculture. There's a little there but it's mostly about bringing democracy and better governments and human rights to the continent. There was a minor industry in the mid-1980's, my colleague Dick Goldman is here was part of this, learning lessons from Asia's success for Africa.

I first met Dr. Borlaug at one of these conferences that Chris **** organized for the Sasakawa Foundation where we were trying to figure out what were the success ingredients in Asia that needed to be translated into the African setting. Obviously, that has been much, much harder to do than we ever would have dreamed 25, 20, 15, 10 years ago. I think the difference is it's not technical and I'm not even sure it's economic. I'm pretty sure the difference is in the nature of the political systems and the nature of political pressures on leaders to make the kinds of investments that Dr. Borlaug pointed out.

You're not going to have a Green Revolution in Africa unless you have decent infrastructure, unless you have reasonably cheap fertilizer, unless you have reliable electricity, unless you have a research system network and there's no great pressure on the leader in Africa or on the donors to make those kinds of investments of the same sort the kinds of political pressures that were felt in Asia. I mean it was '66 and '67 monsoon failure in India, five, six, seven million tons of food aid imports. Lyndon Johnson holds those imports on the so-called short tether.

If India was going to survive as a country and it's a very proud ancient civilization, it was not going to let the United States dictate how many of its people got fed. It needed to make a commitment. Indonesia made the same commitment. China made the same commitment.

These were big countries that could not rely on the world to give it food and in the case of China, Indonesia, India; these are countries that cannot even rely on the world to supply imports even if they had the money to buy it. They're too big relative to the size of that market. These are countries that if they were going to survive needed to make this investment in their own food security provided primarily, not 100 percent, but primarily from their own domestic investment. That meant they had to figure out how to get Green Revolution to millions and millions of small farmers. Technology was crucial to that but it was only a piece of that and I think that was actually the story that Dr. Borlaug laid out. You can't do it without technology but you can't do it with all those other pieces as well and I would argue that until we have the political pieces in place, we aren't going to get the rest of the mechanics right.

Lawrence MacDonald: So if I were going to sum up it up in three words it would be incentives, incentives, incentives. In this case incentives for African leaders and for the donors to reexamine their priorities and to actually face pressure to change the way they've been doing business or not.

Peter Timmer: As an economic historian, I'd say those incentives can be in the nature of long run price averages but in fact, these are political incentives.

Lawrence MacDonald: Dr. Borlaug and Chris, I want to give Dr. Borlaug an opportunity to respond to these things if he wishes and alternatively I'll take some questions from the floor. How would you like to proceed?

Chris Doswell: Do you want to say anything?

Norman Borlaug: You want me to make some comment now or after questions.

Lawrence MacDonald: It's up to you. You want to wait and take some after we have questions from the floor.

Norman Borlaug: Let me just pick up on one of the points that Dr. Timmer made referring to this report of 1993. Look, any place where there's been major change in agriculture and food production to improve its standard of living of the people, it starts with agriculture because there's where 70 to 85 percent of the people live and work and starve too often. And so if the emphasis was the other way around trying to do something in the urban sector, in the business sector as a first step no wonder we don't get any place. It has to be the other way around. That's where the people are. That's where the capital investment and infrastructure largely has to be made and we forget about our own history, the U.S. agriculture.

I mentioned in passing the importance of water transport in our early period of independence the vision of people to build the Erie Canal to connect the Hudson River and the Saint Lawrence to the Great Lakes all of that agricultural productions plus mineral, iron and ore could be moved to the industrial sectors further east. The Ohio River and steamboat in the Mississippi and the Missouri all of that was by water before the railroads came to be. And then much later the highway system. The highway system from an intercontinental highway was very late and it was at the insistence of the military that this be done. After World War I when General Pursing came back, he wanted to see how long it would take to send the best mechanized cavalry, not the four-legged ones, the early-motorized ones from New York to

San Francisco so he sent them off and I think ex-President Eisenhower was a 2nd Lieutenant. It took them six weeks to get there and then they started raising the question, "How can we have a united nation or a United States and protect ourselves with this kind of a thing?" And he got incensed at this because his mechanized equipment didn't arrive in France when the expeditionary force did so they had to use French and British equipment and I guess they weren't very happy at that.

So you see then we look at our own internal agricultural development. In the beginning times, it was the land grant colleges and universities who developed the technology. They were the seed organizations or an affiliate with farmers groups who multiplied the seed of the new variety to distribute it. They were the people who moved the fertilizer. Who got the people involved. All that's changed since World War II back home here. Those services that were provided by government and universities prior to World War II are now in the hands of private sector. Good and well, they do it more efficiently but how do we think we're going to jump to all private sector in Africa in one big jump. It won't work. The public sector has to place an interim role to get this thing going. Hopefully, and there are signs now ****.

It has to start with the land where the people live, where the majority of the people. You get that going and lots of other things start to happen, when that road comes in, I mentioned the schools, the public health, but I didn't mention that there's a truck that might be carrying fertilizer, that there are probably 30 people piled on the back, and that's tearing down ethnic borders, cultural borders, linguistic borders in Africa as the handicap **** in different cultures, which also handicaps.

Lawrence MacDonald: Dr. Borlaug, your reference to American history reminded me, I was so struck in reading your biography by Leon Hesser and in reading your own autobiography, Leon, that both of you grew up on farms. And I want to task our audience a question. Besides Dr. Borlaug and Leon Hesser here, did anybody here grow up on a working farm?

Wow, I'm impressed. Maybe that's why you're here today. I didn't think that there'd be anybody. But I'm wondering, for those of you towards the front – it looked like maybe there were six –

Next Speaker: More than six..

Lawrence MacDonald: More than we might have expected. But that leads me to wonder if, as the farm population dwindles to an infinitesimally small one in the U.S., whether we'll have another generation of farm policy researchers and agronomists like Leon and Dr. Borlaug. Chris, did you grow up on a farm too?

Chris Dowswell: Yeah, the only – I would add a little bit to what Norm said, but when we started our program in **** Global 2000 in '86, we were moving to help strengthen government institutions when the whole donor world was moving to dismantle them, and you know, it's been a great myth that just getting rid of the public sector would result in the private sector rushing in. It certainly hasn't happened and, even in research, there's been very little interest in research except maybe South Africa and perhaps Zimbabwe before in proper search, and certainly in orphan crops, you know, say beyond maize hybrids. And there's a big role for the public sector there, but how do we create those mediating organizations which I think are small and intermediate enterprises, to produce that seed, to

distribute that seed and then, of course, in biotech where you really need economies of scale, but how to get those partnerships working.

I mean there's tremendous regulatory resistance in Africa to biotech, a lot of it because of the links to Europe. Really only South Africa has any biotech products out there. Kenya plays the game and talks the talk, but basically, to milk money, often to get more research, to do more studies, but they never seem to get anything really happening to move it toward commercial release. And one of the things we're struggling with is to figure out how to convince, and USA's played a big role in this, but how to convince now public, the leaders at least separate the research process, so you're having efficient research process that takes you to field experimentation. So you're not cut out of another agricultural scientific revolution, and separate the issue of commercial release, which you can decide later on. Because we're really not seeing any movement in biotech either. Lots of promises but, you know, ten years later, Kenya is still debating its biosafety law.

Lawrence MacDonald: Thank you so much. I want to open it to questions and comments from the floor. We have a wealth of knowledge here and I got a signal from my boss, Nancy Birdsall saying she'd like to speak, so there's some prerogatives when you're the president of the Center for Global Development, and one of them is you get to speak from the floor first. Nancy? And would you please stand so that people can hear you better and see you.

Nancy Birdsall: Thank you very much Lawrence. I have two questions. The first is actually for Gawain. I don't want to put him on the spot, but I think this issue of the GMOs in biotech is maybe fundamental, and I'm interested in whether Oxfam has or will take a position that is more positive on the potential for GMOs to advance the technological breakthrough and lead to increased productivity in African farming. The second question is for any of the panel members. As an economist, you know, trying to look back at what the differences are between Africa and Asia and being rather naïve about agriculture being part of your problem in a way.

I observe that there may be a difference between a comparative advantage or potential comparative advantage in food crops like wheat and rice, relative to a comparative advantage in non-food crops – coffee, cotton, cocoa, tea and to the extent that African agriculture, where there has been export potential, has relied heavily on non-food crops, and then run into all kinds of problems associated with bad policy, including long periods of over-valuation of the exchange rate, plus global forces, the secular decline in commodity prices – do we face a problem in thinking about a green revolution in Africa, namely that the dynamic comparative advantage in many parts of Africa may continue to be not in food crops, which seem to generate the kinds of responses and maybe healthy political pressures that led to the institutional complementary steps in Asia that ensured agriculture contributed to growth. Sorry for such a long sentence. I hope you got that.

Lawrence MacDonald: We get it. Thank you, Nancy. Um, Gawain, question about, I guess, especially Oxfam's views, but I think more broadly, you know, where you see the NGO community's role on GMO's headed.

Gawain Kripke: Well I certainly can't speak for the NGO community. I wouldn't –

Lawrence MacDonald: As an observer I was hoping, but start with Oxfam, however you're comfortable.

Gawain Kripke: Well I think, the question of GMOs is highly, as we know, highly politicized, very ideological, everybody has an opinion about it. And Oxfam doesn't. Oxfam hasn't taken a position and what we have tried to do is set, develop a set of criteria about what should we be looking for in this technology, and we should be looking for something that plays a role for poorer and small holder farmers, and that is replicable and usable by them without oversight or doesn't increase their dependence or reliance on other supports. So that's one thing.

We don't want to weigh into this sort of highly politicized debate. We want to hold the bottom line to be the producers and poverty reduction. Those really should be the goals. GMO is a technology. There's lots of technologies that are potentially advantageous for production and unfortunately, a lot of the focus among some donors has been on GMOs and a lot of the research institutions in Africa have been pressured and supported to look into GMOs while neglecting many other potential and less politicized technologies. And you hear it from researchers in Africa that they can get funding to do GMO work, but they can't get funding to do a lot of other technological research.

So I think we need to take a step back and Oxfam's been trying to not engage in that debate, although we've been doing some research to try to analyze how the impacts of diffusion of GMO technology has been. Have they been pro poor? Have they led to greater incomes, greater production and so forth and unfortunately, we don't have the results of that research. We're in the middle of a two-year research project right now to look specifically at the case of BT cotton, and hopefully, that would give us some guidance on if it's possible to get some parameters to set in the adoption, about whether or not to do it. African countries, I think – many developing countries are very suspicious of the IP issues, the intellectual property issues around GMOs, I think, and some of the suspicion is not driven by Europe or ideology, it's about wanting to own the intellectual property and not be dependent on paying the patent rights outside.

That becomes another dependency, so you see, this strategy's developing in many developing countries like China and India, to develop basically their own IP industries and the resistance to adopting foreign IP technologies isn't as much ideological as sort of commercial. So anyway, I think for us, what we want to do is draw a bottom line about small holder agriculturalists and whether they can benefit from this technology, whether it can be utilized by them when there's very weak infrastructure, very weak extension support and so forth and, if it's viable, then we want to support it. If it's not, then we want to make recommendations on how to make it so.

Lawrence MacDonald: Gawain, thank you very much. I sense a lot of interest in this question of genetically modified organisms, but I want to push ahead on the other question about whether Africa does indeed have a comparative advantage in nonfood crops, especially the beverage commodities that Nancy mentioned, and whether that changes, I understood your question Nancy, essentially the political economy of getting a green revolution going – is there anybody on the panel who would like to address that. Peter.

Peter Timmer: Yeah. I think the political economy of food security resonates very, very deeply. It certainly does in Asia. I've actually written a good deal about why

export crops don't generate the same political support as domestic food, and yeah, if politics are driving the difference, then relying on export crops for your agriculture as opposed to food staple crops that provide sort of visible supplies in the marketplace for your population, that goes a long way alone, in explaining the differential political response in Africa, compared to Asia.

Lawrence MacDonald: I think there's an underlying question, and I don't know if anybody knows the answer, but maybe some of our agronomists do, and that is, is Africa just basically, the land and the climate, better suited to producing nonfood crops or is this tendency towards the nonfood crops the results of policies and institutions and perhaps culture? Chris.

Chris Dowswell: Well, first of all, except for tea, I believe Africa has lost ground in cash crops, in every other traditional cash crop, to Asia, so it's lost in cotton, it's lost in coffee, it's lost in palm and it's lost in cacao. I mean Vietnam, I think, is the second largest exporter of coffee now. And part of that reason is that they have, is the whole post production issues and technology in general of revitalizing its export industry, and this goes again back to infrastructure. If you want to be competitive in a globalized world, you have to have a competitive transport system. It's \$75.00 to move a ton of maize from an Iowa farm to Mombassa, 15,000 kilometers away. It's \$100.00 to move that ton from Mombassa to Kampala.

So you're never going to be able to compete in food crops with those sorts of transport problems. But in the end, sure, cash crops are important, but there's also elasticity of demand. There's only so much paprika that the world wants, and the main things are food crops. You still have to modernize those, but yes, by all means, develop your import industry and there's a lot of nontraditional export crops that can be developed. But many of those will depend on an efficient transport system to be able to – and there's a whole bunch of quality issues because there's a lot of non-tariff trade barriers.

Lawrence MacDonald: Thanks so much. I want to take some questions from the floor. Who do we have here? You're the first gentleman I saw and then we'll take the gentleman back there and the fellow next to you. We'll take those three, sir, and then I'm going to come to you.

Next Speaker: Thank you. I'm John McCormick and I'm with the Energy Policy Center and Dr. Borlog, it's an honor to be addressing you. I have a question, and that is, it's evident that farmers in Africa and people of Africa are going to benefit from what you can offer them, the things that you can control. But there are other things that are going to affect Africa that you cannot control and I'm afraid that global climate change and global warming, by every person's estimate who's seriously looked at this, Africa will be one of the greater victims of increasing global temperature, bordered by the Indian Ocean and the African or the Atlantic Ocean, it's very possible that the Sahal could be green in 50 years, but it could also be possible that droughts will be much more severe in the south of Africa, and I'm wondering if you might address how, in the coming years as we learn more about climate change, that it begins to affect the decisions being made by the efforts that you will put forth.

Lawrence MacDonald:: Okay, great question on climate change. Yes, and please do identify yourself and the organization.

Next Speaker: My name is George. I'm with the **** Office. I'm from Zambia which is in southern Africa. My question is, any person from the panel could comment about this, what lessons could we in Africa today learn from the areas where the green revolution has been successful in terms of land? How was the land distributed and if you look at southern Africa today, we have many land issues, which hasn't been resolved. In places where land reform has been put up, there has been so much chaos and failure. So in places where the green revolution was successful, how was the ownership of land, how was the land distributed, because today, we got no talk about it, **** not talking about who owns the land. Thank you.

Lawrence MacDonald: Okay, a question on land distribution and I think that that may be one for other panelists, perhaps, as well. And finally, we have the third question in this set.

Next Speaker: Yes, I'm Germont Boussant from Paris, France. In principle, it is easier to increase production, in Africa and ****, because in Africa you have land, you have plenty of land and in Asia, you have no land. This is, of course, the reverse side of the coin is that in Africa, transportation is more difficult, but this is not a problem for export crops, and the reason for why food crops have never been expanded in Africa is simply because cash crops have been given advertised fixed price and **** by government, while the cash crop, the food crop, have never been, never been in a fixed priced, so **** should be to the market and it did not work clearly.

Lawrence MacDonald: Okay, terrific. Thank you. Question about land abundance in Africa, relative land abundance and whether fixed prices for cash crops paid by the government versus no fixed price for food crops from the government has been a factor in impeding the green revolution. There's a sort of buzz on that portable mic, that's just what I was trying to signal our friends on the sound in the back. I don't know if you can sort it out before we use it again. Dr. Borlaug, I'm sorry Chris, you were explaining the questions – I had a chance to speak to Dr. Borlaug earlier about global warming, so I was quite interested in his view and I wondered if you wanted to say, address that question.

Norman Borlaug: Well, I think the evidence is fairly clear that we are going through a period of global warming. I don't think there's any question about that. The question is, are we capable of making dramatic changes to cut that back to where we thought was the normal trend without disrupting the whole economic production system, and then we have to remember that there are long time geologic changes that are cyclical – the glaciers that have covered the earth, not once, or much of the earth, but several times. And it was before there was burning fossil fuel. If the temperature goes up, the evaporation goes up. I'm not sure that our prediction of where that additional precipitation is going to take place is very accurate. We should be concerned about these things, but we better have a lot more research information before we tie ourselves all up in knots and make things worse, rather than better.

Lawrence MacDonald: Thank you. Okay, who wants to tackle the question about land distribution? Is there any comment? Vij?

Vijaya Ramachandran: I'll make a short comment on that. Access to land comes up systematically as one of the most significant constraints in interviews of households and in

interviews of private enterprises. Land rules change, ad hoc changes and rules often driven by donor or partial donor reform programs. The imposition of western-based land rule systems upon traditional systems in an uneven or ad hoc manner have all contributed to this consistently high rating of access to land, the ability to purchase land, to set up a business or to set up a farm, as a very significant constraint and that speaks to a wider issue, which the gentleman from France also touched upon.

I think underlying all of this discussion and this diagnosis is the fact that African households and African firms face very, very high levels of risk, and not a lot of policy reform has addressed that. If you look at the microeconomics of production, whether it be in farms or in firms, the amount of risk that producers face is very high and the policy mechanisms to mitigate risk that have been implemented in other parts of the world have not yet been implemented in sub-Saharan Africa. I think if we approach the problem from that perspective, we might have more success in some of these reform efforts than we have to date with our much more macro economically focused performance.

Peter Timmer: Can we just –

Lawrence MacDonald: Okay Peter and then Dr. Borlaug, and I promised I'll come back to this gentleman here.

Peter Timmer: Okay, just very quickly on land distribution, land reform – I urge people to go to the CGD website and look at the Zimbabwe story of the before and after communal lands versus the commercial farm lands, before the land reform efforts in Zimbabwe, and then it's just a green line. Commercial farms are green and the communal lands are brown, and then after the land reforms, you start to see the brown creeping into the commercial lands. It's a little scary, but it shows viscerally the importance of property rights in making investments, at least for the private sector, in agricultural productivity.

Lawrence MacDonald: Peter said it, but in case anybody missed it, these are actually aerial photos from Google Earth and they're extremely dramatic, so it's not like he's asking you to go and read one more paper, he's asking you to go and look at some pictures.

Peter Timmer: Go look at two pictures.

Lawrence MacDonald: Dr. Borlaug.

Norman Borlaug: I would just like to comment on the ****. Sure, land tenure is a real obstacle to development of the rural economy, but turn back further and you will see that that migration and slash and burn agriculture goes back to a basic shortage of nutrient, and you have to remember that the landscapes of Africa, with the exception of northeast Africa, where there's been volcanic activity, and it continues, all of the rest of the continent except for that little volcano that popped up a few years back at Cameroon, there's been no volcanic ash. Volcanic ash rejuvenates. It may not bring all the nutrients but it brings most of them. Of course, it doesn't bring nitrogen, but when plants grow, the organic accumulation, when you're moving and leaving long time fallow corrects this.

You can see this case in point in the opening of the **** soils in Brazil. They are of the same origin, the same age, as much of the land of Africa, highly leached, highly weathered – it's like the continent or the landscape under the ice in Antarctica or Australia. It's not like North

America or Western Europe. So the whole thing, in a large part, comes back to that fertility thing, nutrients, and it's tied also to land ownership or tenure, but beyond that is the infertility of those old soils. They were leached by Mother Nature, not by agriculture. The Serrado that's being opened up now was never cultivated. We have many of those soils like that in Zambia. I've seen them. Acid. You plant ordinary varieties and they die when they're that high. We've got lots of problem soil that we haven't faced up to in Africa.

Lawrence MacDonald: This is going to be the last question.

Next Speaker: Thank you. Franklin Moore and I'm the Director of Environment and Science Policy for USAID. I'll restrain myself from talking about biotech, which is an area that I like a lot. Before I ask two questions, let me make one comment, and that's the comment that looks at cash crops and food crops, and my one comment in that area would be that in Africa, it is clear that for every dollar that could be earned from a cash export crop, there is the potential to earn \$10.00 from inter-regional trade. So the dichotomy is not so much cash crops and food crops. The dichotomy is, as many have pointed out, the infrastructure that allows things to move, because if the infrastructure were in place for Africa, there would be approximately \$40 billion a year in inter-country trade on food crops and each of the areas of Africa would be taking advantage of their comparative advantage for those food crops. So in some ways, it's a false dichotomy in the question.

The two questions I have, the first question, I would like several of the panel members to talk about how they see Africa compensating because of *****, and by that I mean if you will notice the three places we've compared Africa to, and we've talked about Africa as if it's a country, not a continent, but the three places we've compared it to are India, China and Pakistan – huge in terms of population under one administrative head. So you have India, one country, Pakistan, one country, China, one country, Africa with half the population of India or China, 54 countries. So how does one compensate for these small units as one moves forward to adopt the green revolution or gene revolution?

My second question is to *****, and it kind of follows on something that Chris said. You talked a bit about the private sector and the role of the private sector in agricultural research, and what we find is that the real research that needs to be done for most crops in Africa, are around what one calls orphan crops, i.e. they are crops that are not corn, wheat, maize, where commercial interests are very interested because they have huge markets. They're around smaller crops where the market isn't so big and so it brings into question the commercial interests. Could you comment a bit on how you see the private sector coming in and see them interacting with the public sector?

Lawrence MacDonald: Two great questions. How does Africa compensate for its huge size and many countries compared to the comparators which we've been throwing up, which are large, very large countries with single governments, and what about the orphan crops? Who would like to go? On Africa's size first? We want to think about size for a minute and go with the orphan crops? Dr. Borlaug.

Norman Borlaug: The second part of your question I think comes back to political stability. The private sector isn't going to invest in countries where the social political condition is chaotic and where it changes very rapidly, the investment may be lost completely. This is a real problem and where does that political stability have its roots and what happens to the massive, the rural people? Back to basic food is the first step, not the

only step, but the first one that has to be challenged. Unless there's some hope of political stability, which is worsened by hunger and famine, there won't be investments of any magnitude by private sector in those countries.

Lawrence MacDonald: Thank you. Peter.

Peter Timmer: Just quickly, on the size question. I mean, if politics is what's driving the lack of investment and the priorities with respect to agriculture, small size is clearly a problem because research establishments have economies of scale, but if we've learned anything, as trade economists, it's that small countries need open borders and they need as much sort of external cooperation as they possibly can in order to be competitive, and we just don't see very much of that happening yet in Africa. So there's a lot of the size can be overcome if you get the border barriers reduced.

Next Speaker: This would be the EU of Africa approach. Right? Lots of small countries, but low border barriers.

Next Speaker: Exactly.

Next Speaker: Roads, infrastructure.

Next Speaker: But roads don't work if they don't cross the borders. I mean the problem is that roads that cross the border without barriers. I mean, economists hate borders because they, you know, they restrict trade. What we've tried to do is get that whole thing opened up and you can't do it without roads, but roads won't be enough if the border itself is still blocked.

Next Speaker: I feel like we didn't address the orphan crop question. Is there somebody – Vij.

Vijaya Ramachandran: I think following up on that, **** integration does seem to suggest some of the answers to the woes of getting the private sector to engage. I mean any one of these countries is very small but together, as you pointed out, you know it's half of India. So you see potential for a wider market once you get beyond these sort of individual country borders or **** borders, and while it has been difficult for the private sector to have success in developing technologies around orphan crops, there have been, you know, a few cases which are worth looking at – Vitamin A rice, you know, successes that have occurred with an interesting combination of public and private sector money and engagement and time, and I think those are the ones, you know, we need to follow up on if we want to extend the model of getting sort of good research that's relevant for the soil conditions and climatic conditions and so on.

Lawrence MacDonald: Thank you very much. I think we'll end on time. We always try to start on time and end on time. I'd like you to join me in thanking our panel, and especially Dr. Borlaug, for being with us today. Um, I would add that there are some copies of Leon Hesser's terrific book. I would recommend it very highly. He's kindly agreed to sign some. Dr. Borlaug would rather not sign. It's painful for his hand to do that, but Leon will, and I encourage you to pick up a copy if you haven't done so already. Thank you all so much.