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THE GLOBAL AGRICULTURAL CRISIS OF THE 21ST CENTURY

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Thank you, Ambassador Quinn. It's a great pleasure to be back here in Des Moines for this World Prize celebration.

We are in the middle of a number of crises. The financial and the food crisis, and terrorism, are probably the biggest; but there are others too. And the features of these crises are that, first of all, we don't really understand them very well. Secondly, we don't know how to manage them very well. And thirdly, and I think even more scary, is that they're beginning to join up.

This is an English cottage loaf, and it's the best image I've got of what we're seeing today. The top of the loaf is the immediate crisis, but underneath is a chronic crisis. I bet you'll never eat an English cottage loaf again.

The crisis is summed up in these FAO food statistics: Food prices went up by 50 percent in 2007, another 15 percent or so this year, but have gone back down to what they were at the beginning of the year. We know pretty much why that happened – grain stocks were falling in 2006 and 2007. Partly that was due to falling production.

Australia had several years of the worst draught they've had for a hundred years, particularly in the Mary River. They had less grain to produce, so did Ukraine, so did elsewhere. Biofuel demand was rising rapidly, and you can see the figures there – since 2005 well over double. And oil prices were going up. And significantly, of course, the oil prices were going up before the food crisis went up.

And most important was the consequence on fertilizer. The blue line there is diammonium phosphate; it's gone up over six times in the past year in price. And I've been puzzled by that. It's much greater than the energy increase. But last week in the World Bank, Amit Roy explained it to me. He says if you make diammonium phosphate, you do need energy, of course; you need the energy to produce the ammonia that goes in there. You also need phosphate, and that's in short supply, and it's high in price. And you also need sulfur, and the sulfur is expensive, in part because

it's being increasingly used in the industrial processes in India and China. This is one example of where the crises are coming together.

And one of the biggest questions we have to face is: How do we make fertilizers cheaper and more accessible? What that crisis has done is to create another 100, 150 million more hungry people. And that's on top of what we have already – the 850 million we've got already.

The worst statistic on that table, I think, is the 400 million women who are anemic. If a woman is anemic and she gives birth, she may die, the baby might die, both of them may die, or at the least they will become very ill. It's a great stain on the world that we've got 400 million women living like that.

Now, let's go down to the bottom of the cottage loaf, away from that spike, that the commoners like to refer to it as, and recognize that there is a list of drivers: rising populations, in particular rising per capita income, not only in China and India and the OECD, but also in Africa; growing demand for livestock; growing demand for biofuels; shortage of land; impact of climate change; and the slowing of productivity increases. I'm not going to go into each of those, but I'm just picking out a few.

First of all is this pressure on the land. We need land for food and feed, for biofuel, for industry, for forestry, for pasture and range of ecosystem services. Is there enough? Some countries have still got land that they can expand into in terms of agriculture – Mozambique, Sudan, Angola, Brazil. But in many countries, there's no arable land left.

How are the poor going to benefit from this divvying up of land between these different functions? And most important, the question for all of us: how can we manage market forces to get an equitable and sustainable solution to determining what each piece of land should be used for, for the benefit of not just the owner or the tenant but for the population at large?

Secondly, this question of meat consumption. If you look at the top of that graph, the white and the gray bar, that's consumption of pork. Notice that China consumes half of the world's pork. Meat consumption is going up dramatically. I know people think we should all become vegetarians. In some ways, it would solve a lot of problems. I just don't think it's going to happen.

And so how do we improve livestock conversion efficiencies? It becomes even more important now than it was in the past. And how do we reduce the greenhouse-gas emissions from livestock rearing? Two more questions for this meeting.

And then, biofuels. I think we need to recognize that we may grow biofuels for energy security, we may grow them to increase farm income, we may grow them to reduce carbon emissions. They're not mutually exclusive. What I am arguing is that we need to be much more explicit about why we're growing the biofuels. We need to be upfront about why it is that we're growing a biofuel crop.

And in particular we need to do a very careful and thorough life-cycle analysis of the biofuel crop in each place. And if, for example, we're trying to assess a biofuel for reduction of carbon emissions or for increasing farm income, we've got to answer this set of questions: Is it profitable, is

it cheap, environmentally friendly, socially acceptable? Do the poor benefit? Is it at least carbon neutral? And actually if you do that, very few of the first-generation of biofuels pass muster.

And one of the questions is: How quickly can we move to second- and third-generation biofuels? We've got to get much more in terms of literage out per hectare than we do at the moment, in part so that we don't have the conflict between producing a crop for food or producing a crop for biofuel.

We need to move towards cellulosics like switchgrass, which would probably produce double what sugarcane does now. And for biodiesel, the potential is through algae to start producing something of the order of 90,000 liters per acre. The day that begins to happen will be the beginning of a new revolution. Maybe we should have a World Food Prize on this, in which we transform the world, from one dependent on petroleum and fossil fuels, not just for energy but for production of all the chemicals we need in the world, into one that depends on plants as a basic source of our economy – that will be a huge generational change in our, maybe not in mine, but in your lifetimes.

Cereal yields remain low in Africa. One ton per hectare – you can skateboard along that line. I usually say one ton per hectare is what we used to get in Britain at the time of the Roman Empire. Unfortunately, the Romans left and it actually went down but... One of the great tragedies of British life is that we stopped being part of the Roman Empire.

One of the reasons, of course, is that public funding of agricultural research has declined. That hasn't mattered in the developed countries. In fact, the private sector has picked up the mantle and is producing the seed and the technologies we all need. But that's not working in the developing countries and in particular not in Africa. We have to get the public funding of agricultural research up if Africa's going to benefit.

Let's ask this question: If the food prices have gone up so much, why on Earth aren't all these small farmers in Africa and elsewhere suddenly producing more food? Where I live in Sussex, we've got lots of farmers around my house who normally grow turf for grassland on – I should say, on Roman fields. They grow this turf, and they make a lot of money on it, but they're digging it all up at the moment to grow wheat – they're responding to the market. But in Africa, farmers aren't responding to the market. They're not responding for a whole range of reasons, of which I've listed, I don't know, seven or eight.

But the key point about these reasons is that the mix of reasons change from place to place. And we urgently need a new set of diagnostics, country by country, state by state, province by province, to work out exactly what are the barriers to improving agriculture production and profit.

So what's the way forward? Well, I've been arguing, as you know, for some years for "a doubly Green Revolution." I wrote a book about it ten years ago, and I was delighted at Iowa State on Monday night that they seem to have reprinted it. And I actually had students coming up and asking me to sign it, which was rather nice – it's like being rediscovered after ten years of being in Limbo.

One of the key issues of this doubly Green Revolution is sustainability. And the big challenge, it seems to me, is: How do we get sustainability, given the current realities? We use biophysical inputs, but of course they're much more expensive. Ecological and agronomic

technologies work, but they are skills-intensive. We can build sustainability into the seed, but there are the problems over the controversies over biotechnology.

Let me explain. We're going to have to do much more of this in applying fertilizers to focus the fertilizer, to target it, to provide in this case a single briquette of urea for four plants of rice.

Another example: controlling striga. We now have a maize that's resistant to Imazapyr produced by BASF. You can treat the seed with the herbicide and the plant then takes up the herbicide and kills the striga, the terrible weed. So you're using a very small amount of herbicide in a very targeted way.

Irrigation, another example. Irrigation is extraordinarily expensive, enormous environmental and social effects. Very little irrigation in Africa, under 5 percent. Can you increase it? Or maybe the alternative is to work on small-scale water projects, using, for example, treadle pumps and drip irrigation. There's a dilemma there that we face.

Ecological and agronomic approaches often work. Here you're getting five tons of maize by interplanting with groundnuts or soybean in Kenya. Here you can control striga by interplanting with desmodium, a legume that kills the striga. But these are quite labor intensive and relatively skilled activities.

So how do we deal with the notion of getting the sustainability into the seed? We know what the challenges are: improving the nutritive value; countering the new pest and disease outbreaks – two great big outbreaks that are hovering out there, about to devastate our crops: the new rust of wheat that's in Iran and will spread to Afghanistan and India and Pakistan; and the new, resistant forms of potato blight.

We know we can do a lot with tissue culture. Monty Jones is here in the audience. These are the "New Rices for Africa," which have genuinely built sustainability into the seed by crossing the Asian rice with the African rice. We know that marker-aided selection works; it's being used extensively, for example, to build in proteins into local maize varieties to select for drought resistance.

The controversy, of course, is about GM crops. But everywhere in the world now there's a growing acceptance of GM crops, or everywhere in the world except Europe, I suppose I should say. There's a growing acceptance of GM crops – enormous increase in hectareage, even in Africa – and I wonder if Dr. Gahakwa is here in the audience. I often show this picture, and she's often in the audience. Dr. Gahakwa, who was running the biotechnology lab there in Uganda, a great scientist working on transformation of bananas and then became minister of agriculture in Rwanda and is now the minister of education, and I know is here today.

The challenge for GM is to try and produce products that are really valuable for small farmers, for consumers, and for the environment. Cotton has done a good job, but what we need is more things like this, things that will control diamondback moths. All of you who've lived in tropical countries and have eaten cabbages know what they taste like; they taste as though they're full of insecticide – and you're absolutely right, they are. And what the caterpillar does, if you don't spray with insecticide, is it produces a work of art, which could actually go in the Borlaug Hall, it seems to me, of Fame – an example of what we're trying to overcome.

The advantage of a genetically modified cabbage is it reduces the damage, it reduces the insecticide use, and in particular it reduces the loss of insecticide into the water that goes into the drinking around urban areas. We need more of that. And I know that the Chinese have got something like 20 or 30 different GM crops waiting to be released. And when those start to be released, I think we'll see a major sea change in what's happening.

Finally, just to say about technology – of course, we need to work out whether it's appropriate or not. And, of course, we need to imbed technologies in a context. How do we scale up technologies? It's one of the big issues for this meeting.

One solution, I believe, is what I've referred to as "layered interventions." This is in Western Kenya, which Rockefeller worked and where AGRA is now working, where we helped the Kenyan Agriculture Research Institute produce new, hybrid maizes. The private sector then took on the hybrid maizes. They were then marketed through agro-dealers, local fertilizers were produced, cereal banks were created, and private markets became active, and there was market information provided by the government.

All these things began to come together and created a more vibrant agricultural community. These are the agro-dealers for the women in little shops who sold small packets of seed and fertilizer. On the left there is the Cereal Bank, a cooperative bank of grain. On the right, a man listening to the information about cereal prices in the markets that was coming from the government system.

We need to build regional markets, and of course the World Food Program, very exciting, I think – this Purchase for Progress, which we'll hear about later this week. Building regional markets through its own acquisitions of grain.

And we need to build up the participation in high-value agricultural markets – a very good IFPRI study (sorry, I've misspelled that), a very good IFPRI study showed that contract farming really does work in many situations. You can begin to see it working in China. Here's a simple, plastic greenhouse. It costs about a thousand dollars or so to build, growing flowers there for the local market in Xi'an; it's on the lowest plateau. And this is also a picture on the lowest plateau. It's a wheat field, and when I looked at it, I said, "You seem to be planting trees in the wheat field. What are you doing?" They said, "Oh, we're planting walnuts." I said, "Walnuts? Why are you planting walnuts?" The said, "There's a very good market in Singapore." We're talking about thousands of miles away. They're growing walnuts in the lowest plateau to sell in Singapore. It's that kind of entrepreneurship that we need, not just in China but all around the world.

And here's an example. In Rwanda many of you know you can go into some coffee shops in the United States and you can buy beautiful bourbon coffee from Rwanda. And you can name the village you want to buy it from. And there are women from the villages doing the proper tasting – the taste the coffee, they spit it out, they write down on the forms. Quality control is absolutely essential to producing good export crops.

I think this layered intervention could also work at the national level. And I think the example of Ghana is probably the best. Ghana has achieved the Millennium Development Goal, the first one, hunger and poverty, already. No other country in Africa is going to achieve it by 2015. Ghana has done it already.

And it's very interesting to work out why that's happened. In part it is due to agricultural technology – new maize yields, new cassava yields, new pest-resistant cassava. It's also due to a buildup of cocoa and pineapple production in small holders, due to market liberalization in Ghana, and also due to extensive rural infrastructure.

These different approaches – from the public sector to the private sector, from public/private sectors working together in a country to make things change.

But finally, my last five minutes or so, I need to say something about climate change. The most important thing to recognize about climate change is it's mostly about water. As a result of climate change, we're either going to get too much or we're going to get too little – and in particular, we're going to get too little. This is the best we can do at the moment about what's going to happen in Africa.

The top is temperature. Temperature is going up by 5 degrees in the north and south of Africa. Rainfall in the south, rainfall going down by 10-15 percent in the north and south of Africa. In the middle we don't actually know what's going to happen. We don't know whether the Sahara is going to get drier or wetter. We don't really know whether there's going to be greater rainfall in Kenya and Ethiopia. We simply don't know. We don't know enough what's going to happen with individual country levels. We do know there's going to be a lot of drought. That's the increasing drought throughout most of Africa. The Congo is going to get wetter, but the rest is going to get a lot drier.

So how do you deal with that kind of drought? Partly through breeding, partly through cropping systems, partly through small-scale, sustainable water supplies. And this is where this wonderful seed vault at Svalbard comes in. We're going to hear later from the Crop Diversity Trust. They've already got 300,000 samples of crop seeds down in that vault.

And I'm told by Cary Fowler that, for \$35 million, he will guarantee that they will preserve for eternity all the genome of maize, of corn. So anybody in the room who's got \$35 million, Cary is over there somewhere – they'll do it. That's a bargain; just think about it – \$35 million, forever you'll have it.

And we're going to need it for this kind of reason. With climate change the cropping niches are going to change. That's South Africa – you're going to shift from a temperature niche that's defined by the blue lines to a temperature niche that's defined by the red lines. You're going to need new varieties to replace the varieties that were there for the blue lines. And you're going to need them in 30 years, which is two cropping cycles – not long to go.

Cropping systems: Zimbabwe is doing a great deal of minimum tillage. You all know here, who are from the Midwest, you all know what minimum tillage is like. This is what it looks like in Zimbabwe. Instead of plowing, you let the stover of the maize lie on the ground. It preserves soil; it preserves water. The farmer makes little holes in the maize and plants seeds in there. On the left, three years of plowing, a dry pit of land. On the right, three years of minimum tillage, and I kicked the soil with my shoe – you can see my shoes, and you can see the sticky nature of the soil – literally one meter apart. The farmer on the left got nothing that year, last year when I was in Zimbabwe. The farmer on the right got two tons per hectare.

And water conservation. Another great example from China – I was visiting Ningxia, and I went all around the province. Ningxia is up in the Mongolian, up on the border of inner Mongolia. And as I went to every municipality, the mayor and all the officials would come out and greet me, and they say, “Come and see our experiment.” I saw 38 different experiments on water conservation in Ningxia Region alone.

But the problem is going to be that in many places droughts and floods will occur with greater frequency and intensity. In the same place we’re going to have droughts and floods, and we’re not going to know from year to year which we’re going to get. So how do you build resilience?

Well, one answer is to build the diversity of the source of livelihoods of poor farmers. There’s a woman in the Sunderbans of India. She’s got a rice field, but she’s also got this nice little plot of vegetables that she sells in the village. She’s got a husband, and he raises, with the boy, fish fry. He’s also got a little kind of taxi bicycle; he rides people around for a small fee in the village. So they’ve got the rice, they’ve got the vegetables, they’ve got the fish, they’ve got the little taxi. And then as I was leaving, I looked up, and on the roof he’d got a solar source of light, of energy. And I said to him, “What are you using that for?” And he looked at me as though I was stupid and said, “Well, for light bulbs in the evening.” He said, “If we have the lights on, the children do their homework, and if they do the homework, they’re going to get out of school, and they’re going to get a job in the nearby town.” So that when the next flood or drought or riverbank erosion or whatever else it is that comes to that village – and it will – that family will have a range of different sources of income to rely upon. And that’s what’s going to be crucial.

And finally I need to go back up from the farmer to the world as a whole. These aren’t, I should say these aren’t cottage loaves, although some of them have a similarity. We have an international agricultural architecture, which you will all recognize. Many of you are a part of different bits of this architecture. It’s got itself a new lease of life because of the food crisis. The CGIAR is on the brink of reform. FAO is on the brink of reform. The World Food Program has just launched its great new program of Purchase for Progress. The World Bank has produced a fantastic report on agriculture just recently. Gates Foundation is spending large sums of money on agriculture.

The issue is: Can we get this better coordinated? Can we get people to work much better together? And one proposal that’s out there from the European and the American donors is a global partnership for agriculture and food, and that’s being worked on at the moment and I think will be launched early next year.

I want to finish with one picture. I live in Sussex, south of England, in a little town called Lewes. It’s famous, first of all, for the University of Sussex where I was president, but it’s also famous for being a very radical sort of town. And we’ve decided that our response to the financial crisis is print our own notes. And you can buy these on eBay. They’re a pound, so that’s about \$1.75, but they’re up to \$30, \$40 on eBay. And we’ve put on them the image of one of our most famous inhabitants.

And I’m sure all of you in the audience recognize that’s Tom Paine. He lived in Lewes before he came over here in the United States and got all these Americans worked up. And they threw us Brits out as a consequence. And so he’s on the pound note, and he says there, one of his

great quotations, and I think it's for us now: *We have it in our power to build the world anew.* And, of course, the inspiration that we have for that is Norman Borlaug.

Thank you.
