2014 BORLAUG DIALOGUE

October 17, 2014 – 11:00 a.m.
Panel: ***Dr. Ronnie Coffman, Moderator***

Introduction:

Ambassador Kenneth M. Quinn
President - World Food Prize Foundation

So this next panel is special for several reasons. First, of course, because it's on wheat, both Dr. Borlaug's specialty and Dr. Sanjaya Rajaram's specialty, but also to me; because, linking to our earlier discussion on national security and conflict, I'm so pleased that one of the panel members—and should be reflected on the slide and not, so that's why I want to make special reference to it—is Dr. Goodarz Najafian, who's down there.

And Dr. Najafian is from Iran, and so I think many of you know that I had a unique invitation to Japan in August. And I was the first-ever former United States ambassador or senior official ever invited to Iran to address a government conference. And it was in Karaj, the institute organized, Agricultural Biotechnology Research Institute. And there Dr. Borlaug is a hero to them and especially in his work in biotechnology. So I extended an invitation for the Minister of Agriculture, Balyan, to nominate a scientist, someone who is working in wheat to come here.

And we understood that normally it takes eight or nine months for someone in Iran to get a visa to come to the United States. So we should have been thinking about next year, but we have this panel. And so I made some calls, and we were able to get his visa interview, and then it has to be processed and then has to be put in his passport. So last Friday, just a week ago, he was in Armenia, because you can't get it in Iran, and got the visa put in his passport in about four hours. So we telescoped the whole process down to about three weeks, and he's here. And it's the cooperation among countries on these kinds of scientific issues that can be so important in a time where there's conflict and political instability. So I'm so pleased, Dr. Najafian, you're here.

Dr. Ronnie Coffman, over to you.

PANEL:

BORLAUG'S DREAM FOR WHEAT: TECHNOLOGY AND COLLABORATION TO CONFRONT RUST DISEASE

Panel Moderator:

Dr. Ronnie Coffman
International Professor of Plant Breeding, Director of International Programs, Cornell University College of Agriculture and Life Sciences

Panel Members:

Dr. Catherine Feuillet	Sr. VP Trait Research, Bayer CropScience
Dr. Hans-Joachim Braun	Director, Global Wheat Program, CIMMYT
Dr. Indu Sharma	Project Director, Directorate of Wheat Research
Dr. Mahmoud Solh	Director General, International Center for Agriculture Research in Dry Areas (ICARDA)

Ronnie Coffman

Thank you, sir. Some of you might know that Dr. Borlaug asked me to keep a special eye on Ambassador Quinn, and I've done it for many years. And just when I think he can't get any better, he does. He's had an amazing year, absolutely, and this symposium, Ambassador, has been an amazing feat. I think last night we… The entertainment each year, I keep thinking, you just can't excel yourself, but you do. So we owe this man a great deal of appreciation. Ken.

So our panel—I'm going to brief on the introductions, because I think a lot of you know who they are. Dr. Braun here, Hans Braun, he's the Global Director of the CIMMYT wheat program. He spent, before he came to CIMMYT as the director, he spent 20 years in Turkey. He knows wheat up and down. He's a graduate of Hohenheim in Germany.

Dr. Mahmoud Solh, you know him as the DG of ICARDA. You can't imagine how many problems he has had and solved in the past couple of years, especially. He's been in that region, he was born in that region. In Lebanon he worked for the Arid Lands Program. I think he'll show a slide of the founding of ICARDA where he played a significant role. And he's a graduate of UC Davis, an accredited institution we know at Cornell.

Dr. Indu Sharma sits at the center of the largest contiguous wheat-growing region in the world. She heads up the Directorate of Wheat Research. Wheat production in her country has exceeded 90 million metric tons every year since she's been handling that job, and it's a big one.

And I guess I don't know if you're encouraging me to start with the slides. Not yet.

And Dr. Catherine Feuillet is the senior vice president of Trait Research in the Research and Development Department at Bayer CropScience. Many of you know she used to work for

INRA. She's a AAAS Fellow named in 2011, and she's one of the co-chairs of the International Wheat Genome Sequencing Consortium. She's a major player in the leading-edge technologies of wheat.

And Ambassador Quinn has already done a good job of introducing Dr. Goodarz Najafian, who I don't know if Ambassador Quinn mentioned, is the top cereal person in Iran. He's head of the Seed and Plant Improvement Research Institute, SPII it's called, in Iran. And we're really fortunate to have him with us.

So I'm just going to say very briefly that wheat rust was Dr. Borlaug's focus really for his whole career. He went to Mexico in 1943 for that purpose, and he finished up focused on it, working closely with us in the Borlaug Global Rust Initiative.

So, Hans, as Dr. Borlaug's successor and leader of CIMMYT's global wheat program, how do you see us fulfilling his dream and meeting the challenges of durable rust resource in wheat, especially stem rust, which was a big focus and will be an important factor in meeting this whole expectation of nine billion people. And moreover, how do you expect to deal with the fact that rates of gain in crop yields are really no longer adequate to meet the expected demand on existing farmland.

Hans-Joachim Braun

Well, thank you, Ronnie. And let me first start with a quote of John F. Kennedy. And he said in 1961, "We have the capacity, we have the means to eradicate hunger from this earth. The only thing we need is the will." And I think that is still a topic, as we have seen during the last days.

When Ug99 was identified and Dr. Borlaug recognized what threat it is to global wheat production, he put all his weight and his authority to make the world respond, and there was a need for this. At that time there were less than ten scientists worldwide working on stem rust, and stem rust is historically the most important disease. So there was a tremendous complacency, and thanks to Dr. Borlaug, the global rice-resistant wheat and the Borlaug Global Rice Initiative was established. And today nearly a thousand people work on rust, and their combined knowledge has produced tremendous, tremendous tools. And I'm very optimistic that we can solve the rust problem if we continue to invest in this area.

Dr. Rajaram started. Well, 40 years ago he had a concept, which is called adult plant resistance, which is combining several genes. And today we have the tools to combine these genes and make cassettes, which then provide durable resistance. We also start to understand gene agents today, and we have seen that some of these genes really function against a very wide range of diseases. We have now the tools to clone the genes and put them together, and I really believe that over the next ten years we will be in the position to develop rust, endurable rust resistant varieties, which will have a big impact, provided the seed can be given fast enough to farmers.

There is also another area where the Global Rust Initiative has made tremendous impact, and that is in the area of monitoring. Just a key example, Ethiopia. In Ethiopia a new rust race broke out and some of the varieties were susceptible. And in normal circumstances, that would lead to an epidemic. We have now monitoring systems in place where scientists, extension people and farmers work together. And this is year we managed to prevent an epidemic, because we knew,

we monitored it very well, and there was also an inventory made of fungicides. And I have to mention that fungicides are always a potential to control it, provided you know that a rust epidemic is coming and provided you know whether you have fungicides and how you can apply it. All these came together this year in Ethiopia, and it shows what potential we have if we were together to address. So I'm very, very optimistic that we can solve rust problem.

For me, honestly, the biggest threat to rust is complacency. If we again fall back in what has happened in the 70s, 80s, we were very, very successful in developing rust resistant varieties, and that caused tremendous complacency, because policymakers and possibly farmers forgot that rust can be a threat.

Let me also talk shortly about crop yield. And I think if there was one message from the World Food Prize meetings here is that there are tremendous opportunities by agronomists, in agronomy and related technologies, in breeding and policy. But only when the three go together we will succeed.

And at CIMMYT we have recently started to really look into bringing knowledge together. The reason for this is that investments in wheat are relatively small to other crops, and we really have to bring the brightest people in wheat research together and work together for targets. And we have established what is called the International Wheat Gene Partnership that is a consortium of more than 30 partners worldwide—public sector, private sector. the best breeding companies, the best breeding institutes in the world are working together, and the target there is to raise the yield potential of wheat over the next 20 years by 50%. And we will achieve this through investments in making photosynthetic efficiency better but also tremendously increase the translocation rate from starch into grain.

Wheat also has a tremendous benefit, and that is it has possibly the biggest natural resources. In the gene banks of CIMMYT in Dakar are more than 200,000 accessions are sitting. And we started now to really sequence them to understand the molecular side but also phenotype and to make this data available over the next ten years. And I think if this data becomes available, breeders have new tools and genes to raise the yield potential of wheat.

And another thing I also have really to mention here—I said it already. Wheat is relatively underinvested compared to others. Wheat is after rice the second-most important crop in developing countries; it's worldwide the most important protein and calorie source. And until today we have not sequenced it. I mean, maize and rice, they enjoy all the molecular information, but in wheat we don't have it. We may need 15, 20 million more to do it, and I don't know why it cannot be done. For me this is ridiculous that we don't do this in wheat to get this information, because that would provide the wheat breeders the new tools to go ahead.

And my last word on this one is I think a big issue here is—it was also mentioned in the previous talk—we need to recognize that agriculture is not the problem. I understand policymakers here, rises in insurance, threats, diseases, global climate change, water shortage. But agricultural research is really the solution to these problems. And I hope that policymakers understand that agricultural research really needs to be prioritized again, and then I'm very optimistic that we meet the targets which you have touched about, Ronnie. Thank you.

Ronnie Coffman

Thank you, Hans. So Mahmoud, Dr. Borlaug was a major player in the genesis of ICARDA, an organization that you've really so ably guided for many years. How do you see Dr. Borlaug's dream being realized in your region where stripe rust, or yellow rust, has been such a major challenge, and what needs to happen in your region to meet the challenges of feeding the perspective population.

Mahmoud Solh

This is the slide of 1975 where the main headquarter of ICARDA was selected. You can see Dr. Norman Borlaug with Bob Havener, who used to be the director general of the Arid Land Agricultural Development program, the predecessor of ICARDA, and Dr. Jit Srivastava, who has been really the wheat breeder of that program, and of course some officials from the Syrian Government.

Now, CWANA, Central West Asia and North Africa, has been really a major target for ICARDA, whose mandate is to work in the nontropical dry areas where this region has been the platform to address the complexity of the challenges that face dry areas. The region covers about 54 million hectares of wheat, which is about 50% of the world, I would say, wheat production in the developing world. And at the same time that region is the largest wheat-deficit region in the world. A country like Egypt imports annually 10 million tons, and lifting subsidies like Egypt, Morocco and Yemen did create even street riots because of the value of wheat in the daily diet. The per capita consumption on the average in West Asia and North Africa is about 165 kilograms per person per year, and in countries like Morocco this can go to 200.

Now, rust certainly and particularly yellow rust is a major problem that we face. And, therefore, besides working on high-yield potential as well as drought and heat tolerance, we focus a lot on rust resistance. In 2010 the serious epidemic of rust did break, I would say, some major genes that were resistant, and some farmers lost up to 80% of their crop because of yellow rust.

Now, of course, we know rust never sleeps, as we learned from Dr. Norman Borlaug, so you have to have constant research in working on rust and on durable resistance, as Hans has indicated. And what we really do at ICARDA, of course, we do work on several aspects of yellow rust.

By the way, the region is a region that is a crossroad for the spores that are windborne, moving from the Ethiopian Plateau, Ethiopia and Kenya, all the way north going to Yemen. And as you know, Ug99 even reached Iran, as we will hear later. But certainly this route can really take the rust diseases to Southeast Asia as well as to Northern Africa and Europe. And so, therefore, controlling the rust in this region is so important to global food security.

So one thing that we really do, again, our work, which is in collaboration with CIMMYT, is we distribute crop nurseries to about 65 locations all over the world. This involved the various types of rust, yellow rust, Ug99, as well as leaf rust.

When we really had to move from Syria for the unfortunate development, we did establish a Regional Cereal Rust Research center in Izmir, Turkey, with the support of the Turkish Government. And on this occasion I would like to express appreciation for the Turkish Government for establishing this important Regional Center. I would like also to express appreciation to the Borlaug Global Rust Initiative for their support. And in this center we have regional race analysis, regional field screening for durable resistance. We distribute the trap nurseries that we used to do from Aleppo in Syria, and certainly capacity development and networking is a major role of that center.

And now this is really one major development in line with, of course, the dream of Dr. Norman Borlaug in terms of controlling rust as soon as possible. The other very important, I would say, example of one of the achievements is what happened really in fast-track variety release and accelerated seed multiplication and delivery of the rust resistant varieties. This has been done through the USAID support in several countries in Egypt, Ethiopia, Pakistan. Again this has been also in Iraq as well. And I want to mention this has been again in collaboration with our sister center, CIMMYT.

The very big achievement is the fact that in three year through a project specifically targeted to Ethiopia, rapid deployment of rust resistant varieties in Ethiopia, we distributed—not we; I'm talking about the National Agriculture Research Institute through collaboration with public and private sector—distributed resistant seed varieties that were released by the Ethiopian colleagues from the germ plasm of CIMMYT and ICARDA. They distributed those to about 570,000 hectares, which is about 40% of the total acreage of wheat. This is no doubt has been really a major achievement and I think pretty soon I hope in the coming few years we will have really resistant varieties with most of the farmers in Ethiopia both resistance to Ug99 and yellow rust.

Now, this is a very interesting slide. This is the last visit of Dr. Norman Borlaug to Syria, and this is one of the Syrian farmers. Syria used to be a country that imports wheat in the 70s and the 80s. In the 90s Syria became self-sufficient, and in the early 2000s Syrian became an exporter of wheat. It's the only Arab country in the region where it really reached self-sufficiency in wheat, and this is mainly because of the efforts and the contribution of Dr. Norman Borlaug over years. Of course, you see here Bob Havener at that time was the board chair of ICARDA, not really the Arid Land Agricultural Development Director General. And one farmer, one progressive farmer gave a horse as a present to Dr. Borlaug, and really the horse is the best present that a farmer can give for royalties. And you can see the message that Dr. Norman Borlaug always tell us—*Take it to the farmer.* And you can see how he's hugging a smallholder farmer, just appreciating what he has been doing in terms of increasing his productivity and yield.

And thank you.

Ronnie Coffman

So Indu, you have the perspective, as I mentioned earlier, of running the largest national agriculture research system in the world, or being a part of it; and moreover, you're the geographic hub of the greatest contiguous wheat-growing region. So will your country and

your region rise to the task of feeding its population? How do you expect to build on Dr. Borlaug's legacy in South Asia?

Indu Sharma

First I'm thankful to Dr. Quinn and Catherine who made all the efforts for me to be here and share my views of how important India is in South Asia. And if you talk about South Asia with 23% area, 20% wheat production and 21% population, and most of the populace country in the world. And if you see there is malnourishment and we require more food. And if you see the 1947 situation in our country, we had only 5.5 million ton, and it was not sufficient, and we were importing our [inaudible] projects. And 1950s and 60s were the years when India had tall varieties which were nonresponsive to fertilizers. And there was nothing we could much about it.

This morning we had been listening starting with Swaminathan's talk, Borlaug legacy, and also his work in India. To me it looks little bit trepidation, but I must admit that the visit of Dr. Borlaug at the behest of Dr. Swaminathan in March 1963, that they came along with the [inaudible] he along with the dwarf wheat varieties and the Green Revolution ushered in not the one in India but an entire South Asia, especially Pakistan, because at that time India and Pakistan were one.

So if you see how things moved in South Asian countries, you can see the production levels. They had been very high. If you see how much is the productivity compared to the world, it is more than three ton, and South Asia is 2.8—not bad. Look at it. And India's country which is 68%, so that's why India has remarkable achievements made in the wheat reproduction.

But if you see the challenges ahead, there are numerous challenges. Dr. Hans Braun has listed few, Dr. Mahmoud Solh has listed few, but then I will see the practical aspects which South Asia facing and which India is facing. The last few years we have seen, though we are having remarkable achievement—90 million ton, more than 90 million ton consecutively for the last three years, besides the fact that we had bad weather conditions. And what is that climate change affecting wheat production? You see, it is not only the rising temperatures, it is the abrupt variations, abrupt changes in the temperature at the green formation stages. It is not actually the total rainfall; it is the pattern of rainfall which is affecting. Like in seven or nine days you have the same rainfall as it should have been in a full season, so there is a waterlogging in our country.

Despite all these problems—stripe rust, another problem. We had to [inaudible] stripe rust in the month of January this year, and throughout the season there was very congenial temperature, but then it was the farmers' awareness, availability of fungicides that still we could had the corn production this year. I must share that it is the policy, the government.

Amongst South Asian countries, India could have remarkable achievement in the wheat production. Can I have the next slide, please? Anyway, we can skip those slides.

So you know India is a big country, and Indian Consul of Agriculture research, it has all India coordinated improvement project for each crop, and similarly in wheat, we have a project. And we have 31 centers across country involving all geographic regions, so why, you know, we are

not much scared of… Of course, we are scared of Ug99 and other emerging races. And recently we heard some new races involved in Iran. But then because we have a range of temperature across country, so I think we will be able to manage, and we are managing. And also sending over material in Kenya and Ethiopia for evaluation against Ug99, and proactively working in cooperation of resistance against Ug99 and other races.

So our major focus is that let us incorporate not only one gene but there should be two or three genes like SR31 or SR24 is going to be a little more scientific. But then we need to talk about that it is not a single gene that it will be effective in the future. So we are looking at multiple genes, the reason being that in South Asia there's a contiguous area in wheat. If you see up to September or October you can wheat in Nepal [inaudible], and then we have different season. Even within our country, we have wheat mainly in the winter season, but then you will find in the Northern area some wheat grown. So that continuous on the green bridge of wheat is a problem for the rust epidemic situation.

We cannot talk wheat or rest in isolation to South Asian countries when we talk about India. And if you see the Borlaug legacy, how it is being carried forward by Dr. Sanjaya Rajaram, and I'm really happy that I could join their ceremony. And it was 1B/1R, translocation material with him, good agronomic, good plant type, that we could have higher growth rate. The growth rate of wheat had declined in '90s to 2000. They increased from 65 by dwarf wheat, semi-dwarf wheat came into being. But then there was a decline in growth rate up to 2001. But in fact was realized again from 2005 to 2014 in South Asian countries when there was increasing growth rate. This happened more in India and Bangladesh. But then Iran and Bhutan they had lesser wheat, less growth rate and productivity, and we hope that other countries like Afghanistan and Nepal and India and also Iran, they will further enhance their productivity levels.

So we have a lot of challenges, and we are into the Green to Gene Revolution with all that's… In fact, if you will look at all these points, I will emphasize only two or three. One is the genetic diversity. We must have more genetic diversity of our material, and also the high technology, all the genomic science which Catherine will be talking about. But how to integrate that science for the practical application for the development of pre-breeding material and also utilization of this material into wheat improvement programs.

Then we have all issues of nutrition, water, drought. Then seed is another component which is very important. So it is faster seed multiplication, seed delivery to the farmers, and farmers' knowledge and advancement.

For the, how they can develop their own seed and how they can play an important part in their village and in their state. So it is not only the public or the private sector, but farmers' participation is very, very important when we talk about seed.

As we are talking about the climate is changing, we had experience in 2003 to 2004 that there was increase in one to two degrees in temperature and there was decline of 9% yield and the kind of situation which may face in the future. So drought, heat and all these things, and the shift in area because of glaciers melting. If there is a shift in area, how races are going to change? How? We have to manage all these things. So it means these are some practical issues which we need to look into, not only for our production and advancement from genetic gains but also looking at other scenarios of the climate change.

So finally it is the collaboration, the cooperation at regional level which is very, very important. Why we are giving all the time example of rust? Because in epidemiology of rust, the spores, they are windborne, and the adjoining countries, they are affected a lot. So India being hub country, we can join hands with all the surrounding countries with, like you have seen in Savannah region. And we will know that what are the genes deployed and how to manage the rust using the information of the races is prevalent and what genes they have and how diversity could be created.

I will share with you finally one of my experiences that what is future? Future lies in the wellness of farmers. It's simple card. A generous card which was distributed to the farmers, and now we are getting phone calls from the farmers that disease has appeared in their field. How to manage it? So it is then what is important? It is the policy of making available the fungicides to the farmers at the right time. And this year so much of the problem was the initial focus of infection started in the month of January, but we could manage the disease very well and we could again have a corn harvest. So it was the vital change seed replacement.

And then also training to the youth and scientists. So this is what we are closing on.

Ronnie Coffman

Thank you, thank you very much Indu. So, Catherine, you bring the perspective of the private sector, which Dr. Borlaug always embraced, of course. How do you see the role of your company and others, especially about GM technology, the role of the private sector and strengthening wheat production? How do you see that happening?

Catherine Feuillet

Well, thank you very much, Ronnie, and I'd like to thank Ambassador Quinn and the committee for their opportunity to be here, because it has been really inspiring to see these sessions in the past days. And I think the World Food Prize is a unique forum to look at the problem from different angles. And we have discussed several times the public private partnership, and I am to give you a few slides in my new perspective as now a private company person.

So the private sector needs to play a role as a partner for achieving Dr. Borlaug's dream for wheat. And in the next slide you have a few of the challenges that have been highlighted by Hans and Indu, and I don't have to come back to that. We are all talking about rust here, and this is a never-ending story. We will always have a rust infection, new races and we have to fight that permanently. So we need to bring to the farmers new technologies. We need to bring them new opportunities to have a profitable and a good business, and we think we can play a role in that.

And on the next slide we see challenges, of course, but great opportunities as well in wheat. So working for a company that has a strong crop protection background, there is already a lot of work that is put in Bayer CropScience and crop protection. You see that 25% of the sales actually of the product are for cereals, fungicides represent 50% of that. So there is a continuous development of new product, and we want to keep that going.

But what we want to do as well is invest more in the seeds business and to make that profitable as well. Because if you look at the central profit, this was really striking me when I saw that for the first time. Also wheat, the green line is the acreage of wheat, and the blue bar, actually the profitability, so the market represented by the sales wheat and in corn on the left. So you see really the difference between what is happening in corn and what is happening in wheat, and I think it's our role as well to help bringing value into the wheat market.

And it's not just the prospective. I think of private companies it as well three years investment in the crops. So you look at the right side and you see the relative investment in corn and in wheat, and to me there is a problem here. And we are in a vicious circle of there is not enough advancements; we don't make really great progress, and therefore there is no profitability and there is nothing left in investments. So we have to break the circle, and I think we are committed and other companions hopefully as well to break the circle and to make this pie looking very different in a few years with much more investment in wheat.

We have to invest for the reason that is shown on this slide, that we have a problem [inaudible] yield increase in about ten years. And Hans mentioned it, there are partnerships starting to get together now between public and private sector to try to tackle that. We really need to do that, and we need as well to get hybrid seeds, we need to be able to have traits, to understand the yield component and improve all of that. And this is something that is wished by the whole wheat community and with Hans we were a week ago in a meeting of the wheat initiative, thinking of discussing about game-changers; and this was identified by their community as game-changer, so we have to invest in that, and we do it.

The next slide you will see as well a strong commitment that we have, and it was announced by our CEO a few weeks ago. I mean, we have a long-term plan, Bayer CropScience, to invest in wheat, so more than a hundred million dollars per year for ten years. And for me it's not so much the amount, of course, that's important, but this is the long-term commitment. Because I can speak now as my former life as a public researcher for 20 years in wheat. I have seen three waves of investment from the private industry in wheat, and generally they didn't last more than five years, which you cannot do in wheat. I mean, if you don't invest on the long term, you don't have quick wins like that. And so the commitment over ten years is for me a very strong message, and hopefully this is followed up by other companies too.

What we strongly believe, as well, is illustrated on the next slide, that there is not just one solution. So on the next slide you see that we have different departments. We are working on small molecular and chemical side, biological traits that I'm leading, and then the breeding work, seeding representing the breeding. There is not one single solution to a problem. There is not one single solution to rust. Fungicide would not

make it. We need to observe resistance introduced by breeding; biogenetics can be a new solution as well.

So we strongly believe that this is time to bring all these technologies together. We have been working too long in our specialties, and it's really time now to bring that together, and we have the tools to do it. We spoke a bit about genomics. Genomics is a very great tool to integrate things, and we are ready to move on with that, and I think in the public and in the public research we are able to do it, and we should really involve that. And we should do that for fighting rust diseases, we should do that for increasing yield, and protecting yield.

And I think in the last slide, I want to see what is our vision as well for the next year, to give a bit of a timeline. We believe that this is really the time now to have major investments in breeding traits and technologies, so we need to get together, private companies, public research. And for me I really see now that I have switched sides. The complementarities already that exist between the two sectors, there is really no doubt that we really need to work together. And I'm really very fond of this idea. So we need to deploy the combination of new technologies, so we see that for the next five years as a major investment. If we do that properly, the next years after the year 2020, we should start to see already, you know, the delivery and the benefits from breeding, obviously, in the first place for improving yield and protecting yield in a more efficient way than what we can do now, and hopefully start to see as well some hybrids that will help us to increase yield and stabilize yield. So hybrids are not just about increasing yield but the yield stability is as well is a big issue in wheat, and we see that that would be a good solution for that.

And then after that, during that time we should be able as well to identify traits. I mean, Hans talked about the wheat yield partnership. It's about improving photosynthesis, so it's about trying to tackle these traits. So once we have a better knowledge of this biology, I think we will be able also to be more efficient to introduce these traits through breeding or GM or non-GM approaches, whatever is the best solution. So we spoke a bit about GM. GM is a technology that I don't think we have the luxury at the moment to put aside. It should be part of our strategies. It's not the only solution, but we have to have that in our toolbox. And so hopefully we will be by the year 2025, 2030 able to see on the markets things that are really another profound improvement from now on.

So just to finish and summarize, we need to go on and continue. So we are very strongly committed to innovation in crop protection, and so we would continue to do that. This is the stronger part of Bayer. We would invest massively in seeds and trait, as I have mentioned, to bring new capabilities. And we as well think that this is important that the private sectors contribute to the support service and advisors for the farmer. Because we bring a combination of different solutions, and this is the optimization of the use of this solution that makes the agriculture is efficient and that we can reduce the

land on which we are cultivating and we don't impact the environment. So we are very committed in doing all of that, and hopefully we continue our partnership. Thank you.

Ronnie Coffman

Thank you, Catherine. So, Goodarz, you're the only person on our panel who has seen Ug99 invade your country, and you evidently had a very appropriate response, because you prevented the spread. And this is especially important for your colleagues in South Asia, so could you tell us more about your response and how you were apparently able to contain the spread of Ug99, please?

Goodarz Najafian

Okay. Let me at first extend my sincere to World Food Prize Foundation and especially Ambassador Quinn, who invite some scientist from Iran, and that lucky scientist was me, to be among with you and just get a lot of information from speakers and discussions in this prestigious program.

I want to just show those slides to come to your question. Now we have been treated always by the wheat rust and yellow rust was there, and this is a slide showing some years we have got up to 1.5 million tons of wheat reduction in one of the epidemics which we have suffered from that. And leaf rust and stem rust was there. But next slide is showing the history of stem rust in Iran. Actually we have experienced some epidemics also for stem rust, the history is there, but everything has started with this Ug99 and in 2007 when virulence on Sr31 first was detected by Nazari et al., which is now working with ICARDA, one of our colleagues, a pathologist at ICARDA now.

Again, I would like to just refer to the summit of Nairobi when Dr. Borlaug was there, just he also initiated a good movement and just Borlaug Initiative was formed. And this was the start of providing an international opportunity to just come back against this killer virulence.

So now we have four national breeding programs for different climatic zones of Iran. And so, looking to use those, the capacity provided by this opportunity, and thanking to the Minister of Agriculture of Kenya to provide the Njoro station to just provide this place for international community to send germplasm to screen for Ug99. Because we hadn't just extended the Ug99 in the country, so we have to just put the material exposed to the disease so that we would be able to pick the resistant genotype. So we started to send germplasm. Of course, with partnership with CIMMYT. Again I have to refer that we have a tight partnership and long term with CIMMYT and ICARDA. So sending of those germplasm and elite germplasm, which we had in our, circulating germplasm in our program, we could pick some genotypes that they were in the pipeline of the release, and they got the resistance to Ug99 fortunately. So that was the shortest strategy we could…

The next slide, showing, you see that at first this is a slide showing the five to six years of the sending of germplasm to Kenya. At first it was very disappointing and just much percentage was susceptible, but you look at the green color—somehow some improvement was there in terms of percentage of resistance genotype.

This slide you must have seen in just the rust track, or in the BGRI conversations. Iran is among the countries in the region that could come to release about ten varieties of wheat, which have got, fortunately, acceptable resistance to Ug99 virulence. And by that many of those varieties now have got acceptable area, and just we can say some sort of assurance to see whether, if Ug99 is there, we could have at least some varieties to resist against it. Of course, I have to add climate also was, I think, not in favor of Ug99, because you know Iran has suffered from very consecutive droughts. While it was affecting the yield, also maybe that also was effective just to prevent the spread of Ug99 promptly.

So we got some varieties and we started again to develop new germplasm. That's long term, as a breeder we have to do. We have crossed those varieties and many others which maybe in CIMMYT nurseries, ICARDA nurseries to build up new generations of germplasm. And now by the time we have the new nurseries which have come out from those crosses, and we hope that those genotypes could be much better than the before ones.

So one thing is very important right now we are doing is monitoring the disease. Now you said Iran is in the frontier of this new virulence, and we have to just monitor the wheat area to see what is going on. And our colleagues every year at the proper season goes to different corners of the country and just see and record the farms and take samples and also record the location by GPS and send the data to CIMMYT in Ethiopia to David Hodson just to put the international data to each other so that in the shape of this international partnership we would be able to track the disease, what is going on.

And I think I stop here, but I would like also again maybe if I get the time to give an update of stem rust in the country.

Thank you.

Ronnie Coffman

Thank you, Goodarz. So in fact do you want to just go ahead with this slide?

Goodarz Najafian

[inaudible]

Ronnie Coffman

Well, let me just try to wrap up then of where we are. And by the way, on the time, the ambassador has been good enough to give us a few extra minutes, so hopefully we're not keeping you from lunch. Apparently, lunch is not yet ready, so we've got a little more time.

So Dr. Borlaug, as you know, was always focused on the farmer, and that's what we want to do. We're trying to get resistant material out to farmers, and here's the current situation with Ug99 at present. This is where it is, and of course it's headed east where there are a lot of vulnerable farmers in its path. Our big concern right now is Ethiopia, which is right on the edge. The thing has been present there for years, and we are all holding our breath as we try to get resistant materials out to the farmers.

So the big question I want to address, in keeping with the challenge of the meeting is—do we have the science to deliver durable rust resistance? And the answer is clearly yes, we do. But do we have the support of society to take the science to the farmers? And the answer there is evidently no, not right now. So it's a pretty simple challenge, which I think Hans highlighted. I mean, if you're going to try to deploy a single gene, the pathogen is going to win. You've got to get three or four out there simultaneously, and we need GM technology to do that efficiently.

So we need better communication. Borlaug was what I call a man on message. He was… Ambassador Quinn has referred to it before—he was wonderful at communicating to decision-makers what needs to be done. And collectively we must do a better job of that.

Now, we're giving it a try at Cornell, and Dr. Sarah Evanega—I hope she's here. Sarah, if you are, stand up, because people might like to talk to you about this. We're starting… There she is. We're starting with Sarah's leadership, the Alliance for Science—remember that, all one word if you want to find it on the Web. The Alliance for Science with the goal of trying to depolarize this debate around ag biotechnology and really promote evidence-based decision-making, try to bring forward the muted voices, particularly of farmers. Farmers want these technologies, and we need to form alliances with some people where we're not quite comfortable, but we all have the same goal.

I think Dr. Borlaug put it, "You know, we're all against starvation." It doesn't matter how you want to approach it. We're all against starvation, and so we've got to get together somehow and help ensure that science is not hijacked by the radical fringe and try to expand the choices of farmers and consumers.

So we have two big objectives. One is to try to reclaim the conversation around biotechnology so that science and evidence-based perspectives drive the decision-making. And the second is, we want to populate this alliance—that means you all and others—populate this alliance with a skilled network of communicators through

specifically designed and innovative short- and long-term communications training activities. We all need to learn how to communicate better. It's essential. Dr. Borlaug's not here to do it for us, and we've got to learn to do it.

So here's all the contacts, all the social media—please make a note of them and particularly the Alliance for Science. I'm going to leave that up on the screen so that you have a chance to photograph or make a note of it or whatever. And we've still got up to 15 minutes or so for questions, so I wanted to lead off. I wanted to give Goodarz a chance, since he's here. Goodarz, you're presently dealing with a threat of a new race, so can you update us on what's happening in Iran right now?

Goodarz Najafian

Yeah, I think I refer to the monitoring of the rust by colleagues. As far as my knowledge is concerned, in Ethiopia also the original race, which was called Ug99 now is not prevalent. And another race is just get over there and even in Turkey. And Iran this isn't up on the information. My colleagues just observed in the context an area that has been a local races is getting our, means, as some of the varieties which were resisting Ug99, so we were expecting a strain of Ug99. But now another race is getting over, and that's not Ug99, according to gene postulation, which ICARDA and CIMMYT and my colleagues in SPIA have done. And so this is sort of, you can say, a chess game. We just expected Ug99, but another race is coming on the context.

So I have to say the only thing is our continuous job as sort of inspiring from Dr. Borlaug's concern about rust. As Dr. Solh was referring that rust never sleep, and so we have to just take care of the context and just see what is going on. Hopefully, with this good partnership of CIMMYT and ICARDA and BGRI, I think we are just looking in the context, hopefully nothing take place. But another race is there, so some of the varieties are resisting to that, some not. Some of those good varieties which we have developed against Ug99 now are susceptible. And so there is a gene, TMB gene, in those varieties now. This virulence is resistance on that.

So we have to keep just jobs continued and hopefully as the other scientists told, we can manage the rust. And I believe that we have to live with rust, because we cannot eliminate microbes and fungi from our life. They just are very, very strong components of the ecosystem, so we have to reduce the population and just with the different varieties we're playing with the genes… We do not have millions of resistance genes. We have to just maybe again go back to the earlier genes because now virulence for them is not available to put in the varieties and just maybe with the pest integrated management of the pest and disease so we be able to just keep the context and production going on.

Ronnie Coffman

Hans, maybe you would like to just clarify about this too. I mean, we were all alarmed by it when we saw it last year, but it's not as alarming as we thought. Maybe you'd like to just clarify the situation for people. For Ethiopia especially, but it's also in Iran, obviously.

Hans-Joachim Braun

Yeah, right. And I mean fortunately the initial fields they are not there. We identified the new races. Some of them are not Ug99 related, but there were interventions through chemicals, and we really have now, through the international network we are in the position really to monitor very well the gene that the new isolate was immediately sequenced in a very short period, so we understood what it is. Today we have the capacity to respond very fast. We didn't have this five, eight years ago.

And in Ethiopia, as I said, we have new varieties coming now also; that is another thing. We have varieties in the pipeline, and we also have the seed system, which delivers it. Now, as Dr. Solh has shown before, the turnaround rate from basically nothing to 500,000 hectares in a few years. That is remarkable. That was not possible a few years ago. So if we maintain the investment and we maintain the awareness, even if a new rust race comes up—and they will come up; I mean, they will; it's absolutely sure we will have future problems also in rust because of the mutation—but if we have the monitoring system and if we maintain the supply of new varieties, then we can control it.

If we bring in complacency again—and this was the big problem of the success of the wheat breeders in the 70s. Dr. Borlaug started in Mexico in the '40s, and he developed rust resistant material. In the 70s there was nowhere in the world anymore stem rust outbreak, and that was thanks to the plant breeders. And so they were so good that everybody thought the probably was solved, until Mother Nature hit back, and then we became very vulnerable. So I hope that we can maintain a reasonable amount of investments. And Phil Pardey from Minnesota has just recently shown in a study that annual investment of around $60 million would be easily warranted to protect from drainage. And, well, I'm not sure we are at $60 million. And you made it so evident, society has to decide—do we want to control it?—and then we need to make investments and go along, or otherwise we will face again problems where rust will wipe out a lot of wheat.

Ronnie Coffman

Mahmoud, you operate in a volatile region of the world. I think everybody's wondering how things are going to go forward there. How do you see it happening?

Mahmoud Solh

One thing that ICARDA did over the years is we did develop excellent relationship with national programs, and we build lots of confidence. And certainly a problem as serious as rust, it is certainly far beyond any one institution or any one country really to overcome.

And therefore building the capacity in the national program is so critical to ensure, I would say, effective control and early warning and early reaction on the new virulence and so forth.

We have been really fortunate in ICARDA that the national programs, after what has happened unfortunately in Syria, opened labs that I would say, farms, the research farms to us, and even the valuable collection we have, which has more than 7,000 accessions of wide developments of the wheat has been rescued. And we have been really using these wide developments to, I would say, extract new sources of resistance. And as Hans indicated, this is a constant battle. We continue to look for new sources of resistance and new genes, and we have to follow certainly the approach for more endurable resistance and so forth.

So I still believe it's a teamwork, and your alliance, certainly, Ronnie, will be so important to strengthen this network in rust, globally and certainly focusing at the national level to make sure that we are monitoring and evaluating any new race that is coming up.

The problem with climate change, I remember in 2010 the temperature in winter was about four degrees more than the long-term average. And I have never seen yellow rust as serious in West Asia as I have seen it because of this high temperature in winter. And this is the time one of the major resistant genes was broken. You go with blue genes in the field, you go out with yellow genes because of the spores that you really get. The only infestation I have seen like this is in a Ethiopia.

So I think honestly we are coming into a more difficult time in terms of more virulence, and we have to be ready. And this is what I wanted to say.

Ronnie Coffman

Mahmoud, so we have just a few minutes left. I want to ask Catherine a question and then wrap up with you, Indu—I have a question for you as well. So, Catherine, in the face of this social resistance to GM technology, what's your view from the private sector? How are things going to move forward, especially in a crop like wheat?

Catherine Feuillet

… But I really welcome initiatives like yours because I think the problem at the moment is that, if the private companies communicate about the need of GM, then that doesn't work because people see think "oh it's just about making money, and it's not needed in fact." So I think it's really important that universities, growers' association, and there have been movement in that way too, from declaration from the wheat growers from Canada with wheat growers in the U.S. to ask for wheat biotech. And I think this is important, but it's still a difficult matter.

So we are motivated. I have to say that it's difficult to remain motivated because the costs are increasing, the deregulation is more and more difficult, so if we continue this path, even the private companies will start to be less motivated to use this technology, which would be a pity from a scientific standpoint. So it's really important that everybody gathers together and the public voice is raising.

Ronnie Coffman

Thank you, thank you very much. So, Indu, climate change is everywhere, and heretofore stem rust has been restricted to what you would call peninsular India, more the Southern part of India. And it's never, as far as I know, occurred in the real grain belt of the North. But are you worried that it could with climate change, and how are you planning for that?

Indu Sharma

What I feel is 160% more yield by 2050 in India and 230 million ton in South Asia from 140 million ton what we today have with the climate change and the rust scenario changing. To me it appears, you know, it is the regional collaboration which matters a lot. The knowledge sharing, like we are putting up data in the global toolbox of the survey lands. Similarly, prediction based on the races which are prevalent, how genes, which genes could be effective in the future for durable resistance. So that we are not struggling each year for the fungicide availability.

So to me it appears that the proactive role based on what does survey lands and the races prevalent in the region, we should be making decisions for the gene insertion or the gene, I mean new technologies there. We know that genome sequencing is there, genes are there. You have the markers; you know how to do it. So I think it is only a little bit of planning.

And then what your question next is how much we are worried about Ug99. You see, I'm worried because in Iran they are not having only the Ug99 but again SR31 besides another race which is not affecting SR31. So this is a new race. It means you are having the variability for stem rust. So let us not say that stem rust only in new areas in the former Ug99, but other variance also. This immediately calls for regional collaborations

for epidemiology, which we have really forgotten, which we are spending more money on the molecular techniques, on the GM technology. We are not spending much on the epidemiology which is a basic science. We explored it in India in 1930s, '40s, '50s. Matar's work in the north, Himachal Pradesh in North India. But now for the last 30 years we are not working on that. So I think DRW under the visionary umbrella, the with the national agricultural systems association. We need to work at regional hubs like savanna region one hub, South Asia is another hub, or Europe another hub. And then we focus on what is prevalent and how we should incorporate it so that every year we have not to struggle. Okay, a new race will come and how to manage? Like how we have seen in Ethiopia last year and again this year.

Ronnie Coffman

Well, I think you can see that we're all dedicated to taking Dr. Borlaug's dream forward. And if we can just bring this slide back up again, I would like to just give everybody a chance to see that again. And please do what you can to spread the word. Let's do a better job of communicating about the need for technology, because that's going to be the key as we move toward 2050. So I want to thank the panel, and thank you all so much.

Ambassador Quinn

Thank you for a great closing session. I'm glad I gave you the extra time. You used it well. Ronnie, Dr. Coffman is a member of our Council of Advisors and was so close to Dr. Borlaug. Thank you for doing a great job. Let's have one more round of applause.