PRESENTATION
Speaker: ***Robert T. Fraley***
October 13, 2016 – 3:20 p.m.

Introduction

Per Pinstrup-Andersen
2001 World Food Prize Laureate

Let me now proceed introducing the next panel, the next speaker who in fact probably does not really need an introduction in this audience. I believe most of us know Robert Fraley. But let me introduce him nevertheless. Robert Fraley is the 2013 World Food Prize Laureate. He is Executive Vice President and Chief Technology Officer at Monsanto. He's been with the company for more than 30 years and currently oversees the company's Global Technology Division, which includes plant bleeding, plant biotechnology ag biologicals, microbials, precision agriculture, crop protection.

Dr. Fraley is recognized as the father of agricultural biotechnology and has been involved in agricultural research since the early 1980s. He has authored more than 100 publications and patent applications. Dr. Fraley's discoveries and applications of science are also routinely recognized for the tremendous impact they've had in supporting farmers and agriculture on this planet. In addition to the World Food Prize, Dr. Fraley's honors include the National Medal of Technology from President Clinton in 1998, the National Academy of Sciences Award for the Industrial Application of Science for his work on crop improvement in 2008, and many other recognitions.

Let me just make a few more points about Dr. Fraley and his work. He has served as a true ambassador around global agriculture and global challenges, leading dialog and engagement for stakeholders that hold many diverse points of view. You can frequently find him engaged on Twitter or LinkedIn. But I forgot to invite him to join me on the podium, so, Robert, would you please join me.

Robert T. Fraley - Thanks, I appreciate it.

Per Pinstrup-Andersen - Robert, you have the floor, but you don't have my apple.

Robert T. Fraley
2013 World Food Prize Laureate

Thanks I was trying to snag one of those on the way out, and she wouldn't let me have one. So, RJ, you're going to have to make sure I get one of those apples. Thank you so much for the kind introduction, Dr. Andersen, and I'd like to thank everybody here and Ambassador Quinn for the opportunity to be here. It's great to be back in Des Moines, I tell you. I think the older I get, the more I look forward to this meeting every year, so that's incredible to be here.

And I think what makes it so special is, you know, look at this room. I mean, we've got folks who are interested in agriculture, in the environment, in technology, science. And one of the things that keeps us, I think, unique and special when we think about the future is a little bit of the past(…and let me just keeping clicking here. Go ahead, one more slide.)

You know, we all share a common bond with Dr. Borlaug. I had a chance to know Norm the last 20 years of his life. I learned a lot from him both as a scientist and as a leader. And we all miss him, and so the opportunity to be back here every year and kind of renew that acquaintance is very special.

I'm going to follow up a lot on what RJ talked about, the future and technology. Before I do, I'd like to just spend a couple minutes and acknowledge the challenges we face. And I know everybody in this room is an expert, and you can probably recite the demographics here even better that I can, but we all need to prepare for a world where by 2050 there will be ten billion folks joining us, and several, two to three billion will be in the middle class. The demand for food will nearly double.

Ambassador Quinn calls this the greatest challenge facing mankind. We have to produce more food by 2050 than we have in the entire history of the world. That's the challenge out there. And it's absolutely an enormous one. And just to make it a little bit more complicated, we know we're going to have to do that with probably using less water for farming. We will deal with the challenges of climate change that are presented to us during this period of time. And we know that around the world regulations and oversight for technology will change, and that will be an important part of the parameter as we move forward. And so it's critical.

I always remind folks at this point—If you say 2050 fast enough, it seems like a long way away. I'm 63 years old. I can count those days. It's 34 years. And I particularly want to talk to the young scholars. I had a chance to meet with the Beachell-Borlaug scholars today, with many of the other students. And I speak to you directly, that this is your world that we will be allowing you to create and take to that next level. And it's really the decisions that we make on science, the decisions that we make on technology, the policies that we put in place will determine how successful you will be in solving these challenges for the future.

I'm going to put all my cards on the table and tell you that… And I think one of the views I have as a scientist in a position of being the head of technology for Monsanto is the ability to look into the future of a lot of innovation, you know, the latest advances in biology that take us beyond sequencing into understanding the soil microbe, or the next generation of gene editing technologies that will literally let us change every base pair of every gene in every genome of everything that matters to us, in a very predictable way. Or the advances in data science that are going to give us the ability and the tools to not only farm but farm literally meter by meter and plant by plant and make decisions based on data and science that are going to be transformative.

I can remember talking to Norm about this next generation of science coming and trying to explain how the advances in biology, the advances in data science are going to really create, I think, that next Green Revolution that the world needs. And that's for me the cause of the excitement and the optimism that I have for the future.

The other very important thing about these tools that I think is unique in the history of agricultural advancement is both of the advances in biology and data science represent unique

technologies where the barrier to adoption is very, very low. I describe it often like this: Take the latest advances in biology—whether it's genome sequencing, gene mapping, GMO traits, gene editing—in the end the product is a better seed. And every farmer in the world knows what to do with a better seed if you give them that seed.

And when you think about the data science tools, I mean, it's easy to gravitate on the new John Deere or the new Case tractor that has a bigger computer in it than the first spaceship that went to the moon, but for a lot of smallholders, the cell phone becomes the delivery vehicle for agronomic information, weather information, market discovery that will transform farming and agriculture around the world.

So I'm excited about the potential that these tools have to really drive and accelerate sustainable intensification of agriculture around the world. And I'm going to come back to that theme very often, because the key is sustainable intensification, getting more with less. And it doesn't matter whether you're a farmer in Iowa who's trying to improve their operations and improve your yields or whether you're looking at it through the lens of the environmental community, which says the biggest challenge that agriculture has is inefficient farming that requires us to continually add more land to production. If we can take the land footprint that we have today around the world and increase yield and productivity and sustainably intensify farming, it's both a win from a food security perspective as well as enhancing the environment.

Now, as the head of technology for Monsanto, I just want to make a couple of comments, because there's a lot of different views on technology. But here's what I see happening around the world. These technologies are dramatically changing agriculture. They're going to change the industry. They're going to change the academic and the NGO communities. Here's what I see. And we just had a beautiful illustration. You know, RJ's team bringing genetically engineered fish, apples; other companies are working on potatoes, mosquitoes. I mean, we're seeing completely new entrants into this field. Last month I was in Silicon Valley giving a talk to startup companies in the Bay area. There were 600 startup companies in the audience working on censors, satellites, new data science tools all targeted for agriculture. So it's exciting to see the landscape changing so dramatically.

The investments—I will tell you I am deeply concerned that at the national level across most countries, we don't have enough government investment in agriculture given the opportunity for the future. But we are seeing a big pickup in private investment. Last year in this country the venture capital community invested nearly $5 billion in agricultural startups, which is a tremendous opportunity.

And then, finally, we're seeing the pace of innovation change dramatically as these new tools come in that let us speed up the process, reduce the cost of sequencing and generating an incredible number of data points. And I thought while we're on this slide and theme, I'd just kind of speak to the elephant in the room. You've probably all heard that Monsanto has received a proposal and our board has agreed to be acquired by Bayer. And that's really a combination of two things, and largely it's driven by the fact that around the world the ag economy is challenging—you all recognize that—but I think even more importantly we recognize the technology discontinuities that are occurring. And we realize that, in order to serve farmers globally, we need to increase our scale, our ability to invest in the future to bring these innovations globally.

So I'm very excited about the merger. I look at it through the lens of more R&D capability for the future. I look at it from the point of view of how do we bring solutions that are integrated so that the seed the farmer picks has exactly the genetic profile, the right types of agronomic recommendations, has the right type of microbial or other seed treatments, has the right type of interventions that make it a system no different than, you know, if you went to your doctor or you made an order from amazon; you would like that kind of continuity in the process.

And, finally, and I think very important for this audience—our business has largely been focused on the Americas. Bayer is strong in Asia and Europe. The combination creates a much stronger global business and particularly a business that has critical mass in key countries in Africa and Asia, where both companies today don't have that capability.

So that's all I'm going to say, but I really wanted to point it out in acknowledgement.

I'm going to talk about technology, and as the guy from Monsanto who helped invent GMOs, probably the first thing you'd expect me to talk about in the future is the next generation of GMOs. I tell you, when I look back over the last 20 years, what I think has been most remarkable has been how the biotechnology tools have fundamentally changed plant breeding. It's been that sequencing of the genomes, it's been the use of the markers that has accelerated breeding far beyond I could have imagined 20 years ago.

And I show you here just to represent the yield curves of corn and soybeans. This year in the U.S. where we've certainly had the benefit of the most highly sophisticated technology introductions with breeding and biotechnology, we will set record yields in both corn and soybeans for this country. It's pretty amazing.

I left my dad's farm in 1970 to go to college. The average corn yields in the U.S. in 1970 were 75 bushels an acre. This year they will be 175 bushels. It's not raining any more, and frankly farmers aren't using anymore fertilizers or pesticides to produce that yield. It's an incredible grain in efficiency that has fueled economic growth and food security globally.

And the point is—with the availability of technology today, with the cost reductions in sequencing, this technology curve can basically accelerate every crop in the world. And that's a big part of the future I see. And just to make that point and illustrate it… And I actually spent a little bit of time talking to Norm about this, that what we will see is basically a transformation in breeding. And clearly it starts with the fact that we now know every single gene in the crop-genome; when we make those crosses, we can identify with the seed chipper exactly the genetics of each seed. All of that is scalable. This Ion Torrent chip can hold the genomic sequences of a thousand corn hybrids. A thousand of these chips represents a million hybrids. That represents a 10x scaling in what's possible from breeding. And that enables us to capture those advantageous genes from germplasm collections all around the world and make unique combinations that have never existed, to drive further gains in productivity. And couple that with tools like the seed chipper, like the double haploids, we can speed up that breeding process.

And finally, as we start to add to our testing capabilities that network of satellites and sensors so that we can really map that GxE interaction that has always driven us nuts in the plant sciences. That really gives us the opportunity to accelerate the curve.

And effectively what it does is it brings agriculture to the point of real precision farming. When I grew up, my dad farmed the farm, all the fields. When you can start to breed gene by gene and you can manage your crop foot by foot and plant by plant, it's a new level of operational efficiency and productivity—and that's what's available on a global basis.

And again you look into the future. There's been a lot of discussion on this meeting on gene editing and what that does to take us to the next level of biotechnology advances. It's incredible. I mean, we will see the ability literally to modify every base pair of every gene in every crop genome to the benefit of enhancing productivity, of enhancing nutrition, of enhancing the sustainability of crop production—quite exciting and really remarkable as we look at the future.

Now, you have to give me just a couple of minutes to talk about biotechnology. This is the 20th anniversary of the launch of Roundup-Ready soybeans and BT cotton that launched in 1996. Over that course of time, we've seen adoption of this technology in 30 countries now around the world. It's been one of the most rapidly adopted technologies in the history of agriculture. And as I always say to folks, one of the things I'm most proud of is—there are 18+ million farmers around the world planting this technology for the simple reason, it works. It improves their yields, it reduces their insect pressure, it helps them with weed control, and improves their operations.

And it's been a huge boom from an environmental perspective. Herbicide-tolerate crops have effectively eliminated tillage, which is one of the great challenges from an erosion and from a sustainability… As a kid, I loved coming home from school, getting on my dad's tractor and plowing those fields and churning up that black Illinois dirt. But I realize that every time we did that, we had wind erosion, we had water erosion, and we were releasing all that carbon that the crop had stored during the year. So it wasn't really good for the environment. You know, insect-protected crops have transformed farming. It's made India the largest cotton producer in the world and doubled yields and productivity. So I'm really, really proud of the impacts.

What I'm most proud of, though, is that scientists and one of the developers in the 20 years that GMO crops have been in the marketplaces in 30 countries around the world, there's not been a single food or feed safety issue ever associated with the technology. You all know that the U.S. National Academy of Sciences has just reviewed the science. They've spent two years reviewing all the data and affirmed the safety of the technology. And just in the last couple of months—and I know, Mark, you've been deeply involved with it, Mark Van Montagu—a hundred Nobel laureates have signed letters and affidavits supporting the technology. And it's exciting to see this momentum as we go into the future.

From a science perspective, I think we're just at the beginning of a wave of new biotechnology products. You know, Roundup-Ready soybeans have been very popular for farmers around the world. There's been challenges with managing some of the weed-resistance issues. This year we'll launch the first traits that have multiple herbicide tolerances. And in many ways we're following the same theme of the pharmaceutical industry. Just because you develop resistance to an antibiotic, you no longer fail to develop antibiotics, you need to develop more and use them in combinations. And what we need to do in agriculture is take advantage of the fact that we can create stacks of products for both insect and bug control that allow us to manage resistance. And we're excited that the Xtend technology that we'll launch this year will bring the benefits of several products in that same seed. And I think that will universally again reset the basis for cost-effective weed control in many of the world's major crops.

On the insect control side, exciting stories. Last year with the sequencing of microbial genomes, we discovered more BT trait platforms than have been discovered in the last 30 years. But what's really exciting to me is that, while we're advancing into new mechanisms for insect control based on Mello and Fire's discovery of RNAi. The RNAi mechanism, whether it's built into the plant like a gene to express an RNAi, as in the case of our SmartStax pro product, creates a completely new mechanism for controlling insects. We identified the most sensitive genes in the rootworm, the RMAi inhibition—build that into the corn plant, and the corn rootworm is effectively controlled—brand-new mode of action that will both enhance the performance of the product and, importantly, their durability.

What's really exciting is that we also learned that those RNAi molecules could be manufactured; they could be delivered to provide unique pest control as an exogenous agent. We call that "biodirect." And really interesting—one of the cool science results that we're seeing is with honeybee health. So as you know, there's been lots of challenges to bee health in colony collapse disorder and lots of inferences what was cause and effect. When you talk to the bee experts, it's pretty simple—it's Varroa mite, Varroa mite, Varroa mite. But it's a huge challenge, because you're trying to control a mite. Can you see that picture on the bottom right? Here's how you have to… You know, pretend you're a bee for a second. Pretend you have a football right here—that's your Varroa mite. So that Varroa mite is feeding on the bee, draining it of its hemolymph and infecting the bee with viruses.

But you're trying to control an insect on an insect. But what we've found is that we can sequence and develop unique RNAi sequences that are only recognized with genes in the mite, not in the bee; and if we provide the bee a diet of the selected RNAi molecules, we can actually control the mite within the bee population, which is a really cool advance from a science perspective and a great demonstration of how biotechnology can create such precise advancements in the future that I think are pretty, pretty cool.

The last area that I talk about from a biology side is—all these improvements in crop improvement historically have come from how we put better genes, better combinations of seed, how we do more targeted genetic modification, whether it's a GMO technology or gene editing for the future. These tools are now being redirected for—how do we better understand the soil microbe and promote better soil health?

And you all know the phenomenal story of the human microbiome and how much it's changed our view of medicine. You know, it's basically the recognition that, if you think about your body and you think about your blood cells, your skin cells, your brain cells, it's recognized that we have as many or more bacteria living on us or in us, and it's impacting everything from our digestive processes to our propensity to get ulcers and many other healthcare considerations.

The same is true of a corn plant or a tomato plant. That plant is covered with its own unique microbiome. And now with the ability to sequence microbes in the soil, with the ability to do targeted testing, to be able to apply that seed treatment, just like you would when you take that probiotic yogurt, to the seed, we can start to alter the soil microbiome and enhance it.

So several years ago we created a collaboration called the BioAg Alliance with Novozymes, who is one of the largest producers of microbes in the world. We brought together our R&D capability to identify microbes, and we're seeing now literally remarkable advances in yield.

And basically the yield comes from two points. Imagine your root system and your plant, and all of those root hairs are covered with bacteria. If you pick the right bacteria that's providing micronutrients, they serve as microfactories on that plant to enhance growth. They could be microbes that are producing molecules that are repelling other pests from the plant root. But in either case, it's driving yield.

One of our most advanced products is the one on the right. This will launch commercially in 2018. This is a penicillin species that helps the plant's solubilize phosphate, so it provides an enhanced micronutrient. Obviously, there's lots of research in this field on nitrogen supplementation as well as opportunities for pest control. But I think, importantly, what it represents is a very nice intersection between the advances in biology and in the future the advances in data science. Because what we're finding is, is each field has a different microbial ecology based on crop rotation, agronomic history; and being able to understand the breeding gene by gene, understand the environment in that field, and the microbial ecology of the microbiome, I think, is a breakthrough that can drive another round of crop improvement.

So when I think about all these things, a lot of what ties it together are the data science tools. There's been lots of talk in this conference about data science tools—you know, an incredible explosion. I mean, satellites, sensors, sensors built now into farming equipment that give growers a real-time feed-out on moisture, on nutrient levels, on organic matter—again making those decisions for farmers more precise, more exact for the future and giving them better alternatives as we move forward. I think it's an exciting advance and one that creates a huge breakthrough for farmers around the world. And whether this information is delivered to the cab of the tractor or to the cell phone, it's going to provide remarkable insights that will enable us to make better decisions at the individual farm level.

Now, when I bring all this together, this is kind of my view of the future. The blue line is the one you've all seen—that's world population. You know, by 2050, 2100, it levels off at ten billion people. The red line is what we need to do from a food production perspective—we need to double the food supply. I believe that's technologically possible, given the incredible advances that we're seeing in science.

I think another important point is that green line. The green line is the amount of farmland around the world that goes into producing our food supply. Here's the point. It's arguable today that we're at peak farmland around the world. Every investment that we make today in technology not only ensures that we can address food security, but that investment in higher-yielding, more sustainable farming lets us make better decisions about which lands we should farm and how we can use that information to manage the environmental footprint of agriculture better and better in the future.

And I think it's a key message for audiences and particularly audiences in this room. Food security is number one, and hunger. For a lot of audiences, the investment in agricultural technology that drives enhancement to the environment is equally important. And I think what's beautiful about the innovations that are coming is that they do both. They drive food security, and they will enhance the environment as we farm better and smarter in the future.

An important part of food security that I'd just like to mention… Because a lot of times when we talk about it, and I know I talk about it, people read it and, well, it's all about yield, it's all about crop productivity, it's all about the input side of agriculture. We all know that there's a huge opportunity in reducing food waste. And there's lots of estimates, but certainly a large

portion of our food supply is lost every year. And depending on which part of the world and which crop, it can either be food lost in the field or in transportation or in storage or food waste from a consumption pattern or a food storage issue at home.

But here's the point. All of these technology advances… And RJ just gave you an elegant example of how we can change the consumer appeal of foods. And we see that all the time in our vegetable business. But these technologies that help reduce competition from weeds, help reduce damage from insects or diseases in the field, all contribute to reducing food waste as well.

So I think taking that broader view of technology, not just from a yield perspective but how these tools have actually enabled us to reduce crop and field waste is an important point to make in the dialog.

And the last point technically that I'd make—and this is a key one from an environmental perspective—is, as we increase the yields of crops globally, we increase the ability of those crops to fix carbon. Everybody understands and has the mental picture—if I plant a tree, I fix carbon, and we have a whole carbon credit system based on that. It's now true that here in Iowa and across the Midwest, high-yielding corn with conservation tillage where we don't plow, where we have cover crops is a net carbon fixer. And we are now starting to see where increasing agricultural productivity is part of the solution for the future.

I'm going to take Dr. Andersen's hint and step off the stage. Before I do, I just want to make one last point that I think is so critical. And it follows a lot on what Norm's advice has always been. We need to take it to the farmer with technology—that's true. What I've come to realize clearly and sometimes painfully on the GMO front, that we also have to take it to the consumer and to the policymaker and the regulator.

So I ask all of you who are involved in agriculture, who are passionate about it, to recognize that, while science is absolutely critical, the commitment to communicate and reach out to the public is as important. And I leave you with that message. Thank you so much.