

# Bayer AG Capital Markets Day

## Crop Science Sessions

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### Advancing the Digital Transformation

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Good morning. My name's Mike Stern and I lead the climate corporation and digital farming for Bayer. I'm really excited to be here today and give you an overview of how our digital tools and digital agriculture I believe, will shape the future of how we farm. The video was a great overview of our FieldView platform and the entry into how we bring growers into the digital ag ecosystem we're creating. Today, I'm going to talk to you a little bit more about our strategy, our unique capabilities, our product offerings and how we are creating value for farmers and for Bayer.

So, I often get the question, 'What is the opportunity associated with digital agriculture, digital farming. I'd like to frame it in with information on this slide. On the left-hand side is a digitised yield map of a field in central Illinois displayed through field view. The red parts of this field are bad. The green parts of this field are good. The difference between the red and the green in this particular field is over 75 bushels an acre. That's variability that growers see in every one of their fields every time they drive their combine across their acres. And they're asking us, 'How can we help them manage this variability to improve their yields and productivity, help them manage risk on their farm and farm more sustainably and generally simplify their operation. We know that there's many variables associated with what's causing the green versus the red. We like to simplify that very complicated system into a yield equation that says yield is a function of the genetics in the field, the environment that the genetics are exposed to and P stands for farmer practice. How does a farmer actually manage that field?

We believe that the use of digital tools to solve that yield equation, data science, data and advanced computational technology that you hear permeating our society like machine learning and AI can help us do a better job of solving that yield equation. So, let me give you an example. If you look at the National Corn Growers' Association yield contest winner. So, how does this work? A grower goes out, buys a bag of seed and they plant it on 10 acres. Okay? And they highly manage that crop. And that crop last year won – the person that won generated 542 bushels an acre on a 10-acre plot, but the national average was about 175 bushels an acre on about 90 million acres. That's the challenge. How do you go ahead and develop tools that allow you to begin to address this variability on millions and millions and millions of acres simultaneously? The good news, by the way, that you can see that genetic component, the G part of this equation is just fine. The genetic capability of the corn plant to produce 540 bushels an acre is there. That's not the limiting factor in this equation.

The limiting factor are all the other components that go into how to manage that genetics in the field. So, that's what I'm going to talk to you about today. That's really the opportunity and this variability exists in every field in every crop globally. It's the nature of agriculture, but we believe

that digital tools can go ahead and begin to address this. So, what are our products and how do we create value?

We believe we can create value in three areas. The first area is in our agronomic services. That is our FieldView Plus and Drive products. The entry point into the digital ag ecosystem we're creating called FieldView. These are tools, and you saw them in the video, essentially, that allow the grower to digitise the activities in the field begin to organise their data, visualise this data, begin to tabulate and understand performance of products and understand some cause and effect around the decisions that they make. We offer that in the U.S. and it's a thousand-dollar annual subscription and the FieldView drive, which is a key element which allows us to digitise these acres, is \$300.

I'll talk to you a little bit more about the Drive in a moment. But the next layer of value creation is can we move from enabling them to tabulate and observe, to how can we actually recommend products for them. Those are two offerings I'm going to talk about their example in the slide. One is the advanced seed script. A seed script is a map – a digital map of how a grower should plant corn at different densities in a field that is driven by the field characteristics. We can write that script in the United States today on more than 2,000 hybrids in any field and we charge a dollar an acre for that. The next level of value, though, that we can create is in our new seed placement advisor. And this is new and I'll talk to – about that in more detail. But what this is, this is saying, 'let's look specifically at Bayer genetics, the genetics that are in our products' and, 'Can we develop algorithms that will allow us to do a better job of placing those genetics in their field to drive yield.

The second way we're creating value is through our platform partnership approach. Several years ago, we made a decision that we were going to open up our infrastructure through APIs to allow other partners – and we have more than 50 in the industry right now – connect to FieldView. The reason for that is there's going to be a lot of innovation going on. We're not going to be the only innovator in digital agriculture. In fact, there's been billions of dollars invested in a whole bunch of different countries out there trying to develop innovation in agriculture. Our platform approach allows us to connect these companies to a bunch of progressive farmers that sit on our FieldView platform and it's the largest platform in the world. Everybody wins in this scenario, so these companies that are innovators have a mechanism now to access growers who exist on FieldView, to actually offer their services to them. The growers win because now they can go to a single spot, FieldView, and access a bunch of digital innovation. And all the data and information that might be generated by our partners sits in their FieldView account so they can see it. And it sits, by the way, in our data science warehouse, which I'll talk to you a little bit more about. And we benefit because we will go ahead and have a value share of any product and service sold through our platform to a customer. But even more importantly, what we're doing is we're helping the industry to recognise that FieldView is the digital ag platform and is the place to access in a single spot digital innovation in the industry.

The third way we can create value as we've developed our products, we're learning about this, and I'm going to show you specific examples is what we call 'enterprise benefit'. That's really how we're seeing that the use of FieldView and the development of the algorithms, if we turn them internally and use them internally in our seed production and our supply, our breeding and understand how growers interact with this product – our FieldView product, we're beginning to see how it's driving sales of our products in the field. So, I'll show you some examples of that. So, three ways to create value as we see it today. So, the value we're creating is supported by the growth of our platform. So, we launched FieldView in late 2015 and between 2015 and 2018 we've seen that grow from about five million paid acres to 60 million paid acres and we plan on being on 90 million paid acres next year globally. We're offering our services now in North

America, in South America and in Europe. Mind you – most of our acres right now are in the United States, but we're seeing great growth in these other regions as well.

Let me give you a little sense of this. 60 million acres in the U.S. is about 40/45% of all the corn, soy and cotton acres that are planted are on the FieldView platform. The other way to look at our leadership in the industry is from our brand health indicators here. So, we've gone out and we could ask growers what brands they recognise, what brands are the leading brands in digital agriculture and in this awareness funnel– and we did this in May of 2018, every category of FieldView is the leading brand. So, the take-home point here is that we have brand recognition far beyond even our key competitors of Corteva, BASF, ChemChina and a whole vast slew of venture capital backed start-ups.

Let me talk to you a little bit about FieldView Drive. FieldView Drive is a device that's shown here. It looks big on the screen. It's actually about that big. We call it 'the puck'. It's very small. It's a very simple device. It plugs into the diagnostic port of a tractor, planter or a sprayer – fertiliser spreader or a harvester and in a simple way it allows a grower to digitise all the activities in their field. So geospatially tracking all the activities that are going on. The yield map that I showed you was created through FieldView Drive and driving that combine across a field. This is as easy as going into your car with your cell phone and connecting through Bluetooth to your car. That's the simplicity and that's what growers tell us they love about this is the simplicity.

This is a map of a single day of harvest in North America on October 18 that we tracked this at our operations centre, this is an example of more than 10,000 combines harvesting simultaneously in North America streaming data directly into the grower's account and directly into our FieldView cloud. Now, we have a lot of data on our products, but we also have a lot of data on other people's products. In fact, the bottom line here is that we have more real-time data on the performance of our competitors' products than they do. And that's going to allow us to go ahead in the future and create recommendations around their products as well.

Let's talk about our data infrastructure. FieldView Drive data and that grower data is incredibly important. That 60 million acres is a very unique dataset that nobody else has. But we couple that data with an enormous amount of data generated – proprietary data generated in Bayer, both Bayer and historic – Legacy Monsanto. All the information around the development of all of our products now sit in this data set. We have research farms and Climate users to generate data and we have an enormous amount of environmental data that's publicly available. The key here is that data is the new currency. Data will be the currency in digital agriculture and we have the largest, the most diverse and the most unique dataset in the industry and it's growing every year.

Now, where does all this data go? This data goes into a proprietary data science warehouse that we've built that allows us to take all of this data and geospatially reference it around a field – a grower's field. And it can be millions of fields. This is a scalable infrastructure, so all of these data layers represent a different variable. It could be soil type. It could be elevation. It could be drainage. It could be what corn hybrid or soybean variety I plant, what's the density of that plant, where I planted it in that field? How did I fertilise that field? Was it a variable rate or not? Was it a static rate? How did I apply crop protection chemistry?

We think there's over 200 data layers that we're creating that are associated with this. Now, this data allows us - and the infrastructure allowed us – to then to go and accelerate our ability to develop algorithms through our machine learning and AI capabilities that create value for growers. We are simply getting faster and smarter as we gather more data. So, this is a little slide. The slide kind of shows you our strategy and I call it the virtuous data cycle slide. So, growers enter into our system through FieldView Plus and Drive. It's the entry point. They gather their data. They organise it. They digitise it. They can tabulate it. They can begin to compare and benchmark it.

They can begin to understand cause and effect and they can see product performance. The next level is our ability now to utilise this data with many other data sources to begin to develop recommendations and be able to prescribe solutions and diagnose issues on their field. This creates value for the grower, right? Creates stickiness to our platform and they go ahead next year begin the planting cycle where we gather more data.

The next few slides I'm going to give you specific examples of how we are creating value with this data for both the farmer and for Bayer Crop Science. So, one of the things that FieldView does, and FieldView Plus does is it allows growers to understand product performance. Now, Bob Reiter told you that on average Bayer seed products are the best in the industry. Right? But growers actually don't care at all about averages. They actually care about what is happening on their field. FieldView uniquely allows them to go ahead and do that. Right? It allows them to look at product performance and so we ask the question – and this is the first time we had the dataset to be able to do it – we asked the question, 'Since we have the best products in the marketplace, does FieldView allow discovery of that product performance? 'Does Fieldview use actually drive purchase of our products as a way to create enterprise value?'. So, again, the first time we had this data was in 2016 – was really at the end of 2017 going into 2018. What we did was we compared purchase behaviours on a farm between 16 and 17 for an engaged FieldView user.

Now, I want you to look at – this is 4,000 growers here and this is 3,500. This is not market research. This is actual behaviours that we can see in FieldView, right? And what we found is that growers using FieldView purchasing our products we saw in both corn and soy from 16 to 17 about a five percent increase in the share of their farm that they allocated to our products. Now, more importantly, what's the reason for that?

Well, the reason for that is they're seeing the performance on their farm are the best performing products in the marketplace. It's exposing performance to them. We also found that we were able to look at retention and we saw retention of those customers year over year increase about – between three and five percent depending on the crop. And we know that it's much more expensive to go ahead and reacquire a customer than it is to retain a customer. So, this is just one example of how growers are utilising FieldView and we see it driving our enterprise value. Now, we didn't get into this business thinking that was what some of the value was going to be. But the fact of the matter is we're seeing that. We're seeing how growers are utilising this tool to do a better job of understanding the performance of their products on their farm.

So, let's move now from tabulating and comparing and understanding performance to how do we think about recommending specific elements of how to improve a grower's operation. Farmers make many decisions over the year, but they will tell you that few are as important as a seed purchase decision that they make. They're really interested in knowing, 'What products should I buy? How many of them should I buy? How should I place them in my field? What density should I plant them in my field?'. These are all very, very critical questions and we asked ourselves, 'Could we develop an advisor based on data that would inform growers how to go ahead and make this decision to drive yield on their farm. So, now, many of you who've known us for many years knows we've been trying to develop the product for a long time. But only now do we have the right type of data, the right quantity of data and the computational infrastructure that we can actually go ahead and create a valuable algorithm that we can bring to market.

So, what is that? So, within Bayer, let me explain to you the seed placement advisor. If you take Bayer seed genetics and this is about our genetics. It could be our licensees' genetics, that we license. So, in any county in the United States in the corn belt, there could be 20, 30, 35 different products that are offered to a grower with our genetics. The question is, which product performs

best on which field and how can we use data to begin to help inform the grower in that decision and of course create value for them.

So, what do we do? I told you that we had an enormous dataset provided by historic elements of developing these products and so we took over five years of our R&D data to develop all these genetics. Millions of data points from yield, thousands of fields, 53,000. Thousands and thousands of hybrids. And four and a half million acres of FieldView data where we can go in and see actually how growers – how these hybrids performed in fields in the Midwest. And we brought all of this data together in our data science warehouse and we trained an algorithm. We trained an algorithm to help us see if we could predict what the best hybrid would be for a field. Now in 2016, we trained this algorithm. It was the first time we could do this. All this is done on our computer and our computer, using FieldView data, we brought it together – brought it all together and we decided, ‘Look, it looks like we can win 80% of the time and create three to four bushels an acre. So, in 2016 we took that algorithm and we took it to the field in 2017 and we worked with one grower in central Illinois. We worked with him on 1500 acres and we simply said, ‘Look, let’s compare the choices that our algorithm would make to the choices you and your trusted advisor would make. And he said, ‘Fine’ and what we did is we did side-by-side split planter trials on 1,500 acres on their farm, okay? So, it’s as good a data set as you can get with split planter trials.

And it turns out that our selections won 77% of the time at about six bushels an acre. That was a good start. So, while we were running this trial, we went ahead and we had another year of development data, right? Remember a lot of this is driven by our own internal market development data of our products. But we had another year. So, we went and brought that dataset in and began to retrain the algorithm. It’s a learning algorithm. So, we retrained it. This new, retrained algorithm, with another year of data suggested that we would go ahead in this selection process and win about 90% of the time. So, we took that algorithm to the field. This year, we expanded it. We worked with about 20 growers on about 4,500 acres. The same question: ‘Could we use this algorithm to pick the best hybrid to put in their field out of the 20 or 30 they had to choose from and compare it to what they would have picked or their trusted advisor would have picked?’. We have virtually all of the results in. Not complete, but these are the results we have to date. We’re winning about 90% of the time. We’re creating about 10 bushels an acre advantage so this for me is a breakthrough. This is an example of how data and the right type of data and the right type of data and the right infrastructure can begin to create value around this critical point for the farmer.

Now, we’re developing this for soy, right now, in 2020 and in 2019 we’re taking this algorithm to field right now. We’re expanding it even further. We’re working with about 50 retailers and three states, about 200 farmers to go ahead and expand the trial one more time. And our plan is to actually go and launch this product in the 2019 selling season, a year from now, to be planted in 2020. Now, think about this. So, let’s talk about enterprise value with this algorithm. So, this algorithm now is going to allow us to work with a grower to figure out what hybrid is the best hybrid to plant in which field. Now, imagine if we had turned that internally because we’re a seed company and one of the biggest things we have to deal with every year is, ‘What seed do we produce?’, ‘How much of it should we produce?’ and ‘Where should we produce it?’.

This algorithm can tell us that. It will tell us, in the future, what we’re going to sell to a customer. Now, we have billions of dollars associated with seed production costs every year and we believe that turning the seed placement advisor internally, using it internally to understand these variables, ‘What should we produce?’, ‘How much of it should we produce?’ and where we should produce it. It’s going to be a real opportunity for us to drive efficiency in our supply chain, another example of enterprise value.

So, we talked a little bit about the seed selection process and our new algorithm there that we're really excited about. Another decision our grower needs to make is around fungicide applications and disease. Typically, a grower wants to know, 'Do I have a disease?', 'What field is it in?', 'How pervasive is it?', 'Can I get information in time to do anything about it?'

That's really the question. The problem is, is that typically today the way a grower would figure that out is to scout their field. In the U.S., a typical farmer has 30 or 40 fields, so it's really not practical to be able to do that. It's really not that practical to be able to scout one or two fields. But we believe now, with digital tools, that we're developing algorithms now using satellite imagery and also going back to the genetics. So, again the genetic components of disease vulnerability associated with a corn hybrid or a soybean variety, we're building all of that into an algorithm that we believe will allow us to help predict the probabilities of disease development in a field for a grower. So, this is the components of our product. The first thing is a risk ranking dashboard. So, it's taking all this information, again training an algorithm around it. And this simply is going to say, 'Okay, if I am a grower and I have 30 fields, show me the two, three or four fields that have the highest vulnerability'. Right? So, immediately we've taken their decision set down to a handful of fields versus 30. The next component here is we can now go to a sub-field level. Remember, we have all this data on fields, right? At a sub-field level, all decided by their field boundaries.

We can take this now modelling down to a sub-field level and say, 'Which zone in a field actually is more susceptible or might even have a disease?'. So, now we've taken this decision tree from, 'I've got 30 fields. I've got four I can look at and within those four I can drill down, 'Of those four, these are the regions in the field that I have to be concerned about. I can take my smartphone and my tablet. I can use GPS'. This is GPS aligned and I can use that GPS tool on the phone to actually scout directly to that spot in the field, right?

And now, we've developed a computer imaging tool algorithm that allows you to go ahead and look at the disease actually on the leaf and it will identify that disease for you immediately. So, now, you've taken this very complicated problem of 30 fields, 'How do I understand what to do?' right? Now, we've taken this down to, 'I can find the field. I can find the zone in the field. I can use a simple tool to go to that zone and I identify the disease and now I can work with my trusted advisor to come up with a plan to address those issues in real time'.

Now, again, think about this. This is another example because we're developing these algorithms, the more data we get, the more pictures of diseases we get, the more understanding we have on vulnerability in a field by the genetics of the variety or hybrid. That's just more information that comes back into our data science warehouse to retrain the algorithms that get smarter for each field. So, if we learn more about how our products behave, we can begin to think about different business models that we can employ for a grower to help them manage risk in their field. So, one example of this is about fungicides in the U.S. and so on the right-hand side this is internal data of the response of DEKALB genetics to fungicide applications. So, everything above this line is a positive response. If you look there, about 80% of the time, if you apply a fungicide, you'll see a positive response – yield response. But, what's even more interesting is about 50% of the time you're going to see a yield response of about eight bushels an acre, yet in the United States, only about 15 to 20% of the acres are sprayed any year in corn. So, the question is why is that?

Well, the reason for that is that you have to make an investment up front in order to invest in the fungicide and its application without any real certainty about what the outcomes would be. So, if we asked the question, 'If we could develop a business model that would be based on performance and where we could begin to work with and partner with growers, would they be interested – would they actually go ahead and purchase more product?'. So, we went to the market and we asked

them. That's what's on the left-hand side. This is market research. We simply asked them, 'If we went and helped manage risk with you through an outcome-based pricing model, would you buy more fungicide product?' and 75% of them said yes. What was even more interesting we asked them, 'Well, would you go ahead and switch brands to the company that would provide you this outcome-based pricing model? Would you buy their brand preferably?' and 50 percent of them said, 'Yeah, I would do that'.

So, clearly, there's appetite in the market place for us in finding a way to go help growers manage this risk. In the U.S. alone, if you could just go ahead and take – if you could just go double the acres from 20% to 40%, in the U.S. of fungicide spraying in any season, that's about a \$250 million opportunity. So, what's it going to take to operationalise this business model? First of all, it's going to take an automated mechanism that it will allow you to actually set up a trial in a field with millions of acres. To be able to set up a control and a treatment element in the field. You need to have an automated system that's going to allow the grower to easily execute that trial. Because they're not going to take a whole bunch of time fiddling around with stuff, it needs to be automated. You need a system that will allow you to actually determine the outcome of the trial on millions of acres and you need a system that can help settle and administer the programme that you would run through a retail partner.

FieldView and the FieldView platform is absolutely uniquely capable of enabling all of these capabilities. Let me tell you what we did. We went out and we made this offer to a handful of growers this year. Small, about 20 growers. We said, 'Look buy fungicide from us and if you don't get a certain yield response in your field, we'll go ahead and refund the cost of the fungicide in the application to you. Now, our retail partners are doing this for us so one of them said to me this was the easiest sale they ever made. How do we go ahead and do this? This is what's shown on the left-hand side. This is a screen within FieldView and it shows you the capabilities that allow – would allow us uniquely to go ahead and operate this model. So, first of all this is a digitised spray map of the field. Here is the field, the field outlined. And this blue box is the area in the field where we designed the trial such that the grower would turn off the sprayer. So, there's no fungicide applied in that strip yet the rest of the field where it's green the fungicide was applied. So, we've set up the control and the treatment element in the field.

Now, later on in the fall, here is the yield. Here is the yield map. Again, it's a digitised yield map, geospatially referenced to that field and you can see where the blue box is again. That's the same area in the field where we didn't apply the fungicide. If you look real close, you're going to see a whole bunch of red in there, which is bad. What this allows us to do is we can go compare the control to the treated area and we can look at whether or not that treatment actually brought value to the grower. That is the example of an outcome-based pricing model. We're really excited about this. We don't have all the data in yet, but our preliminary results on this show that it's very, very promising and that the treatment of fungicide in corn is a good bet. Growers are seeing value and it's not surprising because we've had the data for years. I would suggest that on average you're going to see a positive response. There just wasn't a mechanism to go ahead really and be able to get growers to help them manage their risk on that application. So, coupling these business models with our tools and our capabilities within Bayer I am absolutely convinced is an opportunity for us to completely change the way products are sold in agriculture and Bayer Crop Science is the most enabled company to do this.

So, let's bring it all together. We talked a lot about tailored solutions and – so here's an example of a tailored solution that is based off our FieldView capabilities. Just one example. So, we can go work with a grower, around our seed advisor we can help them pick the best genetics to place in their field and we can give them a variable rate seed planting prescription on how to plant that hybrid in their field. We can then work with them through our tools to help them monitor whether

or not there's a disease progression in their field, and in which field it might be happening. And then we can go to them and say, 'You've got a disease in your field. Let's work together. We're going to share some risk and do an outcome-based pricing model with you that will allow us to work with you and partner as you go ahead and treat that field with a fungicide.

This is just one example. I am absolutely convinced there's going to be many, many more. This is really early days. As we work with farmers and our retail partners and as our capabilities begin to increase, we're going to find many different examples of how we can begin to tailor a solution specifically to a field to help them address that variability that I showed you early on and drive value through yield increases, productivity increases, help them manage risk on their farm, farm more sustainably. Farmers understand the promise of digital agriculture, but they're looking for companies to partner with and they're looking for someone who can bring them a simple, integrated system that allows them to use digital tools on their farm to drive value. Bayer Crop Science is that partner and FieldView is that unique system.

So, we are planning to be on 90 million acres. That's just the beginning in our opinion and if you look at our key crops of corn, soy, wheat and then the geographies we already exist in there's over a billion acres of opportunity. We're widening the gap with our capabilities compared to our competitors. There's no doubt about that. Our data science – and this is driven by our data science capabilities, our infrastructures, our ability to use machine learning and AI tools. We have a broad industry partnership model that will allow us to bring innovation to growers from other inventors, but bringing it all through FieldView, so condensing everyone into FieldView and have them understand this is the platform for digital agriculture and capabilities. And I'm even more excited about what we have coming in our pipeline. Liam showed you that slide and we're going to further improve FieldView going forwards in our offerings.

This reminds me a lot of where we were 20, 25 years ago with biotech. But the changes that we're going to see with digital agriculture are going to happen faster and they're going to be more profound. So, these are the key takeaways. I hope I've left you with a better understanding of our capabilities, our strategy, our products, how we're going to work with growers and how we're going to use digital agriculture and our tools, coupled with our broad product portfolio to be able to go and shape the future of agriculture. I'm very excited about this future. Thank you very, very much and I look forward to your questions.

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