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Panel: ***Dr. Pedro Sanchez, Moderator***

PANEL:

SOIL HEALTH AND THE FERTILIZER GAP

Panel Moderator:

Dr. Pedro Sanchez
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Panel Members:

Esin Mete	President, International Fertilizer Industry Association
Dr. Ruth Oniang'o	Chair, Sasakawa Africa Association
Dr. Amit Roy	President and CEO, International Fertilizer Development Center
Kari Niedfeldt-Thomas	Executive Director, The Mosaic Company Foundation
Dr. Xinping Chen	Director, Center of Ecology and Environmental Sciences, China Agriculture University

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Pedro Sanchez

Thank you very much, Catherine. It's great to be here and have a chance to tell you a little bit about soils and fertilizers. It is our turn to mention that in this dialogue.

I have an excellent panel here with me, and I'll just introduce them very quickly. And at Professor Oniang'o's suggestion, I'm just going to introduce them quickly, and if you want to find more about these people, you can Google them or use [inaudible]. So we have Kari Niedfeldt-Thomas from the Mosaic Corporation. We have Amit Roy, President and CEO of the International Fertilizer Development Center. We have Esin Mete, President of the International Fertilizer Industry Association. We have Professor Ruth Oniang'o, who is… She told me the other day she was board chairman of about everything, a very distinguished scientist and political figure in Kenya. And I have Professor Xinping Chen from the China Agricultural University here. This is our panel.

So I'm going to say a few things early, and first is that we are really dealing with convergence now. I think what you've seen yesterday so far and what we will see today and tomorrow, there is a real convergence in the whole issue of increasing food production the right way and doing it fully across the value chain. And there's also a sense of optimism that we saw here early.

I've been to previous meetings like this in the last sort of months, and the first one was in Addis Ababa with Yara and AGRA Bi-annual Forum, and it was explosive. The interest, the convergence, the involvement of people—it is a movement out there, the African Green Revolution in this case. It is a movement that's organic in the sense it's like an amoeba, doesn't have the structure, but it's sure moving fast. And also the United Nations a couple weeks ago, there was also a tremendous movement towards convergence. So this is great.

I'm also proud to say that, for the first time since yields have been recorded in 1961, Sub-Saharan Africa has increased its cereal yields by 50% from 2005 to 2013—and that is excellent news. The numbers are very small, of course, but it's from 1 to 1.5 tons per hectare. But it's already happening, and we see…

In our view the issues are—how do you go from 1 to 3 tons per hector, which doesn't require much technology, just brutal force in terms of using better seeds and fertilizers. Then how do we go from 3 to 5? Three is the average in Southeast Asia and Latin America. Five is the average of China and it's much more now, and Professor Xinping will tell us more about that. And then how do we go from 5 to 10, which is the average cereal yields of North America, Europe and Japan.

So we'll have this theme of one, three, five ten—keep those numbers in your mind.

I want some clarification on the whole issue of why fertilizers. If we didn't have fertilizers, if the Haber-Bosch process had not been discovered early in the last century, the world would be able to feed about two billion people only with organic resources. Of course, we're now at 7-point something billion. And it would have to do that at the detriment of great environmental destruction. We just don't have enough nutrients to do that. So you may ask about organic farming. Organic farming is certainly scientifically correct, but it's very much limited by having a 25% penalty, a yield gap lower than conventional farming. And it's fine if somebody can pay for the premium price and so on. But the majority, and the way nine billion people are going to be fed, will depend on the use of fertilizers.

Now, fertilizers sometimes are labeled as chemicals, and that is used in a disrespective term, as not a good term. As a scientist, we're all chemical, but anyway they use it as a chemical. And I want to make a decision between two types of agrochemicals. Fertilizers are food for the plant. Fertilizers are needed because the plant needs food. Pesticides, insecticides are like medicines. They need to be applied when the plant is sick because of insects or disease attacks. So please don't lump all these so-called chemicals together. Fertilizers are food; pesticides and insecticides and so on are medicines.

So also you hear a lot in the press about fertilizers poison the soil. And I'll use the analogy of food and drink to try to explain it. If you drink a can of beer you feel fine, maybe two, depending on your tolerance. But if you drink a 12-pack of beer, you're going to be sick. And that's what happens with fertilizers. If you add it at the correct rate, there are minimal, minimal,

really very little negative consequences. But if you add it at an exorbitant rate, of course, there will be environmental consequences—nitrate leaching into the subsoil and so on. So think of it as food, not for you, not for humans, but for plants. And the analogy, if you eat too much, you're going to have some problems.

So having all that in advance, I would like to ask the first speaker, Kari Niedfeldt-Thomas, to take the floor, sitting there. And we've asked each of them to do seven minutes, so we have a process policeman here who will time us a little bit. Thank you. Kari.

Kari Niedfeldt-Thomas

Well, thank you to the World Food Prize Foundation for inviting me to be on this panel, and also thank you to Dr. Sanchez who's been a great leader on the issue and importance of fertilizer. I work for The Mosaic Company, which is the world's largest producer of combined potash and phosphate, which are toward out of three macro crop nutrients (if you don't know your fertilizer terminology). And we're celebrating our ten-year anniversary next week. We are known in our industry as a leader in both product innovation and also our sustainability efforts.

Want to talk today a bit… I'll kick things off around why is fertilizer important and how does it make a difference in the world. So there's a slide that I want to show you. I don't know if it's up on there yet. By 2050—everyone's heard this term—we must feed nine billion people, and that means we have two more billion people that we need to feed over the next decades.

And as you can by this chart, agriculture has been winning against very big odds, that we have continually found ways in agriculture to be able to feed populations. And a key source, and the reason why we've been able to do that is because of fertilizer. It has played a key role in making that happen.

The population increases that are projected are going to demand that we increase our crop yields by 70% over the next few years. And to put that into perspective, that over the next 35 years the amount of agricultural innovation that will need to take place incrementally will be the equivalent amount of agricultural innovation that has taken place over the last 10,000 years. So a lot has to happen in the next 35 years, and fertilizer can play a key role in being able to make that happen.

In North America during the past 40 years, farmers have used less land while tripling food. And what we can do is we can really narrow this yield gap that everyone talks about and be able to address global food security if we recognize that we need to be able to give access to fertilizers and at the same time make sure that people are well aware of what the best practices are for application and making sure that we're using the right technologies. Can you go to the next slide, please.

So if you look at this, this really tells the story about how global food security has really benefited from crop nutrients. And in here you can see that the world's crop yields, that over half of it attributed to the application of fertilizer. So when you look at how much has to be grown going forward, fertilizer will be playing again a key role in making that happen.

Also what's important to think about, though, is what's called sustainable agricultural intensification. And that is that years ago, back in 1960, one hectare fed two people. By 2025 it's projected that one hector will have to feed 25 people. That is a tremendous amount of people being fed off the same amount of arable land, so there are needs to make sure that we are increasing the amount of production on the current land that is in production and at the same time making sure that the resources that are applied to it, all the inputs, for example, fertilizer, are used most efficiently, while at the same time we're finding ways to minimize any kind of environmental impact and best management practices and other kinds of techniques can contribute toward that.

So when we look at our current agricultural production system, in the U.S., for example, from 1979 to 2000 new technologies made it so that fertilizer application could be reduced by 30% on those lands. So new technologies are making it so that fertilizer is adequately being used in the right ways.

If you know anything about what precision agriculture is—it was referred to a few times yesterday—there are GPS-located farm fields, and there is technology that can do variable rate application of fertilizer, really maximizing the resources on the land, looking at each plot bit by bit and what the soil types are. That all can make a difference in being able to make sure that plants can maximize the uptake of the nutrients and be able to produce the yields that we need. Can you go to the next slide, please? Thank you.

And then what I think is also important to keep in mind is that these are actually nutrients and that, if you look at what a periodic table is, out of that there are 17 elements that are macro, micronutrients and other kinds of minerals that plants need to eat. So that little chart there on the left, that is what plants eat. And we eat the plants, because they have the same nutrients that we need.

If you were to look at the product that's on the far right, the one that has kind of a peach tone to it, that's potash. Potash is the kind of product that helps plants be able to utilize their water better and reduce drought. And then the one in the middle, that's phosphate; and phosphate is very effective at being able to make sure that plants are able to store and transfer energy, so if you think about photosynthesis or other kinds of processes that plants have. So these are natural-occurring elements. This is what plants eat, and then we eat them in turn.

Soil tests that go on can determine how much nutrients are in those soils at the time and then can determine what additional amount of nutrients need to be applied, based on the kind of crops that are being grown, because crops pull nutrients out at different rates; they use different combinations of nutrients, and soil tests are really critical to making that happen. But soil tests don't go on everywhere around the world, and there are challenges for smallholder farmers to be able to access that kind of technology.

There are some initiatives that are going on right now that are really making a difference in that way. Columbia University and University of Maryland have developed a mobile soil doc kit that is able to go out to rural communities, be able to test the farmers' soils, be able to transmit that information back to some broader cloud networks and being able to in turn provide some agronomic advice back out to these rural communities.

When we have our Mosaic villages project—and we've worked with a number of different implementing partners around the world—having the understanding that simple nutrients like this and applied in simple ways, whether it's big precision agriculture or just a little bottle cap, putting it into a hole next to your seed, all of those kinds of technologies can make a difference. We've worked with the Sehgal Foundation in India and helped International in Guatemala, and both of those programs have seen tremendous yields for smallholders being able to just use the right amount of nutrients in the right way.

Balanced crop nutrition is a critical component to plants being able to be the healthiest that they can be. And balanced crop nutrition means you're combining all of these macro and micronutrients in the right way. And when plants have access to the right balanced nutrition, they are able to process water more efficiently, they are able to fight off disease, pests and other kind of pestilence; and they also are able to make sure that they are becoming the healthiest plant and they can produce more yields. And when we think about that earlier chart about needing to produce more food, balanced crop nutrition is a critical component of that.

And then when you think about how crop nutrition has evolved over the years, there is innovation going on in our industry. Right now there are new technologies that exist that take macro and microcrop nutrition, and they combine them together into single granules, and they're able to be applied on farm fields. And then farmers are getting better results because plants are getting the maximum amount of nutrients that they need at the right way.

And there are also other technologies that are being evolved. There are enhanced efficiency products, controlled release products. And Europe just released its first low carbon product.

So when you think about plant nutrients, it's important to know that we are able to eat what we eat as humans because we're relying on the plants to get the nutrition that they need—and that's all very connected to the soils. Soil health is a critical component of making sure that plants are getting the nutrients that they need. There is right now, the U.N. Global Compact is finalizing the Global Principles for Sustainable Soil Management. And one of the quotes in that document talks about soil as a "thin global membrane that supports life on earth."

So we need to make sure that our soils are healthy, that the soils are both protected and they're also productive—and we can do that with crop nutrients.

Pedro Sanchez

Thank you very much, Kari. Here you have a view from a major fertilizer company. Now we're going to go to Amit Roy, head of IFDC, the International Fertilizer Development Center, who will give us his viewpoints from the point of a fertilizer research institution. Amit.

Amit Roy

Thank you very much, Pedro, and thank you to the World Food Prize organization for inviting me.

You have heard from both Pedro and Kari regarding fertilizer. What I'm going to focus on is what are the needed processes for producing the fertilizer in topsoil—the raw materials. I'm

also going to talk about access to fertilizers by smallholder farmers, which is a big issue, as you know, with the population growing particularly in Sub-Saharan Africa. And the third one, the fertilizer research related to new products.

So fertilizer—the three major nutrients are nitrogen, phosphorous and potassium. Nitrogen we breathe. Air has 78% nitrogen everywhere; we just need energy to convert that into a form that the plant can use.

The second are two important ones—one is the phosphate, and the other one is the potash. These are all mined minerals, and phosphate is the one which has received a lot of attention recently. And could I have the first slide, please?

Anyway, in 2010 there were articles that were published in referred journals, which said, the world is going to reach a peak supply of phosphorus in 35 years and is going to run out of phosphorus in 135 years. As a research institute, we have significant data on phosphate, and we did our analysis, and we came to a different conclusion.

Now, any raw material resources, the reserves and resource depends on technology and price. It is a dynamic number. As the prices go up, the ones which are not mineable become economically viable; and, if the technology improves, you certainly can mine resources out of deposits that are there. So you see in the graph there the recent data shows that we have, based on our analysis and the United States Geological Survey, which keeps track of all the resources, that we have reserves at present technology and price of at least 300 years. And if you look at the resources, and with the technology improvement, we can go five or six hundred years. So in its present form, this is what we have.

Now, phosphorus is an element that one does not destroy. We're using it; it's collecting in some other places. But in its present form, that's what we have. We have done our research with the ETH in Germany for the three years with 50 scientists and practitioners around the world. And the book that you see on the right-hand side is a book that has just been published, which gives you a more detailed analysis and gives reasons why the data that we produce are substantiated. It also has issues related to use, related to mining of phosphorus, which is a mined mineral. Having said that, we still know phosphorus is a finite element we need to manage the losses. The runoff losses of phosphorus, both from the livestock as well as the fertilizer, is significant, and we need to manage it. So that's a very important part of phosphorus.

As far as potassium is concerned, it is again a mined mineral. It is mainly found in temperate regions, which is Canada, Russia, Belarus, Germany, these are the major areas that you find it. And we have deposits that, at present technology, at least five to six hundred years. So we do have resources available. The question is how to manage it more efficiently?

I now want to focus on another area, and that is access to fertilizer. Could I have the next slide? If you look at the population demography, the largest increase in population is going to be in Sub-Saharan Africa and in Southeast Asia. And in Sub-Saharan Africa not only is the population going to increase, but a lot of the people are going to be in the urban areas.

The access to fertilizer is a big issue for the farmers in Africa, and we have done analysis in both access and affordability. And one of the biggest challenges that we see in Africa is the number

of paved roads per million population. If you look at the graph, what we have on the left-hand side, most of the countries which have very low road densities are in Africa. Now, what does it mean? It means the price of fertilizer delivered to the farmers in Sub-Saharan Africa ranges from three to ten times, depending on the location. We did a comparison of price of delivered fertilizers in Thailand. Compare that to Tanzania—both are coastal countries. The price of fertilizer in Tanzania is at least 60% higher than Thailand, and most of that increase is because of the poor infrastructure that we have.

Now, what is the solution? Certainly building roads is a way to do it, but there is another solution, and that is looking at the resources of Africa. Africa has 60% of the world's known phosphates, and they are dispersed extremely well. You see on the right-hand side, that's a graph of the deposits of phosphates in Africa. So the new focus is to build small plants strategically located so that access for the local and the regional becomes an important element and reduces the cost. Many of the big companies are now looking at strategic locations of plants which are tailored to the soils and the plants in that region. So that is an important area.

Now, having said that, even with access, the issue of affordability and incentive becomes a very important part. So that brings me to the question of (third slide, please) new fertilizers and efficiency. When we look at nitrogen, for example, and look at in Southeast Asia and other places, not in developed countries but I'm looking at mostly developing countries—that's why 70 to 75% of the fertilizer is used in developing countries—the efficiency of nitrogen fertilizer for rice production is only 30% or less. Now what does it mean? It means that, if the farmers supply three bags of fertilizers, nitrogen, they get the benefit of one bag.

Now, this is economic loss for the farmers, but it is also a loss in terms of energy; because, to produce one ton of nitrogen fertilizer, urea, you require energy contained in four barrels of oil—that's what you need. Now, you can do a quick calculation to see what are the losses in terms of energy, in terms of economic losses for the farmers, and the third thing is the environmental issue in terms of losses.

So we are looking at two new products that I am focusing on, one in the left-hand side called the large granule, urea super granules. And what we see is the farmers are using it, particularly in Bangladesh, more than two million farmers, they are deep placing it; they're reducing the fertilizer consumption by 35%, yet they're getting 15 to 20% more yield. Economic benefit, they're earning more money, the governments are reducing the subsidy. Seventeen countries in Africa are testing it. The next item is what is called delivery of micronutrients, measured amount of micronutrients, which are both important for the plants as well as for the human nutrition. And it's called the seed core, where each granule in the seed will have the micronutrient, and that will be measured and delivered to the plant so that the farmers don't have to do guesswork. This has been commercialized now, and we have some results from China, India and Bangladesh, so a very good result.

So these are the three areas that I wanted to cover. Thank you.

Pedro Sanchez

Thank you, Amit. There hasn't been a new fertilizer produced and widely used in agriculture in about 60 to 70 years. Now we're beginning to see a real revolution here. This thing about having

a nutrient, a micronutrient core there is just amazing. So that's a view from the fertilizer research. Now we're going to turn to Esin Mete, who is the president of IFA, the International Fertilizer Industry Association, to give sort of her viewpoint from the association of fertilizer industries. Esin, please.

Esin Mete

Thank you very much, Pedro. Well, I join my colleagues to thank and appreciate the invitation of the Borlaug Dialogue for me to speak here. Of course, we know that Norman Borlaug is known for his tremendous achievements in the seeds, which he referred to as the catalyst that ignite the Green Revolution. But he acknowledged that the mineral fertilizers were the fuel that powered it.

So I start from there, and I would like to continue by saying that sustainability intensifying the food production, which is vital if we are going to feed nine billion people by 2050, requires fertile and healthy soils. Healthy crops can only be produced when the ground in which they grow is healthy too. So this is where fertilizers come in.

I would like to just mention a little bit about what International Fertilizer Industry Association means. The acronym is IFA. IFA is the only global association representing all actors along the fertilizer chain. We have about 542 members coming from 81 countries, and half of which are from emerging economies.

Our core vision is that efficient and responsible production, distribution and the use of plant nutrients play a vital role in achieving global food and nutrition security and sustainable development.

IFA provides for its members a framework for collaboration within the fertilizer and larger agribusiness value chains on areas of common interest, platforms to discuss the complex issues facing the sector today, and a structure for agreeing upon common positions and joint actions.

An important function fulfilled by IFA is a multilateral engagement on behalf of the industry. This engagement aims to highlight the industry's contribution for solutions for global societal challenges, such as eradicating hunger and malnutrition.

We have this, and we know that food security exists when all people at all times have physical, social and economic access to sufficient, safe and nutritious food. Nutrition security means access by all people at all times to the adequate and absorption of nutrients in food, in order to be able to live a healthy and active life.

There is no single solution to food and nutrition security. Food security is a global challenge that can only be met through the contributions of all actors in agriculture and food sectors. However, feeding the world's growing population will require more efficient and innovative use of fertilizers.

Today I would like to focus on two issues pertaining to fertilizers, which is, one is nutrient stewardship, and the other is micronutrient fertilization.

Nutrient stewardship refers to the efficient and effective planning and management of plant nutrients. This is done in a manner that improves social, economic and environmental performance of mineral and organic fertilizers. Universal scientific management principles related to source, rate, timing and placement are implemented in a site- and crop-specific manner. Nutrient stewardship programs, which we refer to as the "Four R's," aim at encouraging knowledge sharing on fertilizer best management practices and in partnering with other stakeholders to transfer knowledge to farm advisors worldwide.

If we take a world view of nitrogen use, what is striking is the diversity of the issue. Some regions of the world use regrettably too little nitrogen, whereas others have an excess nitrogen input. Similar imbalances also exist for phosphorus and potassium.

It is important to address the significant imbalances in global fertilizer use. In regions of underuse, the industry has an important role to play in improving supply and promoting balanced fertilization to bridge the yield gap. The yield gap represents the difference between the farmers' actual and attainable yields. And fertilizers play a vital role in closing this gap.

In regions of excess or imbalanced use, the industry also promotes balanced fertilization and nutrient stewardship. IFA recently hosted two country seminars on sustainable fertilizer management in China and Indonesia to relay to our members the importance of nutrient stewardship. We will continue to hold these national dialogues. IFA is keen to partner with others and has already initiated dialogue with farmer organizations and other actors in the food value chain.

For those who simply argue for reducing fertilizer rates, we need to explain the importance of balanced fertilization that seeks to provide the right source at the right rate but also at the right time and the place. Improved nutrition not only extends and improves the quality of people's lives but also plays a significant role in boosting their productivity and sustaining a healthy economy. The U.N. Food and Agriculture Organization estimates that malnutrition alone costs the global economy around $3.5 trillion each year. This is about 5% of the global GDP, due to the lost productivity and healthcare costs.

However, having enough calories is just the tip of the iceberg. Sufficient intake of essential nutrients, including micronutrients, is also necessary. More than one-tenth of the total disease burden for which the global population suffers can be traced back to micronutrients. The micronutrients can be provided in several forms, the most common being dietary supplementation. But they can also be provided by agriculture through fertilizers, by making the food we eat more nutritious. This reaches out to more people and makes it available through the food they eat.

Agronomic biofortification is not well known as genetic fortification. The objectives for both are to enhance the levels of key micronutrients in staple foods and make them bioavailable for humans through food consumption. Together with the International Plant Nutrition Institute, IPNI, IFA researched and published a scientific report on fertilizing crops to improve human health. The research documented in this publication demonstrated that micronutrient-deficient soils reduce not only the yields but also the bioavailability of minerals that are essential to humans who consume the crops cultivated on these deficient soils.

The added micronutrients have immediate and profound impacts. Chronic deficiencies affecting mostly women and children in the local population are quickly eliminated as a result and contribute to eradicating many micronutrient-related illnesses.

Among all micronutrient deficiencies, zinc is the most common. Two billion worldwide are zinc deficiency. One and a half million children die each year due to zinc deficiency induced diarrhea. Fifty percent of the world's agricultural soils are zinc deficient. I feel very strongly about this case, because I have seen the result of micronutrient fertilization firsthand in my home country, Turkey. After scientific research revealed that soils in Turkey were severely deficient in zinc and wheat yields very low as a consequence, my company, Toros Agri, dedicated itself to produce itself to produce zinc-enhanced fertilizers. Our efforts have been repaid not just with higher yields but with a new generation growing up free of deficiencies.

We feel it is our responsibility to help promote this good practice everywhere in the world. The zinc success is not limited to Turkey alone. In fact, half of the soils in the world are deficient in zinc. Important work and field trials are being conducted under the Zinc Nutrient Initiative in China, India, Brazil and Bangladesh.

The fertilizer industry is also hopeful after zinc in promoting iodine, and this will be our next topic to discuss. Iodine deficiency remains a major public health concern with two billion people being iodine deficient. We believe that biofortification is the solution. Recent research has shown that there is tremendous potential for iodine fertilization as an alternative to iodized salt, which provides the iodine necessary for the human body without the risk of heart disease and elevated blood pressure caused by high salt intake.

Other successful examples in micronutrients exist in the world, and this is one in Finland. For example, the government implemented the addition of selenium to fertilizers in order to help tackle the heart disease.

So I would like to conclude here, and I think I have shown the importance that micronutrient addition to fertilizers can play a big role in eradicating the hunger and the malnutrition.

Pedro Sanchez

Thank you very much, Esin. I think what this shows is that, in feeding nine billion people, we're talking mainly about calories. To a lesser extent, we talk about protein. But then I learned, working with human nutritionists, that there are four micronutrients, very different from our soil micronutrients—zinc, iron, vitamin A precursors, and iodine—and the most important one… Well, they're all important, but the iodine is perhaps the most pervasive. If you don't feed children less than two years old with sufficient iodines, their intelligence will be severely impaired, and that's irreversible.

So now that we're seeing biofortification, of course, but now the fertilizer is getting into iodines, that little nugget, Amit, you showed of human micronutrients, shall we say, is very exciting. So these are new things.

We'll move on now to the users and the researchers. Professor Ruth Oniang'o needs no introduction, but she will talk about representative countries that have too little fertilizer, like

her native Kenya, and particularly with emphasis of what this Green Revolution, of which fertilizer is a major component, can do to women and youth. Ruth, please.

Ruth Oniang'o

Thank you, Pedro. You know you chided me four years ago in this same panel, and we'll see what the difference is this time. I want to start by thanking Ambassador Quinn for having me participate in this panel again. Thank you, Ambassador. And we come here every year. We come here every year because now I'm chair of Sasakawa Africa Association, and we are very grateful to Dr. Borlaug that in his later years he actually came and spent like 20 years on the African Continent. So we too celebrated his Centennial birth in Uganda in July, and we were privileged to have Ambassador Quinn, who came and just was a light and just, you know, he was just everywhere, and it's like with the presence of him and Dr. Borlaug in Uganda and Jinja and coinciding with the agriculture week. We were also privileged to have Jeanie Borlaug and Julie Borlaug, Dr. Amit Roy here, and our representative John Hardman from The Carter Center.

Sasakawa Africa Association was started by Dr. Borlaug, President Jimmy Carter and Philanthropist Sasakawa. So we come here because we feel a responsibility and that connection to this. The Green Revolution may not have happened in Africa the same way it happened in Asia, but do you know the major ingredient in Asia was that the political leadership took it up. And in Africa it's only this year that the AU, the Africa leaders are recognizing that they need to feed their people through agriculture. So maybe now we can begin to have that Green Revolution in Africa. And so it's very important that we put that into perspective.

And I know you have given me seven minutes—don't worry—so I just use those seven minutes to do what I need to do. I normally say that… I'm a grandmother now. When you chaired me four years ago, I was a grandmother three times; now I'm a grandmother seven times. And the grandmothers in Africa are really respected, more than any man, more than anybody. We are the ones who show the way. We can say anything, get away with it. And so I normally feel that I'm representing Africa—and mind you, Africa is not one country, it's 55 countries.

And today I'm happier. Last time on the panel, I complained, I whined, and I was upset. And if I was white, I would be white, but I wasn't, you know? This time I see hope. I see hope. And I see hope despite the Ebola. Because Ebola, everybody's focused on it. Imagine, it's here in America now. It's in Europe, it's everywhere, so we all focus on it. So you can't ignore any part of the world. I just want to quote Dr. Nwanze when he talked the other day, he gave a address—you cannot ignore any part of the world.

And so I come from mother continent where all your original placentas are lying, and we have now to focus that continent. And I'm happier now because the focus is there. I'm also happy because Dr. Emma is here. When we were in Uganda, Ambassador Quinn and I went to see her, and she gave me hope. This is the smallholder farmer we need to see in Africa, this smallholder farmer who doesn't know what to do with the soil. She has no education. We have neglected her. She's a woman, you know, and nobody cares.

Now we have young people, young people—they may not even be trained in agriculture or anything, but they want to do business. So they'll use that fertilizer, they'll use the science and

the math. Am I going to make money or not? But the same young people are into social enterprise. They don't want to see their continent, you know, being portrayed the way it is—always, you know, food handouts.

One thing I remember from my mother is that, if you go begging for food, nobody, nobody respects you. Nobody respects you. But you can still give me food when I'm able still to feed you. So many people, I invite them, come to my village, come to Africa, because we feed you even when we don't have food—not sandwiches—real food. We feed you even when we don't have food. So there's a lot to learn from that continent, and especially for the young people who want to… By the way, I have many cards—any young person here, if you want to come to the village, I'll give you my card. You can just come. So it's very important.

Now. Amit Roy invited me ten years ago to join his board, and I said, "Amit, I don't know anything about soils. I don't know anything about fertilizer. Because I was not connecting soil with the food science and the foods I eat. Now with my education, PhD, professor, if I didn't do that, how can politicians even do that? I remember the late Wangari Maathai, you know a Nobel laureate with the trees—you know her. She talked about trees. She talks about rains. And then one politician, a minister, says, "I thought the rain came from the sky. What is the connection between trees and rain?" Oh, my goodness. It was such a scandal.

So even our politicians don't know that there's a connection between the soil and what we eat. So when Amit Roy asked me to join, he told me it was because you asked those questions. You will learn. And I said it to pressure him. I say, "Amit, there must be a connection between the soil and human nutrition. There must be." And I'm happy the previous session, and also Kari has just said, most of the nutrients in the plants are the nutrients you must need. So we have to make that connection.

I also learned from him that the African soils are tired. They have nothing. No wonder they are tired. That's where we all came from—right? They have been around for a long time. There have been overmined, and yet we don't even put anything back. You know, we keep mining, mining. We don't move around anymore. We don't shift like my mother and grandmother used to do. We stay in the same place. We plant. The plant comes up, it's not green—we wonder what is wrong.

So people keep asking me, "Why don't smallholder farmers use fertilizer? Who is there to encourage them?" The cost, they don't even understand. They used to shift all over. Now they're in the same place, you know? Where fertilizer is needed is where it is most expensive. Where we use manure, we don't produce enough forage because what we plant is very little.

So my hope is that young people, and the Emmas, young people—they don't have to study agriculture, but they need to know that they can do agriculture as a business. But at the same time, we continue to worry about these women I worry about. And the same Africa, through Sasakawa, through Dr. Borlaug's work, we were able to quadruple yields—that's how I got connected to them. They invited me, say, "Ruth, we have all this maize and sorghum. What do we do with it?" It was coming from those African soils, because you are mixing biomass and also some NPK. But we have misused NPK. You ask a farmer, "What are you using?" "NPK, NPK, NPK." What is it? NPK. Until the soils say, "I'm tired of NPK. Don't give me anymore of this stuff." Right?

Look, Pedro, we don't even have enough soil scientists. We need them. I'm happy since I started coming here, thanks to Ambassador Quinn, thanks to the many supporters, companies—I won't name them—universities in this country. I meet many African young people. It's like people come to me, "Oh, Ruth. We have a Kenyan in our university." Oh, good. "Oh, Ruthie, we're supporting someone." Oh, great. We want to see more and more of them. So, so long as I'm still alive, I just bring Africa to you, because Africa right now, light is shining on it. It is our next frontier. It is where you see things happening. If you want to see what old civilization was like, you come to Africa.

But to tell you the truth, we also still need clean water. I should be to drink water from the tap like I do here. We need healthcare. You have seen Ebola, what it is showing you about the healthcare systems. We need women to be assured of surviving when they deliver, not dying at childbirth. We need electricity which doesn't go off all the time when you want to use a PowerPoint. I don't use PowerPoint anymore. And we need good roads so that people can get to market.

Thank you.

Pedro Sanchez

One thing, and I think, Ruth you were in Addis also for the African Green Revolution, that we talked about there, and she's an example of this—Africans are happy people. And that's one thing to put in the equation about all this stuff about Africa. Africans, whether poor or well off, are happy people and are also energetic. And the leadership African women—she's a scientist, but many other ones are just fantastic. So thank you, thank you, Ruth, for inspiring us.

Now we have Professor Xinping Chen from the China Agricultural University, who is tackling, their group is tackling with excellent science a major problem that China has of actually too much fertilizer, not too little applied. And I was there about a month ago, so impressed that I asked Ambassador Quinn to invite him, and here he is. So Xinping is a fantastic scientist and certainly a leader in soil science in the world. He just published what he'll talk about in a paper, in *Nature*, about a month ago, and that is just quite a paper. Xinping.

Xinping Chen

Good morning, ladies and gentlemen. Firstly, I would like to thank the World Food Prize Foundation for asking me to take part in this great event. I also would like to thank Professor Pedro for inviting me to join this session.

Pedro asked me to talk about how to increase yield from 5 tons per hectare to 10. I think this is the things we are working now, and this is the goal we want to realize in the future, in the near future.

Last year the average cereals yield in China about 5.9 tons per hectare. It's 51% higher than original level was. However, the projected demand in 2030 in China, we should still increase our yield by 30 to 50%. And maybe you already know that China use 80% of cropland produce about 21% of cereals to feed 19% of the population in the world. But maybe you don't realize that, at same time, China also consume about 35% of the chemical fertilizer, 35%.

So in a lot of regions the overuse of fertilizer is a major contributor to air, to water and to soil pollution nowadays. So environmental pollution has become serious problem in China nowadays.

So we believe this is a big challenge today for agriculture science, not only for China but also for the other developing countries, how to increase yield, meanwhile increase the nutrient use efficiency and reducing the environment costs.

This is because, firstly, after great success in yield increasing from the Green Revolution during the 1960s to 1980s, the rate of gain in cereals yield have slowly, markedly in the past 10 to 20 years, as Professor Ken Cassman yesterday mentioned.

And secondly, in such developing countries, also we use already too much of nitrogen and phosphorus fertilizer. The environmental pollution problem such as eutrophication, greenhouse gas emission, soil acidification has become so serious in such countries.

And thirdly, crops are produced by hundred of millions of smallholder farms. It makes agriculture technology more difficult and significantly different than in most developed countries.

So the question is—can the necessary increase in yield be achieved? If so, can the environmental cost of intensive agriculture can be mitigated? For answer of these questions, we addressed this field experiments under the large scale experiments covering the immense ecological areas for rice, wheat and maize production in China. We found that a set of soil integrated soil crop system management could increase cereals yield significantly by 30 to 50%. And meanwhile you do not need any increase in nitrogen fertilizer use. So the nitrogen use efficiency can be increased significantly. And we also use model simulation and the lifecycle assessment to calculate the environmental cost. We found that the environmental cost can be reduced substantially by this integrated soil crop system management.

If farmers in China could reach average of yield, 80% of this treatment by 2030, over the same planting area as in 2012, the total production of rice, wheat and maize in China will be more than enough to meet the demand of direct human consumption and a substantial increased demand for animal feed. And at the same time, we can reduce nitrogen use the environmental cost could be reduced substantially. So the gaps in yield and the environmental quality from 5-10 to a 10-10 with increased efficiency, it can be achieved, so integrated agronomic approach, especially given the yields in China are already higher than in most developing countries.

This approach is economically robust, and relatively easy and inexpensive to adopt. In practice, China already has doubled the public agricultural research and the development investments. So on this China achieved new progress in agriculture in recent years. For instance, from 2004 to 2013, China increased its cereals production by about 28%, more than double what was achieved everywhere else. It also increased the vegetable production by 33% and the fruits production by 64%. At the same time, the chemical fertilizer increased only by 27%. This is the first time since 1960s when China start to use chemical fertilizer that the production increased rate when the fertilizer consumption increased rate.

But even so, it still remains a daunting and challenge to transfer the result into the farmer's practice. The sheer number of small farms makes this especially hard. To address this issue, the government is funding research leader demonstrations through the country. It also established serious programs and subsidies to support a transfer of knowledge and technology. For instance, our country invested five billion Yuan each year, only for soil testing to improve fertilizer recommendation in country level.

So finally I would like to say increased yield from 5 ton to 10 ton, meanwhile increase nutrient-use efficiency is possible. However, it needs an integrated system approach, it needs regional specific research and the technologies. It needs more investments and it needs to transfer knowledge and the technology to smallholder farms. Thank you.

Pedro Sanchez

Thank you. Thank you very much. So the panel has concluded. Ambassador Quinn wants us to finish a little bit overtime with minimal, so we will not have questions. And I'm sorry about that, but each one of you can ask the panelists here.

In our preparation, I just wanted to say, in our preparation, we were talking about, well, how about, first, why yields are so important? Well, yields is a necessary but not sufficient condition. All sorts of things have to happen afterwards. But we were talking about this one to three to five to ten, and I asked, was anybody thinking about ten? And Kari here said, "Oh, yeah. No. We're doing experiments that are going over to 17 tons, in this case, of corn per hectare." So there's a lot there.

The bottom line is, with proper use, in our case, the proper use of nutrients, aim at efficiency, aim at minimizing or eliminating environmental costs—yeah, we can feed, the world can feed nine billion people.

I want to thank the panel very much, and I want to thank the audience now. And for the audience, feel free to contact the panel members in recesses until one. So thank you so much. And Governor Quinn, on to you—Ambassador Quinn, excuse me.