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EVENT: USDA: PRACTICAL CONSERVATION TILLAGE FOR ORGANIC CROPPING SYSTEMS

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>> JENNIFER RYAN: Greetings and welcome to today's webinar entitled Practical Conservation Tillage for Organic Cropping Systems. My name is Jennifer Ryan, and I am a Natural Resources Specialist for the

I want to remind you that the use of trade names and the webinar is for information purposes only. The mention of a tradename does not constitute a guarantee of the products by the USDA. Nor does it imply endorsement by the department or the Natural Resources Conservation Service.

We will now begin; at this time, I would like to welcome our moderator, Mary Hathaway.

>> MARY HATHAWAY: Thank you so much. My name is Mary Hathaway, and I am the Research and Education Program Manager with the Organic Farming Research Foundation. Today I am pleased to introduce Mark Schonbeck. Mark has worked for 35 years as a researcher, consultant, educator, and advocate for sustainable and organic agriculture. He works 1-on-1 with farmers and homesteaders, taking a site-specific approach to soil test interpretation and organic soil, nutrient, and weed management for vegetables and other crops. In his capacity as Research Associate with Organic Farming Research Foundation, he develops research-based education materials including a series of practical guides on Soil Health and Organic Farming. These resources are available on the website.
In the past, Mark has led or participated in several on-farm research projects conducted by Virginia Association for Biological Farming and collaborated with VABF and National Center for Appropriate Technology to help USDA Natural Resources Conservation Services programs better serve organic producers. Mark also serves as policy liaison with National Sustainable Agriculture Coalition of which VABF is a member group and writes the policy update column for the monthly e-newsletter. He also has worked to develop policy recommendations to help organic producers mitigate the impacts of climate change on their operations and the communities they serve.

We are very excited for Mark's presentation today on Practical Conservation Tillage for Organic Cropping Systems. I will now turn the presentation over to Mark. Mark?

>> MARK SCHONBECK: Thank you everyone and thank you for the introduction. My name is Mark Schonbeck and today we will talk about Practical Conservation Tillage for Organic Cropping Systems. So, we want to figure out how to use a system that does not have herbicides. How do you manage to keep tillage, intensity and frequency at a level that is compatible with a widely shared goal of improving soil health? A principle that the organic community has held as central since the beginning of history over a century ago.

We are all familiar with the cost of tillage. The increased risk of erosion, the degraded structure or plowpan. Other issues like the loss of organic matter or the damage to soil I. We know that when you stir up the soil you can have fungal hyphae or earthworms. That are damaged. It can damage the soil structures well. Organic farmers are aware of the cost and in fact the level of adoption of conservation tillage of any kind is known to organic or conventional farmers. So more often, conventional farmers would have the continuous no till system.

The National Organic Standards require the producer to select and implement tillage and cultivation to protect soil health and maintain or improve the physical, chemical, and biological condition of the soil. They want to minimize erosion. That is a pretty high bar to set. Since tillage is one of the leading causes of soil degradation.

So, the biggest dilemma is weeds. We do use organic systems or annual cropping systems to keep the weeds under control. So doing too much you will lose soil and not enough in the weeds will grow within the crop. That is continual, a continual concern and a high research priority.

In 2022 the Organic Farming Research Foundation conducted a survey of organic producers to learn more about what they considered to be the challenges and production or other aspects of organic farming.

Tillage emerged as very important among the challenges and two ways; one is controlling weeds. Over 67% of respondents said that were severe hurdles to overcome. 31% mention the effects of tillage on soil health. A similar percentage find it challenging to avoid soil erosion and physical degradation.

Here are a few quotes from the focus groups to illustrate the amount of attention that farmers have for how to reduce the amount of tillage and still get the seed beds prepared and keep weeds and control.

When and why do organic farmers till the soil? To prepare the seedbed for planting. So, for organic farmers the type of soil that is used is usually not soluble and they are most effective if they are mixed into the surface and not on top. Those require microbial action. For those nutrient resources. Site disturbance to the surface will stimulate the microbial release of nutrients. Especially nitrogen mineralization. Of course, you will need soil condition at the surface that facilitates seed soil contact with planting.

We have talked about managing those weeds and covering crops as well. There are sometimes when the soil physical properties are such that a tillage operation is needed for the surface or subsurface compaction, lifting, or chiseling the tillage to open that up. Or improve the aeration or improve water infiltration.

There is an example on the right-hand side is a genius way to use the Rototiller that will work one inch deep. This former spin seeds cover crops onto the field. After initial tillage. By broadcasting the seed and then doing a very shallow pass to plant the seed and one pass.

The small, seated crops I think that's arugula and the center and on the right-hand side are carrots. They require a fine seed bed to have adequate seed and soil contact. That is an example where tillage, it does leave vulnerability between the time that the bed is tilled or planted and the time that there is enough crop to protect the soil surface.

All specialty crop farmers that grow these crops must deal with that. So, getting the most out of the organic nutrient sources is important. Leaving compost on the surface you do not have the greatest benefit because you need microbial action to move their relatively insoluble nutrients into the compost. To the root zone. To liberate the nutrients for plant uptake.

You have the cover crop and that leaves residue on the surface. That can work well sometimes, however if you are looking for nutrients from the cover crop to the next crop, they will be released more effectively if worked into the top couple inches of soil.

So, for weed control, obviously as everyone knows is a timely shallow cultivation will take care of those weeds around the crop so the crop can have a head start. The next four pictures across the top of the slide show four of the most stubborn perennial weeds. These that spread I shallow, underground rhizomes or on the surface. So, Johnson grass, Canadian thistle, this is one of the most aberrant. It is actually one foot down. The roots also grow sideways to make thousands of new plants. We have fields

of bindweed. Then we have nutsedge as well. So, in these cases if you till once you propagate them. If you then let each bit, get to the point where it has three and it is expending energy. If you hit it with a cultivation sufficient to sever the top layer, you deplete the underground reserves. It may take several passes. This is a case where you have to make a compromise between handling a stubborn weed and minimizing tillage impact of the soil.

The photo on the lower left is an example of the soil that has a very large weed seed bank. There are millions of seeds in the soil and every time you prepare the seedbed a lot. You get flushes of weeds. And may be extremely difficult even with diligent cultivation to keep up. There is a technique, and it requires intensive tillage. If you take a mold board plow and go 4 to 6 inches deep, you do not want to go deeper. Shallow plowing is less disruptive than this deep plowing. So, you want to stay within the topsoil. If you bury the seeds for inches deep, they cannot emerge. Those fine seed weeds. Then you have to avoid deep tillage or inversion tillage for three years. So, you let the seeds sit down there until the majority have died.

Here are some tools and techniques that organic farmers use to reduce tillage intensity. The first I would like to touch on the two conservation practice standards that purpose pertain to tillage and residue management. So, we have CPS 329 no till. There is no full of tillage. The total crop cycle STIR must be less than 20. That is adding all of the field operations, planting, injecting manure, minimal strip tillage or whatever is done. From the seeding of the production crop until the seeding of the next crop. With that rotation. This is very difficult to sustain through the organic annual crop rotation.

We also have CPS 345 reduce tillage. This does not allow full-field tillage. As long as there is no inversion. We need a non-inversion tool. There is a total crop cycle STIR of less than 80. There are many organic farmers who reduce tillage to this level. At least some of the systems will fall within the criteria.

Here is a relatively new tool that a lot of organic farmers have found to be valuable. The power harrows. Instead of using a Rototiller, these rotate horizontally. Around a vertical axis the soil is stirred three inches deep or so. It is good for making seedbeds and incorporating light residue. It incorporates amendments and light residues, like if you plant one production crop after another. It does take out small weeds. It leaves most of the soil profile undisturbed. There have been a number of studies about the effects of different forms of tillage on soil life or soil organic matter.

A larger category of shallow non-inversion tillage, not going deeper than six inches or disturbing the soil profile. Does considerably less harm to soil life. Versus the mold board plowing which is very deep at 8 to

10 inches. The power harrow, the STIR is from the RUSLE2 program. This one is number 21. So, a couple of passes this could certainly be during the course of a Cropping cycle. This could fall within the criteria. 345. Another important point for the power harrow is that they maintain better soil organic matter than plowing. They maintain a higher microbial biomass including fungal or bacterial in the prokaryotes. That microbial biomass is about two times as much in a reduced tillage non-inversion system. Then a field plowed each year.

This is a high- speed disc. This is a modern design with a disc tool. A lot of organic growers are finding this to be a valuable tool. They can incorporate the cover crop and prepare a seed bed in one pass. You may need to get one more pass if you have a certain crop. This has a STIR of 41. With a rolling basket. It is efficient for larger scale acreage because the forward speed is 7 to 12 mph. It is hitting the soil harder but on the other hand when you have a disc or Rototiller in your moving fort at higher speed, any particular is subjective for brief instant to the tillage action. As if you are driving a spade a Rototiller at a slow speed. Each chunk of soil is beaten more and impacted many times by the rotating. That can pulverize the soil surface.

There is another tool and I think I have full photos but there is vertical tillage. You have little lateral movement in the soil. You have vertical loosening from a depth of 2 to 6 inches. The coulters with a 0 angle the STIR value is low. You are still at number 19.

This also is an interesting and invaluable tool. These are in areas where the dryland of field crop production is. Especially weeds or cereal grains growing 10 to 20 inches a moisture year. It undercuts vegetation just below the surface for cover crop termination or weed control with high residue cultivation.

And the residue is left on the surface. You can see from the pictures by the University of Nebraska how the soil surface is protected and greatly reduces wind erosion. It leaves a deeper soil profile undisturbed. If you are lucky enough to get rainfall in that climate, the force of the raindrops is broken by the residue. So, the porous structure of the soil is undisturbed. You have better soil moisture storage.

The studies from Nebraska show that terminating the cover crop ahead of the field crop soybean or corn, the blade plow was yielding higher crop yields. It saves moisture and reduces wind erosion. Compared to just running a disk.

We also have a non- inversion tillage for a small-scale system. This makes weeds very easy to pull out.

There is a moderate impact deep tillage. This is a speeding machine. It has a STIR of 31. It has a rotary or reciprocating spade. It does not pulverize the soil; it also does not create tillage pan. It mixes rather than inverting the soil. It can incorporate cover crops or sought in one pass. In Washington State University there are studies on organic vegetable systems. They have found that the compared with the disc which is the standard full tillage or conventional tillage. It can improve yields.

There is strip tillage where you are telling only a part of the field and leaving 70 to 80 % of the soil surface undisturbed and covered with residues with what you have.

Here are crops that were grown in a strip till situation. On the left this was with a small walk behind Rototiller. The former still bets on five-foot centers with a 20-inch swath. The alleys were mowed until the summer heat slowed the growth of the winter rye. The tomato crop was established in the strip. On the right-hand side is a peanut crop in a narrow strip till system. One of these implements was used to prepare those roads.

One of the things about strip or ridge tillage there have been studies verifying the particular benefit. This is what they call soil functional zone management. We are wanting sole disturbance where the crop will grow. You leave the intro rows undisturbed and if there were high carbon cover crops or residues, they are keeping the nitrogen levels down and you slow the weeds down, but you allow the undisturbed soil to build the structure or sequester carbon.

Another way to do this is to plant those cover crops, and you can plant legumes or crucifers. In the other rows you can plant crops to cover the weeds.

So, there are organic rotational Noto systems. This is based on a high biomass cover crop. We want to get these established and the first step in this is to grow a high biomass cover crop to maturity. We need that to reach a stage of maturity where it is flowering in full bloom. The three cover crop mixtures on the left, the barley and crimson clover. And then we have the pearl millet and sunhemp or cover crops that are ready role. These are still vegetative.

The next step is the termination step itself. Most often the systems use a rolling crimper that had been improved over time. There have been good successes with these. Sometimes you can terminate a cover crop just by flail mowing very close. The advantage is you can terminate those cover crops quickly. There are cover crops if you plan in the late summer like pearl millet, they have a tremendous biomass in the

winter kill residue is sufficient to cover the ground. However, if you see that mess on the right that would not be great for a gardener like me.

There is also the rotational Noto for organic crops. You will have to manage weeds. If you have a three-ton per acre biomass you will have good weed suppression but eventually there may need to be weed control. Especially for a long season crop. There are some that can work and high residue. Another approach is to use opaque weed mats or landscape fabric. In this case they were laid between the rows. We will talk about a specific example in a little bit. This is dependent on the rotation.

This is a challenging system. Some have had success.

But there are some reasons why a may fail. If your cover crop is thin. If you can see that the ground would be too thin to get very good weed suppression. If you have a very heavy weed seed bank like the second picture. Enough will get through that cover crop it will be very difficult to keep the weeds down in the organic crop. Perennial weeds are stubborn, and they will come up through almost any cover crop! If you are in a rotation of a sod crop, with annuals. Or if you are in a vegetable rotation, you have those cover crops rotations, or three years of sod, after you break that sod, you have chunks of that coming up.

Another thing that could happen is if the cover crop is over mature, look at the two pictures on the lower left you will recognize that one is sick successful squash crop. On the left the rather stressed and starved crop of the same squash overwhelmed by the barley and crimson clover. That was prime for role crimping. So, when they were crimped the same day. The results were very different.

There is another difficulty with roll crimp, nitrogen mineralization under the cover crop residue will tend to be slower. In a very warm climate, with the sandy soil, the slowdown can be very unofficial. They can time between the nitrogen crop in those needs, but in most cases, it will be slow down so the crop will have to have more supplemental nitrogen to maintain those yields.

Here is a specific example of a study that was a conservation innovation grant, this was awarded to a consultant by the name of Tom William who had been in organic farmer for many years. Three large vegetable farms, Park Farming Organics, Full Belly farm, and Pinnacle Organic growers. These are midsize but they were committed. They were trying to reduce the tillage including highly diverse cover crops. Trying to reduce the tillage with role crimping. The outcomes, the good news is that they all reported that these steps to reducing tillage and improved soil health. They found more earthworms, water infiltration was better, the tilth was great. They are also a yield a drag and that was with the nitrogen

limitation. So, what is going on is that they are all dealing with a Mediterranean climate where although wearing fall occurs in the winter. But all production is in the summer. It also depends on irrigation or sufficient moisture. To mobilize those nutrients.

The nutrients in a roll crimp cover crop are not moving to the roots. They found that if they put plastic mulch over a drip line after the no tilt or minimum till cover crop termination, they could restore those yields. All of the farmers were concerned about the plastic waste with that approach though. That is a serious concern.

They have tried several approaches to improving mineralization without waste. You have the option to aerate the drip irrigation. They are trying in row soluble nitrogen boosting. Something called corn steep which is readily mineralized will nitrogen. There are forms of nitrogen that are allowed in small amounts. They are also looking for bio-based, come compostable mulch. When is the approach likely to exceed success? If you have a high biomass, we freely cover crops. If you have a warm, rainy climate. If the season is long, you will have lots of time to grow their bio crop. If you have healthy soil and good tilth. It does work better in sandy soils that warm up weekly.

If you are planting a strong nitrogen fixture into high carbon residue such as rye or wheat, this nitrogen fixing cash crop is self-sufficient. That has worked very well. In many cases. The farmer's experience and the right equipment is vital.

Some of the tips that emerged is that it may take two times with the roll crimper to ensure termination. You also want to make sure you adjust the planter for high residue. You might have to add weight to the toolbar which could be very helpful.

Let's take a broader look at soil disturbance which is what we are trying to get away from with tillage. So, tillage is physical disturbance of course, and we know that it is damaging physically to organisms. As I mentioned, shallow tillage reduces harm and if done carefully could increase microbial biomass in activity versus the inversion tillage or no tillage.

A biological disturbance occurs if there is a long gap in the rotation with no living roots. This could cut off the food supply for soil life or increase the risk of erosion. Research has found that if residue is removed that is very detrimental. With chemicals we have pesticides, herbicides, etc. They have adverse effects on soil life in soil organisms. In some cases, the impacts on microbes, or earthworms, may be greater than that of routine tillage.

We are looking at these approaches to reduce soil disturbance. The question of soluble fertilizers, it turns out, is not so much that they are soluble fertilizers, as in fact when farmers did end on soluble fertilizers, we see the system receives less than the soil amendments. That results in stress on the soil life. There is that imbalance.

If you take a more expanded look at the National Organic Standards on tillage or soil health. In addition to selecting tillage in cultivation to protect soil health, organic farmers are required to manage soil fertility with inputs and rotation and cover crops. To maintain or build soil organic matter. The purpose of crop rotation includes organic matter in preventing erosion.

So, soil conditioning index or SCI has these considerations in organic production. There are three components one is related to this soil and tillage intensity rating or STIR. You also have SOM losses through erosion. That is based on the crop residue, cover crops in all organic inputs minus the expected organic matter decomposition. That is based on soil type, climate, or management factors. There is also the issue of erosion. That is a serious aspect of soil organic matter loss.

So, for example if you have this open field, you get these terrific reigns with climate change, in the field may be in great danger of looking like the picture on the left-hand side. On the right-hand side is an organic farmer who is working on a 10% slope. However, has organized the field into a series of berm and swale terraces. The terraces are perennial vegetation. It stops that erosion.

Another example is cropping rotations, we have the conventional system may be with corn soy with winter fallow. Many organic crop rotations include winter covers in a cereal grain over seeded with perennial legume grass forage and return more organic matter to the soil.

The lower sequence will have a positive soil conditioning index with the organic system because there is greater year-round cover of that living route.

So, the comparison of the three cropping systems one is organic, one is conservation agriculture, and conventional. So, talking about organic and conservation that use the best regenerative practices. So, the tillage intensity will be lowest in the conservation system. It takes the approach of eliminating tillage and uses chemicals when we need to. The organic system says we say no to synthetic chemicals, and we used tillage judiciously as needed.

Both of those minimize the bear fallow and both use organic amendments. That is part of conservation agriculture when it is fully implemented. To seek out compost manure or other sources of organic

nutrients. Also reducing the dependence on the soluble materials. In the conventional systems, as practice through the 20th century and today. The living route in diversity is limited often. Both the pesticide inputs and tillage intensity can be high. That is where you get the negative soil conditioning index.

Let's talk about a few farm stories. We want to reduce tillage intensity in organic production. A few tips for developing a strategy. You have to start with the sound soil health system. That is required by the organic standards. You take every opportunity to reduce the tillage. Be clear with your goals for tillage operation. Adjust the tools for the job. One thing that a lot of the advanced organic farmers have learned is to rotate the implement and working depth. To prevent the tillage hardpan. It can vary the type of impact so if you do not need a high-impact operation you can do something with lighter impact. As soon as you till also plant the next crop without delay. The one exception is if there is heavy weed pressure where you need to make a stale seed bed and wait for a few weeks. And then hit that with a light shallow tillage. To take out those weeds.

For the most part, a lot of farms talk about thickening beds. Prepare the seedbed and then plant the next crop. It is also important if you look at the entire farm landscape, try to think of perennial enterprises that you could put onto the steeper land that is erodible. It could be Orchard or agroforestry approaches.

It often requires us to have an adaptive approach. You may use the blade plow if it is too wet or too dry; you have to find another implement to get the job done. You do not want to damage the soil. When it comes to weeds use an ecologically based weed IPM to reduce the need for cultivation. You want to have strategic rotation and relay planting to thwart weeds, minimize bare soil, and reduce the number of tillage's passes. You want to use non soil disturbing tactics, like flame, mowing, grazing, etc. If you do have to do aggressive tillage like taking out a stubborn perennial with a few passes to knock off the weed growth, hit it with an aggressive weed competitive cover crop. To increase that we control. On small-scale operations it is a handy technique to use tarps or manual tools to manage the weeds in the cover crops.

So here is a farm story. This is a Rough Draft Farm in Kentucky. They have an intensive mTight vegetable rotation. There is an intensive rotation with vegetable rotation. These are a series of crops shorter than 60 days. They plant one after another. They maintain the living route all the time. They have season crops long season like tomatoes, garlic, winter squash, etc. Then you go into the popcorn. They use

manual tools such as the broad fork when needed. Here are some of the soil health or tillage practices. They use the broad fork to open the soil on average once a year or less. Otherwise, those are raked into the surface with the amendments. They do not pull out the spent crop. They cut those heads off, they do not pull the remaining plant. They cut it at soil level to let the roots stay undisturbed. That is a lot of maturity to leave in place. They are now planting living covers in alleys to stop the erosion and provide traffic between those rows. It protects the soil's health. You prevent the wash way. They have entered cropping tall and low, deep, and shallow rooted crops. They also rely on plants. Like the radish and summer squash, the summer squash can grow big, and they follow the radish with green onions. That will go later in the season when the squash is finishing. They take this washout. And plant Chinese cabbage. So, in the relay system you have continuous living roots. And harvestable crops. They have good yields, and the soil health remains good.

Here is an example from Georgia we have Brian Hager who manages two acres of organic vegetables and strawberries, with black landscape fabric tarps. He started out with depleted farmland were most of the topsoil was washed away due to the Gulf of Mexico decades ago. If you see red clay at the surface, you have lost the A horizon. Clay is natural in the B horizon. He had oh four-year rotation with winter cover crops. One is a full year of cover. When he terminates the cover crop, he mows down, and lays the fabric. He lays out the fabric by planting holes. He uses that and replaces that solid fabric that was used to terminate the cover crop. He uses fabric with holes for those crops. You see those strawberry crops within that landscape fabric. After harvesting the broadcast amendments and cover crop seed, they use a Rototiller with the PTO off as a Packer. A month before planting, He lays the fabric. He removes the fabric and then adds fertilizer, within drip line or fabric with those planting holes. Generally, he uses an infrequent shallow tillage or broad forking. This helps return those residues to the soil to keep the soil well fed. He has pulled up the soil that had been eroded down to the horizon and now has 5-8% organic matter. He has found that cover system very successful.

We have another example near Cape Charles Virginia with Mattawoman Creek Farm. They have loamy sand and low SOM. They have a tight crop rotation of diverse vegetables and cover crops. The cover crops are mowed and incorporated 3 to 4 inches with organic amendments at moderate rates. The Rototiller is operated at a very low PTO speed in about 2.5 mph tractors needed to protect the soil aggregates.

So, all residues will return to the soil and he uses subsurface drip irrigation to encourage the per roots. This is an interesting strategy. If you have deeper roots, you have drought resilient crops. You also have

the active root in a micro biome building those organic matters deeper into the soil. He also has developed sandy soil with visible crumb structure. The SOM has increased 2.2 %, which is excellent! Most over there are 1.5 or so. The soil fertility has steadily improved in the crops no longer need fish seaweed fertigation. The soil test has not exceeded the optimum range. The soil gets better every year according to the farmer.

Here is another form up in Huntington Vermont. Burnt Rock Farm has 35 acres of mixed vegetables. That is a lot harder to imagine working with that and no till system. Vermont has very strict rules to prevent excess phosphorus use on soil. To threaten the water quality. There is a strict water quality limitation and how much compost he can use. He has developed an intensive cover cropping system. This is the field he is restoring, it's a hayfield. You can tell that the massive cover crop is 57 days in the northern location. That is very impressive. There are 35 acres every year, ten acres are in year-long cover each year. [MUFFLED AUDIO] this is a good practice to maintain the healthy soil and a tilt system. He has a high speed this that works 3 to 4 inches deep for the primary tillage. This is another way to address the concern with the Rototiller. [MUFFLED AUDIO] The soil is healthy and furred out and gets with yields the profitable farming operation.

This is another example out in Georgetown Kentucky. Elmwood Stock Farm [MUFFLED AUDIO] For several decades since I first met the former. They have a rotation for three years of vegetable crops or feed grains. Again, with winter covers. That is followed by five years of pasture. It is rotationally grazed. They have cows, sheep, poultry... and I believe hogs as well. They cycle as many nutrients and resources on the farm as possible. There is minimal reliance on farm inputs. I asked how much they buy and bring in and I did a calculation, the 550 acres car receives one pound each of nitrogen and phosphorus. And 4 pounds of potassium per acre per year. That is a very low input. They only sell the edible portion. The animals are processed on-site. Only the edible meat cuts are sold. The vegetables are only the edible portion, everything goes back to the land directly or composting. The flat 200 acres are in cropland rotation. The others are in permanent pasture as you see in the photos.

Here is some of the cropland with the livestock rotation. He uses the annual cover crops are disked. The outcomes are that the farm has a thriving, resilient and profitable operation. They have excellent production. The drawdown can occur for the three years under the intense rotation and restored. However, breaking the law to begin that three years of crop production, he does find that there is a burst of carbon dioxide and nitrous oxide. You are mixing a lot of organic matter all that once. That causes the

burst of microbial activity. If you have heavy rain, that is a perfect storm for nitrous oxide. During the sod phase, you can build up certain perennial weeds that he, problem during the crop land period.

He is looking at system modifications to terminate the sod by grazing very hard and then tilling shallow. So, like the Mattawoman Creek Farm, he is using the Rototiller to minimize the soil aggregates. So instead of the soil being slammed against the box, they are turned once and kicked out the back. To drop behind the tractor. At a high forward speed. And if he sees that it is not fully taking out the sod chunks or big sod chunks, he will slow down a bit. So, there is just enough tillage to break up that side. In the spring, they will do a second shallow tillage pass and go into production. The yields have remained high as with the plow disco system. So that is successful. The modification has reduced tillage. He is working with roll crimp winter annual covers with a no till feed grain when practical. It is a learning curve because it is challenging. He is experimenting with an alternative rotation with an annual cover crop grazing and one production crop. You have the rest of the time with the forage crop. The intensity of tillage required is less. So, he seems happy with that experiment.

This is an upstate New York with Martens Organic Farm, they have 1900 acres of organic grains, forages, dry beans, peas, and vegetables. They have silt loam soils. The silt plugs the soil pores after plowing and hinders the roots. It creates these hard pans below the surface. It can hinder that redevelopment heavily. It is a soil specific challenge. They are a part of a study to develop extended no till or minimum till sequence for in production. So, they are tilling only when he really needs it for specific goals, releasing nitrogen, or preparing the seedbed. Or managing weeds. So sometimes they omit the tillage passed to protect the soil environment. So, on the right-hand side we have sorghum Sudan residue that provides a favorable climate for winter rye and pea sow. They have found that there are certain strategies to tackle specific problems. If they have compaction, in the fields with the silt plug, they can use a narrow chisel subsoil on 30-inch centers. And they have forage brassica right in the slots, the deep-rooted crop goes down and brings biological activity into the slot. It improves moisture infiltration greatly. He does use a mold board, but it is European and design. It is shallow and the inversion is partial. Deeper down it is only a partial turning. I am not an agriculture engineer, but he says that the main problem with mold or plowing is that we do it too deeply in the plows are too heavy and it flips the entire profile upside down.

He found that adding winter cereal grain to the rotation makes it a weak competitor. So, changing the micro biome or the schedule of soil disturbance and crop cycles. The perennial thistles including Canada thistle or adding a winter barley or double crop is the barley is harvested at the time same time that the Canadian thistle is most vulnerable to the effects of mowing. And then immediately planting a crop like buck wheat helps to keep that down.

He has come up with some prolonged sequences that he was able to do without tillage in the favorable years when the conditions were right. They planted a barley grain, then Sudan grass forage. They then planted rye and pea cover. A good crop of those combined. This allows then for a no till soybean for harvest. Which could be over seeded or direct sown without tillage to the winter cover crop.

You may need a tillage pass for weed control or soil conditions. So, we also have one last farm story. We have Doug and Anna Crabtree who are with Villiscus Farms. They are very innovative farmers who are drug growing dryland grains, pulses and oil seeds and cover crops. 25 species total. This is on less than 12 inches of rain per year. It is a cold temperature climate. Most of the region is in a wheat fallow rotation. This is a 14 to 18 months follow-up period. They have fields of native prairie strips with 26% of acreage. This makes a complex and complete agricultural system. The other 75% is in the 70-year rotation with five production crops and to green fallow years. The cover crop is terminated at some point to not use up the soil moisture and hurt the next crop. The rotation is stark with a light feeding grain and finds that the ancestral wheats that are successful at organic markets. If you follow that with a green fallow and when he terminates that fallow, then that is the one time that maneuver is spread on the field. That was retrieved from a nearby farm. Villiscus Farms Have started to raise cattle as well to integrate that livestock into the rotation.

So, they have the manure, and the third year is a heavy feeding grain. So, for year 4, 5 and 6 is a diversity of pulses like legumes, peas, or lentils. You also have a life feeding green grain and then the seventh year is the green fallow with the ancestral grain.

With soil health he rotates this tillage type and depth. They have a speedy disk that is 2 to 3 inches and then a chisel plow that has wide sweeps of 3 to 4 inches. He doesn't mold board plow and does not go deeper than 6 to 8 inches every seven years. All of these tillage operations, he waits until 7 to 10 days before cash crop planting. So, when the residues are left, they are still there on the surface until it is time to plant. The planter has sweeps to take out those emerging weeds. You will see in the picture with soil health practices, leaving the residue on the field service and on the right hand of the photo you will see

the green fallow coming up. That sweet clover is used on certain years. The green fallow termination is adapted based on the rainfall conditions. They have been developing severe climate change, some years have had only 2 1/2 inches of rain and other years there is 26 inches of rain. That requires very adaptive approaches to tillage. He can use the blade plow to deal with the weeds during an unplanned time. But if it is too dry or wet, they resort to the speed disc.

So, with composting manure they started this to improve the quality of the amendments. It is on a heavy feeding grain every seven years. They are integrating livestock now into the system. They are doing this in lieu of tillage to terminate those green fallows. There has been substantial improvement over that soil organic matter. There have been very severe climate limitations. It is very hard to grow organic matter when you get so little rain. It is amazing that they have had the improvements that they have been able to succeed under those difficult weather extremes. They have also maintained the soil surface coverage well. They have done this as much as possible in the wide prairie strips. That helps to curb wind erosion.

So, thank you so much, it is time for questions.

>> HOST: Thank you so much. Do you know who does no till transplanters?

>> MARK SCHONBECK: Yes. There were people with the 1890 land-grant and I unfortunately do not know which company have kick that up. I know that they are available. You may find those answers online.

>> MARY HATHAWAY: Yes, I believe there are some publications in the southeast that outline no till devices as well.

>> MARK SCHONBECK: Yes exactly. That is a great publication, and it has excellent information on soil health and history. There are some soils that has been lost there and A horizon. I have seen people grow in red clay with very good years of soil management.

>> MARY HATHAWAY: There are some farmers who do not have to worry about erosion. How much of soil health or biodiversity do you think these types of firms are making compared to operations that have reduced tillage but do not use much. Can we get the best of both worlds?

>> MARK SCHONBECK: If you bring a lot of material off site you can develop nutritional imbalances. You could build up too much potassium or if use manure compost more than the light rates you will have a phosphorus buildup. I think that there is well I would integrate both approaches. You want to be using

organic amendments but not depending too much on those amendments. So organic mulch may not be practical with 100 acres. But growing plants is the best thing you can do for soil health. Overall, you are creating new organic matter in that place. Certainly, you want to reduce tillage as feasible and practical. You also want to use the mulch when it is an official to the system. If you are working with 1 or 2 acres and you have a good source of organic mulch material like leaves etc. Use those. But also, a lot of the farms will also use hand tools like the broad fork to loosen the soil without heavily tilling. Or a shallow tillage or Roto tiller infrequently. I think he may combine both approaches.

>> MARY HATHAWAY: Great thank you. We have another question; this one is in reference to the farm story from Rough Draft. Speaking of leaving the roots, do they leave tomato roots instead of taking those out? I am thinking about diseases.

>> MARK SCHONBECK: Very good question. I am not sure, but if you had a wide enough rotation, you may not have issue with root disease. But you may pay attention to the roots and what you want to do is to be sure that there are breaks and rotation where you are growing ever cover crop that is at best a non-host. Ideally it is directly suppressive. That varies with cultivating and with species of root which is 3 or 4 species exactly. And it is a complex question, and I cannot give a formulaic answer. I always say unless you know that there is a disease problem that the soil microbiology is not going to control naturally. If you have a disease organism it will not necessarily take over the soil if you have a vibrant soil health community. There are some diseases that are viral, and you may need to say that we need to take this out by the root. And burned that because there is a very large amount of disease that has to be controlled. It is a matter of monitoring the crop. You want to determine if that is necessary. Most often I would think that leaving the root in place, but sometimes you have to cut below the surface. If you leave it on the surface, then the root crown could regrow. That could interfere of course. So yes, it is very much on a case-by-case basis. I like the approach. As a gardener I do like the approach to not yank it out but just cut it.

>> MARY HATHAWAY: One more question, are there any examples of conservation tillage practices in organic commercial action?

>> MARK SCHONBECK: More samples?

>> MARY HATHAWAY: Yes, I think we had some but are there any other indicating at a larger scale?

>> MARK SCHONBECK: Yes, that was being tackled by those three farmers with the conservation innovation grant. They are still working with that system and that is a real challenge. But if you are looking at taking a reduced intensive full field shallow till approach. That could be done, for example the 35-acre farm is using the speed disc. That is certainly not known till but if it is limited to once per year it could fall within the reduced tillage criteria. So, I would say reducing tillage in a way that is practical on a larger scale. That is a work in progress.

>> MARY HATHAWAY: Absolutely. Here is another question, do you have any more thoughts on mitigating greenhouse gas emission resulting from tillage?

>> MARK SCHONBECK: Yes the whole thing about mitigating carbon dioxide from the soil, we really find the greatest soil health and the soil that is biologically active and it is microbial activity that is continually rebuilding soil structure in accumulating, " Mineral associating matter." so if you have a vibrant soil biology performing all these wonderful functions, including carbon sequestration, you will see higher carbon dioxide emissions. The question is, is the soil emitting high carbon dioxide? You have been providing organic amendment from outside. And everything you can to optimize that swirl life, infrequent, judicious shallow tillage or whatever you are doing. Then you could say that this is a high emission soil or a biologically active soil. On the other hand, if you go in and read a bunch of chicken litter which is concentrated and can burn the organic matter. Then you till. You get the same high burst of CO2. Then you have stressed the SOM with too much tillage and matter. And especially if you have a bare fallow that is much more concerned with the carbon dioxide. Some of the farmers have said that if you have a solid canopy of vegetables, and the soil is emitting a lot of CO2s because it is biologically active, it actually, the theory is that it can emulate photosynthesis and crop growth. So, you get the soil biology in terms of the CO2. As it goes about growing. And healthy crop canopy is absorbing CO2. It will go into the air and become a part of the global climate problem though. So, measuring the CO2 in the soil you have to look at that in context.

>> MARY HATHAWAY: Great thank you. We have one more question. Asking about how many years can you increase the water holding capacity using organic amendments for Sandy loam?

>> MARK SCHONBECK: I would say that you want to use organic amendments as a supplement lightly to maximize the plant growth. It is the living plants and roots that will be the primary food source for the soil organic matter or soil system. So, the input, what is interesting is a little compost in conjunction with living cover crops or living room while mass in careful tillage or reduced tillage, those together give you

more soil health outcomes than anyone alone. There is a synergy between those effects. Of soil organic amendments. There is a new conservation practice standard 336 the soil carbon amendment. It focuses on the finish compost or biochar or sometimes high carbon residue like straw or chick brush. These have very different effects. But they contribute to building the soil organic carbon. One of the things compost and biochar do is that they anchor carbon or stabilized SOM that is present from other sources. So, building the water holding capacity is improving the physical properties of soil and it is related, as you build the soil organic matter, there is a relationship at each percentage of soil that is organic from 2% to 3%. You increase the percentage of the soil volume that could be water holding Capacity. Another aspect of this soil moisture capacity is how deep can the plant go? Is it an inherent property or a result of improper tillage, not optimum tillage? If you do a careful subsoil and deep root cover crop and reduce the tillage intensity or change the tools. Then all of a sudden, the crops can grow roots up to five feet. That will make a huge difference during a drought! There are studies on the recovery of crops in the southeastern coastal plains. The increased yield could be up to 30%.

>> MARY HATHAWAY: Thank you so much. We have another question on amendments, is there any suggestion on using wood chips as mulch? Would those help to build the soil? We know then you cannot till for weed control, and in new application some tools are not available, do you have comments on using wood chips?

>> MARK SCHONBECK: Wood chips are fresh, or acidic. They also can give off chemicals. So, when they are fresh, I would use them in the alleys. But if they are aged for a year or so, they become excellent fungal food. If you dig those in, they will tie up the nitrogen. If you put them on the surface as mulch for perennial crops and let them break down slowly. They can be highly beneficial. They do help with perennial weed control. But some weeds may push them out of the way and come up anyway. They do have strengths and weaknesses. But it is surprising if you talk about hard wood chips, if you take those the day after they come out of the sawmill or the forced operation out of the chipper. They are very acidic, but if they go through the aging process and breakdown and they feed the fungi they are alkalizing. They are so rich in minerals. You will also have a lot of mineral leftovers. The same thing happens with hardwood tree leaves. It's a matter of balance you need to watch the pH. If it creeps up, you want to scale back. But the best way to maintain soil health is with living plants.

>> MARY HATHAWAY: Thank you so much. I believe those are all the questions that were posted. Thank you so much for the thorough answers. Going deep into those discussions.

>> MARK SCHONBECK: You are welcome.

>> JENNIFER RYAN: On behalf of the USDA and the Natural Resources Conservation Service I wanted to say thank you to Mark and Mary for providing an excellent presentation on Practical Conservation Tillage for Organic Cropping Systems. Thank you again to everyone for attending the webinar. Participants do not forget to provide your feedback about the webinar and if you selected to earn a CEU, please return to the open browser window to continue the process offered by Step 2. Go to conservationwebinars.net to submit. This concludes the webinar presentation. Thank you!

>> MARK SCHONBECK: Thank you.

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