Transcript of the Inaugural

Henry C. Gardiner Global Food Systems Lecture

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“2050: Agriculture’s Role in Mitigating Global Change”

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Henry C. Gardiner Global Food Systems Lecture Series
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I’m floored by the turnout here. I think that means there’s a lot of interest in agriculture and food and we’re going to have a great dialogue tonight. I’d like to start by thanking the Provost and the Dean and all the faculty for pulling together a great afternoon. Of course, my favorite part was getting a chance to meet with the graduate students and the undergrads and I think I’ve got two or three signed on to join me at Monsanto at some point. I consider it a great day.

What a wonderful honor to have the opportunity to give the first lecture on the global food system, which is absolutely key. We are a global world and we’re trading grains around the world and our opportunity for the future to help meet these daunting challenges is to manage the food chain both locally and globally. That’s what we need to do. It was a special privilege to be recognized as the first speaker to have the opportunity to be part of the Gardiner Family Lecture and to have a chance to honor Mr. Henry C. Gardiner’s legacy and accomplishments. I had a chance to do a lot of background reading. I’d never had a chance to meet him but when you think about the pioneering work that he did, the innovation. And then the family’s foresight in really creating a dialogue about this, it is really a remarkable insight. It’s a real privilege to be a part of that and I hope to add to your understanding.

I’ll do the good and the bad news. The bad news is I’m probably going to show too many slides. The good news is that there isn’t going to be a test at the end so you can just relax and enjoy. What I want to do is spend a few moments setting up the conversation on the global food chain and some of the challenges and issues. I’d like to talk about some of the technologies and tools and put those into perspective. And then, let’s spend our time in a great dialogue and move forward and address the questions that you have. For those of you who want to follow the dialogue even deeper, I’ve given you my Twitter account. You can reach me on Twitter @RobbFraleys and I try to address all of those questions and comments.

You know, I think one of the reasons we have so many folks here in the room tonight is there’s so much interest. That interest can be driven both by the science opportunity, the challenges that lie ahead, concerns that we all share over food security and the environment, and the opportunity to mitigate what’s going on.

I’m sure you’re all aware of the demographics but let me just frame the challenge this way. I celebrated my birthday yesterday. I’m sixty-two years old. I really want to speak -- I had a chance to talk to a lot of graduate students and students today and here’s why it’s so real. It just seemed like a few years ago I was sitting in the front row of auditoriums like this listening to speakers. And the reality of it is that the next thirty or thirty-five years is going to go by in a flash. Importantly, the conversations, the decisions we make, the policies we put in place today you will live with. When you’re my age, we will either have made the right decisions or not and that’s why I think this conversation is so important.

If we frame the challenge I think about it this way: everybody knows world population continues to grow. The FAO has actually revised upward the 2050 target to 9.5 billion. Good news is the reason population levels have gone up is that there’s been such incredible progress in addressing healthcare challenges across Asia and Africa and so that’s a good thing.

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Probably as important a statistic is that the middle class will explode over the next thirty years. We’ll see another two to three billion people join the middle class and that’s a result of world wealth creation. A big part of that will be folks living in Asia and across Africa and that’s incredible. That will create an increased demand for healthier foods, more calories in some cases, and more food.

If you do the simple math, to be safe we need to double the food supply between now and 2050. Let me say that again, because if you say that really quickly it seems like a long way off. That means in the next thirty-five years we have to double the food supply. Let me put it in perspective. We will have to produce more food between now and 2050 than we have in the entire history of the world cumulatively. So this is a huge challenge and I don’t want to underplay it but I want to put all my cards on the table and tell you I’m an optimist that I believe we can do it.

That’s also recognizing the fact that there’s other things that we need to do in terms of eating healthier. We know that water will be a huge challenge. I know that here at Kansas State there’s a lot of research and a lot of interest in this topic - it will be critical. Obviously, global warming and the implications that it has and the things that we can do to mitigate are an important conversation. And then the policies -- how we bring all of this into actions that promote good, sustainable farming practices, that promote actions that support food security.

I’d like to highlight just for a second the impact of climate change because that can be controversial with different groups. I’ve studied those facts and I actually have commissioned research with the scientists in our organization nearly a decade ago to look at the data and determine what’s going on and what we can do. I think everybody fundamentally knows that temperatures have changed. It is fundamentally getting warmer. A lot of people think immediately about drought and heat stress, and that will be an important consideration for crops. But even a one or two degree change in a local temperature in a local environment changes when insects hatch or when diseases will have an outbreak. So a big challenge of putting ourselves in a position to mitigate and address climate change is going to fall into using basic tools in breeding, molecular biology, chemistry, and precision agriculture to better understand and control pests, to better understand how we can use water effectively, and how we can breed for crops that can withstand the kind of drought pressures.

Like I said, if anybody -- and I’m sure you all tell the stories about how it was different from when you grew up -- this is just a twenty-year snapshot looking at Kansas in terms of the temperature zones that existed in 1990 versus 2012 today. You can see a remarkable change. That can be replicated across Illinois, across the Midwest. In our case, as a company, we are now doing breeding trials for corn and soybeans in southern Canada because the climate has changed so much in just the twenty years that we’ve been in the breeding business that it will be possible to grow high-yielding crops in southern Canada. So it’s clear that we have seen the implications of climate change and that’s true globally around the world. Clearly as a scientific organization we will work hard to look at what things we can do differently, what can we anticipate, and how can we address this challenge.
Now I said I’ll put all my cards on the table and I’m an absolute optimist. I’ll end basically laying out my vision and my view of what’s possible. But the reason I’m optimistic at the highest level is this: probably the two greatest technological innovations of our lifetime are the advances in biology and the advances in information technology. If you think about what’s going on, the advances in biology have changed literally the way we breed crops today. Imagine the ability to sequence every single gene in a corn plant or a tomato plant and have markers and be able to identify every single gene that comes from the mom and the dad to create those new kids. That’s possible today. Or the biotech traits. We’re able to precisely add new genes for the future. Couple that to the advances in information technology where today every single field in the United States -- all thirty million of them -- have been mapped. Increasingly, each one of those fields is being gridded into an area the size of this stage so that farmers can literally farm meter by meter and optimize their inputs and use that information very powerfully. That combination of these incredible advances in biology and information technology are converging on farms around the world. I think for me that’s what drives the optimism that we can fuel the next green revolution if we have societal permission, if we have the policies to utilize these tools effectively.

When I talk everybody, knowing that I’m from Monsanto, knowing that I helped develop the first biotech products and GMO seeds, they kind of expect me to come up here and say GMO is the answer for everything. I will tell you that, if I look back at the contributions our group has made but more broadly what the scientific community has created, for me the most remarkable story is how these tools have literally changed the way we breed crops. Having that knowledge of every single gene, being able to breed faster, more precisely, to be able to target the introduction of diverse germplasm from breeding pools around the world has been game-changing. As a result of that, we are just starting to see increases in the rate of gain of every breeding cycle, the ability to map-and-tag multiple disease and drought and yield traits and bring them together in ways that have never been possible before. So the breeding story is really the one I highlight and clearly that’s been augmented by advances in technologies that literally let us take each individual seed from a corn plant or a soybean plant or a wheat plant and shave a small sample so that we can do a DNA test. And that’s why I say from a breeding perspective, not only are we able now to breed gene by gene, but literally seed by seed. That greatly increases our probability of creating new combinations that have never existed to drive our yield and our opportunity for the future tremendously.

I was talking to Mark (Gardiner) earlier and you inspired me that I think we need to add to our robotics capability where we’re doing the seed chipping capability. I think we need to add like a prime rib or a nice T-bone steak testing analysis, so I’m going to have the team on our robotics group work on that because I think with a few more markers we can pick out the perfect T-bone. We’re going to work on that as we go forward. Importantly, the cost curve for doing this -- a decade ago this was frankly only possible to do with corn and super high value crops. Today, this is being applied to all crops. All the fresh fruits and vegetables have been sequenced and mapped. Increasingly we’re working with organizations around the world to start the sequencing on orphaned crops, whether it’s the millets, the chickpeas, the cowpea products and crops that are important crops in certain local countries and diets. The ability to do this and have that
precise blueprint of every crop is what is game-changing in my mind and, as we look back on the impact that these advanced technologies have had, it will be this phase that drives the difference.

You didn't expect me not to talk about biotechnology and GMOs, so let me just add a couple of comments. I'll talk about some of the controversy in a little bit and I'm sure we'll get a few questions on that later. Let me point to the thing that back in 1983 when we first put the first biotech transgene in a petunia plant I would have never dreamed that standing in front of this audience in 2015 that this technology would have become the fastest-adopted technology in the history of agriculture. Today GMO crops are grown in almost thirty countries. They’re grown on over 400 million acres, which is about a quarter of the world’s farmland. What’s important -- and this is the point I want to emphasize -- there are more farmers outside the United States using this technology than in the US and many, many, many of those are smallholders in India, in China, and in Africa.

The beauty of this technology -- and this is what's so key -- if you think about what we get out of all the breeding efforts, what we get out of all the biotechnology efforts, it's a better seed. That's what this produces. A higher yielding seed, a better disease resistance, a better insect resistant seed. Importantly, every farmer in the world --no matter how big or how small -- knows what to do with the seed. So if we can give the smallholder a better seed it can transform their farming operations and that we can see. If we give a large farmer in Brazil and the US the technology, they also accrue benefits from the technology. It’s really important that we address small farmers because frankly I’ll tell you there’s no way to feed the world and double the food supply without ensuring that small farmers increase their yields dramatically. I believe with our tools we can double the yields of corn, soybean, cotton, and wheat in the US, but in Africa, in Asia we need to triple and quadruple yields. They start at a lower level and we have every opportunity to do that and achieve that in the future.

I’m going to talk a little bit about some of the benefits of biotechnology. I think, probably more important than what I say, I’d refer everybody to this study by Klumper and Qaim1. This was just published before the end of the year. What’s important is this -- first of all, these are German economists funded by the German government. As you know, Germany is not a big supporter of GMO or biotech crops. But this is probably the most sophisticated analysis of all of the studies that have talked about the benefits of biotech crops. You can see their summary here in terms of – overall, as they’ve analyzed these hundreds of studies, what farmers have experienced is an increase in yield, a reduction in pesticide use, and importantly an increase in farmer profitability. That’s really why we’ve seen such phenomenal adoption of this technology around the world.


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Growing up on a farm in Illinois, realizing how much time my dad spent making purchase decisions, I can tell you that there’s no farmer in the world that you can fool with the technology. You might get them to try something one time but if it doesn’t work, if it doesn’t provide benefit, you’re not going to achieve 400-plus million acres of farmers utilizing the technology. So I’m really proud of the broad, global acceptance of the technology by countries around the world and we continue to see progress every year in new countries, new crops, adapting the technology. But what I’m really the proudest of is the incredible track record of safety that the GMO technologies had.

Let me give you this perspective to think about. The very first gene cloning experiment was done in the 1970s out in California -- Herb Boyer and Stan Cohen did the first gene transfer experiment. That was done in the 1970s. We in our laboratories in St. Louis made the first transgenic plant in the 1980s. We field tested and commercialized the first commercial crops in the 90s. Wherever you want to start in that calculation, we now have twenty, thirty, or forty years of experience with GMO technology and GMO crops. In that entire history, there’s never been a single report related to food or feed safety with the technology. For me that’s really impressive. That’s really a reflection of two things. First of all, what we’re talking about is genes that make RNA and protein like every other gene in our bodies or in any other form of life. So it starts with an inherent safety. But secondly these products are reviewed extensively.

Just to put this in perspective, if I were the head of a drug company I would get FDA approval to sell a new drug. That would be my job, I would have been successful, we could sell the product in the United States. Being head of biotech effort for Monsanto, we get approval in the US from the EPA, the FDA, and the USDA. And because we’re so good at it, as a US farmer produces grain that gets shipped around the world, we get regulatory approval by forty other countries around the world who all have their ministers of health and environment and agriculture. So these are by far the most thoroughly studied food products in the marketplace and in the grocery store shelves, and I think that also is really an important testament of their safety. And there’s a huge consensus -- it’s real popular these days to talk about the scientific consensus around being pro-science on vaccinations or pro-science on climate change -- every organization of note around the world from AMA to the National Academy of Science, the American Medical Association -- has given GMOs the thumbs-up in terms of their safety.

But that being said, it’s very clear that there’s more work to be done on communication. There’s a huge interest that people have in terms of the dialogue on food and it’s something that I recognize that we need to do more and a better job on. If I could look back on my career and just tell you the biggest mistake our company made is we were excited by the technology -- we were a strong scientific organization. We launched these products in the mid-90s and we put every bit of our attention on talking to farmers about these products and their benefits and we didn’t pay any attention to consumers or consumer education. That has bitten us because in the absence of information from companies or from industry, the internet has been filled with a lot of misinformation, a lot of things which frankly are not accurate and now we need to do the double work of both correcting and moving forward on a communication front. That’s something we’re doing and that means getting involved a lot more with social media, with reaching consumers in 2050: Agriculture’s Role in Mitigating Global Change

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the way that they want to get their information and that’s important. I would just throw out to all of you who have any touch point to agriculture, whether you’re a farmer, a producer, a student, that we all have this responsibility.

When I grew up on my family’s farm in Illinois I farmed with my dad and my grandfather. When my grandfather was farming, sixty percent of the state of Illinois was in agriculture. Today as you know, because of the success of farming and the efficiency gains that we’ve made, probably less than one percent of the population of the US is involved in farming today. That simply means that all of us who understand agriculture, who are involved in agriculture and farming have the responsibility to communicate to the other 99%. The good news is there’s a lot of interest and there’s a lot that we can do. It starts with really I think sharing our common values. I have never talked to a person yet who didn’t really care deeply about healthy food or someone who cares about a food-secure world. Or how do we minimize the footprint of farming and protect the environment. And these are all great common-ground elements to build on and share those values.

The other important thing that I’ve learned -- and I am clearly an originator and an advocate for the technology just based on the incredible good that it can do and my knowledge of the thoroughness and the safety and the benefits that it provides. Too often as an advocate I would focus on the critics, the folks from organizations that are never going to accept this type of technology. And often what I forgot is that the vast majority of people are in the middle. They just want good, straightforward answers, they want to be involved in dialogue and that’s really where we need to put our attention and put our focus as we go forward.

I told you I’d share with you a little bit about the science. How many of you are growers or work in farming operations? So probably about a quarter of the room. These next few slides are for you. I’m going to tell you what’s new and exciting and again there won’t be any test here. Let me start with an exciting breakthrough in insect control. Those are corn plants and it’s bad when they don’t have any roots because they don’t grow good and that’s because the insect is eating on them. The plants on the right contain a brand-new gene that we’ve discovered that can protect the corn plant from corn rootworm feeding. It’s a very different approach than what’s been used historically with the Bt genes which are the products that have come really from organic farming and organic gardening where we’ve introduced the Bt gene into crops.

This is a technology which is based on RNAi. For those of you who are now hardcore biochemists and molecular biologists, when I went to school back at the University of Illinois back in the 1970s, we were taught that the DNA made the RNA that made the protein and that was the central dogma. Obviously it got a lot more complicated a few years ago when Andrew Fire and Dr. Mellow discovered a new mechanism of regulation or at least newly-discovered called RNAi. That means that there are little messenger RNAs -- RNAi derivatives -- that can regulate gene expression. That’s what we’ve been able to do. We actually can go to the rootworm or any other insect pest, figure out what are the key genes that make it grow well, and then target an RNAi that knocks out that gene and very selectively can kill that insect. A very powerful method, we can put it in as genes in the plant or we can actually formulate these
RNAis, spray it on the bug, and get enough RNAi in to be a very targeted, a very specific biological control agent. So exciting breakthroughs. We’ll be launching our corn rootworm product based on that in just a couple years.

Another product that was designed specifically here for our western Corn Belt -- that includes Kansas, the Dakotas, and Oklahoma in this area -- has been our DroughtGard® technology. DroughtGard® is really composed of two things. It’s a biotech trait that is actually a sheathing protein that protects the machinery of the cell from degradation during heat stress, and it contains the advances from breeding where we’ve been able to use these molecular markers to target corn hybrids that are super-resistant to drought. It doesn’t make any sense to put a drought gene into corn genetics that’s sensitive to drought, so the combination has given us a yield benefit; we’re getting five bushels of yield benefit. The results this year are so good that we are already sold out on DroughtGard®. We have probably touched about a million acres. So we’ve made the decision to expand DroughtGard® to the rest of the Corn Belt because every year there’s a drought somewhere in the core Midwest or a farmer has a sandy hilltop or wants to cut the amount of irrigation and preserve water. If they can substitute a gene for an irrigation cycle, that’s a good thing for everybody. That’s a cool technology.

What’s especially neat about it and makes the point on a global basis is that we’ve actually taken that same technology, partnered with the Gates Foundation and WEMA (Water Efficient Maize for Africa), and have worked on how we create those drought-tolerant corn hybrids specifically for Africa. The reason we picked Africa and this opportunity is that everybody appreciates the important role that rice plays in the Asian diet. Well, corn plays that same role in central Africa. It’s the porridge, it’s both the human and animal feed source. What we’ve been able to do is breed with WEMA, create especially drought-resistant hybrids. We’ve launched seventeen hybrids this year and we have doubled the typical yields that are available. It’s just a nice example of private-public partnership. One of the points I’ll make is that these challenges are big. This was a seven-year collaboration. We’ve created the largest corn-breeding program in Africa together with WEMA to address this challenge. It’s the kind of thing we can do for all of the crops that I think are relevant for local production.

Last thing I’ll talk about as an example is an advance in herbicide tolerance. I know herbicide tolerance isn’t real popular with a lot of folks. Let me just give the other side of the story. When I was a kid and I would come home from school in the fall. I’d get off the school bus, I’d get on my dad’s tractor and we’d plow all of our fields because that’s the way that we controlled weeds. It looked really good. We had great black dirt in central Illinois and then, when the wind came by, the dust blew off the field. When it rained, we would see erosion. We were using a lot of energy running that tractor up and down that field; used a lot of greenhouse gasses. Today farmers can spray with a chemical, control their weeds -- we’ve made the Roundup Ready® technology available. It’s lowered overall pesticide use and most importantly it has dramatically promoted conservation tillage. If you go back and you look at how many acres in the US were under conservation tillage programs before biotech crops and look at today, we have doubled the footprint of conservation tillage in the United States. That’s been a very, very good thing for the environment.

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Yet we know there’ve been challenges. We’ve seen weeds become resistant to Roundup. We know that the long-term success is going to be built on using multiple products and multiple modes of action and that’s what we’re doing. So it’s exciting. In just the last two weeks we got the first approval from the USDA for our Roundup Ready® Xtend system where we will bring the benefits of both Roundup and Dicamba together on the farm for growers to get the benefit of two modes of action, which will give them better and more durable weed control. It’s a very exciting example of a company-university partnership because this gene was discovered by Professor Don Weeks at the University of Nebraska. It’s a great example of working closely with the university to bring an innovation into the marketplace that will help farmers. Incidentally, I will show you examples here of the technology in soybean and cotton which will be our first product launches, but this is a prime technology to be introduced into wheat and other crops to provide those multiple modes of action. Of course for those of you who are really into it, you know the importance of designing new formulations with lower volatility, giving farmers better tools in terms of the spray technology and the nozzles that they use. It absolutely can bring a tremendous product to farmers to benefit them. So those are the kind of established areas -- advances in breeding and biotechnology in some of the new chemistry work.

Let me talk to you about some of the breakthrough areas that I find really fascinating. I had a chance today to meet with some of the faculty who are specialists in soil health. I think this area offers incredible promise for the future. If you think about it, everything I’ve talked about today has largely been above ground. It’s been the genetics of the seed, it’s been the traits that we can introduce into the seed. The opportunity to use a lot of these advanced tools to understand soil in a way that’s never been possible before is for me going to be a fundamental breakthrough.

If you think about a teaspoon or a tablespoon of dirt, it can have millions if not billions of microbes. I got my official PhD as a microbiologist and I can tell you I would still be growing off one colony at a time if we were going to do this the old fashioned way. But the advancement in the DNA sequencing tools literally lets us extract the DNA from that teaspoon of soil, do the sequencing, deconvolute the genomes, and print out tens of thousands of microbes and really create an incredible footprint of what’s going on, not only in an individual field, but in those ten meter by ten meter grids. Having that information lets us both discover new patterns and to be able to identify microbes that can be very beneficial. I think this is exciting.

In many ways the human health field is ahead of us. One of the hottest areas of medical research today is understanding how the microbes that are on us or in us influence our state of health. This may sound a little bit disgusting, but just to give you the magnitude: if you think of all your brain cells, your bone cells, and your blood cells, imagine that you have ten times more bacteria living on you than in you. We’re more microbe than we are people. Keep that perspective and that’s what we’re doing. So there’s a great deal of interest in understanding the relationship between the microbes that we ingest or the microbes on our skin and human health in lots of examples. We’re trying to do the same thing. We’re trying to create probiotics that we can coat that seed with, which can either enhance the uptake of nutrients or can provide for
defenses against insects, nematodes, and other challenges in the soil. The science is letting us tap into this.

I think the other area that plays well into this are the precision ag tools. We can think as we map fields and we understand different compositions of soil, different needs for different plant populations, the ability to decide which microbe, how much microbes, to be able to use multiple microbes in a field are possible. So we’ve had a lot of excitement in this area. Again we’ve taken the approach of partnership. We’ve partnered with a Danish company called Novozymes and we did our first extensive yield test this year. Basically we were able to see a couple of bushel yield advantages in soybean, which is very significant, and four bushel advantages in corn with the best of the microbial strains. Early days, but for me it’s an area that’s going to go through explosive growth and will become an important part of our soil health profile. Importantly, the ability to interconnect the crop, the soil conditions, the microbe, the trait packages, the seed treatments in an integrated way that give growers the best approach to mitigating the challenges they face.

The last area I’ll focus on is the incredible advances that are coming from data science or precision agriculture. We are literally right now living through the computerization of the farm. I think about it this way: agriculture is the last major industry to be digitized. We’ve already seen the transformation of the worldwide entertainment and communication industries as a result of data science. We’ve seen other industries -- many of our manufacturing industries -- agriculture is the last great opportunity. Let me put it into perspective this way: the average new car has about four thousand sensors in it that tell you everything from are you over the yellow line to all of your gauges and all of your recommendations and when to shift and when not to and all of those things -- you’re familiar with that. We’re just a few years away when we’re going to start to see thousands of sensors in our tractors, in our planting equipment, in our harvesting, in our cultivation equipment, that will give farmers real-time information on compression, moisture levels, nutrient levels, and build that into the analytics.

Here’s the most important part: you see that guy up there on the upper right-hand side? He’s probably not a big Kansas farmer. But what does he have? He has a cell phone. This is what’s transformational and it plays the same way. You can give a farmer better seed and it can make a difference. A cell phone to a smallholder -- in this case in India, but I’ve seen the same thing in Africa -- becomes the tool by which they can aggregate and discover markets. The first fundamental question after I harvest a crop is do I take it to this village or that village? If I work with three or four other farmers, can I take more product and get a better price? Market discovery via cell phone.

Second thing: what’s one of the biggest tragedies that limit farming and smallholders? It’s the loan shark, it’s the middleman, it’s the usury laws where they’re borrowing money at twenty, thirty, forty percent. If you have a cell phone you have instant access to credit and microcredit and you cut through all that and you cut out the middleman and you cut out a lot of the stuff that goes on.
Finally -- and this is where we’ve played in the game -- the cell phone can become the delivery mechanism for personalized agronomic information. Today -- believe it or not -- we are reaching three million smallholders in India via text messaging on a cell phone that’s giving them weather advice, it’s letting them know that the wind currents have changed, the moths will be flying in and will be laying their eggs, the eggs will hatch and the caterpillars need to be mitigated over the next six days. That kind of information is game-changing and, in many ways, it’s just like the better seed. A smallholder who can’t even read and write -- these tools can become so logical that they can use this information and make their decisions. Today we’re seeing about seven out of every ten smallholders in India have access to a cell phone. In Africa it’s less but it’s going to move very, very quickly so that’s an exciting area.

We’ve gotten into this space originally to help plant our seeds smarter and better but basically, if you think about a farming cycle, a farmer intuitively makes about fifty decisions to grow a crop. Right now they’ve harvested their crops, they’re sitting around making decisions. Which fields should I fertilize? Which crops should go in which field? If I’m a farmer and I’m farming five thousand acres I might be farming twenty or thirty or forty or fifty fields, the first question will be this spring which fields are workable? Which fields if I statistically plant first will give me the highest yields? In that field, what populations should I plant and then all the other questions on adding supplementary nutrition, mitigating disease or insects -- each one of those decisions now can now be taken based on a digitized analysis of how that field has performed in the past, what it means with the specific genetics that are used, and importantly with a lot greater insight into soil health and into moisture and the weather outlook.

This is an example. This is a farmer who farms in central Illinois, farms about thirty fields. The first question they always ask in the morning is where did it rain, how much rain, and where do I go? And in the old days you’d send your hired man or you’d start calling up your neighbors or send your dad out. Today the ability to map moisture is more accurate than a rain gauge. And doing it from a very sophisticated intercept of the Doppler radar. That’s an area that we’re looking at. This year we’ll launch another tool called our Nitrogen Advisor where we’ve been able to look at nitrogen levels that are applied, look at the precipitative processes, whether it’s rainfall, moisture, weather events, or denitrification and come up with models that help farmers make better decisions on whether it’s economical to do more, whether they should add supplemental nutrition. So those are the kind of tools that I think are going to be exciting, that are going to be transformative, that bring the advances in biology and information technology together.

Last point I want to make and this is so critical and I’ve tried to emphasize it several times is that nobody can do this by themselves. Partnerships, whether it’s on discovery, whether it’s on development, whether it’s delivering technologies to the marketplace, are incredible. We had a chance today to meet with faculty, talk to a lot of folks. We had the chance to tour the Wheat Innovation Center and see what wheat growers have funded in terms of bringing new innovation into Kansas for Kansas farmers. We enjoy a long relationship with Kansas State, particularly in the wheat breeding area, but also in other areas around pest control that are very important. And I think, as we look into the future, one of the ways we all address the challenges of tackling
both big problems and doing it with a finite amount of resources is by doing it together. I think public-private partnership is absolutely a key and I see a lot of exciting opportunities to work together and I hope we follow that up here.

In many ways, one of the interesting stories I’ll tell you, kind of brings this all together. I consider Norman Borlaug one of my mentors. I had a chance to know him the last twenty years of his life. We worked together on projects, on technology transfer to developing countries. I visited Norm at his home in Dallas about a month before he passed away. He was pretty weak and a frail guy in the corner by the fireplace. We got to his room -- I was there with a couple other folks and we went down to say our goodbyes. We started talking about the science. We started talking about DroughtGard®, we started talking about the new breeding technologies and he starts perking up. The next thing I know, he’s standing up and he’s lecturing us as only Norm could do on what we needed to do. Then he got a tear in his eye. I said “What’s the matter, Norm? Did we say something?” He goes, “No, it’s just that I realize I’m not going to see all this stuff happen.” Importantly, what he said was “What I’m worried about is, who’s going to take it to the next level?” His request was how do we fund more wheat and rice breeders.

Another point of collaboration with Kansas State is the work that we’ve done to support the combination of Beachell-Borlaug scholars. As you know, Professor (Henry) Beachell got his training here, has been an instrumental rice breeder. Between Norm and Professor Beachell, they did tremendous things to help smallholders around the world. So we agreed to fund fellowships and scholarships. I think we’re now up to seventy-five PhDs that have been trained in wheat and rice breeding and I’d just like to acknowledge that there’s four of them who have an affiliation here with Kansas State. I think three of them are here -- are you guys all here? I know I’m not going to embarrass you and ask you to stand up. So thank you so much. It’s really an important partnership, one that I’m really proud of and it is still a very emotional one because, as I said, Norm was a special person in my life.

I’m going to close and I’m going to make one last point. I told you I’d share with you my dream and what I think is possible. The challenge of food security is an enormous one. I’m not going to tell you that the answer is going to be all new genes and all new seeds. I actually like what the National Geographic did this last year when they outlined how we feed nine billion people. They talked about clearly the need for sustainable intensification and improving yields. They talked about being more efficient, particularly with water use and nutrients, but also clearly we have an enormous opportunity to reduce waste, whether it’s waste that’s lost on the farm, in storage or transportation, or frankly in the kitchen. So that’s huge. We can all do a better job in our diets in terms of our calories and how we consume those calories. So it’s going to take all of these areas working together but the role of innovation to drive sustainable yield is super important. If you look at the right-hand side, the blue line is world population and the dotted lines are what’s happening in the future. The solid lines are where we’ve been.

You can see, as we’ve talked about, 9.5 billion people by 2050 -- just thirty-five years from now. You can see that as we increase education, particularly education with women and women’s health, you see that population flatten everywhere in the world and we will level out on a world
population. The other important thing is food production and you can see the red line. That’s what we need to do, to double the food supply. You can see it’s a huge challenge and I don’t make light of it. But the important thing to recognize is that green line. That’s the amount of world land that is actually farmed around the world to meet the food security needs. You can see it has already started to taper off. To feed the last two billion people who joined the planet only required about an additional 100 million acres of farmland.

As we increase and intensify sustainably, our ability to grow crops in the Americas, to be able to dramatically increase yields in other world areas, I believe that we can not only achieve food security, but that we can actually start to lessen agriculture and farming’s footprint around the planet. For you farmers I want you to be clear, I’m not saying to sell your farms, because I think we are great producers and we will be in the game and will be the breadbasket for a very, very long time. But there are clearly going to create an opportunity where we think about which lands should be taken out of farming, which ones would be better used if we reforested, which ones would be better served for the public as wetlands or sinks to fix CO₂.

So my goal and what excites me is a world where we’re smart about our innovation, we look at all the other opportunities to advance food security, but we take the bold step forward and we rely on science and technology to address what I think is the world’s greatest challenge. And I think we can do it.

Thank you so much for your time this evening.