[Live Captioner Standing by].

I want to remind participants that the use of trade names during our webinars is for informational purposes only. Mention of the trade name does in order to imply endorsement by the department or the national resources conservation service over products that are not named. With that, we will now begin. At this time I would like to welcome Lindsay Haines. Lindsay is national organic pest management for NCRS. She has worked with them for over 30 years and started as planner and scientist conservationist and providing technical and financial assistance to local producers. She has been involved throughout her career and working on organic farms providing organic assist ants to farmers and farming organically herself. Lindsay you may now begin.

>>LINSDAY HAINES: Great. Thank you for joining us and Mark and I have the pleasure of introducing him today. If you can go to next slide. Mark has worked for 30 years researcher and advocate and works one on one with farmers and homesteaders to soil test interpretation organic soil nutrient weed management for vegetables and other crops and capacity with the research foundation he develops research based educational materials including a series of practical guides on soil health and organic farming. You

can continue to read on many about accomplishments again we're so thrilled to have him the important topic. With that I'll turn it over to you.

>>MARK SCHONBECK: Thank you, everyone. I first want to start by saying and this is not going to be overwhelming technical discussions of plant genetics per se because I don't know that much about all the details and secondly because the focus is really on selecting the varieties that are going to help us field to rebuild soil health.

There's a number of ways this can happen and most simple and straight forward simply having traits to make it living with organic farming. Because you end up with traits that improve yield and reduce the need for inputs, so you will likely reduce the cost environmental as well as direct cost for unit of production. A specific example is resistance to whatever pests and disease are prevalent and strong adaptation within the organic community.

Another way that plant genetics will influence the soil health outcome is the reduction for input. Cultivars efficient in use of nutrients and moisture don't need as much irrigation and applied fertilizers including the national organic program approved fertilizers which have environmental costs as well as we discussed in an earlier

webinar. Another input that is often reduced by well adapted cultivars and the ability to crop out weeds less need to be out there all the time as a result indicating and then a way the cultivars can directly benefit the soil and that is what we will look at next.

Basically if you recall the four principles of soil health enhancement to NRCS develop over the last ten, 15 years. The living plant 19 foundation of soil health and nourishment for the soil life community.

Traits that include the plants ability to protect and feed the soil will directly improve the soil health outcome of the farming system. A high photosynthesis rates, leaving sufficient residue to protect the ground after a harvest, a root system that is not only substantial in biomass but is also releasing substantial amount of those these roots that support tsunami life and that process of the soil life feeding on the roots is what build social security and maintains soil structure. Another aspect is the plant's capacity to enter into beneficial relationship with soil microbes such as microbial fungi. And cultivars with deeper

root systems and breaking to hard pan especially vigorous cover crops.

I'm talking a little bit about the national organic standards do talk about cultivars and seeds and require the farmer to use organically reduced seeds if possible and if that's not acceptable seeds not been treated or developed through engineering process but developed through standard conventional inbreeding.

There's another section relates to pests and decease suitable to science specific occasions prevalent diseases and pests of the region.

The organic Farming Research Foundation conducted a survey over one thousand organic producers in 2020 and published the results in national organic research agenda. This is done in collaboration with the organic seed alliance who had a detailed survey about the use of organic seeds and how farmers view issues such as finding certified organic seeds and finding cultivar better suited production systems and local climate and soil.

What we found was that be a little over one-third of the respondents to the survey indicated that it was challenging for them to find the appropriate crop for organic production and this jumped higher to traditional organic farmers and concerned about as they are under taking that transition and the market they hire for southern organic region farmers and a little over four and ten reported that the lack of organic seed with the desired traits might tell them to buy nonorganic seeds. And organic seed alliance found in their part of the survey found that almost all organic farmers -- important to the integrity of the organic food and about three out of four expressed some degree of concern about contamination with the crop species of course, are those that are highly prioritized and those most widely grown. Tomatoes and the squash, cucumbers melons and berries high value crop and carrots came out of V one high priority and corn soybean wheat alfalfa and organic field crop rotation. And very interested in cover crops that are better adapted to organic systems and better meet the multiple purposes for which organic farmers use cover crops.

Breaking sub surface hard pan, supporting beneficial life etcetera and yield organic management that's got to be top priority. And the competitiveness of weeds and nutrient efficiency is very important because not using

fertilizers definitely creates challenges in achieving high yields and in recent years inbreeding for the organic community has taken new approach using multiple genes and multiple mechanisms for resistance and as the climate gets hotter and more erratic and heat if you have a crop that actively exclude cross-pollination with pollen that --

(Technical/audio intermittence).

>>MARK SCHONBECK: You like your produce to be nutrient dense so it's going to have a high matter content and crop surfaces to stay on the surface and you want ample amount of going below ground to feed the soil microbes etcetera. There is a tradeoff there, there have been cases where select of one trait at the expense of another one example is during the 20th century a lot of focus on harvest index. The ratio of harvest to the field crop to the plant biomass.

(Technical/audio intermittence)

>>MARK SCHONBECK: Beneficial substance and they can also eat go out into the soil and directly suppress or

attack pathogens or they can stimulate that is induced systematic resistance so have r by having these organisms and the root the plant is able to defend itself against pathogens such as leaf flight in carrot and enhances all of these properties. Disease resistance is selecting for that. You want to select for multiple genes and multiple mechanisms because you have a single again the pest organism going to reduce around it for several years.

I don't know of organically approved but there are some that have effects on environment including copper and sulfur and able to grow a crop without those materials or with very light use of them is a tremendous benefit for the soil and the farmer not having to spend all that money on that and all that time spraying it.

The nice thing about copper and sulfur toxic and low amounts it's clearly does makes poisonous situation there so being able to cut down on their use is a big benefit. Weed tolerance and weed competitiveness is a high priority for a lot of growers and because the less you have to cultivate the more you protect the soil life, the soil structure and soil organic matter. Drought resilience is getting important as climate change in the south where we have phenomenon of flash drought where you can go from too

much rain to none at all can leave crops stressed.

About conserves water resources as well. And then just general nutrient efficiency and nitrogen fixation and also can host nitrogen facing bacteria definitely some of the grain crops and corn and million let used as cover crop and warm seasoned glasses can host nitrogen fixtures that will produce a third to a half of what nitrogen that the crop needs.

So this reduces the need for fertilizers and protects water quality. And then there's a whole issue of crop genetics for teamwork with soil microbes effected and research over the past ten years that really is beginning to delve into how the genetic makeup of the plant will affect how well it associated with things like disease antagonists and other beneficial organisms. The genetic makeup of the plant the traits will affect the quality of the root basically whether the soil is getting yummy and balanced male or whether they are getting prison food or cafeteria food that may not be as nourishing. And another aspect of whether it sends specific chemical signal that is invite the desired organisms and a lot of variation documented in many crops.

That shows substantial variation enough for effective inbreeding and selection for these traits. And traits such as nutrient moisture uptake, nitrogen fixation, the ability to suppress or consume pathogens and pests. And also the plants response to beneficial organisms in this reduced systematic resistance. We'll talk about that later.

Well, there's a lot of -- you'll see if you look at vegetable seed catalogs you often see variety in the summer crops being built as drought hearty or drought tolerant because in research trials or observations these particular varieties some of them old and new hair looms are able to withstand hot dry weather and bring in good crop without less irrigation. Found in okra, peppers, lima bean. This is interesting because this is my own observation. I was setting out seed of lettuce and grow in a flat and varieties and the root clumps on the new variety robust than the others and one day this loan head of lettuce, be about three dates before I took this picture, we had a really severe drought and I had forgotten it was there.

I dumped a couple liters of water and synch or swim and three days later came right back and gave me delicious marketable head. On the right this Juliet, a variety hybrid tomato produces grape tomatoes, and I planned -- eight plant and we had a moderately drought, and I watered them a couple times and I suddenly realized they are getting big enough and I cutoff the water and grew to seven feet and produced 25 per plant.

It's not like I have the best country in the so I think that's an example of drought resistance. Another one here growing tomatoes on less water. I have seen in the seed catalogs Arkansas traveler is supposed to maintain in the face of drought and heat we're trying to out this year and see if it does.

California some farmers are taking for dry farming you instead of irrigating heavily and continually they

irrigate to much less -- they do some irrigation or cutoff fairly early in the life cycle of the plant and very low rain they give limited amount. They found if they take early girl or new girl varieties known for deep root systems they will sustain because roots go down and use sub soil moisture that less robust varieties can access.

Again as I say, climate change coming and it being harder to obtain the water you need to irrigate although this year may be exception with the snow melt that's going on right now but in general irrigation water can't be taken for granted so seedily important to develop this drought tolerance.

I'm going to talk about few challenges we face for developing seeds for organic systems. Some way to meet them. The first one is modern cultivars available now were not designed for organic systems. They were selected in the context of fairly high input conventional production with soluble fertilizers and crop protection chemicals that protected them from things like disease and

kept weeds down as well. They are not as likely to perform really well in organic environments in my personal opinion this is the main reason why there is a yield gap. Why organic production systems tend to give 20% less yields give or take.

One of the things have modern cultivars forgotten how to communicate with soil life. You call in the really best partner from the soil microbe buy ohm and for one thing if the soil is very rich and readily available nitrogen phosphorus and potassium a lot of these beneficial organisms go to sleep or die altogether.

As you read in select crops in those systems than the crops gradually lose the ability to create signals that call in these microbial allies and this has been demonstrated in tomatoes, corn, and land races of sorghum and maintaining the field without concentrated fertilizer of any kind versus the modern hybrids. Well, the organic research extension initiative which is USDA national for food and agriculture competitive grants program that was established in 2004 is now funded 50 million per year and typically offers about 30 or 40 grants to support various organic research

and tremendous boon. Supported long term participation grant efforts started to crank out new variety for organic systems. One of the priorities request for application calls for strengthening systems including both plant inbreeding and organic seed production and the seeding objective list covers all of the priority traits that I discussed earlier.

Including the ability to perform well in the best most soil improving climate friendly systems such as organic no till.

And OREI invested plant endeavors and here's a leading one. A carrot inbreeding is one of the best projects I have seen come out of the program given the holistic approach for variety of organic systems.

We'll talk about these more later. There were several different farmer networks on corn. On quinoa and other crops and other the choice of cultivars is rather limited right now and not suitable for organic. What has happened as a seed industry consolidated the private plant breeders focused on few large topics.

They have given less attention to the specialty crops which are the bread and butter of many organic farmers and also a lot of the corn, soil, contain GMO traits which are not national organic production standards. One way the plant inbreeding networks and partners in university lead programs that the OREI has supported for organic farmers and this collaboration has taken farmer scientist working as partners to do in the field to identify the priorities evaluate inbreeding lines and new cultivars from start to finish and ramp up seed production.

If you select for one trait and focus on that you can get rapid improvement in that trait but you may have losses in other traits. If you focus on yield you can have some decrease in nutrient density and returning less plant carbon to the soil. And the OREI supporting many of these endeavors and the scientists from the projects when we interviewed them these farmers are essential partners in these projects and really valued the collaboration and as a new network that has been established in upper Midwest and second or third year of funding and produced webinars designed for farmers, students and other independent breeders.

I'm going to mention at this point there are

dozens of cultivars now in the seed catalogs. Many of them include vegetables and other specialty crops but also some field crops as well. Organic seed alliance, I mentioned them. Super if you want to dive into this more.

Farmer participatory plant inbreeding and organic production of crop seeds. They hold organic seed conference every other year. The next one is in 2024. They have established organic seed commons online in which some of projects are utilizing. And their report in 2022 parallel to the report I was quoted from the survey is the state of organic seed 2022.

Third challenge ask public plant breeders themselves are what I called endangered species because at university they are retiring and they are not being replaced one for one and the funding that has been available for university and USCA public plant breeders has been diminishing. New farm bill language mandating that the USDA devote reasonable amount of funding to support public plant inbreeding. However there's an urgent need to train, recruit and establish next generation of plant breeders particularly for organic and also for sustainable and resilient

farming in general.

Here's a couple of examples of OREI funded projects that are helping to train in the next generation of breeders. The 20 -- the student organic seed symposium has been annual event sponsored by the University of Wisconsin and several of these were supported by the organic research initiative to a conference grant which grants up to $50,000 to help hold an event like a conference or workshop. The 2016 event took place at the University of Wisconsin and it included graduate students and representatives from seed companies and nongovernment organization organic seed alliance.

Six of the students who participated in that one planned the next student organic seed symposium which took place the next year in Davis and in 2020 after -- this actually was 2022 -- that's an error there. Award was 2020ened pandemic postponed the conference to 2022 and it strove to build long-term network of breeders and students and farmers and they focused on some regional seed initiatives crops that are grown in Appalachia and another project, and this is fully integrated project. Student collaborative organic plant inbreeding and education called scope. It's lead by Brommer in UC Davis and two purposes

one is to develop more cultivars for the organic farming sector and involved experience hands on training for undergraduate and graduate students in plant inbreeding.

I find this to be one of the exciting projects funded in this USDA organic research initiative.

Students work closely with local farmers and faculty plant breeders to develop variety and inbreeding objectives and then going through the whole process from initial trial variety evaluation to finishing a new variety and helping with seed increase. This released six new cultivars of bean that combine heirloom flavor and traits and variegated beans that you see sometime in organic health food stores. Combined with high yields resistance to very common serious viral disease of beans. Sweet pepper and two varieties of large jalapeno for stuffing. They are released or about to be. And teams working on tomatoes and zinnia and advanced breeding lines for the tomato project.

It's just been an excellent opportunity. I think it's a marvelous model for how we can bring on this next generation of plant breeders. So, this is another challenge intellectual property rights in seed patenting. One

of the reasons it is difficult for farmer to adapt seeds to their own site is a lot of variety covered by utility patent prohibits the farmer to save seed for his/her own next year crop and restricts breeders access to that germ plasma. This highly restrictive level of intellectual property rights is known to be slowing progress in new cultivars to meet emerging needs created by climate change.

And utility mostly impact cultivars developed through genetic engineering and not directly reflecting organic farmers per se and some that are covered by patents taken out on naturally occurring traits and some cases land races appropriated indigenous around the world and placed under patents. One way to address this challenge is a movement called open-source seed initiative and a number of varieties developed under this initiative which basically says you can use this seed in any way that you want. You can use to grow for family, save seed for next year, food for market, seeds for market to other organic growers and develop locally adapted train plant breeders can use it crossed with another variety with no restrictions. The only restriction is that any seed or any product from the new variety has to be open and not restrict.

If they don't have the regular source of

funding, there is a concern that if the entire seed industry, you know, plant inbreeding sector especially let's say for organic was completely open source it could be more difficult to finance all the work that it takes to create new and improved varieties. There's no way to adjust the challenge. Okay, how do we balance farmer's rights and plant breeders livelihood here.

Several ways to do is the plant variety protection act. That means you can save your own seed. If you have a variety and you really like it you can save seed and use it to develop a new line researchers at university or seed companies can use to develop new lines. You just can't grow seed to sell to another farmer. So much less severe restriction. Licensing agreements in university non-profit plant and users and buyers, I think there was one system that had ten percent royalty. You tack ten percent on to the price of the seed and it goes right back into the inbreeding effort. Seems more agreement than slapping utility patent and restricts germ plasma use by plant breeders.

Let's look at some examples of outcomes of

organic plant inbreeding research. The northern vegetable improvement collaborative was established in 2010 and earlier network that laid some of the groundwork, another USDA competitive program for organic farming. This one funded by OREI since 2010 and farmer breeder pubs in Oregon, Washington, Wisconsin, and New York so it covers the northern half of the country basically.

Again, it's farmer identified priorities including agronomic and market traits. Some cultivars that have been marketed that came out of the network includes sol students, broccoli, mire's best and several variety of butternut squash and resistance to three major disease and Brandy wise which is Brandy wine that has been developed for and modified through the conventional inbreeding for greater disease resistance and several varieties of sweet corn.

This network also evaluates existing cultivars and identified one that is perform well in organic production. An example on the right a snow pea variety that had done really well is now being marketed organic growers. In the third cycling of funding just wrapping up. They identified nationwide inbreeding objectives for some crops and regional for additional crops. And outreach the

workshops and webinars. Some of the outcomes include some high yielding cucumber variety. I have not been able to grow cucumbers in my own garden until I tried this variety so they are inbreeding these varieties for different parts of the country. Early sweet peppers and sweet varieties as well.

I find this to be one of the most exciting projects. It had three awards. The last one in 2021 they have identified a set of priorities flavor and arrange of colors in rapid emergence in canopy density. This is an interesting one. The first round of funding identified varieties that have a larger canopy. They come up fast ere and don't need cultivation for weed control. And then the leaf blight is a serious one. You get nematode and distorted and probably don't taste as good either. This is one they delved into the soil microbes and collecting obsessions from all around the world extremely thorough search and so far they have commercial lied several varieties. One is a red carrot available and they are making really good progress on the in them toad of disease resistance.

On the right is my favorite variety of carrot for here in southwest Virginia is the 126. Grows well in heavier loam soils and very large, very sweet, long is one of

the best carrot I tasted or seen. One year I started -- what I liked about it because of large top you see the ones on the right much larger than the one on the left. That's different cultivars. I'm not sure which one. However on the right, that large canopy means that I can get away the with one less hoeing or if I hoe once puts mulch and good to go.

One year I started noticing all the outer leaves start turning black and shriveling up. Turns out that is a very widespread serious disease. This carrot improvement for agricultural inbreeding network lead by Phillip Simon has found both sources of leaf blight resistance in carrots and the large top have been able to combine them in advance reading lines hopefully, we'll start seeing those on the market fairly soon so you can grow these weed competitive carrots and not have so much trouble with this leaf blight disease. I have to think that that large top is why they are able to make such large, sweet carrots and you can plant them in (indiscernible) and you still get a good carrot by the end of the season.

This latest grant is focusing on -- they are calling leveraging on farmer and on farm continue and

expand the farmer participatory inbreeding network they already established and below ground focusing on -- improving the capacity for the plant to partner with these microbes and there's several effects they are looking at.

Beneficial organisms directly suppress pathogens and root on in them toads and seen variation in the ability of different cultivars and carrot to respond to a certain fungus if I can remember -- oh, Trichoderma not only suppress some pathogens directly but they will induce this systematic resistance response. The carrots response to that is somewhat link today genetic basically varietal differences.

And that will protect them from the leaf blight I was talking about earlier. It will reflect on nutritional value and flavor and another thing this program is looking at is when these carrots are grown in urban community gardens where there may be heavy metal genetic traits that reduce the uptake of heavy metals again through interactions with beneficial organisms aimed release cultivars and found sources of resistance due three major species of root in them toad. And another thing they are doing any inbreeding line they find promising is kept in the public sector through a new

online tool called the plant prior policy.

This is prior to art and this keeps in the public sector. Another one funded through OREI tomato organic management and improvement and tomato disease program which is challenging because tomatoes don't just have one or two like carrots, do they have like a dozen a different one each year; one next year. Keeps shifting. The idea is to develop multigene, multidisease resistance and to integrate the inbreeding for these traits with improved use of bio fungi. And you will cultural practices that stimulate micro buy ohm and can include different kinds of compost and such and some of the outcomes of the first tomato organic improvement project they already have multidisease resistant varieties they found one if you know fudge side effective as copper against some of the pathogens and that's when they discovered (indiscernible) can stimulate against plant defense and they found the land races show greater response than modern cultivars and now trying to integrate that into the cultivars developing.

Continuing in the part two funded in 2018, I believe, and continuing on this line of research and so far,

improving the flavor and disease resistance and really expanding the understanding of how this interaction occurs between plant genetics and the soil microbiome and some of it is epi genetic is not a different again per se but how expressed through the DNA is modified in the plant cell. And another one is that some of the beneficial microbes and there may be organism that is can be transmit in the seed you want there because going to reduce systematic. They have been looking at compost and soil type that how that effects disease suppressiveness.

Some examples in grain crops.

Nitrogen-efficient field corn. This has been extremely exciting. Several corn inbreeding projects were funded. One partner is a non-profit nongovernmental institution that focuses on plant inbreeding developing corn and wheat variety that don't need nearly as much input that do well in organic. They collected a germ plasma these land races host both nitrogen fixing organisms in their root zone and also organism that is enhance the efficiency windchill crop utilize soil nitrogen from organic sources when grown through conventional practices in the Midwest they require only about half as much nitrogen as standard hybrids and they can get it from organic sources.

Initially it was sought a that the yields were pretty much similar to the standard hybrids and higher protein and content and meth neon very important one of the limitation difficult to get efficient in the bird diet on the nationalist for the program is allowed because organic poultry producers have struggle with nutrition efficiency for their flocks.

These hybrids that Mondovi Institute and lead scientist there have developed is that they have been a third more than standard so when chickens feed on that, very large root system with heavy root formation and makes more drought tolerant.

This photo on the right is comparison corn hybrid on the left. One of the Mondovi Institute and you can see the difference in vigor there and this is the harvest outcome. The ears on the bottom which look like good yield on any standard corn variety that is what they harvested from the Mondovi -- low fertility conditions. One of the things that the researchers have discovered is that many decades of corn inbreeding in nitrogen fertilized soils have modified the root microbiome so the nitrogen fixtures don't really occur.

They are suppressed. There is a nonpathogenic form of fuse which is bad word because causes disease and these are nonpathogenic do benefit the corn under conventional input management systems but the system does require nitrogen fertilizer to succeed. They found that even a few years of seed increase under organic management can improve the corn's crops ability to survive on less nitrogen in organic series.

There was an independent another one of the OREI corn inbreeding did find that the hybrids do seem to have lower yields and that lead to a further investigation of the relationship between root architecture and corn yield. This may be a case where selecting very heavily for certain root traits may have entailed something of a sacrifice. I would be interested in looking at the question of when you consider nutrient density of the different varieties of corn whether you get equivalent amount of nutritional value because the yield may be higher. This is just an example of the many ins and outs of the journey toward crop varieties that are going to meet our needs for good yield, good profits, and benefits to the soil. Certainly hybrids that do feed a lot of exchange to the soil and beneficial to the soil health. Here's another -- this is very interesting project. It's meeting specific climate challenge along the coastal plain of the

Carolina area major rice growing area for the United States. They grow the Carolina grain rice. Seed level rise has caused salt into the rivers which rice farmers rely on for irrigation and also when there's a flood like during a hurricane there's more salt intrusion on to the land through the flooding and most rice cultivars are quite sensitive to salt. So this is creating severe yield losses.

The goal of the project is to identify salt tolerant cultivars inbreeding lines and cross them into the Caroline gold and develop new varieties that can tolerate the level of salt is that that this climate change sea level rise has changed in the region and have the traits of the Caroline gold. They are looking at the rice weed interaction. Under salt intrusion with the new varieties. Eventually they are going to be working with six organic farms affected by salt and they are going to be conducting farmer participatory breeding and cultivars vacation evaluation trials. It's a really excellent example of using plant inbreeding to develop climate resilience.

Another thing they are tracking is organic production of these new varieties positively affect health of soil and water quality? Quinoa, a combination of plant inbreeding and the idea was to basically jump start the U.S.

organic quinoa sector. A lot of customers demand for organic quinoa is really strong in this country. However the varieties available -- I mean, the amount of quinoa available is not that great. A lot of imported organic quinoa. There's actually been concern about the social justice impacts on importing large amounts of quinoa from lands that can just as easily be used to feed the local population.

The question of, you know, are we diverting land that is needed to support the local communities to export production? So it's a great interest in building up in this country. Very strong farmer participatory network generated over two hundred inbreeding lines selected by farmers from trials on their farms and this is in different places across the country. It's going to be different regionally adapted varieties and several new quinoa variety released soon and in the meantime there's a lot of research into how to grow organic quinoa successfully X. looking at root -- related to -- not micro rye some as well they have found some of the strains benefit from that soil microbiome partnership.

Cover crops. I'm going to go quickly. I'm a little overtime here. Thank you for your patient sense. Cover crops play essential role for soil health for all farmers

but especially all organic. The national organic program requires crop rotations and there's been variability for successful use of this important soil health strategy practice. Nitrogen fixation, nutrient recovery, cold hardiness resistance to resilience of other weather extremes and here's an interesting one. That facilitates organic no till and weed SUPPRESSED and ability to suppress pest pathogens. A few examples of traits discovered -- 20 degrees Fahrenheit. You get colder night it's killed which can be handy early spring vegetable planting but if you want -- you want to over winter breeders in eastern Washington will tolerate 0 degrees and give you a good stand. And some Harry strains Minnesota and maturity date of the rise is southern variety heads about three weeks than other -- it will take so long may well into summer cropping season before you can successful because it takes that long to head out and flower and shed pollen.

Purple heads earlier and windy acre farms unfortunately has gone out of business at the time they gave excellent presentation using these two together quite successfully for organic minimum till. OREI funded now third cycle of funding to nationwide inbreeding network and developing improved cultivars of Harry veg and Harry pea clover and award 2021 trials all cross the country to Georgia

to Washington state and now they have a trial site in Alaska to test survival in extreme winter cold of course, even with climate change. And they are looking at all the important traits that I mentioned before. Another set that's important is disease resistance so that the crop itself can grow good seed, biomass, and you don't want weed to come up at the wrong time. They are developing variety trial database to help the network informed what is being uncovered in different parts of the country.

Well, thank you for your attention. Open up for questions.

>> Great thank you mark. We have a couple questions in the chat. The first one has to do not so much with genetics but any thoughts you have on biodiversity in the cropping system relate to the soil and plant quality.

>>MARK SCHONBECK: Very important fascinating area. You can find research that shows that biodiversity makes really important contributions. You can find others that say beyond two or three crops doesn't make that much difference. I happen to believe it's important in so many levels different plants will support different soil microbiome and very often they will enhance each other. Occasionally they may not or may cancel each other out. But overall it's important for disease management. It's

important for soil organic matter. They are finding that diversifying crop rotation even if the total biomass returned to the soil is not changed that contribute to the accrual of soil organic matter and will support more diverse and more complete soil microbiome. Very good question.

>> Very good. Thank you.

>>MARK SCHONBECK: Interestingly there's some studies about diversity and cover crops when you mix species sometimes you get benefits and soil microbiome etcetera and other times doesn't seem to because one species out puts the other but found several mix foliage or cover crop you can often get better biomass better weed suppression and other benefits as well. Really good question. More research is needed.

>> Very good thank you. Next question is about patent how can company patent something that occurs naturally. Aren't patents showed to be for new things and not in the public domain.

>>MARK SCHONBECK: I'm not up on the legal notice and I just know at least an attempt to patent things like basmati rice and a yellow bean indigenous Native American or Hispanic culture and I think Native American. I'm not sure how these were resolved. But I know there have been cases

where naturally occurring traits or land races have been -- patent in my opinion, it's confusing and it is an injustice that needs to be addressed. We need to have sweet spot on this intellectual property spectrum but a lot of bio piracy of, you know, like private (indiscernible) going around the world and picking up genetic traits and trying to cover them by a patent. Yeah, I think that it's -- something needs to be you are sorted out. I don't think it should be happening. I think utility patents for things like hybrid auto engines and other advances that are clearly of human creation and not -- I mean, I'm definitely in all favor of a genetic columns and I want to find that sweet spot that allow plant breeders to make decent living at the hard work they do so that there is a maximum support for innovation by farmer scientists working together.

>> Great question. The last question has to do with the heat storage and atmospheric conditions underground storage facilities operated by iron mountain cooperation which is initially the storage cooperation during the Russian atomic cold war. Question is can seeds in storage facilities in disruption of earth catastrophes?

>>MARK SCHONBECK: That is a question I'm not really up on. I think there's one in Iceland or Greenland very cold but of course, with the big glacier melt even those might be in trouble. It's very good question. I think what needs to

happen is seeds need to be preserved by people who are willing to grow them out regularly so they don't go, you know, lose viability and go extinct that way.

>> I can interject. Sorry, Mark, and I sent a couple links to the person who asked this question.

The one that Mark is referring to is the small bird global seed vault and they do have over a million seed sample from almost every country in the world including now indigenous communities contributed some of them gene bank and their seeds to the seed vault. As you said, Mark, given we do have glacier melt this could not work in the long term, but for now the reason global seed vault was set aside for safekeeping for natural catastrophes or etcetera and the USDA also has a facility in Fort Collins they have a vault and I believe it's called the agricultural genetic resources preservation research facility. And they do have plant germ plasma there as well so they are saving seeds also in case of an emergency. But I agree with what Mark said, you know, having all these seeds in one place it would be better to have more disputed system where we can have seeds more accessible in case there as disaster for people to access them and have these more readily available as quickly as disaster as possible.

>>MARK SCHONBECK: That's another argument

for eat open-source seed arrangements or things like the plant variety protection plant which allows you to keep the seeds, save the seeds, select the seeds, improve them. So that's another severe disadvantage of too many seeds locked up in patents. One, if disaster strikes, the patent holder well good-bye to that variety.

>> A couple more questions did come in. I think we have a few minutes. This person is from Bangladesh and has a question about CIA three, fungi effecting the plant how much time does it take to destroy the plant?

>>MARK SCHONBECK: This leaf blight? If it's not one -- in my experience, it's a matter of reducing yield. It doesn't destroy the plant overnight. The plant typically doesn't die completely but it reduces the photosynthesis that capacity so you -- I watched over a month period and, you know, if weather conditions become unfavorable to the fun Gus or the plant variety has some resilience to it than the disease can stop in it track and center of the plant will grow out and more foliage I seen get pretty severe. It's not a rapid death situation but it is a yield diminishing situation.

>> Last question is about flowers. Talk about how focuses on sort of base ready flowers and looks. Any thoughts on how organic growers can get cut flower to

change the focus for organic field producers?

>>MARK SCHONBECK: You know, cut flowers is one area that I have not seen OREI research of any kind, either production practices or inbreeding. That is a very good question. Oh, one exception. That scope project out of UC Davis where they are training students to be plant breeders for organic. They have a zinnia team now, and they are working with growers to find out what they need just as they are with vegetable. Huge gap right now. Much needed.

>> Very good. Altogether one just came in. We all know plants need urea nitrogen requirements. Is it possible to inject so it can get nitrogen from the atmosphere?

>>MARK SCHONBECK: Do you mean to actually what can be selected for is the plant's capacity to host nitrogen fixing bacteria. Now, in the case of legumes that would be increasing the plants of the efficacy of the rhizome and that varies with plant genetics and microbiome genetic and there was one at least one OREI study to look at both the plant and the rhizoidal genetics to optimize that association.

When it comes to nonlegumes we're talking about what are called free living things like AZ (phonetic) -- and some others but a number of them. They don't form nodules but they live or close to the roots in the rhizosphere objective to identify plants with trait that enhances the efficacy of that association so there's more nitrogen being taken up by the plant.

Here's a fascinating tidbit. There is a fun Gus that others at pen state are studying. This organism lives in plant roots, grows out to the soil, directly attacks certain pests. I think certain grubs or maggots will actually invade and proceed to transfer -- transport the nitrogen, the protein in the body of the insect plant. There are all kinds of possibilities.

I'm not sure if you have gotten into the plant genetics of efficacies of the that association, but apparently the bio fungicide does something similar grows directly into plant roots to the benefit of the crop.

In the organic system we will not be engineering genes, say, from a nitrogen fixing bacteria into the plant genome but what can be selected is the capacity of those plants to associate effectively with the microbiome that

nature's given us.

>> All right. I think that's it for the questions. Thank you so much, Mark, for a great presentation and information on these diverse questions. Really appreciate that.

>>MARK SCHONBECK: It's great and excellent to have questions. Thank you.

>> With that we'll turn back to Jenn.

>>LINSDAY HAINES: Thank you, Lindsay, I wanted to say thank you to Mark and Lindsay for providing excellent presentation today on the role of plant genetics in soil health selecting crop cultivars for organic production and thank you again for everyone to attending today's webinar participants do not forget to provide feedback about the webinar if you selected to earn CEU continue to browser window offered step two. This concludes our webinar presentation. Thanks, everyone.

>>MARK SCHONBECK: Thank you.