>> Greetings, welcome to today's webinar, the word of soil organisms and research conservation, my name is Jen and I'm a resource conservation services east national technology support center. And I'll be your host we'll get started with the presentation just a minute. This webinar is being recorded.
And today's are in listen only mode and all probroadcast is through your computer.
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Before we begin the use of trade names during any of the webinars is for information purposes only.
The mention of the trade name doesn't constitute a guarantee by the US department of agriculture, nor does it imply the conservation service by the products not named.
And by that I'm going to hand over the webinar.

>> Hi, can you hear me.
>> Jen, yes.
>> Thank you, I'm the research and education program director at the organic research foundation, if you haven't heard of the organization we have been around for over thirty years and serving organic farmers and education and advocacy.
Today I am really excited to be joined by Sean who is a research F O F, he has worked for over three decades as an educator, sustainable and organic agriculture.
And he has helped us produced soil guide books, and he has helped with the organic life and farming and the micro bio and a little bit of fore cite and we'll focus on the new try entered management and farming systems.
With that said I'll let mark take it off and his experiences and his information.
>> Thank you. Can you all hear me.
>> Yes.
>> Great. I'll be talking about soil life, one of my favorite topics and I hope that you find it's one of yours as well.
I call the soil life, the tiny but mighty component of soil. If this pi chart represents the volume of soil and less than half of it in the soil in the good condition and structure is the solid mineral component and the five percent is the organic component.
And then you have the air filed and pore spaces, and right down here is the soil life is one or two tons per academicer and this process of releasing and nutrients from the nutrients.
And the soil life is responsible for maintaining the structure not only enhances the drainage -- and the process for the soil and organic matter, and in this day of climate change is global carbon in balance the other aspect of structure is that the soil when it is good structure maintained by the soil life is better able to observe and deliver

moisture to the crop.
Organic farming ever since it was originally launched in the midst 20th Century the contact of the soil and the soil to feed the crop, and crops need nitrogen, and let's provide ma newer and compose. And all of these things feed the soil, and then the soil organisms then release nutrients from the crop.
And to protect soil life isn't using organic pesticides, and the natural organic program and it will allow it for the natural or mineral base or limited number or synthetic, and so to keep the soil covered and with this care and the expertise maximize soil benefits of the system.
And okay. So before we get to the specifics of organics let's do soil analogy 101, I use the soil food web and it's the basic community everything from the tiny micro bacteria when I say micro boil that is everything that you can't see to the naked eye and using those terms interchangeably.
About 20 years ago and they are organized in the approximation of reality and the relations is more complex than what is shown here.
And you have the plants and they are the source of it and the plant.
Bacteria has a wide range of economic roles in the soil and they are none as de composers and they are the organisms that will consume the ready digest tie parts that is added to the soil or agricultural management or practices, they are added to the residues, and one of the things for bacteria, they are new try entered dents and one thing when they start to work on the residues they will tie up in other nutrients. And we get it back later, and we see that.
And we convert those nutrients into a form and those are not leached or things that we don't want to happen in the system but are available to other organisms, there are others that are here and live in the route zone especially grasses can fix their own nitrogen up to thirty forty percent. That is the next organism, and this is a route and covered in bacteria and other micros and others are in the tissue and most of those are beneficial and those will be a minority and healthy soil.
And they have an interesting group. They are called what is called chemo /TROEB, instead of living on light, like most organisms, they will live in the soil and get the process of turning to nitrate and reduce forms of sulfate or they will convert certain minerals from one state to another -- Actinbacteria -- they have woody materials rather than actual bacteria and they are in the soil of the balance capacities with chip mulch there are plant roots and there is bacteria that associate with the other trees and shrubs.
And so strong antagonist as Bio pesticides -- they make up about half of the micro soil plant community, but they are the two major components weight wise.
And they are a can of bacteria light cells that is related to the bacteria and they make up ten percent of true bacteria.
And so the fungi is two major categories, they help break down plants and animals and more conditions they become more important in the forest, and have a lower soil PH and grasslands it's about 50/50 in it and they are good at doing soil manor and a higher percentage what is put in. The other critically important the rise and really associate with the 80 percent of the plant species on the planet have one or both forms and a single plant can host different species of the fungi and a given species can connect with several different families with plants they are good at the organic soil matter and the they contribute to greater and bigger resilience.
And also there is a lot of anti passages that attack or the fungi that protects the path from it and the plant to become more resistant and we'll talk about that later. And protosew they feed primarily on bacteria and you look at the microscope in high school, and it's really fun to watch.
And -- what they do is they eat the bacteria, they don't need as much as the bacteria per unit carbon.
And so you let the access go into the soil since it's in the face and they feed on the bacteria right there and they release it where they can get them.

And so this can be more efficient then broadcast spreading rather than the fertilizer they are going to leached and they are the plants losses. And some soils, and the nitrogen present in the soil and the feeding on the fungi in the soil.
And again that activity is concentrated to some degree in the route zone or the plants can easily get those nutrients. Nematodes these strike fear in farmers and they are a balance soil and the minority and they are in fact present and some researchers that are a little, and it's a matter of balance, a larger Nematodes they will eat fungi, and their and some are pathogenic, and they will often clean a soil, and you have to subject some of the crit /TERs and the mites and the Spring tails and mostly shredders some of them are predators and they have a beneficial role, and they are and earth worms this is when you think about healthy healthy living soil, and good and so you want to do it with care only when you have, too.
And so you want to keep the earth populations up.
There is one with echo engineers -- the other source of touring the food Webb, and doctor this is the 2017 addition, and a lot of it is directed from that book and it's researched based.
So the earth format, and if you take the earth worms out and you will have that much less available and it's in part the nutrient and other micros in that cast.
But they accelerate the destruction of the liter, and all to the ecosystem that is not so friendly to the forest themselves there is other that take the role of it.
And it's leading soil, in drier climates it's ants and they have a different affect on the soil and they don't turn it over quite as much as an earthworm but they break up the life cycles of the parasites and they reduce the food safety risk.
And there is a lot of be Columbusly or -- and also it really cleans up parasites and.
Let's talk about soil and that it can be accessed and for the de composer fungi and the earth forms that distribute it and break it up and so that it can better access them.
And what delivers them to plant of course --
(Indicating.)
And the associated ones don't form it in the plant roots, and they are a great for most plant species. Then there is theish of the water and it stays drained.
And all of the activities and help sustain soil structure basically improve that when your soil has pore structure and the pores are well connected you have more water capacity and it can stay air rated and it can go to the dry /PEUR /KWRODs and the wet periods.
(Indicating.) And the plant roots the micro channels.
And they contribute to the glue and creating the structure.
And you have it directly. These are the micros and the parasites and they are also and it's been finding that there is a major role in that.
And this is ancient partnership. And the and through fluffing of the fine roots that die off in the case of a growing annual.
And in the return the micros help the plants get nutrients.
And the way it helps with the fungi shows a sketch in the corner here.
They form these little -- the membranes are right next to each other. And that allows them to get the to to synthetic product. And how many compete with the organisms -- they have the clay and the gravel and not a whole lot of organic matter to work with.
And it was the micro symbol have been found in the record. So that is a good way to get the plants nutrient.
And this is a diagram based by -- and the blue arrows in the plants and feeding the end do and going out to the soil near the route.

The red is how nutrients when the larger protozones feed on the bacteria, and also directly assisted by it they help transform nitrogen compounds with the plants take out. Okay. You biologically active soil, and you have mentioned all of the plant roots Aggregate the soil and keep the open network.
And so because the soil is healthy and you have a deep system, and there is not a lot plant growth and the plants are taken it up as they need it. Now there is a mistake in it.
And there should be residue on the soil surface and it takes longer to form, longer vegetation and residues and the organic farmers that is one important lesson that we can take from the reservation community.
And okay.
Plant disease triangle. This is how plants get sick.
You have a crop how does healthy soil do it.
For one thing, they love to eat it, food and /-B -- and you stay water log long enough for heavy rain and to really explode.
And another thing that I mention reduce the stomach resistance and it goes out there and protects the leaves. The leaves maybe less likely and it's late light.
And the crop rotation is important for keeping diseases organisms from exploding the different plants have different pathogens they are accepting, too.
And so you keep all that in mind and by shifting the type of root or the plant family and by mixing the plant families, they are supporting the diverse and micro, and they will be there, and once in a while you will have a disease problem.
And all of these measures build soil health the -- we also know that healthy soil performs healthy ecosystem services.
And the one that you have all shared great information is water quality.
We don't want nutrients into the ground water. Detoxification, this applies for both test suedes that are applied and the unwarranted /TOBGS ins are all over the earth and do get into our soil. Heavy metals, et cetera.
And also the pathogens and manuer the things that can get into our food and get us sick.
And the break down of the ma newer and other stuff and there is great pesticides, or combine a heavy toxic metal like chromosome, or lead, or /AR sign Nick, and it will be bound to the soil organic matter, and after you have done the work on the residues or the plant or onto think waters. Soils that are treated with certain pesticides, and you will break those pesticides down, and the synthetic pesticides when they don't do the job.
And carbon --
(Indicating.)
And so that is done by plant residues and what happens is during the process the plant residues and ma newer, and a specific percentage becomes dead organisms and bind tightly to the soils minerals particles especially clay and silk.
This is the most stable form, and the most sequester, and I don't want to minimize the fact that having strong aggregation protects other forms with active organic matter inside of those aggregates and so they don't break down as quickly and is more stable in the long run. And then this wholish this is the magic in my view of the soil food web, and creating the aggregates the soil and maintain the aggregation and the roots are essential and I see the part of the soil of the community of life.
And resilience and tilth of structure.
And the traffic in the agricultural feed and all of the organisms will restore the structure. And then the soil matter has to be maintained and that is part of the soil of the soil nourish of the crops, and these are the residues of the crops and then the food and habitat of the new life, and one of the resource concerns, and that

is one of the resource programs.
And what this does is that, it maintains the pore space of the organisms break down the fresh residues and of the food of course, and we have to keep the soil life fed and the fresh in put and the active organic matter.
And that is where the plants and the good management of the agriculture system come in.
And all of the processes that maintain the soil structure, and maintaining their own home and is the aspect of the soil take place.
And so okay, this is basically what happens in the soil and all of the organic inputs and they get processed through the soil and micro Bio and so that is the respiration and that is the necessary part of their function.
And so that releases the nutrients to the crops.
And some of them become stabilized in it near the surface and protected in the organic matter.
And so one thing to remember is that soil respiration, soil carbon emissions /-RBG is not having a less net of carbon, it means you have a net soil of micro by, and it's maintaining crop nutrient and building the soil organic matter maybe requesting the carbon.
And maybe all of the fact of attributes including it and it will be possibly correlated with the respiration.
And we'll get to that.
And organic farming for soil biology and we and cover this quickly.
Well cover that in the next webinar.
And so there is soil health on the soil, and one of the things that happen they can face trade offs between crop nutrient or soil stabilization, organic systems that terminate the cover crop, and that avoid the until league in the crop rotation as much as possible it does indeed do the practices and today's crops are not adapted to completely untilled system, and they are available fertilizers.
Organic nutrient fertilizers, and they have it at race that provides it.
And that will inhibit of it that is the most important parts of the food web.
And they did damage some of those soil organisms and the earth forms are sensitive.
And so you may not partner in the effective organisms, and all of the natural or plant communities or the same of the the varieties of the crops.
Another thing that that we'll talk about, and we'll talk about the catalogs, and should I buy those to make it better, or is not worth the money.
And then climate change itself does a real different challenge, and you have done the soil matter break down in it.
And if organic farmers rely on it the current years crops and to maintain the life of the soil -- is from an unavoidable trade off here -- you have these process for the Bio mass, and you have the Co2 coming out of the soil and the nutrients to the plants, and there is a couple of new ratios here how much comes out with a given amount of input.
And how much respiration, how much respiration is happens relevant to it.
If you have rapid respiration.
And it's not really new it's the three day version of the test, and you have the soil health practice and the measurements and it measures a four day version.
And what was found, and what doctor found this three day test this is the one that they found most consistent.
Is positively correlated with the total, active or how much soil is going to give you whether you fertilize it or not.
And then the microbial biomass is all correlated.
So this can be their practices that can tip this in the direction building organic matter and microbial mass using things with the --
(Indicating.)

And these work together to build the soil organic matter.
And so you can get it in the croup.
And so when your growing a demanding croup. As an organic farm you may want to go more towards rapid stations to make sure that it gets enough.
And plowing down there is tillage and you don't replenish the soil quite as much but you are doing it for a demand and you don't want in it because there is such a climate change in greenhouse gas.
These are the conditions that rapid respiration is a bad sign. It's a stress, it's a tillage, and those organisms are going hundreds and there is not much protection from a heavy rape or hard freeze from the surface air.
And you will often get erosion, and using synthetic fertilizers is not allowed in the organic systems and they will by pass the soil and they will go straight to the plan.
And as you know the outcomes are soil matter organic losses, and depress that respiratory quote goes up and likely to each.
And so how do we enhance the soil soil biota, and water conservation last year, 2001.
And there is several ways that this /PHRAPBLT micro partnership can enhanced.
If you keep a little on the lane side, you won't suppress photo synthesis but you will slow top growth a little bit for the synthetic product and you will go down more root resinates, and therefor more formation or your long term soil.
Now unlike fertilizers and fast release fertilizers in the crop rotation or improves this biological activity because the amino as sides and the other materials and ultimately feed that soil micro Bio, you don't want to bring them in too early when it's recovering into the rapid growth.
And it's the rapid growth /TPA*ETS and it's in the most root and so any practices and if your rotational is not optimal you can bring it in too early or too late, that has been reported in some cases that can be up to a ton of academicer per year.
And so their are some tips from building the capacity.
But basically a Forrest ecosystem and it's a micro risal --
(Indicating.)
But 20 or 40 percent goes to the ground, and it stabilizes the network and builds the soil carbon.
Does this amazing community happen in agriculture.
Yes it's been documented in studies that were cited in the latest version of property soil. There is a four way symbiosis between the grasses, the legumes, the -- the same species will feed on both and this allows the surplus nitrogen to help support the grass growth.
And then in exchange the grasses are more capable to help provides more to the lake fumes.
And so they can go very high, and some biological active soils and it's as high as one hundred percent and it means your economic fertilization rate is zero, and so you don't need ten ten ten, or crop residues and have some nitrogen in them.
And so reverse the inputs with the moderate overall optimizes the soil build up.
And here is an sample a study was done in the costal region of Washington for the culture production of organic crops. Over an 11 year period you have the vegetable which is kinder than the -- but in that system neck use compose, or culture fertilizer with a lower ratio with the total nitrogen, with the compose soil, had better structure and more infiltration, the average was the same.
And so once in a while the compose gave it higher than the long run and it gave it equal.
And so in the soil, in the compose system that will tend to limit the formation
And very often you don't need to do it great.
And so only 35 percent of it is available.

And you will need four hundred pounds of nitrogen.
The other challenge is tillage, and it's thought to the soil organic matter, for a build up is through a cover crop, and you have to come in there and take out the bind weed and the cut grass and then you lost it all.
And that is somewhat true for the Aggregate protective matter right near the surface, and it's not true for the associated organic matter, and the interesting thing is Meta analysis is another term that I'm using when researchers gather from the literature a worldwide review or nation wide review relevant to the question at hand and you take it thousands of studies and take the estimate average affect for a given treatment.
And what they found with the tillage practices and you have it for the plowing and you it for the biomass, and it didn't change the bacterial, and that was the surprising result, and there is some other Meta analysis in recent years in Bio chemistry and that found that tillage impacts on the micro Bio species make up the abundance and diversity tend to be -- and one thing that I forgot to mention on the tour, memory toads because of the community, it's now being used more and more by researchers of the health of the system and the impacts of the practices and these studies are an sample.
And again, I would say that there is some organic pesticides and you can see it and impact the soil.
And so that is why those are considered secondary supplemental that is needed in the organic program and it's been found to give a good seed bed and the soil excessively and this has become a tool for doing the job without it.
And you are not flipping the soil upside down, and just do it only when needed.
And does organic agriculture entail more soil disturbance, I will admit some use too much tillage, but the organic eliminate --
(Indicating.)
And let's get rid of the physical disturbance, and I think that these two are effective.
And they are approaching the Golden optimum or minimally disturbed soil.
And there is evidence that is frequent challenge doesn't really disrupt the soil for microbial, and there is recent research that can do the micro diversity and do the microbial in the various DNA and the analysis shifts micro symbiosis and the fixation and the larger impacts has been serve through the research.
And some of the organic materials can harm soil life.
And so, there is an organic seed challenge, and a lot of them have forgotten how to associate the soil life and mac mice some of those benefits of induce resistance of the up take -- they lose some of their capacity through the microbial relationships and some of these projects are the reading in deafers through the research extension initiative --
>>Indicating and then he took those hybrids to a tropical soil that was very low and was being farmed in an organic way this is what the regular hybrid did with the poor little ears, and here are the ears that came off that the institute has developed and then they have all oh, these products and listen.
And so it's going to make your soil so healthy
And so very often these products don't work in practice, you introduce a micro into a soil and that is preactive and it's been there a while.
And the exotic has been introduced and overwhelmed and choked out.
And there is some products that have a lot of research behind them and it's for the seed, and absolutely get it and you will get it resolved.
And the Mycorrhizal
But usually it should be part of an intergrade effort.
And some cautions one that I have circled in red.
These are on the blends that are intended to apply for the whole soil and well not really because if you have

been taking care of your soil and it has a different by yum, it will probably overwhelm them.
And if you allow one that there is a slight but significant and you get a basic micro that will upset the micro by yum and maybe begin to under mine the eggplant communities.
And so that is a risk to keep in mind.
You may be spending money may not be getting it.
And so see if the soil looks better, and some how if the weeds of the diseases are less.
And the compose teaser is in some risk, if there is an error in brewing, you will brew a plant one, and you will have a caution
Well do we really need these micro -- one of my favorite books is by Gabe Brown, this 25 acupuncture ranch, two percent on North Dakota to soil is really bad,
And his crops at livestock, when neighbors are in the drought here, and he is staying in business and doing well.
And you never purchase it and he said there will be some bit of live in think warn out soil.
You stop destroying the structure and you start feeding the soil through good practices and they will come what about climate change.
As rain false get more extreme and it will impact the soil less server impact on the organic matter. So we are going to do a lot of needs and research and so you are going to have to adapt our crop rotations.
A few pointers for the organic soil biology.
The four principals of soil health that we have developed and are utilizing every day. Great roadmap.
A super roadmap to soil health.
One that I will take a little look at is minimizing the soil disturbance.
And so organic systems is not practical but also the N O P allowed test and disease controls. N O P says things to N P K and that is one of the most severity practices and has the wide spread to the populations.
And so a few tips in the practices.
And so the plant living it, and there is some organic systems managed for the specialty crops there has been periods with the soil being unoccupied and you see it in the field crops in the Midwest and a lot of fields and there it's there all winter and organic growers will get a cover crop on the field for the winter.
And that is important for all systems,
And versing the cropping system is more important.
The more diverse the crop, and the route rising, and that is general helpful.
And the way that I have introduced disturbance, and so the moderate carbon ratio, and so using the nutrients sparingly and getting the boost that they need
And then finding out how much they need all right. It's time for questions.
We have time for just a few.
Can you please explain nitrogen fixation.
That is a process by bacteria, and the nodules and that is an activity in all certain shrubs of the families and free living organisms like it and these live in the soil or they take the nitrogen and that is not accessible to plants and they convert it to it and it's a specialized process that occurs in the bacteria, and the plant and the bacterium both, it's in the bacterial sell.
And that then can be used as a building block do build all of the proteins in the amino acids and other things that plant other organisms needs,
And so you have the at /PHO for nitrogen
Can you comment on the status, one words there is no native earth worm in North America.

>> I am not as much as native earth worm biology, I would think that out in the

Parises there are but that is a good question for Wikipedia.
And what happens is unfortunately one of my favorite worm defined in the soil is that the European night crawler and that is this one that can get up to the eight inches long.
And that is really big and spectacular, and it's an earth worm that goes down six feet and it's European and it's exotic, and there is another one, I can't remember exactly the name.
But there are several from Europe that is generally beneficial in the crop lane. And you can destroy the existing and the existing ecosystem, and it's like powering the soil and the bring earth worms and in term of four, and the preyear, and it can be very desirable or disruptive depending on the ecosystem that you're talking about and the goals are.

>> Thank you mark.
Another question that we have here, can you speak more on you can get a hold of it.
And now the mineral associated organic matter, that is an article of the general soil conservation, and that fall reference and many others are included in the presentation notes.
And so any of these questions you want to go into more depth the information is there, you can probably access the article online or you can go back to last year I can't remember what month it was, but it was in 2021.
How does it work.
There is a couple of mechanisms that are in our loft.
What happens is when micros eat just like us, and when you eat a chunk of food it becomes digestive to the material that it's easily absorbed and the break downs to be an amino acids et cetera, and it's easily absorb, and now the micros, they don't have the greet the intestine, and they will consume the fresh residue and it will be an organic matter in the tabloids. And so you have dead micros, and now these dead micros or simple organic become absorbed to the there is the various simple compound another thing to remember is the nutrient cycling is and to measure soil health.
And about half and they will then leached down to the dissolve any /TRAT Torr.
Another thing that happens is plants don't stop rooting at one foot. Oar even tomato will go down four our five feet.
And you continue to support some biological activity and so the oxygen is scars, and so it's still that process and you will be deposit this in the sub soil.
>> Thank you mark. I'm going to tie in two questions just for I think that we are running close to time. But. You know someone wanted to know a little more is there away to be less invasive.
And you have the compose after tillage will line gate some of the damage. /SPA*EB /SA*EB the surface to three, or four, or six inches, and interestingly enough, this one study, they allowed any non to be considered and that was in this better analysis to find that those treatment s the biomass to be compared to strict no until or in version eight to ten inches deep and you have the analysis upside down.
And you have it the three inches deep and that is a really good example of some vertical tillage implements that are designed to break up and you can go down six inches.
And so I would not spread compose on the top of the soil. That is a waste. I would spread the compose before tiling.
An if you are going to tile, until and plant same day.
Sometimes shallow tillage can result in a heavy crop.
There maybe be 20, 30 percent coverage, a but there is also a practice reduced tillage that the soil needs to be below 80.

And their needs to be a speed disc within that. The important thing is to keep things living when you need to.
And compose is great and it compliments the fresh residues and building the plants and building the soil and the health and the biotic tick community and you want to make sure that you are not using it so heavily and building it so postperuse, and so it really goes a long way.
Did I answer the questions.

>> There are many others ones, I do want to direct all of the participants to check out the PDF with notes there is publications and resources and the quantification of it or e M F mean, and so you will be able to find soil organic matter within those notes as well.
And I'll pass it back to Jen.

>> Jen, on behalf of the US DA and the resource conservation research, and I want to thank both presenters on organic life and farming the role of soil health and resource conservation, and thank you everyone for attending today's webinar, participants don't forget to provide the feedback and you affected C EUs and to continue the process offers by step two at conservation webinar. And this concludes the webinar presentation.