J. Kjaer: Hello, and welcome to WorldCanvass from International Programs at the University of Iowa. I'm Joan Kjaer, we're coming to you from Merge in downtown Iowa City. Thank you for joining us. In this part of the program, we'll be focusing on a joint University of Iowa-Iowa State University research project to provide weather and soil intelligence to Iowa's farmers. Joining me for the conversation are Marty Scholtz, vice president for research at the University of Iowa. Thank you, Marty.

M. Scholtz: Thank you.

J. Kjaer: And next to Marty is Jun Wang, professor in the Department of Chemical and Biochemical Engineering here at the University of Iowa. Thank you for being with us.

J. Wang: Thanks for having me.

J. Kjaer: Absolutely. And at the far end, we're joined by Brian Hornbuckle, professor in the Department of Agronomy at Iowa State University. Thank you for coming. Thank you for making the drive over.

B. Hornbuckle: You're welcome. Happy to be here.

J. Kjaer: Great. Well, Marty, I wanted to go to you first. You're the vice president for research here at our university, and you've come here in the last, what, year? Year and a half?

M. Scholtz: Three months.

J. Kjaer: Three months, three months. I thought it was further back than that. But in any case, could you tell us a little bit about your background before you came here?

M. Scholtz: Sure, sure. I'm a Midwesterner, born and raised in Nebraska. Then went to California to the University of California Berkeley, and then to Stanford as training. And then spent the last 26 years at Texas A&M University as a professor and administrator of sorts. Been here for three months, as I just said.

J. Kjaer: Three months, how about that? So for those of us who don't live in the academic world, what does it mean to be a Research One university?

M. Scholtz: I think a Research One university is the type of university that combines not only, of course, excellent educational opportunities and teaching of the wonderful students that we have here, and teaching them to become proficient in their disciplines and their majors. But it's really the environment and the opportunity for faculty, such as the two sitting next to us here, to come in and have the environment to do their research, their scholarship, their creative activities, in addition to teaching. And it's these experiences and this research

and scholarship that I think really distinguishes our research university from most. And that the faculty do their own scholarship, make discoveries, create things. And at the same time, they can take those ideas, inventions, and then get them immediately into the classroom. So there's this very direct connection between what they do in the laboratory or the studio and what they can convey to their students.

J. Kjaer: Well, we've already had the opportunity to hear from two different groups of very innovative and exciting researchers, and we're going to be hearing from a colleague sitting just next to you here in a moment. From your point of view, what are some of the highlights of the University of Iowa's research profile that you think we should be most proud of?

M. Scholtz: Well, I think this evening's program really highlights a number of very different things. We have some very, very large projects, like the first session with the TRACERS project from NASA, the single largest grant that the university's ever received. And that's a very involved, very large project that has a very defined mission. To things like the last project, where it's a curiosity based project. There is a problem that needs to be solved, and the solution and the path to the solution is not clear, but you have to employ all the tools that you can. So at the university, and that's the great thing about a university, is there's everything to do. We could have 20 hours of talks like this and not even touch upon all the different research and creative activities that are done here.

J. Kjaer: Yeah, yeah. So as the UI's VP for research, you and your colleague in a similar position at Iowa State University have funded a joint research collaboration on Iowa's bioscience priorities. I don't know if everybody knows what bioscience priorities are, but maybe you can give an overview, and then we'll focus in on what Jun and Brian are working on.

M. Scholtz: Sure, sure. So this program started, I think, in 2017, endorsed by Governor Reynolds. She put together a commission to report that showed what Iowa could work on in an economic development sort of thing and if we could have some research behind it. And so the topics that were chosen, which are very broad topics, are vaccines; immunotherapies; precision and digital agriculture, which is what we'll hear about some tonight; medical devices; and bio-based chemicals. So these are things that Iowa has defined as some targets for the state to work on. And as the two research intensive universities in the state, the two VPRs then got together and said, "Well, what we need to do is figure out how to fund some projects in this area." We call them seed grants, to try to bring together some people to really start germinating ideas and seeing if they can work together and bring different expertise together from different fields to try solve or work on some of these problems.

J. Kjaer: Right, right. Which takes us to our other two guests, Jun Wang and Brian Hornbuckle. And Jun, I'll go to you first because you are the lead PI in a project

focused on precision and digital agriculture. Lead us into this. Help us understand what you're trying to do.

J. Wang: Yeah, so basically, the big picture is that the world population has been increasing in the past, and it will continue in the coming couple of decades. So it has been estimated that the world population will grow exponentially, but it will be.....(indistinguishable)...basically by 2050. But if you look in the past, our humankind technology to grow our crops, and that the crop yield efficiency per acre, for example, that has been keep increasing because of our technology. But that increasing trend is very linear. It's never exponential. So you can now see that you've got exponential curve going up quickly in 30 years. But on the other hand, you got that slowly increased trend of the crop yield efficiency. So the RBA cap to meet the demand of the food, because unless we have more to harvest, to invest in agriculture, to make our crop yield efficiency increase dramatically to catch up with the pace of the world population increase. So that's where the agriculture concept comes in.

J. Kjaer: And so precision forecasts and all of that, the idea behind this is that if, through the tools that you guys are going to be working on and the various collaborative methods, it would be possible to give farmers and people who produce food better information on what's happening around them, in climate and weather and so on. So that they have a better sense of when they should plant.

J. Wang: Yeah, yeah. So where I grew up in China, on farms, so from my early childhood, I know how the weather matters. And so in the Midwest here, we had drought, for example, severe drought in 2012. I don't know how many of you in the room actually were here in 2012, but you know that the headlines is everywhere that the crops were dead. But on the other hand, somehow we also have a wet year like this year, it's very wet. So the weathers and the climate change affects the crop yield a lot.

J. Wang: So our idea here is to try to say work... We don't have that many of the piece of land. How can we group our crops on a definite amount of the land more efficiently by not using the one size fits all approach? Meaning that we do the full fertilization all the time. Same amount of fertilization for all the crops, because there are pockets where the crops maybe need more, there are places where the crops may need less. So we try to bring up the 21st century technology to the farmers. That's our big vision, per se. But I think that technology is getting to the point where we have to think about, and I think with time to come, we can actually increase the crop yield very dramatically in that way.

J. Kjaer: Well, so Brian, you're a professor of agronomy, and I suspect that that means that you know a lot about and think a lot about crop yield and how we can best utilize our lands and resources and fertilizers and all these other things. How are you involved in this project? Or what interested you in this particular grant?

B. Hornbuckle: Well, yeah, I'm a professor of agronomy, and it is correct, I think a lot about this, but I don't know as much as I want to. My background is as an electrical engineer. When I was in high school, I really liked math and science, and so I went off the deep end and did electrical engineering. But I also like to learn about the environment, and spent a summer in a national park, and so I wanted to connect to two things. I taught high school for a little bit, and then I wanted to go to graduate school.

B. Hornbuckle: When I went to graduate school, I didn't really know what I wanted to do. But I met somebody at a place I was interviewing, and I told them why I like electrical engineering, especially electromagnetics, studying electricity and magnetism. But I like the environment, but I'm not sure how those things go together. And he goes, "Have you ever heard of remote sensing?" And I said, "What's that?" And he says, "It's using electromagnetics to study the environment." And basically, the best way to explain it is using satellites to study the earth. So these satellites are looking down at Earth and they're measuring things that are coming from the earth. One of those things coming from the earth is electromagnetic radiation. And it turns out this radiation changes depending on what's happening under the surface. Sometimes remote sensing, like the remote sensing that I do, tells us about where liquid water is on Earth's surface, and especially water in soil and in crops. And there's the connection to agronomy.

B. Hornbuckle: So I started thinking about this in graduate school from a technical point of view. Fortunately, got hired by a department of agronomy. And ever since, I've been learning a lot more about that. And I'm a native Iowan, so I have a strong connection to what's going on here. So that's why I'm interested, mainly because I want to see Iowa use its natural resources in the best way that it can. We have the world's best soil, we have a great climate. That climate is going to change some, and we need to understand what we need to do to adapt. And so that's why this kind of a project is really important. We've got to make the best decisions we can. And that's really what science is about, making decisions based on evidence.

J. Kjaer: Wow. Well, so the team is actually larger than you two. You have a number of other collaborators at both institutions, I think. What is the mix of specialties within that group?

J. Wang: Okay. Well, as Marty just point out, we are a very big university, same is the Iowa State. So in the University of Iowa, we have professors from the civil and environmental engineering who look at the weather from the flooding point of view. We have a professor from geography on the team that do UAVs to try to map the soil moisture and the crop yields by flying UAVs. So you can imagine 10 years from now, farmers may fly UAVs to survey their farmland to see where we need to add fertilizer or not.

J. Kjaer: Is a UAV like a drone?

J. Wang: Yeah, like drone, yeah, yeah. Yeah, yeah. So we have that. And we also have people from the Department of Geography and Sustainability look from an environmental protection point of view. If sometimes we add more fertilizer, is not necessarily good. So how do we engage with the community, with the farmers? Especially we have a pretty aged population in the rural area. And finally, we also have researchers from the IHR, who actually try to tear out... Using radar to tear out the precipitation, because we want to estimate how much rain we have today. We also have folks actually in the room from my team, the postdocs and the students that involved in this project, and they actually do the harder work here from different perspective. So that's a nice mixture from the University of Iowa side.

B. Hornbuckle: And I would say there's things happening, at least with this project. Number one is my research on using satellites to tell us about water and soil in vegetation. Another faculty member is developing crop models that we can better understand how they use water and how they use sunlight to produce what we want them to produce, and how we can better understand how that's happening. And then a third piece is that at Iowa State, we have what's called the Iowa Environmental Mesonet. Trivia question, it's the busiest website at Iowa State University, because it archives data from all over the place, weather data from everywhere. It's a treasure trove of information that we hope to use to inform what we're doing, basically. And some of the information is coming from our network of sensors that we have in the state. And Jun did also mentioned that University of Iowa, IIHR, also has some great networks of sensors that have been deployed throughout the landscape. They're telling us about important things. So basically, idea is to get as much as we can out of that information.

J. Kjaer: Yeah. And you mentioned also the community relationship, or the relationship, perhaps, with farmers who could make good use of the information that you have. What kind of outreach is there into the state? Or will there be, perhaps, once you get further along with your project?

J. Wang: So my team is basically trying to improve the weather forecast by using all the observation data available. The weather forecast may be to many, it's kind of a mystery. But to many, it's never accurate. But it's neither of those. So it's based on the size and the equations and such. But in order to predict accurately what's going to happen tomorrow, we need to know what do we have today. If you see from satellite images, you see, oh there are the [inaudible 00:16:21] come in, move to the state where your forecast, where we match that current to know that tomorrow, the temperature will be colder. So we are trying to use solid observations from different venues. We also try to use the radar data from different venues.

J. Wang: But more importantly, we are also developng a smart low cost sensor that is actually funded by the USDA for a $1.6 million grant for next four years. So those things that are major is temperature, regularity, and pressure, all

combined in a very, very small box. And you can put it in your backyard, and you can use it to set up and then link the sensor to your home wifi. And then that sensor will seamlessly transmit the data to Amazon Cloud, and then get to our server right here. So that sensor is actually designed by the Protostudio here, in the same building here.

J. Kjaer: No kidding. Wow.

J. Wang: Right. And the case was built in one of the small towns near Omaha, actually part of Iowa. So everything is built in Iowa for the smart sensor. And so we have the sensors and the data, and now together we try to put the best observation data available. Then we try to assimilate, we call assimilation, we use this observation data. And then based upon the physical equations, we try to predict what weather is going to happen tomorrow. So we have been building apps, and basically deliver this information to the farmers in their fingerprint. They click on what farmland they are interested in, click on them, and then you can look at the next 70 hour forecast, amount of rainfall and such. So that's a way to engage through the apps.

J. Wang: Also through the low cost sensors. Now they can look at, oh, in here your forecast is always two degrees lower compared to what I'm seeing in my backyard. So that's what things we want to know. That way we know where our forecast is not accurate. So in that way, we get that feedback, and then we can correct our forecast next time. So now in the apps that you use, you can complain about their forecast, but there is no way to know your complaints. We have the apps allow you to enter your information there and things like that. So there is one of the things that we try to engage. And certainly, Brian probably can help us to talk more about how the extension goes, because...

J. Kjaer: Yeah, because of the extension service.

B. Hornbuckle: Yeah, so Iowa State's the land grant university, and so we have three missions. To do research, teaching, and extension, which means taking the information we develop out to the public, making it available to everybody, all citizens of the state of Iowa. When we have extension meetings, farmers are always asking about the weather. It's probably the first thing on their mind. There's a lot of work that's been done on what kinds of things we could provide that would help them make better decisions in terms of how they manage their land. So part of the work that we should do with this initial seed grant is make sure that we are aware of those things and ask more questions so that we can keep going further.

J. Kjaer: And when there are major events, you mentioned drought a few years ago, a very wet year like this year, a few years ago we had terrible floods. Would one hope that this process that you're developing would... We can't avoid having these things, but maybe we would have a better sense of when they're going to

be really disastrous for our state. Or are we really looking at day to day weather prediction rather than massive events like a hundred year flood?

B. Hornbuckle: Yeah, I think both are needed. We need forecasts at what we call different spatial scales, which means my field or part of my field, to my county, to my state, to my continent. We need forecasts at different timescales, which would be tomorrow, week, two weeks from now, next season, 10 years from now. Some ways, that's the difference between weather and climate. Climate is what you expect, weather is what you get. So right now, we think that weather forecasting might be limited to about two weeks. But with the same kind of models, we don't need to know the exact details of what happened, we need to know what the average conditions are like in the future, and we can do that.

B. Hornbuckle: All that information can be informative for farmers. They've got to be thinking about it in the spring.... When is the window that I can plant my crop and avoid soil compaction if the soil is too wet? The spring, that window was very small for lots of people and some crops didn't get planted. In the fall, when can I harvest? Same kind of deal. How long can I leave my crops out in the field? So short term forecasts are important for those kinds of things. But if you're thinking about, well, maybe I'm going to start using cover crops on my field, what can I expect in the next five to 10 years? That's also an important thing to know. So we've got our work cut out for us. All scales of time and space are important to know about if we're going to best manage our natural resources here in the state.

J. Kjaer: Yes?

J. Wang: Yeah, I want to share just kind of a... So we we said definite we are focused on the day to day forecast. But also, now even the seasonal forecast, three or four weeks out, it gives you average, the prediction of can you wait or not? That is actually also getting a little bit accurate. I share with you the stories that my lawn, this summer, actually, we had several pockets of grass that were dead. But when I looked to the forecast, I see we're 20% above average in terms of rainfall. So I just plant right away. When data like in the two weeks ago, I bought seed and I planted them. Now they grow happily. My neighbors were so amazed by that. How do you know you don't need to? Because [inaudible 00:22:53] If it's very dry, if you plant a seed, you have to do the wetting it all the time, it's sprinkler all the time, but now you don't have to do it. So how do you know that? I said, "Well, it's just look at the seasonal forecast."

J. Kjaer: Yeah, yeah. Wow. Well, and of course, there has been discussion about the difference between what climate is and what weather is. And you said some minutes ago, as is true around the world, our climate is going to change. Do we expect here in Iowa to have to have warmer temperatures? Do we know anything yet about what we would expect in the next five years or 10 years in terms of planting season and so on?

B. Hornbuckle: Yeah, we're expecting wetter springs, which is not a good thing for planting. We need that recharge of water in the spring to get the soil to where it needs to be to support crops during the summer. But that's a problem when we get too much, and we were expecting that to continue. We were expecting dryer falls, but that's not been true that last two falls, for sure. As a cross country fan, a lot of meets have been canceled because it's been too wet. But really, the big problem is getting crops out of the field. That's really what's the issue there. So we're not quite sure what's going on. If that's a trend or something that's just a blip on the radar.

B. Hornbuckle: But yeah, things will change. It will get hotter. I don't know if you saw the recent climate statement that came out from the University of Iowa State and Drake signed by lots of scientists in the state talking about how we're going to go from less than a month of 90 degree temperatures to basically two months or more of 90 degree temperatures during the summer. That's not good for the types of crops that we plant right now. It's basically going to happen, and so we need to think about adapting now, but also doing things to prevent worse things from happening, essentially.

J. Kjaer: Well, what a wonderful conversation, and really great information from all of you. Brian Hornbuckle and Jun Wang and Marty Scholtz, thank you all for joining us this afternoon. Really appreciate it.

J. Kjaer: And to the audience, I hope that you can join us for the next WorldCanvass on November 21st at a new time and place for this next program. It'll be at 7:00 PM at the University of Iowa Voxman Music Building, and we'll have an intimate conversation with acclaimed opera singer and philanthropists Simon Estes. He'll be the winner of the UIs International Impact Award, and we'll talk about his life in music and his role in breaking the color barrier in the world of opera. So I hope you can join us for that event. WorldCanvass programming is available on iTunes, the Public Radio Exchange, and the International Programs Website. I'm Joan Kjaer for UI International Programs. Thank you so much for joining us. Good night.

J. Wang: Thank you.