PRESENTATION: SMALLHOLDERS IN A CHANGING CLIMATE

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It's a great pleasure to be back here at the World Food Prize. It's always a great pleasure to come to the United States. It's a great country. And last week I was with Roger Thurow (and I can't quite see if I can see him now), but I was in Chicago at the airport and we thought we'd have a drink, so we went to the bar to order beer. And the barman asked for my ID, and he looked at it and decided I was old enough to have a drink. As Frank Sinatra says, "You make me feel so young."

Quite a lot of what I'm going to be talking about is relatively complicated, but what we've got here is a book called *Science and Innovation for Development* that I wrote with Jeff Waage earlier this year. You can buy it on Amazon, but if you come up really quickly at the end, this book is free on memory sticks at the front there. There's about a hundred of them, so most of you can get one.

I want to talk about climate change, but I want to root it in the needs and desires of smallholders in Africa. This is Mrs. Namarunda. She has a hectare of land in Western Kenya, not very good land; her husband died. She's got a tall son who turns up from Nairobi every now and again with a bit of money, but otherwise she's got four children to feed.

And she's got, with her seeds, she can make about two tons per hectare. But along come the weeds, along comes the pests, along comes the drought, and she ends up with less than a ton, and so she can't feed her children. And she certainly doesn't get any money to buy medicines or to send them to school.

She is both a victim and a culprit of climate change. She knows about the former, just about; she doesn't know about the latter.

Agriculture plus forestry plus land use generate over 30 percent of greenhouse gases. There are still big unknowns about climate change. I don't want to go into them in detail, but I just want to emphasize certain things we don't know. There are three great drivers of climate in the tropics - in the tropical convergent zones, the monsoons and the La Niña/El Niño oscillation.

If you look at that slide, you can see the wavy red line, which is the inter-tropical convergence zone, and we're not really sure whether it is going further north and further south each year and therefore bringing less rain to the north and south of Africa.

There's also the great Asian monsoon in the bottom right, that great swirl of wind forces. You need to remember that the Asian monsoon, even though it's called that, creates the rainfall in Eastern Africa.

And then finally there's the La Niña/El Niño oscillation. During the La Niña years the water in the Pacific effectively (I'm being very simplistic) flows from the east to the west, bringing rainfall to Southeast Asia. And in the El Niño years it does the reverse and leaves Southeast Asia and Australia and elsewhere with considerable drought.

What we know is that there are a greater frequency of El Niño years since the 1970s; but we don't know whether that's caused by climate change, and we don't know whether it's going to persist. And we don't know what is the interaction between El Niño/La Niña, the Asia monsoons and the inter-tropical convergent zone. There are huge unknowns about what is happening to the climate that's affecting Mrs. Namarunda.

We also don't know where we're going to end up. I don't expect you to look at this in detail, but you ought to be horrified by it even so. We are aiming through all these negotiations that have been going on and all this commitment to climate change to hit a target of 2 degrees centigrade above preindustrial; we're about .07 now. But actually we're on track for 4 degrees.

And what that shows is the 4-degree world. You can't see it from where you are, but, for example, the temperatures in northern and southern Africa are about 7 degrees centigrade. And what is really scary is you look up at the top there around the North Pole; temperatures there are 8, 9, 10, 13 degrees above centigrade. And you could just begin to imagine what will happen with the green line that I'll show. That is what may happen unless we do something.

Of course, there's a lot of argument about climate change going on with all kinds of exposures of emails and all the rest. But for Mrs. Namarunda it's actually happening, and for others in Africa and Asia climate change is happening, and they know it. This is the rainfall pattern in the Sahel, also in North Africa. You can see that red is the drought that's occurred since the early 1970s. Again, we don't know whether it's caused by climate change but probably so. And it's affecting people's lives and they know it.

Here in the Atlas Mountains of Morocco the villagers now can't grow enough barley to feed themselves. They're trying out drip irrigation as a possibility to grow high-value crops that they can sell in the markets on the coast of Morocco.

But what is interesting is that they're beginning to harvest quite seriously some of the wild plants around. The trees, the argan tree that produces a beautiful oil like an olive oil, and the honey from euphorbia. The challenge of course is that the women are harvesting these, but they're not getting much for it, and the challenge is to convert this into the oils and the honey in situ and get some of the value added there.

But they know what is going on. In general, women in developing countries and men are very good at analyzing their situation. There's a woman in India who is mapping out the changes that are going on around her. She's illiterate, barely numerate, but climate change is a reality.

And I first began to understand this when I was in Ethiopia in Welo Province in 1986, I think, or '88. I sat down with a couple of farmers, and I asked them to tell me how many days of rain there had been for the previous one, two, three, four, five, six years. And after two hours they could tell me how many days there had been per month over those six years. I won't describe how they did it — it was phenomenal. Most of you can't tell me how many days of rain you had last month.

Another example: This is in the village of Nwadhajane in Southern Mozambique. It's the birthplace of the great Mozambique leader, Eduardo Mondlane, and they are suffering from climate change, and they know it. And they know that in particular they have two kinds of land — they have highland and lowland. And in the lowland the crops grow well, but they get washed out with floods. In the highlands they get good crops in the flood years but not so good in the last.

And so what they've done is to create farmer associations so that each farmer gets a bit of highland and a bit of lowland. And the farmer associations are also doing experiments with drought-resistant crops. So farmers throughout Africa are experimenting with how to adapt to climate change, in some cases without site support but in most cases because that's just what they have to do.

Just to remind you of what will happen if we just get to 2 degrees, you can see there the temperature at the top, the dark red, is four or five degrees above preindustrial in North Africa and South Africa. The dark browns show the lack of rainfall.

Much of Africa is going to suffer from greater heat, from greater drought, and that will affect the agriculture — it's really as simple as that.

And so the challenge is how do we deal with drought? Well, we can breed new varieties, we can create new farming systems, or we can look for water on a sustainable basis.

The challenge is in particular that we're moving from one ecological niche to another. The blue lines on there describe the ecology, as it were, the rainfall and the temperature in South Africa today, and the red describe what will be in 2018. So we have to breed new varieties to replace the existing varieties that are adapted to the blue lines to make them adapted to the red lines. And we don't have a lot of time, which is why we need every kind of breeding technique that we can.

And in particular we need (and we heard all this in the last session), we need the indigenous crop biodiversity, because that's where the genes are that can help us and in particular can help Mrs. Namarunda. There are, of course, these great repositories all around the world of the varieties of crops that we have in the world, and there's the great central repository up in Svalbard way up in the north beyond the Arctic Circle.

And for all of you in the audience, your country's seeds are there in Svalbard, and you can go and see them if you want. You just have to watch out for polar bears. I'm serious. There's a man with a gun standing outside, and I asked him, "Why have you got that gun?" He said, "Polar bears." I said, "Have you ever seen one?" He said, "No," but he was standing there.

And there is also support for in situ analysis and evolution and breeding of crop biodiversity. I started 10 minutes late. I'm sorry, I'm just talking to the lady with the little label. The International Treaty on Plant Genetic Resources has now set up a special fund, which is to enable money to go to local communities to analyze their own diversity, their own crop diversity, and to look for new genes. And here in Peru are potato growers that are looking in the local varieties, for example, for resistance to potato blight, but also looking for drought resistance. And both those organizations that I've described there need support.

Water resources — this is in Ningxia in Northern China — a great range of water resources being conserved in many cases by use of plastic, for example.

Some brilliant research has been done on deep-water rice. We now know what the gene is that allows the rice to elongate if it gets flooded. And the gene is called "snorkel" — if you think plant breeders don't have a sense of humor, you're wrong. And on the left there is snorkel at work, the plant is elongating, and as you can see on the right, it grows to eight feet tall — and that poor lady is going to have real trouble harvesting that rice.

They also know there's another gene that they've discovered call "sub" for submergence, which allows the rice to survive underwater if it's only going to be for a short time. So we've now got two genes. If the flood waters are going to rise rapidly, you have one gene called snorkel; if it's going to stay only for a period, you've got another gene called sub. We're trying to get all those genes into high-yielding rice varieties and maybe even combine them together so a plant could decide whether it's going to switch on one or another.

In some situations of course, these changes may be beneficial, and here in Northern China what is happening is that the minimum temperatures in Northern China are going up, and so people can grow winter wheat, and the winter wheat in China is moving further north. But I don't think those beneficial situations are going to

be very common.

What we also have to recognize is that, in addition to these stresses that are going to be big shots, we're going to get extreme events with greater frequency and intensity. The analogy I use (it's not that good but it's not bad) is if you take a pan of water, you put it on a stove and you heat it up, even if you're only going to heat it a little, it gets agitated. And that's basically what we're doing to our climate.

And it's because of that we have these extreme events, and this is the classic that occurred this summer. In July — look at the top there. You can just see… If you look at where Russia is, you can see that very dark brown, which shows the temperature in July being greater than six degrees above the average. Then you look down in the Southeast, you can see the great floods of Pakistan, which are still going on.

Those two phenomena are linked. They're caused by the same climatic effect, which is in fact that that the jet stream has got stuck, as it were, stayed in one place. And above the jet stream everything got hotter and hotter. Below the jet stream it got wetter and wetter. That's the first example of two really big extreme events being linked together as a climate phenomenon.

And how do you deal with extreme events? Well, you take a leaf out of the people who have just been talking today and you conserve diversity on your farm. And so this farmer in the Sunderbans is growing starchy foods for sale, root crops. She's got rice as well. She's got a husband who sells fingerlings. He's also got a little taxi that he goes around the village.

And when I left his farm, or her farm, and looked up, there was a solar panel on the roof. And I said, "Why have you got a solar panel?" You know, if you go into villages, you ask stupid questions, because then you get really interesting answers.

They said, "Oh, for electricity."

"Oh. Why do you want electricity?"

"Light bulbs."

"Why do you want light bulbs?"

"So the children do their homework."

And of course if the children do their homework, they'll go into the local town and get a decent job in the local town, and then they can send money back at times of crisis. In fact, a cyclone hit that village there afterwards. That kind of diversity is one of the ways that Mrs. Namarunda and others are going to face extreme events.

But there's also the issue of agriculture being a creator of greenhouse gases. We just need to look at that. Down on the right there, the dark green and light green are agriculture land use change and forestry — it's over 30 percent. It dwarfs the impact of transport.

All of you worried about traveling supersonic, as it were, from here to there long distances, and you get worried about some little green beans from Kenya coming in an airplane to your local supermarket, just remember that the really big culprit, I'm afraid, is agriculture. It's partly because of carbon dioxide from deforestation and the loss of soil carbon. It's partly methane from flooded rice and enteric fermentation in cattle, and it's partly nitrous oxide from microbial transformation of nitrogen in the soil and in manures.

The amounts of methane and nitrous oxide are relative small, but they're the ones that have the biggest effect

on global warming. You can reduce nitrous oxide and methane by various means, and I've listed some of those there. But the big challenge is to get the carbon back into the soil. And we heard some of those examples just now in the previous session. How do you get this carbon back in?

Rattan Lal, who was going to speak earlier but isn't, I don't think is here, he estimates that if we put all the carbon back into the soil that agriculture has taken out since the second World War, it's equivalent to a hundred parts per million of carbon dioxide — that's a huge amount. It will prevent us from getting to 4 degrees.

But the question is — What's in it for Mrs. Namarunda? 70 percent of all this greenhouse gas comes from developing countries. 70 percent of the mitigation potential is in developing countries, and 90 percent of that potential is carbon sequestration. So collectively the Mrs. Namarundas of this world could make a huge difference. But why should she? And that's the big problem.

One possibility, of course, is that she cultivates according to a win-win situation. Conservation farming, which we've heard a lot about today, is a good example. The top right is the soil — when it's been plowed, it's dry. The bottom right is under minimum tillage where the soil remains sticky. The top right, zero yield, bottom right, two tons per hectare.

So that is a technique that will give her a better living but also will sequester some carbon — not actually very much. According to Dennis Garrity it's about 0.1 to 0.2 tons of carbon per hectare per year.

The way forward is to look at what the REDD program is doing. They are Reducing Emissions from Deforestation and Forest Degradation.

Some of us went to the Copenhagen Conference last year. I presented a speech about agriculture and climate change, and apart from those of you in the audience who were there who agreed with me, nobody else paid much attention to it. Everybody paid attention, though, to the meeting that was conducted by REDD, which is a way of compensating people who live in forests and others for preserving forests. It's a way of getting selective and sustainable logging.

But what they've now done is to move it to REDD plus, which means they've got biodiversity conservation in there. REDD is the flavor of the month; it's successful. Agriculture has somehow got to get on board. We've somehow got to find a way in which the Mrs. Namarundas of this world will be compensated for putting carbon back in the soil. And this is Dennis' slide you saw earlier, with one addition — these trees that shed their leaves in the wet season and help to fertilize the maize add two to four tons of carbon per hectare. That's an enormous amount of carbon to go back.

So I think the way to go ahead is to piggyback on the REDD program — not to become part of the REDD program; I don't think that will work — but to look at that REDD program and to find ways in which we can compensate farmers for doing what is in that slide. It's not easy. It's not easy to measure the carbon in the field. It's not easy to judge whether a farmer has really made a difference. It's not easy to monitor it over a big scale, although some of Dennis' aerial photos show ways in which you could do it. And we don't yet know how you can get the funding for this compensation, although I assume it's going to be somewhat similar to the current clean development mechanism.

So I don't have an answer to this, but I think I know the direction. There's going to be a big conference on this in Amsterdam in two weeks' time, attended by the Prince of Wales, the Prince of Orange and the Princess of Orange, and a whole lot of other hopefully experts who can tell us how to solve this particular problem.

There's an alliance of people working on greenhouse gases, which has just started. I think the underlying

partnership that we need to work on is combining the science and technology of the north with the knowledge and innovation of smallholders of the south. This is where you desperately need that partnership, between very high-level, very modern, very difficult science, and also very intricate, very detailed knowledge by the farmer on the ground. It's a partnership that can really flourish.

If we do that, we might just about avoid this. These are the riots, the food riots in Mozambique earlier this year. The price of bread went up 30 percent, 10 people died on the streets. If we go to 4 degrees, that's what's going to happen all the time. If we can get ourselves to less than 2 degrees, then there's a future for this son of the Peruvian potato growers.

Thank you.