

\*\*\* DISCLAIMER: This CART file was produced for communication access and will not be 100% verbatim. This is not a legal document and may contain copyrighted, privileged or confidential information. This draft transcript shall not be disclosed in any form, (written or electronic), as a verbatim transcript, or posted to any website or public forum. This transcript may not be sold, shared, disseminated, or otherwise to any other students or persons, as such will result in suspension of services (without explicit permission). This is an unofficial transcript which should not be relied upon for purposes of verbatim citation. This draft transcript has not been proofread. It is scan-edited only and may contain errors, including but not limited to, proofreading errors, omissions, computer generated mistranslations, stenotype code, electronic transmission errors resulting in inaccurate or nonsensical word combinations, or untranslated stenotype symbols which cannot be deciphered by non-stenotypists. \*\*\*

Biological Nutrient Management:  
Best Organic Practices for Soil Fertility and Resource Stewardship

2.6.2023

1-2:30 PM EST

>> Greetings everyone, we will get started in a few minutes.

>> Let's get started. Greetings, welcome to today's webinar titled biological nutrient management, best organic practices for soil fertility and resource stewardship. My name is Jen Ryan, I mean natural resources specialist for the natural resources conservation services 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 logistical items. This webinar is being recorded. All participants joining today's webinar are in listen only mode and all audios broadcasted through your devices speakers. Computer or mobile device headsets can help with your 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. You can smell your questions or comments throughout the presentation however, questions will be answered at the end during the question and answer session.

Today's webinar offers close captioning, to access the closed captioning feature, click on the StreamText link in the chat box.

In today's handouts box, you'll find a copy of today's presentation as well as a handout with additional information that you will find useful. If you wish to make adjustments to your view of the webinar, you can make them using the options in the screen share window. If you choose to view the presentation in full-screen mode, you will need to hover your cursor at the top of your window to see the options to return to normal view. You'll need to be a normal bill to see the Q&A box you can type in your comments and questions. Today's webinar offers continuing

education units. To earn CEU at the conclusion of the webinar, use Step 2 in your open conservation webinar.net browser window to take a brief post test, enter your certification credentials and receive your certificate by email. We will submit the certified advisor CEU on your behalf in 30 days. Please submit your conservation planner CEU as you need to meet your local certification requirements.

We encourage all participants to complete the webinar using the Step 2 process, completing the webinar provides an opportunity to rate it using a five star system and you can submit optional comments that are helpful to our webinar program.

When writing the webinar, please focus on the technical training provided by today's presentation and what you learn by participating. The on-demand recording of today's webinar will be available from the webinars webpage at the science and technology training library by early next week.

I want to take a moment to remind participants that the use of for tradename during any of the webinars is for information purposes only. Mention of a tradename does not constitute a guarantee of the product by the U.S. Department of Agriculture, nor does it imply endorsement by the department or the natural resources conservation service over comparable products that are not named. With that, we will now begin.

At this time, I would like to welcome Lindsay, Lindsay is national organic and pest management specialist for NRCS. She has worked with NRCS for over 30 years, Lindsay started as a conservation planner and spent most of her career as a district conservationist leading local field offices and providing technical and financial assistance to local producers. She's been involved in the organic agriculture sector throughout her career from working on organic farms, providing conservation assistance, to organic farmers and farming organically herself. Lindsay, you may now begin.

>> Thank you so much, thank you for joining us. Another webinar in this great series and I encourage you all to be on the lookout for future series also.

I have the distinct pleasure of introducing our speaker, Mark Schonbeck. He has worked for us for 35 years as a researcher, consultant, educator and advocate first stable agriculture. He works one-on-1 with farmers and homesteaders taking a site-specific approach to soil test interpretation, organic soil, nutrient and weed management for vegetables and other crops. In his capacity as a research associate with organic research foundation, he develops research-based educational materials including a series of practical guides on health and organic farming.

In the past, Mark has led our participated in several farm research products conducted by Virginia research collaboration—the national Center for technology to help our agency and RCS with our programs to better serve organic producers.

Mark also serves as a policy liaison with the national sustainable culture coalition, he works with OFR at the organic farming research foundation to develop policy recommendations to help organic producers mitigate the impacts of climate change and operations and communities they serve. With that, I will turn it over to Mark.

>> Okay, thank you all. Welcome to the webinar, I hope you enjoy it. Yes indeed, focused on biological approaches to nutrient management. So we will get started. Shared goals of nutrient management throughout NRCS, the conservation community and organic farming sector, obviously we want to have adequate crop nutrition for production, yield and a good net return. We are looking for often yield which is not necessarily maximum yield both because of increasing cost, when you push yield even higher. Also, we need to balance the production objectives, so soil health and conservation, conservation of course focuses on protecting water quality, air quality, now with increasing ports, minimizing greenhouse gas additions.

However, nutrient management also has a direct impact on the soil microbial community itself. Which governs the biological functions, which in turn determined how nutrients move into the soil whether they get in the plant or in the drinking water, or in runoff. If you look at the nutrient management criteria in the NRCS, also the national organic program, we see a lot of common ground here, the practice standard 590 nutrient management talks about the four hours of resource stewardship. Nutrient source at the right rate, the right time and the right place. We will be looking at each of those in the context of an organic system.

It talks also about reducing nutrient losses to service and groundwater, into the atmosphere. National organic program also requires nutrients to be managed in a way that prevents contamination of water for crops or soil. There is a different emphasis here, in that the organic grower is required to use rotations, covered crops and in the application of plant and animal materials, basically organic residue, compost, it can include manure as the basis of their nutrient management program.

In 2020 the organic farming research foundation conducted a survey of over 1000 organic and transitioning organic growers. To find out what their main challenges are, and what their most common practices are as well as technical assistance needs and research priorities. The practices that were summarized in the quote from the national organic program standards on nutrient management include crop rotation and in 4/5 survey respondents said that they were rotating crops and very likely the remaining 19 percent were doing mostly perennial crops which technically don't undergo a rotation. 68 percent use covered crops regularly, that includes over 75 percent of field crop growers. That compares a ten percent of nonorganic fuel crop producers who cover crop regularly.

Nearly a third of organic growers use inter-cropping which is another means to keep the ground covered and improved diversity. It is pretty substantial use of manure compost and organic fertilizers, plant and animal materials. Those are all about 40– 50 percent and it depends a lot on both the production system and what resources are available close to where the farm is located.

A very large percentage, three quarters are using perennial conservation buffer plantings. One of their functions is to intercept runoff and leaching nutrients with buffers that will greatly reduce the amount of nutrient intake into the river even during heavy rain period the top three technical assistance needs, managing weeds, pests and disease led the chart but close behind our soil fertility and crop nutrients. Overall, soil health management period we will talk a little bit about nutrient management, and I will start with a little historical perspective here.

In the 20th century, the paradigm, the dominant paradigm of nutrient management basically relied on soluble synthetic fertilizers, it is a barrel of an PK, the lead source of nutrients. At that time, soil life was more or less overlooked in even considered a bit of a hindrance. It was thought soil life couples of the nutrients and we have to put on more, and that was also felt that soil organic matter and soil minerals are mainly causes for the removal or fixation of, for instance, phosphorus. The result of putting on large amounts of line completely on this is the increase in nitrate leaching, and a nutrient runoff, and nitrous oxide which is a powerful greenhouse gas.

The reason, the only reason I dwell even for a moment on the past like this, is that whereas we have definitely moved well past this paradigm, it's still informing some of the standard soil test recommendations, that tend to be recommending amounts that will account for and make up for all these losses and tend to go high. Especially private but also to some extent, I believe the university labs.

In the same time in the 20th century, the organic farming movement began and they emphasized organic matter for fertility and protecting soil life. The whole adage was to feed the soil, and practices that were emphasized were returning on farm manures to the soil using Greenwood or crops, basically a cover crop that is plowed down like using the photograph in the top center.

Then integrating crops and livestock, that was a pretty strong principal in the early days of the organic farming sector. There is a belief that that enhanced the agricultural ecosystem function improved by diversity and help cycle nutrients, there's a lot of evidence to support that. Reduce reliance on farm inputs as much as possible, and definitely avoid synthetics right from the beginning. It was thought that synthetic chemicals, especially pesticides which are formed life are xenobiotic for the most part. But even soluble fertilizers, which are compounds that appear in nature but a much lower concentration were felt to upset or damage the soil micro bio, the soil community of life. To interfere with the process by which the soil will feed the crop.

This webinar will focus mainly on nitrogen and phosphorus, however I wanted to take a few minutes to emphasize that the organic approach right from the start looked at all the plant nutrients, not just an PK, which was the focus of the early fertilizer industry. Secondary nutrients, calcium magnesium and sulfur, and another thing that the organic practitioners were quite aware of, is that nitrogen isn't just present as soluble, and nitrate and ammonium, or

phosphorus, they are also present in organic compounds in the soil, so there is a large organic nitrogen reserve that can be drawn upon.

Same with phosphorus and sulfur, all three of those elements are integral parts of biological molecules like proteins, and nucleic acids, Amino acid, vitamins etc. Other nutrients that are central for life are the cations or positively charged nutrients, potassium, calcium, magnesium. They occur both in the living systems and in the soil solution, as soluble ions, which they are then absorbed into the cat ion exchange capacity. Also, present in soil minerals.

There is a long list of micronutrients, the first five are commonly addressed in soil tests, and nutrient management. These days, born which is a deficient in the southeast United States, copper and zinc, iron and manganese, their availability can be affected by Ph so the more locals and the soils in the West United States content to be deficient in those.

There is some evidence that these others, nickel, silicon, chlorine, or essential for crop health, also a few others. Sodium, which actually plants don't need, they can use potassium, which is very similar in its chemical nature. But it is essential for animals and humans, also selenium and chromium. One of the things about the micronutrients at about the organic approach to make sure that all of these nutrients are supplied and replenished in the soil, is that several of them play a vital role in nitrogen and phosphorus metabolism in the plant and nitrogen fixation by symbiotic bacteria. So they have a very essential role in managing the major nutrients we are concerned about today.

Now off to the 21st century, it's been gratifying to see the substantial shift in the whole paradigm of nutrient management, I call it feed the crop in the soil. The soil life is definitely now at the table is considered a partner, it's not just a nutrient thief but there is a two-way exchange between the soil life and the plant available nutrient pool. Soil organic matter also can be a source of nutrients, and soil minerals. In addition to binding nutrients, that under certain circumstances a very healthy soil is a biological activity. The soil and minerals are drawn upon by plants, roots, microbes.

When your and residues, organic sources of nutrients are definitely a part of the picture. On top of this, we have the four R's which is the right source rate of placement and timing to ensure that nutrients are used efficiently, and not over apply. The four principles of soil health, soil coverage, living root, higher diversity, and reducing disturbance, all of these tend to improve nutrient cycling and nutrient deficiency, and opportunities to avoid or minimize both water pollution and greenhouse gas emissions. I would have to say that one area that is relatively weak and practice still, is crop diversity. We still have large areas which are distant to corn rotation and ten percent of that is covered and crop in the winter in the Midwest.

In organic farming, it's the soil life that plays a central role, it is not just at the table, it is the chairperson. As I showed in an earlier webinar, the soil left participates in all of the major functions of the healthy soil, and that includes several, specifically related to nutrients, holding and delivering plant nutrients that come out of organic residues, or out of any fertilizers that are

applied. Thereby protecting water quality, and also it's the organisms that unlock nutrients that are tied up in fresh organic residues and converted into soil organic matter that holds the nutrients.

Inorganic nutrient management, we no longer have the canister of synthetic soluble fertilizers at all, it is relying entirely on organic and natural mineral sources. I did say earlier that the standards require farmers to use rotation covered crops and plant and animal residues to provide for plant nutrition. Organic farmers may also use natural mineral sources, and they also use, there is a certain list of allowed synthetics, these are mainly micronutrients when there is a documented micronutrient deficiency, organic growers can use a sulphate or Carbonate, or oxide of the trace mineral, or in the case of boron, a simple soluble salt like borate or Borax.

In this scenario, the soil life just plays a central role converting all of that into the active and stable organic matter, and in that process releasing plant nutrients. Also, the stable organic expense, the exchange capacity of the soil that the state organic matter forms the organic mineral complex called mineral associate organic matter. That is where the cations magnesium calcium potassium and a lot of the micronutrients can be stored. The soil life in association with plant roots is also slowly unlocking minerals from the soil particles themselves.

When did this all start? About 50 million years ago when the earth really didn't have soil yet, it just had very— rocks and dirt, which is basically rocks that had been ground up by physical forces of nature. Land plants and micro fungi basically coevolved at the same time. At this point in geological history. In this partnership, basically the plants provide organic carbon in the form of photosynthetic products, sugar, Amino acid, simple stuff that you and I think are good because it makes the food taste good and nursing, they go down the plant root and between ten and 40 percent of all the plants photosynthetic product is contributed to the roots and the soil microbe biome. In several ways, micro bios of fungi and bacteria, the little tiny green dots inside of the root. Then the larger fungi with our muscular structures inside the root are taking directly from the plan. The root eggs, even before they get out of the root.

Than the rest of it goes into the soil and feeds a very diverse community of other organisms that live within a millimeter of the roots surface. In return, all these organisms help the plant take up nutrients, the (name) or basically expanding the roots system two or three fold, just giving the plant much greater access to water and nutrients in the soil. Some of those undefeated bacteria are either fixing nitrogen from the air into the root, although that is most pronounced in looms, specialized nodules like the (name), found nitrogen fixing bacteria in corn roots, carrot roots, and other grasses as well. Those other microbes that are living off of the plant, they become prey for slightly larger critters like Anubis and protozoan's and small number totes. As those organisms feed on the bacteria and fungi, they release some of the nitrogen right back, in the root zone where the plant can take it up.

The organic approach in nutrient management focuses on maximizing the efficacy of this partnership. Then as a supplement, using more concentrated organic fertilizers as needed to sustain crop yield.

These are all microbes, they need a balanced diet to do their job. Part of the balanced diet is ensuring that all of the nutrients listed earlier, it's essential to living organisms are present in adequate amounts. Again, at this point I will focus on one aspect of balance and that is the carbon to nitrogen ratio. If we take a soil and organic management and feed it very high carbon residue, straw, wood chips, sawdust, crop residue from mature crops like a grain crop, or even grass hay which is quite mature, the carbon nitrogen ratio above 35 or 40:one, this breaks down slowly. What happens is, the soil and life is starved for nitrogen, it needs nitrogen to combine with all that carbon to grow more microbes. It also has to burn off some of the excess carbon, so this slows down growth. It takes up all of the available nitrogen and nitrate, and Ammonia, so plants have a hard time getting enough nitrogen to grow. This is a classic nitrogen tie up that 50 years ago, extension were to tell people don't try to grow organic, you will tie up all the nitrogen. It only happens when you use too much carbon and not enough nitrogen in your input.

What's going on here, is even though you think the carbon is going back into the soil, doesn't go back that - in that efficiently. As you can see at the lower left, is a pretty significant crop nutrient deficiency in this situation as well. What happens when we go to the opposite extreme, okay let's get some of the (audio cut out) from the chicken house next door and use that as the major input. Then you get a situation that looks uncomfortably like the 20th Century nutrient management because the soil life goes on my gosh, there's not enough carbon out here, so much nitrogen I'm choking on it so let's throw more at the soil and by the way, we can get nitrogen. Active organic matter so they take that up and that is converted to CO<sub>2</sub> and more of it is converted into microbial biomass. But not as much soil or microbial biomass as you would get if things were balanced.

In a balanced situation, use a mixture residues and diversity of materials that is best, use poultry litter, use a little bit of straw, some covered crops around the 25- one like grass mix that is cut down early flowering until then, or crimped.

Then what happens is the soil life has enough of everything, and it is slowly and steadily, but not flooding the soil dividing nitrate and ammonium, and other nutrients to crops. There's a lot of other nutrients in those residues and organic matter. In this balanced situation, the soil life is indeed nourishing the crop and slowly but steadily building stable organic matter, and is also the really best way to build out the active organic matter, which is vital to ongoing fertility. One thing I will point out that I forgot to point out earlier on the high carbon, right here. If it's late on the surface as a mulch, it becomes more sheltered from soil microorganisms and doesn't tie up much soil and nitrogen so if you're to plow in, not plowing but work into the soil some more balanced organic nutrient sources, and then use some of this woodchip or straw as a surface mulch, you will not have that level of starvation that you would if you just use it as your only source.

Those are very important resources.

Getting back to this mixed scenario, finished compost tends to have a narrower carbon to nitrogen ratio around 15– 21, however it's an excellent resource that basically directly replenishes active organic matter. Basically you have taken a mixture of residues and converted it in a windrow or an in-vessel system into this broken-down material. It has some carbon dioxide, so the carbon is less abundant. This will not flood the soil with nutrients, but it will become part of the slowly-release storehouse of the organic matter.

It also has a very important complementary role. What we see is a hole in the sum of the parts, an individual practice with covered cropping, crop diversity, crops with different species of vegetables, crops in each of those beds. We have organic amendment of compost. And on the right, we have an implement called a high-speed disc. This is whole-field tillage, it is not no-till. If it is not done carefully, and on the right, only when absolutely needed, you can have some soil degradation from even a shallow tillage. But there's been a lot of research that shows that when used appropriately, this shallow tillage will maintain twice the microbial biomass and protect soil health tremendously versus plowed soils. It also outperforms continuous no-till if the continuous no-till doesn't have sufficient year-round cover, in other words it's winter-foul with no-till and more dependent on chemicals. That also does not support the biomass that we see with this integrated system with careful use of shallow tillage.

Organic farmers face a few challenges with this. For one thing, in a sense, by not having soluble and pKa as a tool to resort to when you do have a little nitrogen tie or your soil life is not quite up to scratch, we do see that there are a few challenges related to these situations. The advantages, as I have discussed already, said organic practices do build that long-term soil fertility so that even though there may be a few years of decreased yields upon transitioning from conventional to organic system, or when you improve an organic system by increasing coverage and covered crop biomass, and carbon to nitrogen balance in your inputs, you have a long-term increase in fertility that shows up as a yield stability and also gradual increase in medial yield year-to-year. Most organic feed soil microbes quite well, especially covered crops, finished compost is more of a habitat use but it does provide food as well.

The non-use of synthetics really protects soil life, there is a recent research meta-analysis that shows that there is significant impact of agrochemicals used at normal use rates on soil life that can shift the function of the micro-biome in ways that make it a little bit harder to maintain soil health.

So that is a trade-off there, you have conservation agriculture that eliminates tillage, and uses chemicals with care. Organic is to eliminate chemicals that use tillage with care. In both cases, you have a substantial improvement in soil health over what you had in conventional systems.

Another thing is this crop diversity that is typical of organic rotation, especially vegetable rotation but also field crops. That supports a greater diversity of soil life, when your soil life is more diverse, the more the functions are covered things like phosphorus tackling nitrogen cycling, etc.

And the challenges, so one thing is that organic farmers are often faced with a trade-off between building soil health in crop yields. On the left, it's a Promil covered crop that was very successfully role crimped. Killed effectively in the most no weeds, snap beans which are a nitrogen fixer but a week nitrogen fixer. They are doing okay but there's little nitrogen deficient. You can see that. In the center is a field that is an early-stage and transition that had been in conventional agriculture with insufficient covered cropping and organic inputs, pretty depleted soil, so the organic farmers going to have to use more concentrated organic fertilizers, or take a few years to simply build up the soil with covered crops and organic commitments.

One of the drawbacks of compost, valuable as it is, if you rely on compost and provide all the nitrogen or all the potassium that your crop is going to need, you will be building out phosphorus. If your soil is way low on phosphorus, that's okay for a few years but once you get to the optimal level of phosphorus, you don't want to build up any higher because that shuts down the micro rise of fungi which were the early land plants, number one ally to be able to start colonizing Earth's surface. We don't want to knock them out so we want to be careful how much compost, same applies to manure.

Because biological and nutrient cycling, and biological nutrient management are dependent on living organisms, which are in turn affected by a million factors, temperature, moisture, soil, texture, Soil type, soil depth, and because the current state of soil health, it can be much harder to determine how much nitrogen do I really need, and how can I get the timing of that nitrogen mineralization to match crop uptake.

Now will will get into the three R's from the organic viewpoint. The right source, one of the questions is, why are we using organic, if it soluble, mineral or chemical fertilizers. Since we know this fertilizers Armstrong poisons like some of the pesticides are, so are they really that harmful. Since they are easier to use, okay, let's take a look at that. Then there are different ways to obtain these inputs for off farm sources.

This is a quick summary of a large body of research, I want to say or mention one thing is that the presentation note, this is an 18 page word document that will be available as a handout goes into much greater detail than I can in the space of one hour. This is a very tight condensation of a lot of research that includes several meta-analyses, meta-analysis is a review of hundreds, dozens or hundreds of other studies to identify the trend, the actual like to sort the signal from the noise, what effect is this particular practice have. There was a meta-analysis that compared organic versus soluble nitrogen sources. Actually, this is an amazing study, somebody reviewed 113 different meta-analysis related to nutrient management. For each of the long list of questions that these authors asked, there was at least several, if not a dozen or more studies on which to base their conclusions. What they found is that organic sources of nitrogen, this includes everything from finished compost with a moderate carbon nitrogen ratio, covered crops, just like poultry with a narrow ratio. They enhance soil organic matter, reduce nitrogen leaching by a most have and ammonia by more than half.

Yields were a little bit lower, which is why we have seen with general organic production, and a lot of that is the need to develop more crop cold of hours that are well adapted to organic systems, and to form a large root system that partners well with microbes to help them get nutrients. The one negative comment is that nitrous oxide, on the average, those emissions went up slightly with the organic sources.

We will have a look at that, that is one area where we need more research and more refinement of organic nutrient management. Comparing, just in general, organic versus soluble, and PK all three compound fertilizers is an analysis found that the organic fertilizers systems had about twice the microbial biomass including both bacteria and fungi. Also, the number toads, another study showed that the Norman toads feeding on those bacteria and fungi. They are more cycled, Bicyclic nitrogen and making it available right in the roots of the crop. Their numbers also went up substantially and there biomass.

Then there were some studies in the United States and just organic versus conventional systems, it is a whole system here like we talked about before with the multiple practices. Comparing rotations under those two approaches, the management. On the average, organically manage soil had 35– 100 percent higher potential to mineralized nitrogen soil organic matter pre-for instance, the conventional system producing 40 pounds per acre, that was made available to the crop, the organic systems range from 50– 80 pounds per acre. That is a significant increase in nitrogen cycling that reduces your need for applying more concentrated nitrogen.

Again, another comparison in a couple of recent studies that looked at the micro biomes under organic versus soluble fertilizers. They did detect greater diversity and improved a nitrogen and phosphorus cycling, a lower number of plant pathogens all in the organic system.

There are three basic strategies in the sourcing of nutrient sources for organic systems. One is to grow in place. Letting covered crops fixed nitrogen directly, mycorrhizal crops make phosphorus more available, however the only nutrient that it can be brought in from outside the soil system into the soil is the nitrogen. The other all deep-rooted covered crops are very good at retrieving nutrients from the subsoil that can recycle Leach nitrogen, leached cat ions, if you have sandy soil with a low-calorie on exchange capacity, you could have leaching. Sulphate is also leachable and easily recovered by these deep roots, some of the micronutrients. They will also slowly whether the soil and minerals in the cells, sand, silt and clay, thereby turn completely and soluble minerals into plant available nutrients.

There some parts attempting to grow old nutrients in place, then there is on firm cycling, whatever residues generated on the soil, if you are in byproduct, if you have livestock, manure, if you are harvesting grain crops and usually the straws in the field anyway, all those go back under the soil, and this approach tends to minimize all farm inputs as much as possible. When you integrate crop and livestock production, your recycling nutrients that way both through grazing, and through return in the wintertime, manure accumulations to the fields, either directly or after composting.

However, if you are selling products off the farm, you're going to need to bring some materials back onto the farm to replenish what you are selling off. These quantities that are removed, we will get to that in a few minutes, they're actually quite a bit less than what our standard nutrient recommendations, even when soil tests show high levels of the nutrients.

One of the neat things about off farm cycling is a lot of organic farmers use organic waste, there is organic waste in byproduct, there's no such thing as organic waste until we wasted either by contaminating with industrial chemicals that are toxic and can't be broken down, or by saying okay, we can't deal with this. It's going in the landfill or the lagoon. It makes methane, which we don't want because it is worsening the climate situation.

A lot of organic farms get leased from the local or food waste composted, get manure from nearby farms that have more manure than they can deal with easily etc. Sometimes when you are starting with depleted soil, you want a shot in the arm from high-quality off farm inputs, good compost etc. In addition to going high biomass cover crops to rebuild a depleted soil.

Cover crops play a central role in organic nutrient management, not only is there the nitrogen fixation, grass and legume covered crops provide what is called a green bridge. If you have corn, which is (name), in the next year you are planting beans which is mycorrhizal indigo into a wheat crop, that is mycorrhizal as well. After the corn crop, if you have a legume and the grass winter cover crop, that will sustain the mycorrhizal so doesn't go dormant, and comes to life more quickly for your next production crop.

Covered crops are also obviously well known for protecting and enhancing soil health, we use a wide diversity of covered crop species and building that total above and below ground diversity. The other thing that covered crops do, the deep-rooted ones are excellent for retrieving any excess soluble nitrogen that has leached and can happen inorganic as well as nonorganic systems pre-they retrieve all the other nutrients. For instance, radish and grass will send roots down to five to seven feet of depth. If there is any leftover nitrate there, a good covered crop can actually get through an acidic soil layer or even a hardpan and get all the way down, and retrieve all that nitrogen.

It will also enhance the availability of phosphorus, legumes are very good at that. Grasses are good at retrieving and mobilizing potassium from subsoil minerals.

Another thing is if your potassium and phosphorus are already high or very high, covered crops will never aggravate those excesses and in the meantime they will continue to provide nitrogen. If soil nitrogen is limiting the legume and the crop it will fix more.

Here's an example of an excellent example of on farm nutrient sourcing. Elmwood in Georgetown, Kentucky. The member is an 800 member CSA, they grow a lot of things. Rotational grazing on both permanent pasture and 200 acres, which is any rotation of three

years of either vegetables or feed grains with covered crops followed by five years in forage with this multi-species rotational grazing.

Another thing they do is they don't sell anything off the farm that their customers can eat. Maybe eggshells, but like a little bit of bone in the meat, but when they take their vegetable crop, they only take what can be eaten and everything else gets returned directly to the field or the compost pile. Likewise, all meat is processed on the farm, and all the slaughterhouse residue, not waste, is returned to the land after composting. So their annual off farm input to sustain this system for 550 acres, we're looking at about a pound per acre each for nitrogen and phosphorus per year. About four pounds per acre of potassium. Then there is a natural minimum of supplements they need to sustain their livestock but again it's a very modest amount for this large operation.

The University of Kentucky has done some studies of the eight-year rotation and they found that those five years in pasture will restore soil health after three years of intensive annual crop production, restore the soil health and the micro biome to very close to what they have in the permanent pasture. They are still trying to perfect the system because the researchers did see some organic matter drawn down every time they broke that pasture to go back into the annual production. So they're looking at ways to shallow, till more shallow well using a turn plow to break the solid.

This awesome nitrous oxide during the initial burst of breakdown after the sod is broken.

There working on making a great system even better.

Another thing, off farm nutrient sources, there are two commonly used products. Compost, which is carbon nitrate around 21, poultry litter fertilizer, poultry litter is the go to quickfix and PK for organic systems, provided it's either compost or heat treated, is allowed without restriction in the national organic standards. Of course you have to manage nutrients in a way that does not create serious environmental problems. Overuse is not allowed.

Had some very interesting outcomes from the 11-year study that had a vegetable rotation and a merry time in Washington state. After 11 years, the compost treated system had 43 percent more total soil organic matter than with poultry litter. I have to admit, I think I made an error in the next two percentages. There is several different measures of active organic matter that vary from 30– 65 percent increase depending on different ways to estimate active soil organic matter. I believe there permanganate oxidized organic matter when up something like 50 percent. That should be 30 percent higher microbial active, it's pretty substantial. Most important thing is that the soil micro biome was quantitatively different, where the soil was amended was compost. These are an equivalent nitrogen rate, total nitrogen we are talking here.

It's about 150 pounds per acre of nitrogen with treatments every year. The soils capacity to mineralized nitrogen was significantly higher with the compost, and at the same time, when

there was a surplus of nitrogen at the end of the cropping season, the compost treated soil was more capable of immobilizing the axis and eliminating nitrous oxide emissions.

This was accomplished and also, there was improved soil structure and water infiltration with the compost and the crop yield from the systems were similar, there was a couple vegetables that in the poultry litter were heavy feeders, the couple times that the wheat crop in the rotation did better with the compost.

One of the challenges with both of these commonly used organic inputs, good quality compost was moderately high fertility with a one, one, one analysis. Poultry litter was five, four, three. If we look at vegetable production and with the vegetable harvest actually removes, the phosphorus in the red box, those numbers hovered right around ten pounds per acre per year per harvest. Or 23 pounds and phosphorus or PTO five. Now if we go over here and look at the what is contained in the compost or the letter, it provides plenty of nitrogen and provides the right amount of potassium, but it provides way too much phosphorus. If you use either of those amendments at rates that are going to ensure enough nitrogen, and 100 pounds per acre is typical for recommendation. Maybe a little bit higher than we need, we'll get into that later but even with a mixed compost where the nitrogen is just going to go under the organic matter pull and not cause environmental problems because of the higher ratio, we're still going to build up the phosphorus. So that's what happens with field crops, grains are an interesting in that they do take somewhat more phosphorus. So the phosphorus surplus in these amendments is not as extreme. Although if you're going to meet the high nitrogen demand entirely through compost or litter, you will be piling up more phosphorus.

Look at how little potassium is removed. If there is returned to the field, there is a very small amount of removal of potassium. The other extreme, the 4H crops remove large quantities of potassium as well as nitrogen and phosphorus.

Organic growers have a great tool to mix and match, to get the nitrogen phosphorus balance closer to correct. If your soil is testing low on phosphorus, by all means use compost or manure, the manure has to go on at least 120 days from harvest of an organic food crop. The best way to accomplish that is to simply put your manure on a covered crop like when you're planting (name) grass which is a heavy feeder, maneuver spread is on, the two together will work very in a similar matter that builds soil fertility. By the time you have the terminated and planted your next vegetable, you will be well past the 120 days.

If your soil is up around optimum on phosphorus, you only want to apply much as you remove. If your growing vegetables, unless you are triple cropping, you are really only moving ten pounds per acre. You will need to limit how much compost or manure is used. If your soil is surplus at a very high range, both to protect them, to restore your soil microbial balance, and protect water resources, you want to use manure and compost very sparingly. I will look for a plant-based compost. Where you make up the nitrogen in those in the optimum or high phosphorus sinners, legume cover crops is the way to go. There are also rapid release nitrogen fertilizers that are basically phosphorus free that are permitted. Feather meal or blood meal,

about 812– 0– 0– one analysis with a moderate fast release. Chilean nitrate which is a natural form of nitrate, the AP allows only 20 percent of the crop total nitrogen need to be met, that is basically 20 pounds per acre.

However, it's been found that if you provide that in a row, that small amount of the Chilean nitrate, for schmaltz or other concentrated nitrogen gives the plant a boost by not flooding the bulk soil with soluble nitrogen, but giving it a little bit, maybe a few pounds per acre once a week or every two weeks in the crops highest time of highest nitrogen demand. You can support the crop yield without upsetting soil biology or threatening water quality.

Right rate, how much do we really need. There is this concept of the economic optimum nitrogen rate in the point, that is a function of the yield response to the fertilizer, it is fertilizer price and whatever value you replaced on food storage, that is beyond economics, but that is a factor for a lot of organic farmers. They want to make a living, and do right by the land. Yield response in itself is a function of how healthy the soil is and management history. There is a need to credit nitrogen mineralization from the soil organic matter, which labs are beginning to do now.

The thing to remember is if you have surplus soil, nitrogen that will actually reduce the soils capacity and mineralized nitrogen. Total versus available, when organic farming was first getting some, was first beginning to be validated in mainstream community, extension, NRCS, this is 30 years ago, the thought was, let's use compost for nitrogen, but take into account how much of it is actually available to the crop. It may only be ten to 25 percent, or 50 percent for manure and legume green menu era. The total in the end has to be doubled, or in the case of compost for X. That will rapidly build up phosphorus and it is not usable at a larger scale. Some organic farmer said okay, let's till down the manure with a legume covered crop, and that is great for growing a high yield in corn crop for instance, but it does tend to cause spikes in nitrous oxide emissions.

There was a recent meta-analysis where comparing again, organic versus conventional sources of nitrogen. They looked at what happened when the organic nitrogen was used at an equivalent of total nitrogen rates or soluble nitrogen rates. One was based on total nitrogen, the yields were sustained and nitrogen lost to the environment were reduced by 30 percent. When it was based on soluble nitrogen, you have a yield increase but you also had an increase in leaching over the conventional system. There was a study in 2018, this was in another NRCS webinar, as well as conference presentations. Robin did a five-year study of organic systems in South Carolina. Organic corn soil wheat rotates in with high biomass covered crops and was on Orangeburg, this is not exactly a highly for tile soil, it's near fertility that is moderately low. They looked at either applying recommended phosphorus and potassium, or none at all, and they looked at 0– 50 and 100 percent recommended of the nitrogen rate. Of these soils, they were testing high or optimum in PMK. What happened at five years is that the yield was a full grain yield was maintained but no phosphorus or potassium for five years, and 50 percent nitrogen rates. He did not see any significant depletion in the phosphorus or potassium so the soil reserve is substantial, the covered crops are retrieving the PMK for the subsoil etc. The organic system showed an increase in soil organic matter from 1.2– 1.7 percent, which is quite good. He

also cited trials of both on station trials for a role wide range environments, North Carolina, North Dakota, Ohio, Illinois, giving similar results.

Here's another question, doctor Alan France (name) colleagues in North Carolina state had been looking at what is the economic optimum nitrogen rate for crops in soils at different levels of biological activity, and overall health. It turns out, he looked at some heavy beaters, corn salad, corn grain, forged (name). Looked at how much nitrogen was needed to get to the economic optimum.

He looked at soils that ranged in history and overall level of soil health and biological activity measured as a three-day respiration analysis in the lab. 21/57 of the four trials had an EO NR of 0, half of the corn silage and one third of the corn grain trials likewise. No nitrogen needed. The soil was supplying nitrogen to the crop sufficient to maintain top yield. All you had to do was restore total nitrogen, grass cover crop, manure, compost, whatever you didn't eat any artificial or need any concentrated fertilizer, no chicken litter, no soluble nitrogen. Another trial in Clemson South Carolina, soil was under long-term organic management was in pretty good shape, usually high organic matter. They planted summer squash, tomato after a crimson clover crop was rolled down. It yielded well as was no response to nitrogen. An earlier study by researchers at the University of Illinois found that a lot of the times the recommended potassium on soil test recommendations is simply not needed, especially for grain process to have the low potassium requirement.

Here is a counter example, broccoli. There were several studies in the Pacific Northwest and in California on organic broccoli. Here, the response to increasing amounts of nitrogen and the form of organic fertilizers that are concentrated like the feather meal, blood meal, beat meal, there was a continuous increase in yield all the way up to 200 or more pounds per acre. Great, the farmer is making really good money. Hitting the huge dutiful broccoli crops but no no, 180 pounds of nitrogen leaching, and an estimate that between 11 and 27 pounds of nitrogen went off as nitrous is oxide which is bad for the claimant as losing 1400– 3400 pounds per acre of soil organic carbon.

Roughly, three– 6000 pounds of organic matter. We have a little problem, what is going on. The broccoli only removed 25, or at most, 50 percent of the applied nitrogen and the remainder leached in the ground as residue is decomposed.

There are a couple of reasons going on here, one is, this is conducted in a Mediterranean climate where the summer is dry and you have to drip irrigate within the road to keep your crop going. Then after the crop is harvested, you get rainy season and any nitrogen left over will leech. It's a difficult climate in which to manage nitrogen.

The other thing, is that broccoli has a relatively narrow and not terribly deep root system so it is not exploring the entire soil volume. If these materials were broadcast or even across the bed top, it will not have been used with optimum efficiency, and that is again, maybe the Andro delivery of the more concentrated nitrogen is the direction to go.

Right timing, I will try to wrap this up, we are getting close to the end of our time.

Precision timing for organic nitrogen is notoriously difficult, it is one thing to say okay, I want nitrogen on my crop during mid growth, so I will go out and side dress with ammonium nitrate, or something like that and be able to rake in exactly but if you are organic in using things like compost, manure, poultry litter and relying on biological process to release it, you get a lot of wildcards there. When the timing is off, you have both crop nitrogen deficiency and nitrogen losses to groundwater and greenhouse gas emissions.

For most other nutrients, this timing is not as critical, if you have a biological healthy soil a lot of organic matter, you can put down the potassium ahead of time and on exchange capacity, be ready for use, phosphorus is neither volatile or super soluble, as long as you haven't built it up into the excess range or optimum range, it will stay there, same with most micronutrients. Boron is soluble but it's easy to supplement in very small quantities, it's all you need. Nitrogen is the one where this is tricky.

If you have organic nitrogen, and it is mineralized too early or too late, you get that nutrient loss and then you get an adequate nitrogen when the crop really needs it, that growth phase where it's really sucking up the nitrogen, the idea is to have nitrogen mineralization occurring right when the crop needs it.

Then if you have a poor match, it can also cost the farmer a lot because the organic fertilizers are not cheap. You can have poor return on the investment is all the fertilizer.

For example, this rotation on no till where you roll down the cover crop in no till plant your grain, there have been great successes and tremendous failures in this. Let's say you're in the upper Midwest in this beautiful silk long super fertile, you go up there and improve organically and say you're on a roll of cover crop, what happens is, because you have a relatively cool climate, you delay nitrogen release until it is too late in the season. On the other hand, if you're down on the (name) in South Carolina on that lonely sand you say maybe I don't want to till this cover crop in preserved soil structure, roll it down. If you have good luck with establishment, that crop that has been rolled will mineralize more slowly which in the hot climate in the sandy soil means it is just right. When the crop needs and you get to Pompeii crop.

Here is an extreme example of a synchronized. This is a study organic rotation with broccoli in the summer followed by strawberries that were planted in the late fall for harvest the next summer. What happens is, all the rain comes to the fall and winter, you have quite a bit of residual nitrogen, and broccoli harvest. Then the broccoli itself returns another hundred pounds per acre or so of residue nitrogen that becomes mineralized in the fall. Then the rain comes and you put out your strawberry but they're not growing very fast, it is cold, damp, the not doing much. All that nitrogen gets leached away in the 20 inches of rain that fell in the winter. Then

when the strawberry takes off, there's hardly any nitrogen left for it to use and you have to put on more.

Interesting experiment by Eric Brennan in Salinas Valley, he was growing spring lettuce by fall broccoli in an organic system and either had a winter file or winter cover crop. Whenever there was a covered crop, I think he tilt it, I'm not sure, however he terminated the covered crop provided nitrogen to the spring lettuce crop and could even be muster or write, and we do this. What happened was the covered crop was recovering 100 per-- left over from the broccoli and making it available to the lettuce, whereas with the towel it all leech down the lettuce gave either a complete crop failure or a 50 percent yield.

Right placement, a few more slides here. I was mentioning that in row placement, band application or in road trip for negation, this is turning out to be quite a valuable strategy. I think it needs more research. So the idea is to have your soil life functioning so that it is right in the roots zone, where you have the highest population of microbes, but it is working the organic matter, residue, making it available to the crops for immediate uptake and is hardly any chance for leaching.

'S the state trial with organic tomatoes, this is in California in that challenging Mediterranean climate. Look at 13 different organic tomato fields and foundry pattern

Is where the nitrogen efficient, the manure went on the previous winter and it mineralized and leached its nitrogen before the crop to get it and the soil wasn't in super good health to begin with, so the crop was deficient. Soil test nitrate was down around two or three parts per million. Nitrogen Saturated, they were using concentrated organic fertilizers, poultry litter, a peer veggie covered crop plowed down, things like that that flooded the soil and nitrogen, they got great deals. Definitely some risk of leaching. Know the best system was what they call tightly coupled nitrogen cycling, the use finished compost without moderate balance to seed ratio as a primary source of nutrients. She puts a little bit of concentrate nitrogen the middle-of-the-road, there were using one in one firm, and fishing mulch and the other paid what happened is it maximized soil microbial activity, soil organic matter, nitrogen cycling capacity, and while the nitrogen, nitrate levels in the soil were in the so-called deficient range, three– five parts per million, the crop became fully ill because they were getting the nitrogen right in the root cell from mostly from the microbes.

This is an example of what happens, I think we need to wrap this up to give you time to ask questions but this route was feeding a community of bacteria, and the larger spots you see zooming around are the protozoa feeding on the bacteria and making the plant available nitrogen phosphorus right therefore the root where it can take it up.

A few things that are important for maximizing, optimizing the plant root production, one is to keep nitrogen phosphorus and also water at optimum for top growth, just going little bit mean. Don't starve the plant were drowned it, but a little bit on the lien side, what happens is the top

growth slows slightly and there is surplus carbon that goes down to the Ritz, grows bigger roots, more exudates, more vibrant microbial community and more efficient nutrient cycling.

Unlike concentrated nitrogen fertilizers like rooms in the rotation further enhances microbial community. Rotational grazing on pasture that is managed to occur late in the rapid growth phase helps ensure that there is a lot of root exit eight to keep the pasture soil in good shape.

Very quickly, some overall tips using soil tests, fully your analysis, attending to all the nutrients, nutrient budgets are excellent tools for all farmers. Stack soil health practices, don't rely on one or two. Maximizing the living roots and diversity. Bayesian nitrogen applications, once you have the soil in good shape, on total nitrogen relevant soluble. Livestock crop integration is really good, and I think this may take more research but I really think the idea of using small amounts of concentrated nutrients right in the crop rose going to be an excellent tool for the organic community, and for farmers in general.

Questions?

>> Great, I will jump in bark, and review some of the questions. For the folks in the audience, no the questions have been answered so check the chat and you can see the answers to the ones that are checked. So the scope of the conversation, but I will bring it up to share with you is if soil health is at the crop production, why has organic hydroponic production been approved. Mark, before you jump in, I would say that it's an imperfect system, right now it is not that hydroponics are approved, it's more like they are allowed and haven't been disapproved. Some certifiers will certify hydroponics, others will not. There is a whole realm of people across the spectrum having deep feelings about this. But it is not ruled one way or the other.

Mark, do you have anything to add there?

>> Only an opinion. Organic hydroponic is an oxymoron. (Laughing)

>> Fair enough. Okay. There you have it, it is a hotly debated topic. Don't feel alone in asking that question. It is hotly debated area, the only thing I will at is we are trying to feed the world. I think that is one reason it hasn't been disallowed but a lot of folks that feel very strongly about organic principal don't feel like that is the way to go.

>> I'm all for hydroponics in an urban farming situation where it makes the difference between eating hydroponic vegetables and not having any decent food in your diet. Nothing wrong with it, just wouldn't call it organic because of the soil focus.

>> Sure, fair enough. Next question is, by nature, what is in my barn, I compost almost equal amounts spent hay and goat manure. I apply this to track patch garden, it seems to have made a big difference in fertility and particle size, so it breaks up readily. Am I doing this correctly?

>> That sounds like a really excellent balanced mix there. It may be a little bit rich but I would think that overall, what you are doing is combining carbon in that spent hay, and nitrogen in the goat manure. Goat manure is not superhard like a compost chicken, if it was chicken manure I would say go 3:one with three parts carbon but I can't argue with success. You see improve soil conditions and it's possible if you use large amounts of it that you have a very high phosphorus level and you'll have lost your mycorrhizal community, however the other microbes that would step in and do some of those functions, it's worth getting a soil test and if you find your budgeting your optimum on phosphorus, cut back the quantity but still put a little bit and because it is working in conjunction with the covered crops, the really to build and maintain soil health.

>> Thank you.

>> Urban farmer, for looking for good fertilizer.

>> There's a number of questions about sharing the citations of the studies you mention, I think a lot of them are in the presentation and maybe in the handout, but there is one question here specifically about the negative effects of synthetic inputs.

>> That is, all that, there's a long list of resources, of references at the end of the presentation notes.

>> Great.

>> That's why took notes because if anybody wants to dive into it and get into the weeds on this, all the references are there.

>> Perfect, very good. Thank you. Next question, do think national food labels can be changed to show the percentage of live soil to produce was grown in? For example three to five percent live soil versus one and a half percent.

>> Live soil, are you talking about organic matter?

>> I am assuming. It's organic matter versus hydroponic situations.

>> Present organic matter means different in North Dakota than it means in South Carolina. Like when Buzz got the soil 1.7 percent in five years, that is really good. If I was in North Dakota, if I was at one percent I would say oh my gosh, after like build the soil up, it's totally depleted. It is so both climate and soil texture has such an impact on your percent of organic matter. I mean, I think measures of soil test biological activity, I am eagerly waiting. I'm a little bit concerned that maybe Dr (name) said you're jumping the gun but I'm so excited about his research and the studies that showed that this very simple lab test is so well correlated with soil health and all the parameters and functions. I would suspect that if you found soil in North

Dakota that had two percent organic matter, you would find a soil test biological activity way low, like the soil is hardly living at all.

Whereas if you go to the south, the southeast coastal plain and find two percent organic matter soil, it looked pretty darn good on that soil test biological activity. If you try to grow a crop on just soil nitrogen, you might get a decent result in South Carolina, but up in North Dakota if you want to get a good result, you want your soil at 8% between the cool climate and the texture of the soil, the healthy soil is going to be at a standing stock of around eight percent. So it is so context specific. So site-specific.

>> Good point. Next question is on water consumption. Can you tell us about the water consumption of the covered crops, is it minimal or does it help to hold water?

>> Water consumption, this is a really important question in dry climates, because if you only have ten days of rain a year and you're trying to make a living growing cereal grains, you really don't want to grow something like alfalfa that is going to suck up all the moisture in the top six feet of the soil profile because the only water left is - especially if it decides not to want to rain for a month, is the wheat crop.

In most regions of moderate to high rainfall, the benefits of the covered crop to soil structure and hold capacity is much larger than the cost of the water consumption, immediate water consumption by the covered crop, it's true for coming into the spring and you want to plant and you're having a really wet spring, you want the covered crop to stay on as long as you can possibly let it to suck out the excess moisture and get your soil down to a point where you can roll the covered crop or mow it and to living lightly to get your crop planted.

If you have a dry spring, then you might start to think that covered crop is using the moisture I need to grow my next crops, you might want to terminate a little bit earlier. When you get into a climate like, for instance, in Montana, is an excellent grow route there. Doug Crabtree and Anna Jones Crabtree managed Villakiss Farms, it's a region that grows wheat typically, they have 25 different crops. 15 grains and oilseeds in pulses and ten covered crops. They take a totally adaptive approach as to how they till the soil, which they do with great care, how they rotate when they terminate the covered crop, if you have a terminated covered properly to preserve moisture, you definitely want to mow it and leave it on the surface or undercut it shallowly with a blade plow or something like that.

So, yeah, it is a real dance when you're soil moisture is limiting but remember even where you have to worry about short-term moisture consumption, and leaving your next crop high and dry, the long-term benefit of that covered crop, especially deep-rooted figure covered crop that is feeding into the soil microbiology is your soil is going to be better at taking up the next biggest downpour and holding it for the next crop. That gets even more important as the rainfall is more extreme and erratic.

>> Another covered crop question is do the covered crops enhance the soil during the winter or are they just sort of holding things in a good state?

>> It depends upon your winter, if you are in Vermont, your hope is that they are covering the ground. Of course the ground is under snow for a couple of months. But then when the thought comes, your covered crop is there ready to jump up and grow.

Another approach in a cold climate is to grow a very fast-growing fall covered crop so when the hard freeze comes and kills it, at least you have a protective mulch. If you're down here in Virginia, especially with global warming, we are getting some pretty mild winters and you have wrought and veg out there, I think I have winter peas in my garden and they actually came through an unusual freeze. We went to -3 degrees which maybe happens about once every five years around here these days, and they are still there. They're ready to jump when the weather warms up. You get down to like coastal Virginia or the deeper cells, you can grow cool season cover crops all winter, they will grow like crazy and take the light freezes that come and go. So covered crops are valuable anywhere year-round and even if they're not actively growing, once they have a decent root mass and covering more than half the ground surface, even though it is a low Matt, they're tremendously beneficial for erosion control.

>> Great, next question. The quick composted compost looks like it would be very beneficial with organic system due to its ability to detect the outcome. Are you familiar with liquid compost?

>> Liquid compost, is that compost tea?

>> It could be. That is all it says.

>> Liquid compost, I know there is also this very (name) is toying with the idea of basically converting covered crop residue into a nitrogen rich liquid. Like organic nitrogen. I haven't explored these higher tech systems as much, I think that they are worthy of research, I tend to be really old-fashioned and say let's do it the way mother nature figured out 450 million years ago, and grow living plants and let the animal poo go back to the land and then we have big concentrations of civilizations when we go to the organic residence that we don't want to be turned away spray let's get the compost made and get back out on the land.

There may be some value, I have heard different outcomes with compost tea. Some care is needed in making it, because if the brewing process is not correct, you can actually brew up either plant pathogens or even human foodborne pathogens. The NOP, national organic programming is a little bit weary of compost tea as something to apply directly to your vegetable crop like a month before you get a harvest and take it to market.

>> Thank you, next question is can local and CRS offices recommend covered crop seed mixes for upcoming cash crops great I will take that and say yes, please visit your local office

and talk about local covered crops because they have information as well as extension both in the organic organizations in your area will have a lot of great suggestions.

>> I would say that it seems like not all local offices are alike in terms of trading equal and their level of service and level of expertise. It is just a matter of training and getting the information out there. There will be a cover crop webinar coming out later this year.

>> I think organic farm research foundation has covered crop resources to, there is lots out there.

>> All the theories, and one of the things is big on covered crops. It's pretty detailed and outlined as to how to choose your covered crops.

>> Great, next question. Any thoughts on the adjusting nutrient plans based on soil test ratios? For example calcium to magnesium, also any thoughts on rock minerals like grain sand.

>> Interesting, I did a study for about three years, 1998– 2000 on Cation balance ratio, I did a literature study and infield study. I have come to the conclusion that that theory doesn't hold that much water. For one thing, if you have a soil that has an inherently high magnesium level, and you try to correct it to those ratios, you will have huge amounts of lime because it's limestone. It's not ecologically sound and is expensive for the farmer to be putting on all these tons of limestone, and other nutrients that are also ratios and forming those for the micronutrients, sulfur, which looks skyhigh, to me. I would say that you want to take what nature has given you and make the best of it.

If you are, I do pay attention to the cationic ratios, if there really extreme, you have magnesium at 40 percent and calcium at 40 percent. I would say that might really be difficult for crops, or for the potassium that is extremely low, relative to the others, that would be hard for the crop to get the potassium if the potassium is extremely high or relative to magnesium, you get blossom and Rotten Tomatoes and might get cross in your livestock, which you really don't want to see because it's life-threatening.

I use the concept a little bit, in my consulting, but my Optima ranges are much wider range and much more site-specific. I look at if your soil is naturally fairly high in magnesium, if your magnesium is 30 percent, and these Cation balance sensation should be 15 percent, I say well you have got great soil alive, great yield, I don't see any problems here. It is not broke, don't fix it.

If it's showing some calcium deficiencies, you might want to maybe do a full year calcium, or if your pH drops, use a calcific limestone, things like that, common sense balancing.

>> Next question. Various land-grant universities and labs seem to have different targets for which they based their low optimum high ratings. Some land grant to set up for corn and soybeans, should we try to find the closest land-grant with similar soils in our region for that info

or have you found a very good table that could serve as a reference for many regions for vegetables?

>> I would tend to go towards the region specific. I will also add that I think different land grants are at different stages in this progression from the 20th century, Pilate on mindset, to where I would like to see it headed with both organic and conservation agriculture of the conservative nutrient inputs once you built up soil health and built-up optimum levels. It will vary with soil type, it will vary with region and climate, it will vary with which crops are growing. For grown corn, you don't need much potassium it turns out but you need quite a bit of nitrogen and phosphorus. If you're growing soybean, they fix their own nitrogen. But they do need some phosphorus. Again, not that much, very often there is plenty or too much phosphorus in the soil.

And some land grants are getting better at saying, I think it is Oregon state has now started to say 0 phosphorus and potassium if it is high or very high in the soil test. On the other hand, I get a test back from Virginia Tech are some of the private labs in Virginia and it shows high phosphorus, then it says still put on 30 pounds of Phosphate. I said why do you need that, it's like you have to draw this down.

Complex question but a very interesting one. I would say that going local is a good first step, because it will be, will focus on the soils in your region. Like the recommendations coming out of a lab in the Midwest, or out West where they have soil and I them my acidic Virginia soil, they don't know what to do with it. They will but they won't notice much. Like I don't as much about how to manage covered crops in the dry West, because it rains 50 inches a year here. So local is good.

>> Last couple of questions about manure applications, I will insert my two cents on testing, you should always be doing soil and manure testing to make your best application rates with the cyclically a question about can liquid manure be a part of organic production. What would be recommended for grazing pasture system in northern Florida.

>> I'm not a fan of liquid manure, it's going to behave a lot like chicken litter. Just the storage of liquid manure gives off a lot of greenhouse gases, however, if you've got it I would put it on a covered crop or a forage. Let me see, I don't know what I would recommend in northern Florida. If you have sandy soil, I would be worried about leaching because the nutrients are very leachable. It's a matter of balance, be sure you not putting on too much. Like if you are using, I would go any higher than 100 pounds per acre of nitrogen, splitting it into smaller applications that are practical. I'm guessing, I have no personal experience with liquid manure.

Like if you were, if you had access to liquid manure at the same time you had access to a high carbon like tree leaves or chip brush and had an area you are trying to restore with covered crops or trying to build up the pasture, probably putting on the carbon and the liquid manure together would tend to balance the two. Straight liquid manure might have some not so positive effects on the soil micro biome unless it is done very sparingly. Make sure you not putting too much on.

>> I would just add that there is a rule about whether it's liquid or solid manure. If it is being put on a crop that is going to be harvested with an edible portion on it, there is a longer wait time between application and harvest.

>> 120 days, yeah.

>> Just be aware of that. We have time for the last chicken manure question. It is, how much chicken manure should be added and to how much soil, what is the ratio?

>> Chicken manure to soil, I would go on a per acre basis. One ton per acre and it is five percent nitrogen, looking at 100 pounds of nitrogen, is that right? 2000, not fresh chicken litter but dried chicken litter you don't want to go over a ton per acre.

Again, if you're putting it on a fast-growing nitrogen demand covered crop, like if you plant tillage routers, you want to break up the hardpan and you're short on nitrogen, then you have access to chicken litter, that would be a good time to put it down but I would say looking at one or at most, two tons per acre, I would tend to look at the nitrogen and keep it not much more than 100 pounds per acre. If possible, complemented with a nitrogen demanding cover crop, or more carbonation soil amendment. Chicken litter is a good component of an organic fertility system, but when you depend on chicken litter as your main source of nutrients in organic matter, there's a tendency to either burn up organic matter in the soil or not successfully build it up in any case.

>> A couple more questions that came in but I also want to circle back to somebody else about the research studies are they cited in the documents available for free, or do you need a subscription for some of them? I know that's often the case.

>> Some of the ones I did just go on abstracts or I was able to access because a friend had a subscription or a colleague. Some of them are open access. Everything at organic farming research foundation includes references in all of those soil health guides. It is all free, open access. But you're right, some of those referencing journals you have to be a member and subscribe, they get expensive. When you buy an article you pay \$50 for an article, which I never do to be perfectly honest. Very often, two thirds of the time I find the abstract is sufficiently informative to get the general outline of the conclusion. Since I do tend to review a lot of research, I don't have time to read in find detail in each 2030 page article with the technical detail. That is how I approach it.

>> Great, somebody noted that they thought both the handouts were the same. We will double check on that. Looks like they have different titles, but we will double check on that. Then the last question here—.

>> One should be a PowerPoint slide and the other one should be the presentation notes.

>> One should have the notes.

>> And I think we sorted that out once before, we ran into that during our test run on Friday. I thought, I went and set that.

>> We will double check with thank you for letting us know. The last question, is there value in the garden to incorporate (name) and folic acid derived from heat source?

>> Good question, humin like acids, it was once thought that stable organic matter was composed of humin and follow gases even more material called humin, since in the last 20 years, it's been discovered that those are an artifact of extraction using an extraction to measure stable soil organic matter and it takes all the mineral associated organic matter and all the aggregate protected organic matter, but the often extraction process causes this huge Condensation reaction that turned those organic substances into these huge complex macromolecules. So on the one hand, it's an artifact and on the other hand there have been studies that show that it can have some real benefits to crop growth as crop growth factor effects, micronutrients, not sure what exactly it does. They have certainly allowed in organic production if you find it works, then use it.

>> Great, that is the end of the questions. Thank you all for a great diverse set of questions. Thank you, Mark. Any other last comments or questions?

Back to Jennifer.

>> Thank you, Lindsay. On behalf of the USDA and the natural resources conservation service, I want to extend a sincere thank you to Mark in Lindsay for providing an excellent presentation today. On biological nutrient management. Best organic practices for soil fertility and resorts stewardship. Thank you again to everyone for attending today's webinar, participants don't forget to provide your feedback about the webinar. If you selected to earn CEU, returned your open browser window to continue the process offered by step number two, the compensation webinar.net. This concludes our webinar presentation.

>> Thank you.

>> Thank you Mark and Lindsay, Mary and Thelma. Have a wonderful afternoon, thank you all that attended. We will talk to you soon.

>> Thank you.

>> Thank you.

>> Goodbye.

>> Goodbye.

