Climate Webinar November, 2014

Jill: Hi everyone and thank you all for standing by. Welcome to our November webinar entitled Climate Change and Corn Belt Agriculture in the Midwest. These webinars are an initiative of the Ohio State University Climate Change Outreach team, a multi-departmental effort within the University led by Ohio Sea Grant Office of Research, Ohio Super Computer OSU extension and 8 other OSU departments to help localize the climate change issue for Ohioans and Great Lakes residents. I am Jill Gentis Benicki from Ohio Sea Grant and Stone Laboratory and joining me today is Dr. Richard Moore. Dr. Moore is a professor and Executive Director of the Environmental Sciences Network and the Associate Director of the Office of Energy and the Environment at the Ohio State University. He is on the executive committee for the Council of Environmental Deans and Directors of the National Council for Science and the Environment as well as the lead researcher for Ohio State's part of the USDA $20 million grant, Climate Change and Adaptation in Corn Based Cropping Systems. We also have joining us today Professor Dennis Todey. Dr. Todey is the South Dakota State Climatologist and South Dakota State University extension climate specialist. He is past president of the American Association of State Climatologists and has a background in climatology, meteorology and agriculture meteorology. He is the co-PI on the USDA Corn and Climate Grant. We really appreciate both of you coming on today to talk with us about climate change and agriculture. Before we get started, a few logistical issues. During our presentation all participants will be in a listen only mode. Afterwards I will conduct a question and answer session. If you would like to ask a question during the presentation, please feel free to use the chat feature located on the right hand side of your screen and I will collect and pose your questions out to Dr. Moore at the end of his presentation. We have over a hundred participants so far on this webinar, a great diverse group representing governmental agencies, academia and nonprofit groups from the Great Lakes and around the country. Please keep those questions coming throughout the presentation and we should have a great Q&A session. As a reminder, this webinar is being recorded and will be posted onto our website for later viewing. Also, we will post a webinar survey in our chat feature towards the end of the hour. Please take a few minutes after the webinar to fill out that survey. It will help us continue to bring you better webinars. Without any further delay, I'd like to introduce Dr. Richard Moore from Ohio State University, who will present Climate Change and Corn Belt Agriculture in the Mid-West. Dr. Moore you are unmuted and your presentation is up.

Dr. Moore: Thank you very much. I wanted to thank the OSU Climate Webinar series. Also one of I want to give acknowledgment and thanks to Dennis for helping me out here on the climate part of this. Also some acknowledgments to people that have been working on our large grant. Lois Martin who is the lead PI from Iowa State University and Lori Aventrough who works with her there. Also would like to thank Jerry Hatfield for some of his slides that we'll use. He's the head of the new Midwest Climate, USDA Climate Hub and then also my colleagues at Ohio State that are working on this grant, Warren Dick, Rattan Lal, Chrissy Lakies and also thank Tracy who is with Sponsored Projects. So let's just dive in. So the topics I want to cover today are just a little bit about Corn and then Dennis will talk about Climate Change and also Climate Change and Corn and then he'll hand it back to me and I'll be talking more about the grant and then just a couple comments at the end maybe on Corn and Lake Erie.

For those of you right at the beginning, this is a very large grant, $20 million grant with over a hundred researchers involved in this. Our information is just starting to come out. We're in year 4 of a 5 year grant, which very likely will have a 1 year extension, year 6 to firm up the data base that will be coming out of this, but I thought you'd first like to know there's a special issue of the Journal of Soil and Water Conservation that just came out. You can actually get that online right now. While it's still hot off the press you can download the chapters so it's a great opportunity to get much more data than

I'm giving out today. There's a number of articles, almost the whole issue is from the researchers, including graduate students that are on this grant. The other great source is to look at SustainableCorn.org website, which is the website for this grant and you can download a number of items from that as well.

For some background for people who may not know much about corn, it's a major cereal crop in the United States and world wide if you look at caloric intake, about 75% of the world caloric intake is from corn, rice, soybean and wheat. About 70% of US corn is produced in the 9 Midwest states where we have the PIs, the researchers on this grant.

For those of you from Ohio, you can see that corn and soybeans are about equal in value, you can see the $3 billion dollar number there and these go hand in hand and is a very large crop for Ohio itself. Crops of the Midwest, you can see that there's slightly more corn acreage than soybean acreage, but it's also important to realize that we have a lot of other crops. Wheat, alfalfa, asparagus, cabbage, etc., etc. and why this is important, if you look at the market value of these, it's very substantial, $188 billion. So when you get into that and you consider that and also considering particularly the climate change, how it's affecting the West coast, particularly California, this has a lot of potential for redefining what agriculture will be in the Midwest. Jerry Hatfield in his presentation to us just a couple weeks ago was mentioning about this very fact. So something to keep in mind, that there should be a shift that could occur. Great opportunity for the Midwest, let's put it that way as well.

Corn production is shown here and you can see where Dennis is from, but you can also see where Ohio is as far as the corn that was produced for grain in the year 2012 so this is basically when we say the corn belt, this is what we're talking about. It stretches across the Midwest.

You can see some of the big changes that have occurred in agriculture in regard to corn. If you go all the way back to 1860 and you see the yield in kph, 2.2 pounds is a kilogram and 2.14 I think acres is a [unclear 8:13]. You can see back in 1860 though what the production was and all of a sudden you hit 1940 and then the corn production starts to go up and Midwest soybean production also continues to go up as far as yield fairly constantly. These are fairly important to remember. Quite higher yields have occurred in corn production.

Corn was first domesticated in the valley of Mexico from a plant called teosinte. We're just referring to the high yield increases that occurred. The over ride of corn, like with the Native Americans group in North America was more like 70-80 day corn varieties, where today it's common to have 120 day corn. This is very important with regard to the amount of sunlight that corn receives and this pretty much affects the yield per acre. It also means we have a longer growing season for that corn, which when you consider the increase, Dennis will talk about the increase, in major storm events. This also means that the longer the period, the higher the probability of encountering a rain event.

So this is the teosinte, very small compared to corn which this is the same quarter, very large. So this is the transition that occurred. In the United States we find corn and soybeans is the major strategy. Today we also find no-till soybeans, which actually means minimal till, but not absolutely no till. We can see that this corn and soybean sometimes is a cover crop for maybe something like wheat can be grown in rotation of this. This wasn't always the case. Soybeans became popular in the Midwest in the 1960s in particular.

Today you can see what an aerial view, for instance close to Columbus would look like if you colored the parcels in that were soybeans, which are green and corn, which are golden color here. Much of the

Midwest actually gets more dense as you go west from Ohio, but it would look something like this.

Traditionally we had, when the Native Americans grew corn, they called it the three sisters so they would grow corn, beans and squash together, which formed a complimentary protein. Corn was very important throughout their culture. Many leaders were named after a corn, like Cornstalk, Cornplanter and it also played a prominent role symbolically in their culture and their religion as well.

I'm going to hand it over to Dennis at this point to talk a little bit about climate change and the impact for agriculture.

Dr. Todey: Thank you Richard and I'd also like to echo the thanks that he had early on to members of this overall project and to other folks who are doing climate services, other state climatologists. It's a very interesting topic because as we found, a ton of our work in the project and other associated work, there is some misunderstanding about what is actually happening with climate change and how it's actually impacting agriculture and it is also very interesting that as I was looking through Richard's slides, he showed you the slide with the trend overall in the way of corn and bean production, several slides and you've seen the very clear trend that is happening in the way of corn and soybean. You also saw a lot of variability. That's part of the weather and climate impact that occurs in agriculture. We saw that this year was a very good growing season over all where crops, there was very little stress on crops so yields across the corn belt have been outstanding in contrast to years like 2012 where we had widespread drought throughout the corn belt. We saw large yield reductions and complete crop losses in certain areas so there is still a variability that is impacting what is happening with agriculture.

Our standard issue related to greenhouse gas and what's happening to greenhouse gas is changing part of the background of what is happening in the way of climate change. Those are helping to drive overall changes in temperatures across the globe and of course we are seeing some large changes in temperature across the corn belt, but they're occurring in different ways than people would expect them to. We are seeing overall warming, a chunk of that warming is occurring in winter time warming, but it's also occurring in the way of our high temperatures in many cases are not increasing greatly, but our minimum temperatures, our over night low temperatures are increasing more readily so it's decreasing our day time temperature range and a couple impacts it's having on us is, Richard also talked about the changes in corn grown over time and changes in some of the crops. Part of that has been driven by these warmer temperatures are increasing our frost free season and especially these, these slides are the most recent in the national climate assessment released in the spring and you can see that ranging from the eastern corn belts on average 9 days over the last century and in the plains up to 10 days or in some places even more from the growing season so that's a longer period between average last freeze in the spring and first freeze in the fall. What that does is it allows you to grow a longer variety and a longer variety typically has more productivity so that is changing what is happening in the way of some of the corn varieties that we are changing.

Associated with that along with the warming and probably the even bigger change throughout the corn belt is the precipitation. We've seen an overall increase in precipitation, more precipitation overall and increased precipitation occurring in different times of the year than we have seen, which sometimes doesn't line up very well. More precipitation that is in the mid-summer is not a bad thing. That is the time when crops are most actively growing and need that precipitation, but in many places across the corn belt we're seeing a shift to more spring or more fall precipitation and those are typically not times that are as conducive for agriculture. In the spring you're trying to get into the field and get things planted and if you have wetter fields at that time, you are unable to get in the field or you're doing compaction in the field when you're going through it. If you have increase in the fall precipitation, like

this happened in the far west part of the corn belt, you have inability to get into the field to get your harvest out and then that wetness also carries over to the spring. In addition, that precipitation has been occuring in very heavy events. This is also an increase in national climate assessment. These percentages are increases in the amount of increased precipitation occurring, very heavy precipitation events and that ends up not being useful precipitation because it is adding to the soil ure and much of it ends up running off and when you have intense precipitation events that run off, that water goes down stream. It doesn't add to the soil moisture, but also when you have that increased precipitation event that is going to cause more erosion and if you do tillage, tillage it all and you had heavy rainfall events [unclear 16:36] that soil, you're seeing large soil loss and we're seeing that in certain areas of the corn belt.

Those heavy precipitation events have also added to increases in flood banks. This is another slide from the National Climate Assessment. The triangles, the green triangles show increasing trends in flooding. The larger the triangle, the more flooding is occurring and then in a few places we're seeing decreases in floods that you can see throughout most of the corn belt some large increases in flood events. Even bigger ones as you get to the far western part of the corn belt.

At this point I guess I can take these next couple slides. I will also apologize. I will not be able to hang around for additional questions afterward. Unfortunately I have to go to another event, but a couple more slides here Richard talks about Jerry Hatfield. The USDA rolled out these climate hubs a little over a year ago now and the effort of these is to try to do more work and coordinate activities in the federal government, experimentations, operative extension, USDA RS and efforts in the way of climate research and the impact on agriculture. Originally they rolled out as largely climate change centers in agriculture and there's been a bit of a shift in them now to not only talk about climate change, but it talks about tools to deal with the variability because in the large sense, the variability issues are more day to day types of things that agricultural producers deal with and in many cases, that is a way of reducing some of the impact of such activities, is trying to deal with some of those variability issues. You can see that the general location of these in Ohio is sitting as part of the Midwest hub, but adjacent to the northeast hub and the southeast hub. These boundaries are a bit fuzzy based on what kinds of work you're doing.

This kind of reiterates some of the things that I talked about, some heavier precipitation in the spring is delaying planting and field operation. Obviously you want to get crops our as early as you can to get them growing. We've had frequent periods or frequent years where we've been delayed getting crops out and that presents problems and reduced productivity. It also presents problems with people having to, if they're delayed too much they have to change what seed they have to be able to grow it at appropriate times or to have an appropriate growing season length. A lot of variability in precipitation during the growing season, some extreme precipitation brings extreme temperatures. We did not have these this year. In 2012 we had extreme temperatures reducing yield, especially on the southern end of the corn belt and in certain cases we've had extreme not only heat, but heat and high humidity events that have been impacting livestock production. In Nebraska two summers ago, one producer lost over 3,000 head of cattle during a high heat humidity event. Warm temperatures during the winter are causing some early breaking of dormancy of perennial plants. The example that is listed here is the 2012 we had a very warm winter. Tart cherries broke dormancy and started growing earlier than usual in Michigan, much earlier than the average first or last freeze. They broke dormancy, freeze hits and essentially the tart cherry industry for that year was wiped out and we're also seeing expanded rain intensity of insects and diseases. Warmer winters allow insects to [unclear 20:30] further north and changes in precipitation and massive precipitation introduced different disease.

This kind of gives that idea of erosion. These are example pictures that Jerry has shown of erosion losses where you had tilled fields and heavy rain falls sit on [unclear 20:52] fields, which is obviously a loss to your soil resource and a very detrimental thing.

Okay, I will hand it now back to Richard and allow you folks with the rest of the session and thanks for having me.

Jill: Thank you Dennis.

Dr. Moore: Thanks a lot Dennis. Well now we'll shift into the grant itself. So this is a very large grant that spans all the way from Ohio into the area where Dennis is from in South Dakota and the head of it at the center of the grant being in most PIs and researchers being in Iowa.

You may be interested in how much does this represent, the corn belt itself and you can see the varying percent of the US total grain harvest represented here in the grain harvest. This does actually represent a good chunk of grain harvest.

One of the things that we are concerned about is the long term weather patterns and we know that they're going to be changing. There's great uncertainty and little research regarding how these global climate changes will impact local and regional cropping systems. So that was part of the basis for this grant.

We know that these things are happening, lower growing season, shifted frost dates that Dennis talked about, warmer winters, warmer nights, more frequent severe precipitation events, greater annual stream flows and increased humidity within the canopy and we're talking about canopy here is like the plant canopy itself.

The Climate and Corn based cropping systems, this is called a CAP grant. The vision was to create new science and educational opportunities as a transdisciplinary team so there's many different disciplines represented from egronomous and myself, actually I'm an anthropologist by training. I do natural science as well. Also then to another part of the grant is to develop science based knowledge that addresses climate mitigation and adaptation, informs policy development and guides on farm watershed level and public decision making in corn based cropping systems. One of the things that really motivated us when we were starting this grant, different people were trying to get a handle on the greenhouse conditions and carbon sequestration, but there was quite a bit of different methodology being used and so one of the important parts of our grant was to try to come up with a common methodology to do this across the corn belt.

We were focusing on carbon, nitrogen, water, systems that connect these things from the local field level to the watershed and landscape level management and then we wanted to make sure that we could relate our research to the farmers themselves and the people in rural communities as well as teachers at different levels.

So our team is quite trans-disciplinary and as you can see this is a very large project. If you look, this is during one of our team meetings. We have a team meeting once a year so we have a lot of people involved and for that reason I only know some parts of it myself, but here's 140 person team of scientists, graduate students and topic based scientists, more than 19 disciplines, it's a very large project.

We have six objectives: to create the standardized methodology that I was talking about. So many people have done this, but when you look at the literature, you'll find basically a study that was done in one or a few locations, but using a certain methodology and then you'll find another study that was done maybe on greenhouse gas emissions or carbon sequestration that used a different methodology in a different location so we wanted to do standard methodology across a large number of sites in the Midwest. We wanted to evaluate how crop management practices impact carbon, nitrogen and water footprints at the test sites. Then we wanted to apply models to research data and climate scenarios to identify impacts and outcomes that could affect the sustainability and economic vitality of corn based cropping systems. So that's, right now we're in grant year 4. We're really trying to have communication between the modelers and people with objectives 1 and 2 to firm up the database. The data is still coming in, but it takes researchers awhile to get the research into a database so we're working on that. Also wanted to try objective 4 to learn about farmers beliefs and concerns about climate change and helping them to have a better decision support system so they can deal with climate change. Then at the same time we need to get the information out and have interaction with the stakeholders, the farmers in rural communities so we could get our information out. Equally important is the grad students that work on this project that we needed to train this next generation of scientists and develop science curricula and promote learning opportunities for high school teachers.

These are the six objectives sort of inter-related. Diving into the first one then, this is some photos from just the methodology section and the common methodologies that have been developed and then at the same time gathering more information at the crop level trying to find out the carbon, nitrogen and water footprints at the test sites. We have these test sites across the Midwest and each of these dots refers to the test site. We have different types of test sites, corn, soybean rotation, cover crops with the corn soybean rotation, extended crop rotations, organic cropping system, drainage water management, nitrogen fertilizer management, tillage management and landscape position. There's quite a few different types of experiments going on. The stars here represent the sites where the researchers are located I think.

Test plots look something like this and some of the equipment for greenhouse gas measurements look like that. One of the articles that I mentioned this special Journal of Soil and Water Conservation, Rattan Lal, one of the PIs at Ohio State mentioned about in one of his articles President Obama announced on June 2 that the US Environmental Protection Agency would cut carbon emissions from the US power sector by up to 30% and soot and smog pollution by 25% by 2030 relative to 2005 levels. There will also be an additional water demand of 40% by 2030 in which soil water storage will play a crucial role. It's really, the importance of water in the next coming decades is going to increase significantly. Even in the Midwest where we say we have quite abundant rainfall compared to California. We're going to be finding that this is a precious commodity. There's some hope of course with the recent finding of agreement between China and the United States so we're hoping for the best.

Here's one of our researchers from Lincoln University, Nsalambi out in the field collecting insect, I'm not sure exactly what that is. Her's an example of research done by Warren Dick at Ohio State University. One of the things that we have in this grant is back in the early 1960s, we had a continuous corn soybean rotation long term no till up at what's called OARDC, Ohio Agricultural Research and Development Center and Warren is in charge of this long term no till plot so we have done various measurements on these sites.

One of the things that Warren did, for example recent research had to do with methane, which is a very potent greenhouse gas found at lower concentrations in the atmosphere than actually more than carbon dioxide. However methane's global warming potential is 23X greater than carbon dioxide. So one of

the things he looked at were these methane oxidizing bacteria that are present in aerobic soils and the question of oxidize methane and use it as sole source of carbon and energy. This can be a biological sink for atmospheric methane. One of the questions then is what is the affect of tillage? Do they increase or decrease depending on how much you till the soil? The hypothesis was that there would be a variation of methane oxidization rates of soils under different land use practices indicative of methane oxidizing bacterial diversity in those soils. The conclusion they found that long term no tillage soils have higher methane oxidation rates than tilled soils and are a sink for this greenhouse gas.

We also have other research going on other than research of Rattan Lal who focuses on carbon sequestration and Warren Dick and Norm Fausey who is with the USDA Agricultural Research Service and he's been focusing on drainage and things like different types of drainage, controlled drainage at different sites. In an article that he an Rattan Lal and some of Rattan's students published in the 2014 Special Issue Journal of Soil and Water Conservation said "in general, plots under no till with subsurface drainage produced lower greenhouse gas emissions to those under chisel till. Subsurface drainage lowered the emissions compared to those under no drainage. Results from this study concluded that subsurface drainage in poorly drained soils with long term no till practice can be beneficial for the environment by emitting lower greenhouse gas fluxes compared to tilled soils with no drainage". Perhaps another example of research that's on going.

A lot of focus has also been going on currently to try to create a really good database that can be a legacy of this project to go into the future so we have it organized under the site set up that you saw that were set up across the Midwest have the same kind of methodologies of greenhouse gasses and carbon sequestration measurements as well as then we have this organized by watersheds as well.

One of the things with that database then comes the ability to be able to do some analysis and predictive modeling. I won't go into detail about that, but that's one of the things we've been really focusing on because we think that would be a legacy of the project maybe 20-50 years from now. People will be able to come back and realize that a time when people were starting to wake up about climate change that we did these measurements across the Midwest and hopefully by then they'll be able to see some changes and now that we've created sort of a benchmark.

Social and economic research is the 4th objective. Gain knowledge of farmer beliefs and concerns about climate change, attitudes toward adaptation and mitigative strategies, etc. Statistically we surveyed a subset of about 20,000 farmers in 22 hydrologic level, fixed digit watersheds in the upper Midwest. We did this in cooperation with another research project, which is called U2U.

This is the area and the watersheds across the US that we looked at for this survey that was done in the year 2012. This is some examples of outputs of this and you can download from our SustainableCorn.org site the statistical atlas. This is like map 32 so it considers a lot of maps here, but you can get an idea just by the color. The darker the color means the higher percent and the question that was asked of the farmers was 'experienced significant problems with saturated soils or ponding over the past five years', which was 2007-2011. You can see north west Ohio up in the [unclear 36:28] area on the corner of Lake Erie they scored pretty high. I don't know, it looks like it's in the 80-90%. Quite a bit in that particular survey, high recognition about the problem of saturated soils. The same thing about rain itself. The question 'more, frequent, extreme rain' percent concerned are very concerned and while I think we in north west Ohio scored highest on that one. You can get an idea. You can see it's quite a large joint project and many people were helping out on that.

One of our researchers, Jay Arbuckle, an individual in leading this objective also had done some

research about concerns about excess water issues, percent concerned or very concerned. This was done according to whether in his survey people thought climate change was occurring and whether they thought it was mostly human causes or maybe they thought climate change was occurring caused equally natural and human causes or mostly natural causes or insufficient evidence and so on or climate change not occurring at all. Then looking at which group saw that they thought more frequent extreme rains and were concerned about it and then you can see the people were, climate change was occurring caused mostly by humans, which we know that to be the fact scored highest on the rain.

Same thing here on support for collective and individual mitigation and doing something about the problem. Of course this group thought climate change was occurring caused mostly by humans scored highest. Government should do more, I should do something about it on both those.

One of the things that I was interested in was the high percentage in that study. There was a very high percentage of people who were uncertain and so there was a question that one of the possible answers was that there was insufficient evidence to know with certainty whether climate change is occurring or not and when we see this study that was done in the corn belt, you can see it's pretty common to find 30%, this many people, some 30% of the farmers were responding that there was insufficient evidence. We decided to do this in an area where I do a lot of research called the Sugar Creek watershed, which the Amish actually scored 83% of insufficient evidence. This is also in the year 2012 using the same survey. For non-Amish in the watershed, it was something like the rest of the corn belt, maybe a little bit higher, but pretty similar.

So that really sparked my interest. It's like why would the Amish, 83% of them say there was insufficient evidence so here's the comparison. Here's the survey that was done in the corn belt and then you compare our study, 83%. Non Amish in the Sugar Creek watershed, not a whole lot. These numbers are a little bit lower, well this number was lower, not so far off really. This one really stood out.

We were interested and I have some summer interns that their summer job associated with this so we wanted to ask them why this is. Our hypothesis was that perhaps people were saying insufficient data, but maybe they had a lot of specific reasons for it and these were probably, knowing farmers, based on their own experience and their own local situation.

This last summer we did a survey at the Amish Family Farm Day in Dundee and we also took a subset of people from the Sugar Creek watershed that were not at that and we were focusing then on that winter we had a very cold winter and so we started focusing on what would people tell us if we were asking them what you do to get yourself through that winter and did you have any unique stories. There were a lot of stories. Farmers could come up with all sorts of things. Keeping animals in the barn and feeding them more, blocking up windows, thawing pipes with hair dryers, waiting to plant in the spring because it was too cold or wrapping the barn or bee hives in plastic or black cardboard or tarp, using feed bags for insulation. There were quite a number of stories that came up.

We also then asked the same question, is climate change occurring when we know that more flooding is occurring so how would they answer that. Well in this case, the Amish, our number is very low in this survey. We found that they scored it quite differently than the other survey so if you ask the question in a different way, it seems based on their own experience they may be able to actually associate their own experience with things that we know are closely associated with climate change.

Another objective in the grant is extension so we tried to get the word out about what our findings are

to the local people. Here's Chad from Iowa State talking to a farmer. We also have education that we try to train the grad students and develop educational curricula.

One course that I teach is a Stone Lab in the summer time. I will be teaching it again this summer, I'm hopeful. We associate this with the Algal Bloom, with corn being the major crop and so the high nitrates come in and frost is coming off of the corn corp and we have the students talk to the farmers and local watershed coordinators and actually go out into the stream and look at the quality of the streams and then go out actually in Lake Erie and we measure the Algal Bloom. This is at Stone Lab. Like I said, we'll be teaching it again this summer. This last summer we had a lot of students from the grant, really a number of grad students that were in the course. We had a great time.

One other thing that we've done in education is we tried to connect nationally, we work in the area of agriculture, but it's important to get outside of that area from just our own grant, work with others who are doing work with agriculture on climate change, but also connect to the larger audience of science and the environment and this group, National Council for Science and the Environment has a project called CAMEL Project and you can see the URL down below it and so they're posting some of our speed science videos that come out of this project so if you go to our website on SustainableCorn.org you can download speed science videos. These are very short videos for anyone. I get a lot out of them. Like I say, there's so many researchers on this project you can just watch these videos and learn a lot, but we've teamed up with them and it's been a very successful team work.

There's this many grad students this year. You can see a lot of them at the annual meetings. We try to work with undergraduates as well although our focus is on graduate students and Iowa State University and Lincoln University have climate camps.

Last, but not least. Just some things to think about when we think about Lake Erie and corn and we have rising temperature and increasing growing season lengths and greater variability of temperature. Higher night time lows, extreme swings over short time periods, periods of extreme heat and cold and timing of frost events. I guess one thing that I really wanted to emphasize in regard to Lake Erie is some other things. Changes of precipitation patterns. Some places are going to be drier, others wetter, less predictability, decreased snowfall. Of course that will affect, sometimes there's manure that's placed on snow. They're trying to decrease that from happening, but greater variability of precipitation, more short intense events, shifting of timing of the events. Dennis had mentioned about the spring, more spring rain events and these are more severe weather events. One of the things that's really important in regard to Algal Bloom, trying to prevent the Algal Bloom in Lake Erie, this increase in rain events, first of all if you think about it, there have been some studies done that show that 80-90% of the nutrient loss for phosphorous and nitrogen occurs during these major rain events. This is too often forgotten in the discussions and we also find that it's not you just need nitrogen and phosphorous for the Algal Bloom, but also soil erosion itself and one of the problems in Sandusky Bay, in particular Mame Bay is sediment deposition that occurs from rain events going into rivers and end up in the Mame bay. The focus really needs to be centered on what conservation measures can we put in during that would relate specifically to these high rain weather events. It's very hard for us. It's one of the things difficult to monitor during rain events. If you try to go out during a major storm and it's flooding, you don't want to send your workers and technicians into a dangerous situation and it's also difficult to know where you measure exactly during a major rain event where maybe there's flooding occurring. Do you do it where the stream was or do you do it where it over flowed onto the land? There's a lot of methodology and hydrology about this thing, but still it's something we know less about than we know about during low flow.

With that, we need to be more flexible of production, we need to think about more varieties, shorter season varieties, different crops. This opportunity for the Midwest will also as Jerry Hatfield emphasized, will be happening because of California and the problems with the drought there so it presents a real opportunity for the Midwest. Cover crops, less tillage = less greenhouse gases so trying to get more cover crops into a rotation of corn and soybeans. No till that Rattan Lal and Warren Dick and Norm Fausy have been advocating, it means less greenhouse gasses. Build a resilient system to withstand the increased number and intensity of weather events is what we need to do.

Well, with that, thank you very much.

Jill: Thanks Dr. Moore. We have gotten some great questions so let me see how many we can ask Dr. Moore. What questions, we don't have, we'll see if we can post later on our site. Okay so Dr. Moore, this is a question specifically about slide 50. I don't know if you want to go to slide 50. How does this research affect things like drainage tiles in the Mame watershed? I know there have been questions about that practice related to environmental issues.

Dr. Moore: So how does this relate to the drainage tiles in the Mame basin?

Jill: Yeah, so how does this research affect things like drainage tiles in the Mame watershed area?

Dr. Moore: Well we do know one of the response by the farmers on drainage tiles right now is putting in more drainage tile and they've actually had the space between the drainage tiles become a little bit less. There's quite a waiting list from what I hear for farmers who want to put in drainage tiles. That's quite in demand right now. That's been one of the responses by the farmers. With respect to the research itself, there's been, I'm not an expert at this, but there's people like Norm Fausey that would advise the person that asked the question to just talk to Norm Fausey directly about this if they have specific questions. One of the and there's also Kevin King is another researcher that works with the Agriculture Research Service at Ohio State that has done a lot of work on this kind of thing, but one of the issues, there's a number of issues involved with this and when you have no till then you may have more worm holes for instance so that when you have a heavy rain then it may get more connectivity from the surface down to the drain tiles themselves. So that's one of the issues with drain tiles, but controlling so there's efforts being made to put kind of a control drainage in as well that we're strictly on fairly level land than have some major of controlling how much water flows through so you can then hold some water back to keep your soil more moist during the non-rain, after the rain event, but also be able to filter some of the nutrients at that point putting it into a control drainage type of situation. I don't know if that answers what the person is looking at. This no till with some kind of subsurface drainage does produce lower greenhouse gas emissions.

Jill: Thank you Dr. Moore. Another question that we had was dealing with slide 56 and the question is does ponding and saturation also have to do with different soil types or are they all pretty comparable?

Dr. Moore: Yes definitely different soil types affect how much water would be ponding or drain off and that would vary across the corn belt. I guess that's all I can say so yes, definitely that the soil type is a factor. Even within, let's just say on that particular slide, I mean north west Ohio, there's actually many soil types up there. That was actually one of the reasons for the rapid adoption of round up ready soybeans in north west Ohio. Montsano asked me when I first, part of my appointment is with extension and this was around the year, anyway the 1990s and I went to their field day and I noticed that there was a very high adoption rate of round up ready soybeans in that area and I wondered why it was so high, even relative to that time, Indiana and they said it was because of the different soil types,

there were so many different weed types and so round up ready, which means for those of you who don't know, it's a [unclear 54:58] GMO soybean that then you can spray the herbicide round up on it, but the plant survives and the weeds die, so that was one of the reasons why it was widely adopted in north west Ohio because there were a lot of soil.

Jill: Okay, thank you Dr. Moore. We had a couple questions dealing with the farmers surveyed. Can you talk a little more about what you hope to do with the input from the farmer survey results?

Dr. Moore: Are you referring to the Amish part?

Jill: I'm not completely sure. I'm not sure which it was so maybe if you could do both.

Dr. Moore: Well as far as the survey itself you can download the survey from right off the SustainableCorn.org website. It's a statistical survey. There's quite a bit of interest actually to do this kind of survey in other areas and Jay Arbuckle, who is one of the leaders of this and also working with U2U, they are interested in extending this to other areas, even other commodities and other aspects of agriculture, to try to do a similar kind of study in that same area. I know that the USDA climate hub that Jerry Hatfield was interested in doing this. I think Jay Arbuckle, if anyone is certainly interested contact Jay and he can probably update you on it, but I think they're in the process of doing that. It's also an interesting bench mark in the sense of how would it change, does the same study in another 10 years, because it was done using the USDA statistical agricultural services database so they did have a statistical sample of this region. It's a very good study and statistically solid. It would be nice to do a follow up study in about 10 years and see where people are. As far as my work with the Amish, we helped to publish an article about it. One of the problems is our number is very small. It would be sort of a qualitative study in terms of things that we found. A lot of it from a social science point of view depends on the questions you ask and like I said, what sparked our interest was just the high number of insufficient data responses that we saw in the survey across the Midwest, which made me wonder why so many people were putting insufficient data because they probably had good reason for it, but why would a third of them be doing that and so then we though knowing farmers, they probably have some kind of reason for it grounded in their own experience. We found it very able for them to come up with their own experiences. We'll be writing our article about that. Like I said, more qualitative. I should maybe talk to Jay about it and see if maybe we can make it, work it into more of a large scale study.

Jill: Dr. Moore, one follow up with the Amish survey. One of our attendees was asking about the insufficient evidence. If that in the Amish population means perhaps not enough exposure to media or other outlets, just wondering about the exposure related information related to climate change when we're talking about the Amish population.

Dr. Moore: Well, I mean we did find this. In 2012 when we first did that survey, there was quite a push back. I've done a lot of studies with Amish and were very accepted. Very successful projects working with the Amish. This one, there was a lot of push back and when we went door to door, our survey technique normally is we knock on doors, give them a survey or even do it with them right there or come back in a day to pick it up. There was push back on this one. We think that that was probably because actually when you talk about long term climate change and talk about the planet earth and you have to think about in a millennial, in greenhouses gasses and carbon sequestration over long periods of time and you do brush up against the geologic time periods where Amish believe that the earth was created in 4004 BC or something. That could be part of it. We never actually went there with them about that as far as like to try to understand more about that because we knew it was a sensitive issue, but now we're finding that they are able, I mean a number of Amish that were very much on top of it.

As far as being able to get media, actually Amish you'd be really surprised. They're pretty much on top of, they get the newspaper. They read all the time and so they actually get pretty good information.

Jill: Okay, thank you Dr. Moore. We are at 1 o'clock so we will hold any of the other questions for possibly, Dr. Moore I may relay a few of these to you later for some answers, but I did want to again thank you Dr. Moore and Dr. Todey for their willingness to talk to us today about their work. It was really an excellent discussion. I also wanted to thank Ohio State University, National Sea Grant Program and Ohio Super Computer for funding this webinar. I wanted to remind everyone that our survey URL for this webinar is in the chat feature so please take a few minutes to fill that out. I also wanted to refer you to resources and an archive of all previous webinar presentations, which is located on our ChangingClimate.osu.edu website. This webinar series is sponsored by the OSU Climate Change outreach team and we'll continue next month. We'll email everyone when it's available to register. Thank you again Dr. Moore and all participants on this webinar. We hope this has been beneficial and hope you'll join us again in an upcoming webinar. Thank you and have a great afternoon. Thank you Dr. Moore.

Dr. Moore: Thank you.