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Good afternoon, everyone . Let's go ahead and get started. Welcome to today's webinar about the introduction to High Tunnels and organic systems. My name is Jen Ryan with the natural resources conversation resources National Technology Support Center and I will be your host.

I am pleased to and webinar over to Ben Bowell. Ben is in a joint position with NRCS working in the technology support center in Portland, Oregon. Ben, You may now begin. Thank you. Welcome to the webinar. Today it will be the first in a three-part series focused on organic management of High Tunnels and we have three speakers to provide perspective based on expertise and growing region. First we will hear from Julie Grossman who is an associate professor in the Department of horticultural science at the University of Minnesota and then we will hear from Dr. Krista Jacobsen from University of Kentucky and will also hear from Dr. Cary Rivard who is a specialist at Kansas State University and I'm really looking forward to the presentation today . If you have questions, please go ahead and type them into the Q&A pod the you can find in your screen and we will address those questions at the end. Just type it in and so with that I will turn it over to Julie and we are ready for you to begin .

Great. Thank you to everybody who is here on the call today that this is a really exciting thing for us to be doing together because what we are going to be doing is presenting on projects that the three of us have been involved with over the past four years now on the effect of cover crop management on organic production, specifically soil and soil management and it is funded by OREI grant through USDA. The next webinars we will look deeper into the project results with more of a focus on soil and cover crops. This first presentation is meant to provide a overview about high tunnels and the management and to bring you up to speed on the terminology used in some of the many differences that exist between growing your crops in a high tunnel and in a field . It can cause challenges in management that are just starting to be understood today we all want it to look like this for we all want beautiful crops. Many farmers are lured by pictures like this to put up a high tunnel wanting that season extension benefit. As we will talk about today , it is not always so easy. High tunnels are a type of controlled environment. Other types of controlled environments include greenhouses, cold frames , and things like that. High tunnels are different and Krista will look into the differences and the structural issues or drivers and how we can control the environment within our high tunnel. The goal is to introduce you to some of these basic features of high tunnel structures and ways in which these differences will dictate the structure and some of these downstream effects that we start to see on management, including irrigation of facts. With that, I will pass it on over to Krista to start us out.

Great. I will just talk a little bit about some of the basics of high tunnel structures to set the stage for management issues the practice that Cary will talk about and we

thought it could be important for providers to see the big picture of the structure types and some of the options. There is a lot of bells and whistles and we are just going to cover a subset of these and the right options are combination of all of these and will really vary by the site, market, budget, and the bigger climate that they are working in. Also want to make some comments about what we consider to be the basics. I have italicized high tunnels is unheated greenhouses. You can certainly do that but since it isn't designed to retain heat he does are used in emergency situations. For example, for a small window of time. Similarly, hip inground production noted here. Given that we have a soils focus for the project were also referring to the structures where crops are grown in the ground. This is not really the intention of the cost share dollars and we certainly hope to help producers through the kind of research that Julie is leading with your. The other piece to note is that these are typically considered semi-or non-permanent structures. Typically the high tunnel does not fall under this kind of a class. Standard dimension ranges from 14 up to 30 feet wide or 96 feet long are kind of that range.

All right. And then I would just talk a little bit about microclimate to set the stage for the management issues that Cary will talk about emphasizing some of the differences between the open field and high tunnel. The microclimate in high tunnels is different with water, wind, and temperature. For example, it is not always 10 degrees warmer in a high tunnel. Really, the only thing that is truly consistently different is the water situation. There is not water coming in due to the exclusion of rainfall and snow. Irrigation is really a must. We can talk more about that in detail in the Q&A in terms of irrigation practices that might be specific to certain crops. Typically, we recommend drip irrigation for most crops reduce the relatively high humidity, particularly overnight and in the morning. Over all due to the buffering of the wind even though we have higher temperatures typically, we actually see lower rates and the water you're importing into the system will actually stick around and be fairly efficient.

And again, the microclimate is largely influenced by the features of the structure. Especially in regard to irrigation. As we get into a few of the structure details and options, just focusing mainly on the key factors that affect management or are related to temperature factors on the last slide. The first of these basic structure choices are side curtains and additional venting. The drop-down type curtains that you see on the left are interesting because they let air in but not the cold air rushed over the plant canopy in the wintertime, which you actually do need to do. Even if it is 20 degrees for had outside if it is sunny it can be pretty toasty inside. More often than not we see the roll up site where the curtain is on the right-hand side of the picture. This is the picture I'm pointing out right here. This rolls up from the bottom. Typically, we see them vary in height from 4 feet high down south for we are it is to get the good air ventilation so up to about 8 feet high. Additional venting options include things like shutters which we might see more calmly on the greenhouses. And also homemade butterfly events that flip out word or even the ridge event that releases a lot of heat and humidity to the tunnel. I will just talk briefly about the cover that goes over these tunnels. There is a lot of options every year. The standard is the plastic design that is

designed to last about four years they can last longer than that, but after four years it gets a little bit translucent and it starts to reduce light transmission. There is a lot of options beside the clear plastic that might stop perfect spots of the spectrum. A lot of options in terms of the number of layers and then how you might deal with those layers of plastic. It is one sheet of plastic over the top. If you are looking for the extension, people will do a double layer of plastic and then inflate that layer between the two plastic providing a little bit of insulation capacity to the structure. It does come at the cost of loss of transmission there is an increasing number of multi-year plastics. Cary has more experience than I do with those that we can handle it people have specific questions. We will send it to Cary during the Q&A session.

Just a little bit more about some of these basic options here focusing on access and stores. Doors also function in terms of thinking about ventilation provided some of the cross flow of air

in the summer time. They do vary in cost and vary and basically how rigid they are. So what folks need to be thinking about at the point where they are just getting started looking for all of the options is to be able to accommodate whatever implement they want to use inside the high tunnel. Will you be working this with hand tools or do you envision being able to get a small tractor in? This is one that if you make that decision wrong, it is going to be a little bit hard to go back on. I would be remiss if I did not talk just a little bit about movable tunnels. They may not be covered under some of the cost share programs but we do see a growing number of options on the market. I am happy to talk more about that in the Q&A movable tunnels bring unique opportunities with cover crops. You hear the phrase as high-value real estate. Folks are trying to get as much production as possible and it can make it difficult to incorporate the practice. If you can move the tunnel and take advantage else where you can then cover crop ahead or behind that tunnel. Also offering opportunities to diversify rotations and things like that. There is a number of commercial models on the left picture and a number of do-it-yourself models where people are taken commercial tunnel kids or even parts of high tunnels and taking them apart and move them with whatever size and equipment that they have available. The picture that you see on the right is some of the movable tunnels that have made it at the University of Kentucky and there is a hyperlink if you would like to check out some videos. And we have an extension publication on that as well.

And then just a little bit about temperature. It doesn't necessarily correlate with always being hotter or cooler in the tunnel and Cary can talk about that as well. The standard rule of thumb is typically with one layer of plastic you get about a 4th degree temperature by for us tonight and 7 degrees with two layers of plastic. And because of how many degrees of frost protection you get it is that you get the season extension. For example, you may plant one month earlier and be able to keep the summer crop a month later in the fall. For us in Kentucky that means tomato yields five months earlier and we often see greater yield because of the higher quality fruit for the reasons Cary will talk about being able to control that water. In places like where Julie is in Minnesota, planting can take place in February where there is even snow

outside. The bottom line is and the reason that Julie said farmers are interested in this is the season extension. You can grow year-round if you are skilled and particularly if you have the market for it. Some of the temperature data that we have heard over the years, it may come up against some of that conventional wisdom. I will just pull out a couple key points he related to the winter temperatures. What you see in this slide in the light green color you see the high tunnel temperatures. We like the data that we have for about the last 10 years. I just chose a week of data from here in December. This is pretty typical. So in this light green color you can see the low temperature, typically overnight temperatures. This is a daily average. And then in the dark green you can see the high temperature and also the open field temperatures and so the low temperature and the high temperature. What we see here with the low is we actually see very little buffering and it may not last that long but we do see that and then when we get into the daytime temperatures received a huge spike particularly on the sunny winter days where we see temperatures jump from where it may be 45 in the open field and 75 and that tunnel.

And we spent 12 months a year at the tunnels. That is with curtains open.

And Krista, this is one of my favorite slides to show. Especially for what we face here in Minnesota. In Minnesota hours can get as high during the day as you see them getting in Kentucky that night they can drop down to negative 20 degrees. That is a huge temperature fluctuation in places like Minnesota.

Yes or we may be talking about a 50 degree temperature jump, which is huge. You could be even less excited if it is a 100 degree jump like it is between Minnesota and Kentucky in the daytime and the nighttime temperatures. The story is a little less complicated in the summertime. It is hot. That is the bottom line there. You can see the open field and the high tunnel minimum temperatures are the same. This is in June that same year where the high tunnels are open all day long basically four months at that point. The temperature is the same as the open field but then it is warmer as a maximum every day.

All right. And then basically

the reason that we bring things up this because it is interesting with the conventional wisdom is not just for the crops and the people and also for the insects and diseases that we are managing along with our crops. With that I'm going to hand it over to Cary.

Thank you, Krista. Good afternoon, everybody. We want to tie up the microclimate section of the webinar today to talk a little bit about frost versus freeze protection. One of the thing that Krista mentioned that we have similar data. I think everyone has the same data from all over the country. You see the warm-up during the day and sometimes at night you do see thermal protection, but not always. As we do more research, one of the things we find is a lot of it depends on how you manage the tunnel and also how sunny it is during the day. This is a large thermal mass that will absorb heat energy during the day and retain some of it at night. They do not have a

lot of value to them so they really not going to hold a lot in but they are definitely not going to hold any and if they do not gain any heat energy during the day . One of the things we have seen here in Kansas when I worked in North Carolina as well is some nights you get a 5 degree temperature difference in the low and sometimes you get zero. It really depends a lot on how sunny it was the day before and how well the tunnel was closed up and how to keep from losing it. One of the things that I think becomes really important for growers is the ability for high tunnels to provide frost protection. We often forget most of our cool temperature plants are quite tolerant of freezing temperatures . Frost causes issues with leafy greens can cause lesions on the plants. I took this picture one day where I work and typically it is much earlier than you would in the open field. You can see the sidewalls are up open it . It has not been affected with the very heavy frost after that morning. It is interesting to spend time playing around these things. That structure is a physical preventative for frost not only keep the heat in and also it is a room that will keep the frost from falling on the plans early in the morning. There is a lot of growers that there is the idea that frost can develop in the tunnels but if you look at this picture here you can see in our temperatures here in Kansas that is generally not the case. The other thing that we have done and this is where you will see growers get more innovative is to start integrating the use of low tunnels in combination with high tunnels practices the same high tunnel of the three season solo tunnel. We have planted our tomato trial in the middle rose got some early cold Spring weather practices not replicated data and is just what I drew out there because it is getting really cold and it seemed like a good opportunity to get the data. You can see it is about 15 degrees warmer . It is an additional five or 7 degrees or underneath the road cover . This is an early spring in Kansas. And you can see this in January or February. One of the things that becomes important is when you start looking at the microclimate and especially the use of the row cover inside of it it is the post management .

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