

>> Good afternoon everyone we will get started in just a few minutes. Greetings, we will get started? Just a few more minutes. Greetings. Welcome to today's webinar called beating the weeds without herbicides and I am Jen Ryan and I am a natural resources for the conservation east national technology support center and I will be your host. We will get started with the presentation in just a moment. But first a few house keeping items. This webinar is being recorded and all audio is broadcasted through your speakers. Head sets can help with the audio quality and volume. We still want you to be able to participate in today's webinar so please type your questions or comments into the Q & A box. I can submit them throughout the presentation, but the questions will be answered at the end. Today's webinar welcomes closed caption. Click on the CC icon at the top of your screen to view this. In the today's handouts and links boxes you will find a copy of today's presentation as well as other resources that you might find useful. If you wish to make adjustments to the view of the webinar. You can make them using the options in the screen share window. You will need to hover the cursor and you will need to be in the normal view to see the Q & A pod to type in your questions. Today's webinar gives out credit. And you can open this in the.net browser window. And you can receive your certificate by email. We will submit your certified crop advisor C E Us on your behalf in about 30 days. Please submit them as you need to meet the local certification requirements. We

encourage all of you to use the Step 2 process. Completing the webinar gives an opportunity to rate it using a five star and you can submit comments helpful to the webinar program. When rating the webinar please click on the local and what you learned. The on demand recording will be available on the web page by early next week. I want to take a moment that the use of trade names is for information purposes only. It doesn't guarantee a product by the USDA nor does it imply endorsement by the natural resource over comparable products that are not named. With that we will now begin. At this time I would like to welcome Lindsey and she is the national pest management and she is working with NRCS for over 30 years. She spent most of year career in a local field office and providing technical and financial assistance to local producers. She has been involved in the agriculture sector throughout her career from working on organic farms and farming organically herself. Lindsey you may now begin.

>> Thank you Jen, I have the pleasure of introducing our speaker today. Mark finds finding related to agriculture, resource and climate. He develops resource on mitigation and crop, weed, and nutrient management for organic systems. He has 35 years experience as a researcher, educationer, and we are very lucky to have him. I know that you will enjoy this presentation and all the other one that is we are presenting here. With that I will turn it over to Mark.

>> Okay, thank you. Welcome to this webinar about organic weed management which it turns out is the most challenging of all the production issues of organic farmers and what they face. The

reason is that we are not using herbicides in the organic system so the number one tool apparently at least at the beginning when you are starting out is to go with cultivation. It takes out the weeds and the goal is to reduce them enough to get a great crop. If you don't do it enough, the weeds will get ahead and it can be very difficult stating for the soil. This is not an organic farm on the left that is seeing this situation, but it is a serious health situation of the soil and erosion. So the national organic standards, the secret is that cultivation is not the only thing. It is only one component of the organic's weed control toolbox. And in fact the standards require farmers to use tillage and cultivation in a way that at least maintains if not improves the biological condition of the soil and minimizing erosion. And the first step towards managing any pests including weeds is prevention through good crop rotation, optimum nutrient management for the crops, not bringing weed seeds on to the farms in mulches and crop seeds etc.. And using a cultivar that is more an adaptive. And then a range of tactics that can be used to control the weeds. There is the mechanic cultivation and various forms of heat and electrical means and also mulches that are removed at the end of the season or maybe several years in a perennial with something like weed mat or landscape fabric. And in the research of a organic farms it was found that weeds are the number one challenge in the organic farming. Second was soil health at 30% and then in a survey that asked them to rate if something was a substantial problem, two thirds mentions weeds and almost one third talked about the affect of tillage on the soil health. In a number of cases where farmers

wanted to discuss the challenge of managing weeds while minimizing the tillage and protecting the soil health. One thing that emerged is that climate change is making weed management more difficult for all farmers and especially for organic farmers that are relying on non-chemical techniques to manage the weed population. When the weather is more unpredictable it is harder to know when to do the cultivation or operation for managing weeds. Some mentioned drought as a time when weeds become more of a problem. More competitive against crops and on the other hand when it is too wet to do an effective cultivation, the weeds get away and may require more passes, which is harder on the soil. A lot of farmers mentioned the creeping weeds such as Canada chisel and field bind weeds and several others. What makes organic weed control so tough is that it is knowledge intensive and it is site specific. What works here in Virginia probably won't work so well in Montana which is a very different climate and soil type. What works in a grain crop such as running a rotary hoe through it, it is more labor intensive and it can be high costs one of the leading costs inorganic production. And it is a moving target and the particular tactic that works really well such as the annuals that come up every day from a prolific weed set and large seed bank. What works against them allows others such as the creepy perennials to be more of a problem. So we are constantly having to shift the tactics to meet the weed community. It has been found through research that even with diligent cultivation and integrated weed management. Organic farms do tend to have elevated weed seed populations in the soils. This is

an area where more research is needed. Perennial crops are very helpful. And if a farmer is doing an intensive rotation to make a living, that can be an issue as well. And no-till planting of the cash crop and reducing other tillage operations is excellent for soil health when you've eliminated the chemical and cut way back on the physical disturbance and are growing high carbon cover crops the soil health will improve. But very often you're weeds increasing because there is less of the cultivation going on. That takes a lot of skill to keep up with the weeds. There are organic herbicides in development, but this is still in the infancy. Most the products available on the market are really not that cost effective in a field scale. They are more likely usable for very small scale production. And also for just cleaning up around a farmstead. If you have poison Ivy coming in, that is a good place for vinegar to knock it back, but you will not deal with a hundred acres that way. There are some on the way, and be looking for good research on that. I will take a few minutes to talk about what are weeds and why they are growing. A weed for disturbed soil whether it is tillage or clear cutting or a natural disaster such as a sudden slide, flood or a forest fire. The first plants that come are the Pioneer plants that rapidly cover the soil and what they're doing is their presence will stop' rogues. And will also begin the process of rebuilding soil quality if there is a loss of organic matter and soil biology. Having the roots in the ground will help to rebuild it and build the biodiversity etc.. They may be a trouble and the alternative is still worse. We make weeds. These plants have been around since long before the word weed was identified and

invented or coined. And we do it in several ways. We decide what plants are unwanted. This plant to the right now rated as fairly serious cropland weed, lambs quarters and it is extremely nutritious unless is over fed and it is a great way to get your nutrients and the colonists brought it to the country and it saved many a family from scurvy and other problems in the spring. Now it is a weed by definition. We also hold back succession at early stages and create a lot of bare soil. Winter squash or corn, soybeans, potatoes, vegetables, we have to create a seed bed, this has been the habit. And the traditional way to farm the annual crops so there are open niches and we have created weeds by bringing exotic plants into the region. Field bind weed and many others of the creeping weeds down here. Those four came from elsewhere and are able to spread aggressively in our region because the natural checks and balances are not present. Cropland weeds are adapted to this sort of disturbance such as tillage, but they are also adapted to the high fertility. So they will respond to the nutrients. If you have a lot of nitrogen and potassium and phosphorous. The weeds will grow with vigor. And they germinate in response to light and other tillage tools. If you run the plow or rote ory tiller over it. Other characteristics that they grow rapidly and they grow prolifically through the rhisomes and other vegetative needs. It is an a clue to how we best manage it. Some farmers and/or gardeners especially. Weed are nature's cover crop and to an extent that is true. They are Pioneer plants and will provide the diversity that is required to protect the soil and they can absorb the excess nutrients and you

get less leech to go the groundwater if you have vigorous weed growth. They compete for water and nutrients and light and space and they can directly affect the crops. A few of the most invasive do that to a significant extent. And there are ecological costs. I mentioned the invasive weeds. And they displace the crops and other vegetation that we want on the fields or surrounding our dwellings. And they disrupt the microbiome. Because they release substances to which our soil life is not adapted. All of these affects result in a biodiversity. If you get weeds that mostly cover the ground and compete with what you might want to grow but they are covering the soil and starting to restore, especially plants native to the reach. You will get a profit of biodiversity over the time of disturbance. However, when these invasives begin to come into the cropland and native lands. There is a severe impact to the land. Organic farmers take a preventative approach and there are five key steps that I would like to discuss. First is to get to know the weeds on the farm. If you have tiny broadleaf seedlings emerging the growing point of the tiny ones is just above the soil surface. So you come along and cultivate half an inch deep or better yet, flames you will knock them out. But on the right you have little grass of the same age and their growing point is under the ground so you need to get down to the seed depth, which is usually within a half an inch. Fairly shallow, but a little more distance. You want to know the life cycle and the season that they are growing rapidly and become a problem. How they propagate, whether it is seeds or spreading under the ground by the rhizomes or tubers, most of the annual weeds propagated by

seed will be a light cube. But there may be others that are important to consider. What the preferred growing conditions? Maybe you can avoid those situations. Or you can know what the other time of year and the weather condition that is are just right and be prepare today deal with the weed. You want to know how they are impacting the crop. Is it direct or are they hosting pests or pathogens that will hurt your crop. Also know how they respond to management. Tillage, mowing and cultivation, you can have tall grasses and if it is giant fox tail just mowing it down will help. If it is Johnson grass mowing may stimulate the under ground network. And you also want to look for the weak points of the weed. In this example it is the above ground on the tiny broadleaf examples. Common purple lane can be a bad weed in certain low-growing crops because it is so drought tolerant that you can cut it off and the succulent shoots if you get a light shower they will get going again. On the other hand, they are very intolerant to shade. So if you have an at all crop such as corn, you probably only need one cultivation. Any of that purple lane that comes up later. And that means any vigorous summer cover crop will knock them out. If you go through and chop them out once, you will get a million of them coming up, but if you let the regrowth sprouts get about three or four leaves on them and hit them again and you don't have to till as hard, just a very shallow cultivation, it could be a sweet plow or a shallow rotary. And Step 2 is to close the niche. Weeds fill an open niche. So there is a no-till retention up in the top. And that is a lot better than tilling. But it is still an open niche for the weeds to start growing. So you

look at the cover crops and there are five different examples there, and they all have massive top growth and there is no way that the weeds can get any light in any of those stand. That is what cover crops do. They are a Pioneer plant that we are using because it is easier to manage and it also has even more biomass so it is great for restoring the soil and easier to manage. That is why we use them. How do we use them? For effective it is at a seeding rate, which is generally one and a half to two times the generate. If you are planting into a weedy field and weed control is the primary purpose for cover cropping that is when you want to up the seeding rate, it will cost a little more, but save you money in the future. You want to select species with a quick growth and quick canopy close sure. That buck wheat there closes up the canopy in about 14 days. The southern pea on the right. Is a cultivar mix and 37 days after planting that happened to have been a very weedy seed bed. You blew the time on planting the cover crops, all the others were weedy, but not the southern pea. If you have weed issues and that is on your list of objectives, you want to make sure that one member of the mix is one of these fast growing quick canopy types so that you can knock it out. At all erect crops such as corn or rye and wheat and then vining or low growing crops such as peas, the buck wheat is another example. More thoroughly filling the niche. And then you have to optimize the growing conditions. Seeding day rate and method must be selected to ensure the early establishment. And check the fertility and moisture. If there is not enough to get the cover crop up it can certainly pay to irrigate a field after planting it once to get it

popped up and started. So that you don't have weeds growing from under ground vegetative yields such as rhizomes and tubers that come up over the dry soil and overtake the cover crop. Here is an example of what I call complementary architecture. That is a mix treasure of rye and hairy vetch very much on the left. And this is an experiment many, many years ago on the early 90s, on cape cod Massachusetts. We grew rye and very much or rye alone or very much alone. This is the results, when you combine the two and gave it a little bit of organic fertilizer we got a good stand of the crop and little weeds. When it is alone, the broccoli was starved for nitrogen. And the rye by itself did not shade out the weeds while it was growing. On the right very much alone fed both the crop and the weeds. So it was overwhelmed by pig weed.

Another way to close the niche, there are several other ways. You can do strip tillage, and instead of tilling up the whole field you just do it wide enough to get the other crop established. The other one is intercropping, this is in a high tunnel, but it can work in a field too. You can plant fast growing crops like leaves on the sides. As the tomato gains height and another way to keep it partially closed is organic mulching that you see on the photograph in in the upper right. That is hindering the emergence of weeds. This is some crops way up in central Vermont. Even with an extremely short growing season such as 100 days frost free and bitter cold winters. He started to interplant the clover and it gets a slow start under the thick canopy of other vegetables, but it is established. As soon as the crop is harvested and cleared. It is ready to take offer. You don't have a bare soil and the clover gets a jump on the weeds.

The third is to keep the weeds guessing. You don't do the same thing every year. You alternate the root architectures and also crops of contrasting nutrient needs such as soybeans versus say corn or broccoli which is very demanding of nitrogen. You also want to set the rotation and field operations up to vary the timing of all the operations, tillage, planting harvest, especially. And vary the depth of tilling if you are tilling. Most organic farmers have to do some tilling. That is something to keep in mind. Varying how and when it is done. And you also want to vary the weed control tactics. Integrated pest management means multiple tactics and that is important here. Lead researchers have come to the conclusion based on the organic field system trial that is is a good crop rotation is absolutely essential. And that is the good pest and weed management cycle. In Minnesota they found that if you have a corn/soy rotation, you can be complying with all of the organic standards and doing your best, you will have a build up of weeds and a decline in soil health. It is just not diverse enough so they add cover crops and they go corn, soybean, wheat, alfalfa. And depending on whether they grow the alfalfa for one or two full years, the sod crop, alfalfa such as grass or clover or anything like that. Gives the soil especially the ground Beetles and other weed seed consumers to drawdown that weed seed bank. And wheat is a winter crop and the corn, soy, and that is a summer crop. And then the alfalfa is a perennial. So you get better soil health and lesser of the weed seeds. We have four different vegetables here from different plant families and we have several cover crops that include different cereal grains and legumes and you think that is so

diverse. But they are all summer vegetables and the farmer is tilling in the cover crop every year. And even if they use the gentlest tillage as they can, they are still stimulating the weed seeds. And you begin to get some of the summer annual grasses and lambs quarter and others. Here is a rotation that is also 4 years and produces three vegetable crops and potentially one cereal grains that are more lucrative than just seed grains. In this one you are over seeding clover into it for a year or two. And then till it up and plant potatoes and then go into another cover crop and then butter nut squash and you can row and crimp the cover crop rather than tilling it. So you have a very early spring ahead of the lettuce and then later in the spring to get the weeds guessing. So anything that can make a crop healthier, such as an early crop of tomatoes or snap beans put them under a low or high tunnel or some sort of cover that improves the temperature environment for the crop. You pick crops that are very rigorous such as a sweet potato with a heavy canopy and that particular variety of corn is really rigorous. Tenancy red could be. That was about 10 feet high and I grew it in my own garden a couple of years ago. There is a vary in the varieties as to how much of a canopy that they put on. The thick ones don't require more cultivation because they shade the ground. You want to weed and water the crops not the weeds. If you grow a transplant, and then you set out a big start that is 6-8 inches tall and you have a jump on the weeds. In-line irrigation is a great way to water without watering the weeds. Soluble fertilizers and some of the more concentrated organic fertilizer release the nutrients so quickly if

they are put on at the planting they may feed the weeds before the crop is really needing them. A good finished compost will release the nutrients slowly and therefore feed the crops more effectively. And the weeds less so. Here is an interesting set of experiments that was done in Cornell university. And they looked at field corn and kale and the response of several summer annual weeds known to be nutrient responders and this is generally a compost, which is very high nitrogen and M P K material and really a fertilizer. The crops levelled out and did not respond to anymore. If you go over the recommended rate, the weeds keep on growing faster and faster. The interesting thing is you get something such as soybean or another strong nitrogen fixer, you can accomplish some weed control by allowing for a really slow nitrogen fixer. If you have a really high weed seed bank because the weeds went to seed last year, you will have heavy weed pressure. You get the crusting in the soil and that is really bad for the soil health. How do we draw it down? You have to prevent the weeds from going to seed. And this has been known for centuries. One seeding and 7 years weeding. You have to find a way to break it up and keep the top growth skimmed off so that you can actually starve out the underground tubers and you want to make sure that you rethem before they can begin growing. And then any amendments or poor quality crop seed that is not cleaned properly is also a problem. We can bait them. This is a false seed bed. Stale is when you prepare it with tillage as if you are going to plant and then you burn off the seedlings. And you the false one is that you do it once and then use the shallow tillage. The idea is to hit the

weeds when they are small. Here is a double technique on the right. Where the field was tilled up after crop harvest. And then it was in Virginia. He want today plant a cover crop so what he did, just as the weeds were beginning to come up in the white thread stage, he went out and scattered -- spun seed at the cover crop seed and he took the tiller and only winter 1 inch and then he planted the cover crop. We have to let the clean up crew do their job. Fall tillage usually leaves the soil prone to winter and erosion. And the other is that you are disrupting the habitat for the other little critters that will eat up the weed seeds. Even in the best managed field you will have a problem with that. You want the critters to runaround under the cover crop so you have a late summer cover crop and it frost kills, leave it there until the spring. How do you get better weed control with less damage to the soil. This is the perennial question. Any way, so you want to cultivate smart. There are a lot of tools and it is a matter of selecting the best tool for the particular soil, crops and weed flora. And the type of the stages. The rolling basket tool and the finger weeders that can go into the row of an established crop and knockout small weeds. Generally early in the season it is called the critical weed period to prevent the crop from weed impacts you want to do it timely and shallow. If you only go to inch deep you are not damaging the soil profile and you avoid doing it too often because you will pullverize the surface. And there are high residue cultivators for reduce tilling and when you are farming on the surface, which is excellent for soil health. If you stack two different tools, such as a finger weeder behind a tine weeder for

instance. And there are new camera guidance technology and robotics that can increase the efficacy of removing weeds near or in the crop row because they can recognize the difference between a crop and a weed. Alternatives to the tilling are many. Flame weeding or electrical zappers, a lot of farmers use flame weeding, directed hot water steam is safer than the other methods if you have a lot of residue. You don't want to set that on fire. Mulching which can be a mat or organic matter. And then there is tarping. That is a good way to ensure that a cover crop that has been mowed or roll crimped will be fully terminated. Grazing is another method of managing weeds, you do have to pay attention and be sure it there is 120 interval between the harvest and the next crop for food safety. And essential oils and fatty acids and vinegar are some others. There has been some promising results with guided image technology combined with the use of some acids that are fatty acids to selectively control the weeds and the camera guidance reduces the amount of spray that is needed by a large amount. High percentage. Here's a farmer in Georgia, he uses landscape fabric and what he is standing on is where he has just tarped his cover crop and what he is pulling off is another piece of fabric with precut holes in it. And then he will set out the crops and you can see he has a season long no-till weed control. This is quite cost effective on a small scale, one to 2 acres for sure. You would not want it to be done on a hundred acres and a lot of smaller farmers with market gardens are making good use of this technique. And grazing I think of that as a way to turn it into meat, dairy and eggs. You can graze them on the weeds after the

harvest has occurred. Cover crops can be grazed as well and when it is done well you can do it without compromising the other soil health and the benefit was cover crops such as erosion control and nutrient recovery. If you have a crop rotation, and you have a perennial sod phase, if you have a crop livestock integrated operation or neighbors to whom you can rent your field in perennial sod for them to graze. You can get some income out of that phase of the rotation. When you manage the grazing really well with good rotation methods it will reduce the pasture weeds and the cropland weeds and it is excellent for the soil health. Okay, so these are a few farmer innovations and some research findings on the whole topic of integrated weed management. Giant weed management. And I said that it was corn, soy, wheat, alfalfa. There are some farmers in Ohio that are dealing with giant ragweed even in the 4-year rotation, they were finding it overwhelming their soybean crops. And one farmer thought what if we add a fifth-year rotation. He followed it with buck wheat and he let it be a green manure or harvested it for grain. And that was right before the soybean crop and just having that different schedule where you had that stale seed bed it drew the seed production down and then a later planted crop and he was able to greatly reduce the ragweed population. He did this and it was funded by the organic extension. And refined the system and he has started raising livestock and now he added more forages and now it is a 7-year rotations and it is even more effective in keeping this weed from becoming a problem. Canada thistle is a major problem. Especially in a grain rotation and especially in dry land

rotations. These are some examples from vegetables grown in Virginia. It has weak points, one is that it is set back significantly if you mow it when it is tall and just before the bloom. You see the buds and it has 7 to 10 leaves and it is several feet tall. It is also suppressed by a great summer cover crop and what this team found is if you plant this sorghum and Sedan grass in a deeply affected field. When the set an is about 3-5 feet tall and the Canada thistle is in the prebloom stage. They come in and mow it back. And then the Sedan grows back stronger and it releases a chemical that is quite toxic to the thistle. And what happens is that technique reduces thistle pressure by 98%, growing buck wheat by itself which has shown good suppressive activity and the buck wheat didn't do the trick and neither did mowing it at a certain stage. And another way is to grow alfalfa forage. And you usually want to cut it to get high quality hay or forage or the cattle and you do that several times a year and having it cut several times and competing with the alpha fall fa, it sets the Canada thistle back quite a bit. Let's go to the northern great plains and the interior Pacific northwest where a lot of dry land wheat is grown including organic. And there has been some more organic initiative studies one called creep stop, and let's top these creeping weeds. And they have to use as many tools in the toolbox as they can find. Field bind weed and Canada thistle with the two key barriers or two of the leader barriers to successful organic cereal grain production. So these researcher are combining a number of different strategies and tactics, changing the crop rotation, and mowing and till age that is the time to be most effective in relation

to the weed in the crop, grazing, and then biological controls. Fortunately there are some insects and fungi that like these two weeds. On the left is the field bind weed moth. That can weaken it if it is allowed to multiply. And on the right is a rust that attacks the Canada thistle but not most of the crops. Researchers in Montana and other states are looking at these two agents and also at a mite. If your soil is low in nitrogen, you will not have hard time growing soybeans. If you row crimp just cereal rye and try and grow corn or lettuce or cabbage in it, you will get a poor crop unless you load on the nitrogen. But soybeans do quite well and can give yields as good as those in a tilled crop with timely cultivation for weed control. So what happens is the rye residue, first it hinders the weed emergence and you use a no-till drill that places it at the soybean at just the right depth. If you get the technology right and get the soybeans to come up through the mulch. A lot of the weeds are blocked especially in the interrow spaces with no disturbance at all. And the other thing that happens is the rye sucks up all the nitrogen and it is not releasing much as it breaks down as a mulch. And any nitrogen responder weed pigs weed, lambs quarters are growing slowly because they are starved for the nitrogen. And the soil is growing away and fixing quite normally. And a serious disease for soybeans and dry beans, including the heirloom common beans such as a cranberry bean and that is a great success. They use a higher seeding to overcome some of the challenges with crop establishment. And there is 1900 acres of organic cereal grains and very complex rotation and he is constantly adapting to meet the challenge of

what ever weed or soil health challenges arise. He's working with the Cornell researchers that have established this successful soybean after a no-till rye sequence. And they are building on that to create longer sequences of crops that can be grown organically and here is an example. That was rye plus Austrian winter peas drilled into a stubble left by a harvest of Sedan grass forage. No-till drill and established very well and apparently he found that stubble and the untilled soil surface if you have drilled the drop in well, it actually provides a favorable microenvironment for better establishment of the cover crop. And then the rye is benefitting from the nitrogen contribution of the peas, so you have a vigorous cover crop that can be crimped for the soybean planting. Here are a few other examples of sequences that he has found useful for a particular weed problem. He found that growing barley, the harvest occurs right when the Canada and sow thistle so when the combine comes through, you will get a good control of the weed and production. Adding a winter grain to a soybean and corn rotation. If you have wild mustard in the wheat, let's grow a cover crop for that. One thing he noticed is in the picture there is some annual weeds coming in between the drill lines of rye and peas. Things like dead net tells and chick weed. And those weeds are not that big of an issue depending on what you are growing the next season. Here is another exciting research advance. There has been a number of studies, again mostly through the organic research and extension initiative. And that is the genetic variability in how well the crop can deal with the weeds. It is mostly through has been at this time of growth

characteristics and vigorous, tall, grasses and rapid wide canopies and broad leaves and vegetables such as carrots. Not so much related to the L E Lopathy. And he found some that were competitive to weeds and much more profitable as organic rice production. And there are several efforts to breed better cultivars of winter and spring wheat for organic production. And one fortunate target traits is that vigorous growth and tillering and ability to get ahead of the weeds. There is now a cover crop breeding network nation wide that is on the third grant through the organic extension initiative and one of them is to develop winter cover crops and with increased competitive ability against weeds. So another interesting finding out of Cornell is that sometimes you can grow one species of cover crop for forage crop, but if you use multiple cultivars you will get more weed suppression than if you grow a single one. So there is complementary growth habits going on within the species. Here are a few new and emerging technologies that I think are advanced. There is a selective cutting tool that can remove the weeds from a standing crop before they set seed. This will not take it out completely, but it is a device that some researchers in Maine have developed. They can go through a wheat field and knockout the upper part of the weed so it will not set a bunch of seeds. There are others that I mentioned, stacking tools and combining tools. And also multiple practices such as growing a cover crop and following with tarping to ensure the cover crop termination and some of the emerging weeds and sometimes they combine flaming and cultivation and that gives you better weed control. And here is a website that is

available to farmers to engage in a dialogue sharing and observations and findings and problems and solutions around the weed control. If we can get more weed control for less disturbance that is a step in the right direction. Electrical weed control and these zappers are pretty much in the experimental stage, but refining for both grain and tree crops and taking out the weeds, invasive weeds that come in around orchards. And I mentioned the herbicides and there is precision spray technology and combining it with field pea cover crops and organic dry land grains and wheat production. This is in the interior pacific northwest. And this is showing some considerable promise and we may see some of these techniques available to the organic producers. One of the things that I want to mention is that this conventional practice and so you grow one and then you rest it for a couple of years and this is very hard on the soil health even if it is done no-till or with herbicides to keep the weeds down, soil organic matter and soil health declines. A lot of organic farmers, his name is escaping me at the moment, Doug and Anna Jones crab tree, they have 7 or 8,000 acres of organic grains and far from weed fallow, they keep something on the lands, every year as much as of the year as possible. Their rotation includes 15 different production crops that they sell, special grains and oil seeds and pulses and about 10 different cover crops and they are integrating various till age and no till age approaches to managing the weeds. This is a very demanding environment so a lot of exciting developments in that part of the world. So hydro mulches are in development and they will have to jump through hoops to

get N O P approval because there are still some Petra chemicals to what is out there today. They are making use of these and finding them pretty effective. There we go. Just a very quick summary and I will open it up for questions. So the prevention level and identifying the weak points is the key. Good sanitation, clean the tools between fields and avoid bringing new weeds on to the farm. And I was saying the four principles that NRCS has been teaching for the last 10-15 years are an excellent platform for both preventive weed management and good soil health. Keeping it covered by what you want there, fill the soil with living roots, shallow, deep, fibrous, the more roots of beneficial and desirable plants are there, the less room that the weeds have and they will not get the moisture and nutrients to be a problem. Limit the soil disturbance and both the inputs and the till age just as judiciously as you can. Managing the nutrients and the drip irrigation and banding if you need fertilizer boost. And then varying the timing and the type of field operations. The control level, you want to deplete the seed bank in the ways that we discussed as tarping, solarization is another method that can kill the surface weed seeds, as the temperature rises, they will come up and it is too hot and that is it. Then you want to get them before they flower. The creeping perennial, and this is something that Dr. Charles Molar at Cornell university developed and talked about in his book about organic weed management. If you hit them at the three to four-leaf stage you will set them back. And smart cultivation, we discussed that and then you want to use the alternatives as much as possible so that you are not cultivating and beating the soil to

death. Thank you very much and I will open it up for questions.

>> Great, thanks Mark. We have a lot of questions. And what I thought I would do some of the questions might be answered through the presentation, but I will go through and ask them if not. And we can circle back to make sure that all the questions are answered. We have until 2:30 as long as folks can stay on. And we'll just jump in here.

>> Can you share any information on pasture weed management or resources to share?

>> Well, I would say that really good rotational grazing would be the best way. If you leave the animals in for a long period of time, they will tend to eat what is tasty to them. A pasture weed is something that they don't like because it is prickly. To a cow, lambs quarters or pig weeds in there. They will clean it up. They are delicious. If it is spiney amaranth they will say ouch. If you high stocking density and in a small area and for a short period of time. What grazers have said and I'm not an expert in this, but in high-skilled grazing management ranchers and farmers. They say you want to take half and trample half, you want the field to look trampled down, but you want half of the biomass still there. All the weeds because they are in such a tight spot, and they have all of this forage for a short period of time. They eat down everything. Whereas if you have them in a large area where they can pick and choose that is where they are more selective. You have to be careful that you don't have a build up of highly toxic weeds and sometimes the animals can become sick eating them. There are a few biological weed controls for some of the invasive exotic pasture

weeds. But I think that intensive rotational grazing because what happens is when the desired vegetation has that short hit of intense grazing and trampling but is allowed to keep some of the biomass and recover quickly, it keeps the upper hand over the under desirable weeds. That is a partial answer.

>> Great, thank you. I don't know if you covered this but any thoughts about relay intercropping?

>> That is an excellent technique. I didn't have many examples of it shown here, but I have seen it done in the pacific northwest. Where it is hard to establish a cover crop after a fall harvest. What happens in the Mediterranean climates is you are growing the vegetables all summer and you are doing it by irrigation because it doesn't rain and it is pretty hot. And then when you're crop finishes, you have a rapid transition from almost no rain to heavy rains. If you get it just right, you have the first few light rains and you can get a pretty decent stand. But if the rains come in late and it is too close to winter you don't have time to get started or if the rains starts early, the ground is too wet to get any equipment in there. It is tricky. So they have started to intercrop clovers or other things while the summer vegetable crop is still growing. There are many different ways to do this, there are some researchers in Cornell that have developed some implements that can go between the rows of corn or soybeans and drill in the cover crop. The other way is to do it broadcasting into the soybean crop when it is about to drop the leaves, then it drops the leaves and you have the nitrogen rich leaves helping the the cover crops to come up. You don't knock the cover crop out when you do the

soybean harvest. There are a lot of ways and Cornell is really good at researching this. It is where the season is so short that it is difficult to get a cover crop in.

>> Very good. Seems like flaming is just as hard to harm the soil health as it would be to put on any herbicide. Is there any data on this?

>> I have to think about it for a minute. The thing about flaming is that you are only flaming at a level that causes the water inside the weed tissue, above ground tissue to reach the boiling point or even reach a plant killing point. When you flame correctly, you can't see until the end the day or the next day that you've damaged your weeds. You don't charge the weeds. So the amount of heat to which the soil is subjected is likely to maybe affect your soil life about one or 2 millimeters deep is my guess. So yes, there will be some slight cost to soil health, it is less than soil solarization or things like anaerobic soil and these only cause a temporary shock to the biome and the suppression and beneficial organisms tend to unbelievable bounce back the fastest. There is some evidence that at normal field use rates it can significantly reduce the microrisal populations and root colonization by using the glyphosate. So my thought is that it will be more harmful to the soil health than the flaming. If the weeds look like they are torched the moment that you are past, you are moving too slowly or the flame is too intense. You need to make an adjustment. It is just a quick pass to boil them alive not burn them alive.

>> Another impact question about --

>> Lindsey?

>> Yeah.

>> I wanted to jump in real quick in regards to the flame weeding, and is there research or data on this? It is maybe not specific data on flame weeding in agriculture settings, but there are studies that highlight the differences between soil microbial life and fungal activity and species richness and diversity in prescribed fire versus this in the soil. And it doesn't affect the soil richness. So flaming is even less than that. I can plug in some of those links later.

>> Guys that is really interesting. Because I now recall that there were studies that prescribed fire and low intensity natural prairie fires can actually build the soil health by creating the biochar. It is a relatively brief shock to which the soil recovers, I would imagine some of the bad wildfires that are plaguing us, will be devastating to the entire A horizon of the soil.

>> What do you think the soil health with the landscape fabric and how it impairs the soil health?

>> Landscape fabric I tend to favor more than the plastic film mulch. The landscape fabric breathes and it is permeable to rainfall, although a heavy rain will run off. It is not as good as I used to think it was. But it is porous and designed to block light, but not air or moisture. Certainly the best thing for soil health is living plants. And in some ways, I would much rather see a weedy field than a clean tilled field because the weeds are feeding the soil as long as they are not overwhelming or doing serious damage to the production. They are nature's cover crop. So if you have the landscape fabric and you are blocking everything and if the crop is

rigorous and if you have a diversity system and then if you have a row of tomatoes and then lettuce and then strawberries or whatever. You will maintain a good soil biota. If you have landscape fabric over large areas that is a good question when it comes to the tarping technique, where you say we have cut the cover crop and we will cover it with opaque tarp for a month. There is probably some cost to soil health there, but you also not tilling that merits research I would say, however I would say that on the whole when used judiciously just like the cultivator that it can be a good weed management tool.

>> Very good.

>> Is Sedan grass considered an invasive plant?

>> Good question. I don't think in itself is, but however it has a nasty habit of crossing with Johnson grass, which is an invasive weed and you get a Sedan grass that makes a rhizome. We don't want that. So if you want something that functions like sorgum Sedan grass, use pearl Millet. It has a very similar habit of growth and is much more tolerant to soil infertility and even more tolerant to drought. And it has the same capacity to send the roots really deep and it can clean up nitrate down to 5 feet. It can fix small amounts of nitrogen up to 30-40 pounds per acre if the soil is low in nitrogen. I think it is one the best cover crops in there. If you have Johnson grass grow pearl Millet in the summer I would say.

>> Has there been research into using the Sedan extract ant as a --

>> It will probably not be as effective against all weeds, I know it is a pretty strong allelopathic chemical. And for this one particular weed

it is a really good component of the crop's ability to suppress the Canada thistle. I know that there have been, I think it is actually from spotted knapweed, which is in itself an invasive. And I think there has been an effort to extract that as allelopathic herbicide.

>> Is there a particular variety of rye that suppresses white mold?

>> I don't know if there are variety differences, I think the species as a whole tends to be suppressive towards it. I don't know how powerful it is for whether it varies by cultivar. The research team could be looking into that, but I don't know what the results are.

>> Okay. Next question, very common question from NRCS staff about soil erosion concerns particularly on the steeper slopes like 6-12%. Any thoughts on the organic's response to helping folks and tilling on steep slopes.

>> If I say that the slope is over 5% I say consider perennializing it. We need to get all of our moderately sloping land into perennial cropping systems. There is many horticultural perennials and vegetables and common berries and fruit and nut crops. That or either pasture or silvopasture where you have useful trees integrated with pasture that are providing shade for the flock and all of those perennialized systems sequester large amounts of carbon and they save soil and they can help diversify and improve our diet. We humans are eating too many refined products from corn and soybeans and probably not enough fruits and nuts from the horticultural perennial that is could be saving our climate. I think that is important and yes, organic growers need

to be encouraged to do that on their moderate to steep slopes and I think conventional and all corn growers and first to get the wheat and the alfalfa into the rotation and then the hedge rows and forest farming and integrating tree crops in any way, silvopasture, I think there is a huge potential for both organic farmers and let's find the most beneficial way to perennialize it. And it could be replanting the native prairie plants in pastures.

>> Can you share a link to the cutting tool website that you mentioned?

>> Let's see I would have to find that. I will have to find it, but I can send it later.

>> Is there any other finding to improve the fungal habitat within the soil?

>> You mean whether perennials do that?

>> Has there been any research or focus on integrating species to improve the fungal habitat in

>> I am sure that there is a lot of research going on on how different systems affect the soil microbiome. And I can't think of any specific results off the top of my head but it shows that the woody perennials especially support a fungally-based microbiome. And you have heard the woody web. This is different species of trees in the forest and help them to exchange resources and even communicate in a way about pest threats affecting the edge of the forest and things like that. That is an advantage of no-till, especially one that is not too dependent of glyphosates. Getting back to the question. I don't know that there has been any studies specifically about the evolution of the soil microbiome from

transition during annual crop production. But I think there is a lot of research that would indicate an improvement in the fungal community.

>> Good. Here is a specific question about any research on gypsum weed?

>> I don't know of any, that particular weed can be a pretty bad problem.

>> Another one on bind weed and thistle pertaining to sheep and goats?

>> Whether the sheep and goats can control it?

>> Yeah.

>> I think that is one of the strategies being explored by the creep stop project out of Montana state. It is actually a multistate and multiinstitutional pretty large scale endeavor to provide a good I P M for those two weeds. I don't know how nourishing and edible these two weeds are to the livestock. That is something that we have to check. I know that hedge bind weed that grows here in the east is considered very toxic. I don't know if the field bind weed is as well too. That would be a concern.

>> Good, how can I convince non-organic producers to consider using cover crops when they believe that it will reduce the future yields?

>> Showing them a survey that indicates in a good year they don't affect yields and in a tough year they improve the yields because you are building the soil's capacity to hold moisture through a drought. And building the soil's capacity to provide nutrients to the crops and it is a short-term, long-term thing. If

you transition from not cover cropping to cropping, the first thing that it will do is feed the soil and you may have to then feed the crop with concentrated fertilizer either with the organic or traditional fertilizer. But how do you convince farmers to do cover crops, I will do a cover crop webinar in month and you will see how a cover crop on our little community garden from our home community saved us from having a 3-foot gully, our river was 3 feet deep and the day after we planted potatoes, they got out and planted the sore gum Sedan grass and we had 3 feet of it. It rained 7 inches in a day after another 7 inches in the proceeding week or two. It was crazy around here and when the water went away, it looks like we had roll crimped the cover crop, but we did not lose a single shovelful of soul. So one way or another everything was held on to, and the cover crop even bounced back and kept growing. So I don't know, maybe share that story. Invite all of the farmers to jump on the next webinar.

>> Folks as you know in the great plains have moisture issues and that is an important issue.

>> That is moisture issue in a low rainfall environment that is the one cover crop hesitancy that I can fully understand and relate to and all I can say is that the Doug and Anna Jones crab Tree are keeping the ground covered and they are staying in business through drought and climate change issues there.

>> I would echo that, they are right on the Canadian border and they do keep the soil covered and it is pretty impressive.

>> Now they are integrated livestock and that is great too.

>> I wanted to also mention that I just plugged in for that person

who was asking about bind weed and thistle, I plugged in a link about sheep grazing on bind weed and also the importance of pigs because they are better at digging up the roots. That is in the chat too.

>> A few more questions, are you familiar with Peter Andrews in Australia and his natural sequence farming.

>> Oh no, that sounds interesting. That sounds a lot like the area that they are doing here. Because they are taking a very strategic approach to rotation that is responding to what they see in the field. And what seems to give the crops and the soil benefits and keep the weeds under control.

>> Very good. Would you recommend soil testing or P H testing after each cover crop cycle?

>> While you are building up a soil that has been depleted or you are addressing known nutrient imbalances I would recommend soil testing at the same time every year. But once you have soil in good health and you are pretty much optimum levels you can probably test every 3 years and you will not see the effects of a cover crop directly on the soil test so much, it is more building soil biology and it is the soil biology that slow releases the nutrients in the crop zone as the crop needs it. We will get into that more again next time too.

>> okay. Back to the sore gum Sedan grass exudate question. It is not using the plants themselves as a suppressant but rather the harvesting of the allelopathic chemicals.

>> Yeah, I understood that. As I mentioned earlier there was an invasive weed and I have not seen the outcome. Yeah, I think

that it would be a long shot and probably not be a very cost effective thing to take the sorgum Sedan grass and harvest this one chemical and turn it into a herbicide product. I think it is much more effective to use that as one component of a strategic crop rotation.

>> Very good. Do you know of any research and development being done for organic approved preemergent products?

>> preemergent. That is interesting.

>> Are there any approved even? I'm not sure of that.

>> Like you would spray something on the soil? I don't think so.

>> Yeah I'm assuming. --

>> One thing that I want to say, that is an interesting question because one thing when I was researching the impact of ago row chemicals on soil leaf, N O P approved pest and weed and disease controls are not exempt from that. There have been some negative impacts of vinegar and Helen A T H O W has a book coming out, and it was a percent, parameter of of microrisal and she found that a use of a vinegar approved did reduce it sentence till age did. That is one example and the copper fungicides that can have adverse impacts on the soil fungi. I would not necessarily want to explore spraying something on organically managed soils to kill weeds before they come up. I think the best way to do that might be one of those alternatives to fumigation where you are creating a burst of anaerobic and that mostly kills offer the pathogens and another one is soil solarization and also the simple tarping or basically the weeds come up and they don't

have any light and they die that way. All of these methods have a relatively short lived shock to the microbiome and the tendency is for them to rebound. It is an interesting research question and probably not high on my list of priorities at the moment.

>> Right. Okay, well I'm afraid we are over time, it has been a great full time hour and a half, we'll look into ways that we can somehow get back to you on all the remaining questions. We still had a bunch of questions in the chat. Maybe we can put them together and post them somewhere. Thank you so much Mark.

>> Thank you you can send the questions to me and I can write up a bunch of answers and when you do that remind me about the link to the cutting tool.

>> Great feedback on your presentation Mark and we will hand it back to Jen.

>>> on behalf of the USDA and the natural resources conservation service, I wanted to say thank you to Mark and Lindsey for providing an excellent presentation today on beating the weeds without herbicides. Soil friendly weed management and thank you again to everyone attending and participants don't forget to provide your feedback and if you selected to earn CE Us please go to the browser window that is open to fill out the form for certification. This concludes our presentation.