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August 2022
Conservation Outcomes Webinar
08.25.22

» Good afternoon everyone we're going to begin our webinar in about five minutes, thank you.

» Good afternoon everyone, our webinar is about to begin and today's webinar is going to be recorded and we'll start that now. My name is Amy Overstreet and I'm a natural resources communication specialist with the USDA Natural Resources Conservation Service resource Inventory and Assessment division. And it's great to be here with you today.

We host this webinar series to highlight activities across the natural resources conservation service, or NRCS, related to efforts to assess and quantify the impacts associated with NRCS conservation programs. These one hour live webinars occur on

the fourth Thursday of even numbered months. We will get started with today's presentation in just a moment. But first a few logistics.

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Finally, we encourage everyone to actively participate in today's webinar. Please type questions or comments into the Q&A Box that you will shortly see appearing on your screen.

You can submit your questions and comments throughout today's presentation. We will address as many of them as we can at the end of the event.

With that, it's time to get started!

I'm now pleased to turn the microphone over to Dr. Louie Tupas NRCS Deputy Chief for Soil Science and Resource Assessment Deputy Area.

» Welcome to the latest installment of NRCS's Conservation Outcomes Webinar series.

As you know, NRCS has a long history of working with farmers and ranchers to help them conserve the natural heritage and sustainability of their operations.

These recurring webinars give us a way to communicate to our stakeholders the importance of voluntary conservation programs and the funding provided through the Farm Bill for these efforts, and to highlight some of the documented outcomes in terms of natural resource and economic benefits.

For nearly 20 years, our Conservation Effects Assessment Project, or CEAP, has been documenting outcomes of our work on a variety of resource concerns. CEAP works closely with our science partners in other agencies and academia, and outcomes generated help inform improved conservation delivery across the agency.

Today's webinar is well timed with August as National Water Quality Month. NRCS and the University of Maryland's Wye Research and Education Center have a partnership to help improve accuracy in measuring conservation outcomes through CEAP. Today our guest presenter, Dr. Ken Staver, will discuss how cover crops and reduced tillage

practices impact nutrient and sediment losses from croplands, and as a result, impact water quality.

At this time, I'd like to turn it over to NRCS Soi Scientist Dr. Candiss Williams, who works with the CEAP Modeling Team, to introduce Dr. Staver.

Thank you Dr. Tupas. This afternoon I have the pleasure of introducing Dr. Ken Staver, an associate research scientist at the Wye Research and Education Center, University of MD College of Agriculture and Natural Resources and one of our CEAP modeling collaborators. Ken has worked at Wye since 1984 conducting research on water, nutrient, energy, and carbon flows in Coastal Plains watersheds. The focus of his work has been on the development of strategies to minimize negative environmental impacts of agricultural activities while maintaining productivity and enhancing soil and water resources.

He has been actively involved in varying roles as a technical advisor to the Maryland state agencies and the US EPA Chesapeake Bay Program to bring research findings into the watershed management process. He is also an owner/operator of a grain farm in the headwaters of the Choptank River Watershed where he lives with his family.

I would like to welcome our presenter, Dr. Ken Staver, to deliver his presentation on Cover Crop Nitrogen and Phosphorus Dynamics.

» Thanks it's an honor to be here in this venue. Now if I could just see my first slide to say the technology had help on this has been fantastic so what I'm trying do in the next 45 and 50 minutes is talk about the Chesapeake Bay -- Chesapeake Bay community audience so I don't always go through the background because everybody knows the background.

But for you folks out there, first slide is where I'm coming from in the Chesapeake Bay so look on the right land part of the screen we talk with the Atlantic ocean and here's the chose peek bay it drains a good chunk of Maryland, Maine, Pennsylvania, and Delaware and West Virginia and DC too so, we're a highly populated area. We have these parts of Maryland, Delaware and Virginia, it's very rural, it's no main bridge crossing from the population centers, the first bay bridge wasn't put in until the 1950s so it was hard to get to this area going back and fairly.

We have had development relative to the coastal plain it's pretty rural really in agriculture.

Zooming in we try to give background in the middle is Wye Research and education center. Wye research and Chesapeake Bay, got striped bass, oysters and crabs, species of economic concern. And here is field area, so grain production and short culture programs too.

Everyone wants to live by the water so all of the waterfront close to the bay bridge that sort of connection often to the higher paying jobs in this region there's a lot of pressure -- we get to the interior and it looks like snapshot of the Midwest. A lot of this has been in production for centuries.

A slide of mass data from the state of Maryland so some of you in the Midwest probably chuckle at the acres, this is the whole state of Maryland this is not a could you please telly but we're a small state but the interesting thing about this is in terms of where we are in terms of production we mimic the country. So, early on a century ago

we had wheat production for human food and corn production for life stock feed and interstate network was built and the west opened up we're not the best wheat growing area from a climate stand point so we just tailed off no surprise.

Sorry the big change in the last half century is the increase of so I production. So, now we roughly have corn and soy bean acres and this mimics nation, and then we have corn and cheat percent of that. we're a small state but we have a row crop situation that mimics that similar to the whole country.

So, first we talk with rotation and this is a picture that I took in June in our wheat field that harvest the for use of mush room production in southern Pennsylvania. We talk about cover crop and talk about the cover crop windows and some areas of wheat production there's a fairly long window for cover crop planting after a wheat year. Far enough south same stack just earlier this week that we plant soybeans after wheat.

So, when I talk about cover crop the coast we talk about primarily after wheat and soy bean and corn harvest, in this case you don't crop beans after wheat, won't be harvested until early November or maybe earlier. So, we don't have a lot of long windows after harvest. So, one thing to keep in mind we have these cover crop options but you have to think about your primary crops and what are the windows for planting.

The Chesapeake Bay issue the main problem this was nailed down in the early 80s, this is a finding that's decades old, we have too much input. Just today we got the monthly sort of dead zone report for Chesapeake Bay comes out, it comes out monthly, on the first, there's dead zones in the Gulf of Mexico that make the news, these are

excess algae developments and decay, and consume the oxygen. We have a shallow area in the bay that historically were covered in the -- community, where they got their sediment and they got the nutrients out of the sediment not out of the water column. These were important for fish and water quality and erosion, and waterfowl, these were important for the ecosystem.

When the nutrient levels started to increase it was better for the algae big goal to reduce the pits. Signed by all of the states, to reduce the nutrient inputs by about 40 percent and we have had lots of updates, in 2010 because the goals weren't being achieved the government stepped in and established the total maximum daily load, TMDL so now we're in an all hands on deck mode to get all hands on deck to meet this by 2025.

We have a limited amount of tiling compared to the rest of the country our soils are enriched with nitrate and that results in high nitrate levels in the stream flow and the high loading ratios of algal available to N tidal waters.

So, this is just a monitoring site in the Del Mar peninsula. This water in this site in the spring they stock it with trout and the trout like clean water so over all until the water temperatures are warm and when it discharges nitrate it encouraging algae growth.

We have multiple sites, a couple water sheds side—by—side that we do surface run off monitoring for since the early 80s. I think we're north of ten thousand individual samples we've analyzed out in these fields. This is where you do the tour stops and this gets the press in terms of run off but the nitrogen is the subside of the story.

So, it's not always what you see. In the coastal plain where we are, it's sure pleasing how much of the total of the end load is ending up subsurface, but for the coastal plain we look at roughly 80 percent and look at the bottom, kilograms per hectare, on the average, 20 to 30 kilograms per hectare, you get 18 to 27 pounds per year.

I'm probably not telling you anything you don't know it all starts in the root zone. Our management point is the root zone. So, for us if we get the end loads down or reduce the leaching rates that lead to lower ground water, and one thing we have is winter cereal cover crops do this very well.

So, this is an old slide and I just keep using this slide because the point we have known this for a long time, I would say to you, I would encourage anybody, buy a copy, 1938, Soil and Men. Growing corn and so for this this is fantastic nutrient management and we can't do much better for you how much corn we produce for how much we apply. It's been continuous at this point. At the top there's 0 to 4, and 4 to 12, we hear about how inefficient corn is taking up the N, but when the corn is fully done its thing there's almost no nitrate left the corn has taken all most all of it.

The corn is done taking up nitrate in the area and dried out mode we head to the harvest season, and once it takes up night any trait is continues to be used for soil microbes and nitrate levels start to a couple late.

In the fall we see this is about 20 kilograms per hectare this is not about unused fertilizer but it's process of soil organic matter without any up take to utilize it. We looked at soil temperature indicate at that it's easy to see why this happens.

It's about now it's about 85 degrees out, our temperatures are still up above 70 so any time you're above 50 your soil processes will chug along and chew up soil organic matter and release nitrate.

Talking about climate change a lot these days and temperature and just the point here, this is the solid lines this is a monthly total heat units, so this is base 40, so with use base 40 this is the high and low temperature divided by 2 minus 40.

So, that's how you get heat units, that's sort of an interchangeable term. This is what we get per month if you look at where we are in the center, the solid line that the the five year trailing average.

We don't know, we will know someday if this is just a short term blip but it seems that all indications are it's going higher. It seems we have 2010 percent more heat units in September than we did in the 80s and from all indication this is going to continue so from a standpoint of that mineralization process it's going to increase. Winter time we don't see so much difference but in the spring and fall we see warmer soils.

We have as many soybeans, as much soybean acres as we do corn acre and we don't apply N so we don't have a nutrient management strategy to reduce the loss in soybeans.

This is soybeans and we look at growing season, throw in the season before the pods start to fill they don't take up so much soil nitrate as soon as the beans go into pod mode we see them grow quickly and as the beans get made that's where the soybeans

at the end of the season it's in the beans so it's from an energetic stand point it's easier to fix they add more by fixation.

But again once the beans are filled and they go into dry out mode year after year we see this fall creep up with nitrate. This is after wheat beans or double cropped beans so they -- so, that's later, so the longer the summer crop grows the later it is before the nitrate levels buildup again.

So, I think a general misconception and a lot of times we only hear about fertilizer in but I think it's residual plant after harvest, late October, plenty of time we're in the field you see the green the biomass that was in the root zone, former leaching. Here we have the nitrate tied up I think so a picture is worth a thousand words.

The nitrate is tied up and not available for leaching. This is a bottom line side I'm not going through the chain and soil nitrate tests and soil does show how cover crops work but this looks at ground water and in two centers where we monitored ground water since the 80s. We've done a lot of ground water sampling and pouring at the side, these numbers we see all over, sometimes higher. We started using cover crops in the late 80s and we used rye, people say why rye? We did a lot of testing early on and rye came out ahead and I heard a talk recently where the speaker said rye was boring but the bottom line is it's probably the best to reduce nitrate losses.

That's a conclusion we came to early on. We plant rye right after grain harvest, and after a decade it's about scrubbing the nitrate. We're starting to put cleaner water into the system so slowly over at the present years we cut the nitrate in group water by

hatch or even by 2 or more. So, for us this is a bottom line slide, what can we do, maintain yields, and in some cases increase yields reduce the nitrate in the production system.

I think we have the highs, obviously we are a small state so we don't have the highest number of cover crops but I think we're number one in terms of percentage in terms of crops land that gets could have rage over winter. In the end it gives farmers the chance to play around with cover crops and figure out the logistics and how to do it for the least amount possible and fit in the labor and machinery and time and all of that without having the financial resting.

Because the one thing with cover crops is you have cost up front and busy time during the season and the very soonest you'll get a return is the next harvest so it's a risk for farmers up front.

At the bay level this is a cover page for the tracking system model. So, overall we have a bay water shed model that does all of the accounting to see whether or not we're on track to meet the TMDL, the species, the timing, the planting method in terms of the reductions you can expect to a achieve with cover crops you have to look it at your heat days.

Even in the Chesapeake Bay area, in up state New York we talked for an October 1 planting day in Richmond you go over 8 thousand units and you're in October, you're hard pressed to get to 500. You move a little later in the fall the parts of the water shed there's few heat units available for cover crops. Where by mid November

we can have adequate heat units to produce a fall cover crop. So, where of you are you have to look for best cover crop options.

Back to the heat unit slide, just sort of a point that's -- I know this nail is hit every time someone questions a cover crop they get the months you go from to October you okay cut them in half and go to October to November and cut them in half and then from November to December cut them in half again.

Pushing to get cover crops established here into the fall is crucial because the heat unit a availability tails off fast as you get later in the season of the to wrap up the old part of the story, the cover crop nitrogen story we have the subsurface, total nitrogen is get getting to the bay from cropland. Winter cereal are essential for us to have our goals and if you do water shed Restoration you have to address large averages. It's great to do things in small spaces but if you want over all goals you have to changes the landscape early planting is almost always better and again at the bottom, implication is the challenge that's the hardest thing.

So, now we move on to the next part of the cover crop story. Left side is the institute, cover crop nationally, based on mass data over here so the two, big practices are no—till and could have crops here in Maryland I know we're number one in terms of percentage of land using cover crops and we're second or third in no—till and we started no—till back in the 80s, pretty active and now there's hardly any soybeans planted in Maryland that aren't no—till. B

Ut on the right hand side we have a trend graph from USGF website, you can check after the webinar and it has stream and nitrate data and stream and water quality date on the monitoring site. So, over here where we are, we're Chesapeake Bay, Nan this case we talk about phosphorus, we're in an area where we use no—till and use a lot of cover crops so we come out high orientation the soil quality and standard but for P, we are seeing it in the wrong action. They're degrading in the point of soil phosphorus.

This is the Toledo I know in fresh water system we're talking about water systems and anyway we lose out on available phosphorus. That's part of the category too I guess it's falls under everything effects everything.

This is about 2 inch rain in about a half hour and you see where the corn is in late jewel and a picture is worth a thousand words, no—till, cover crop and water ways we have almost no erosion out of our system. I would say overall we have naturally low erosion rates and when we do these, we have soil loss in the hundreds of pounds not in tons. We don't lose much erosion which is overall a great thing but for from a phosphorus standpoint it's not quite that clear.

Of course, what gets it could be with grain, it gets fed to life stock and our life stock is poultry so most of the grain goes poultry production and we have a long term study looking at all of the different options. There's almost no conventional till left. We looked at all of the options and the bottom line and I'll show really just to make a point here, this is surface run off monthly average monthly surface run off phosphorus concentration,

and we look across the whole year by month, so we are in corn grain production and this particular graph, we have two tillage options in one case we have full manure and in another case we do no—till.

And we have both for the primary end source. We know that poultry manure has high N and P and after the months of application we look at 4 and 5 milliliter phosphorus concentration and the dotted symbols that's P and the difference between the solid and the hollow is the par particulate P. So, almost all of the phosphorus lost out of the system is P. We have more particular P loss but again dissolve P is come Nate our systems.

When we put a soluble P source on the surface we end up with high surface and run off and so that's an issue of manure application and tillage. Agreed clear—cut case and intuitive.

This is corn for grain, into rye, we have adequate P levels according to the recommendation here. We always do no—till because green is the good color right. So, where are our peaks? Our peaks for force us loss are in the spring, but in no—till we see a spring after we kill the weed growth in the cover wheat field and in the fall, the corn grape harvest that's when the vegetation comes out this is phosphate leaching out of the dead corn tissue. So, this is a tip off that we need to think about the vegetation part of the roll that the cover crops might play in phosphorus dynamics.

Looking at some like this this is corn being no tilled into a corn rye cover crop, say this is a fairly idyllic looking situations great for soil erosion, great for carbon and weed

control, good for nitrogen for sure, on phosphorus, not so clear for us. So, I would say the bottom line, if we talk about reduced tillage or even go into no—till it's not always a phosphorus fix, I think continuous no—till leads to P stratification and we'll have a higher soluble P there and we have a higher level closer to the surface.

Anything that we add to the soil surface that increases the soluble P it increases the potential for P flow and so, in lower settings like we have we can increase the P to the point with a thank we can offset to the point where it's reduced. So, the total P loss, many people say we reduced our total P but we increased the dissolved P. For us we increased the dissolved P and can he creased losses.

The cover part of it, as soil P minors, take it out of the soil and move it up to a above ground vegetation. Cover crops play some roll that we need to be mindful of.

Looking at a bunch of cover crop issue, nitrogen availability in the root zone and possible in the root zone, and -- trying to get a better handle on the overall impact and I think just from the standpoint of us starting with nitrogen where we're going now, in 2020 and many of you probably get the conservation news briefs and basically the federal roll, to pay farmers to plant cover crops in this case to offset emissions from -- cover crops out on the landscape you have all of these benefits.

Anyway the bottom line here is not just talking about phosphorus and water quality and nitrogen but now all of the impacts of cover crops. It's going to be a bigger impact as we go along.

So, we looked at the soil moisture impact and the temperatures changed and a big one is, so if you're in areas with life stock and many places have very high P levels, we have the same thing here where we have poultry manure as a source which effects the phosphorus level in plant tissue for us we looked at different phosphorus stimulation rates to look at P mass and looked at the leaf cake coming from the biomass and in this case it's just detritus. This is just dead animals.

We get samples from natural rain fall so we're not doing a lab study, this gets put out like this, it gets covered with row covers and every time it rains we get the samples and we get the leaching out of the cover crop residue. We looked at the early glue on dates, the winter kill like the radishes, after corn harvest for us, after corn grain harvest it's too late to plant radishes so we include aerial seeding in part of this.

So, this puts radishes on the water shed. This is what it looks like you know what it looks like. This is the combine coming through the corn. This is the radishes the combine is coming through already. So, they got ahead start before grain harvest. After corn grain harvest we are not short or on residue. It gets more important, actually just a slide here early on, so this is late fall radishes after the corn is harvested, first what's wrong with the radishes they just run out of nitrogen.

This is the nitrogen systems we don't get the picture when you see them as big as your armor leg they're night pictures I would say if you get pictures like that you should look at your nitrogen management plan. For us we don't get those in our systems with management systems in place.

These have not been hit with cold weather they're just out there this is in early February so this is dead radishes. This is a winter kill cover crop, it has appeal to farmers because they don't need to worry about cover crop in the spring but there's concerns that it goes into a very active period. I think our highest margin is our largest surface run off and if we don't have a cover crop out there we don't have the soil tide up.

Also looking at taking off the forage. We have a beef operations here we can use the silage, finally the spring kill system. Adding a few more weeks of suppressed nitrates in the soil so, the less likely we loose nitrate in the spring. A quick slide here this is above ground dry matter N. For us, 9 cover crops planted in the fall after cover harvest can take up more nitrate than is generally available. Basically by December 1, there's another tolls take up.

We have a higher end status situations the cover crop can take it up. This is a summer fallow field so we kept the weeds suppressed so there was a nitrate here because there's nothing taking it up, we have a huge nitrate load, the winter serials respond, we have extra ability to take up the crop if we do the cover crop early.

The green line at the bottom is what we look at. The top line, this is an early kill date so we kill the cover crop here in mid March, as soon as it warms up, this is not nitrate with soil bases this is water concentration. We see them start to shoot up, as soon as it starts to warm up we increase the nitrate and there we go. We keep the cover crop there for a month and the bottom line, as long as it rides there as long as it's not released it is taken up immediately.

So, we kill the cover crop here and the good news from a production point is there's nitrate. It's not like there's no any trait, it's delayed but recovers fast. Spring management to keep the nitrate levels down. I would say cover crops I just think of them as they're climate change fire wall. They take up more nitrate in the fall than usual, if we plant them early and we plant them in the screen so we can use cover crops to negate the impact of the nitrates.

This is looking at rye tissue phosphorus levels, this is rye tissue phosphorus content. This is concentration in the rye biomass as a function of phosphorus that was applied in the fall, so, for all dates and different lines or different dates, so for all of the dates even putting on a relatively small amount of phosphorus, just 50 grams per hectare, we get tissue P as the available phosphorus in the root zone.

Now go on to the leaching total phosphorus. Look at the leachate coming out, you get double or triple phosphorus coming out of the rye tissue, we're just out on appear Wii owe mass basis, we get double to triple the amount of phosphorus coming out of the cover crop tissue in the spring as a result of the available P in the fall.

Looking a year later, we've done it again without adding more phosphorus, same thing, here we have double, even triple the amount of P coming out of the cover crop so, clearly when the P levels are high in the soil the tissue levels are higher and phosphorus tissue that's killed is going to come out that's how things work.

I would say keep things in perspective, phosphorus in cover crops we talk 10 to 20 pipeds per acre are we talk manure application we talk -- cover crops are problems. We have to be careful of our overall management system.

I think the old cover crop basics, mineralization of organic N, key contribute to the high nitrate leaching losses from cover crop options. You have to figure that out and figure out what works for you. Better late than never, if you get half of the up take that the better than no up take. You can't just quit, they're just the most reliable for reducing nitrate leaching following corn and soybean, and rye is generally the best of the best, boring but it works. Winter cereal cover crops are generally N limited.

Finally, some challenges, increasing temperatures are likely to lengthen active mineralization period and leading to loss of soil C and increased nitrate leaching. I think that's where we're heading. Practice A cover crop phosphorus mining adds to the no—till stratification were on recommend.

It's not a dominant thing but it's a contributing thing. Spring cover crop growth can be used to suppress nitrate leaching potential and add carbon to the soil but hire residue may could be contribute to higher P losses and soil P as a factor in determining residue. We keep everything where it needs to be to reduce nutrient losses.

With that I'm finished and thank you vetch and I guess I'm open for questions.

» Thank you Dr. Staver for your informative presentation. Now questions from the chat. Have you evaluate waited cover crops over than rye, and what is your opinion on cover crop mixes?

» Of course there's lots of work being it could be on mixes now, I would say back in the late 80s and 90s folks here in Maryland were doing a lot of work with mixes regarding -- Andy Clarke and Paul Mill, and they were working with vetch, it's not water quality benefits, it is more of an economic benefit for the farmer.

Nitrate leaching so I think it goes back to the comment I made you know I was quitting someone who said rye was boring burr for those of us focused on nitrate leaching, and with the planting windows that we have, we always fight the late harvest and short windows, and rye gets us the most nitrate up take, allows it in short windows and cool conditions so I think rye works the best.

You know the mixes can work, but, I think for our windows here, I guess I would go back to saying people have to look at their windows in their objective but if you're really into nitrate control the winter cereal is hard to beat and rye is the top of the top.

» Thank you we have another question, if you will, Dr. Staver are you familiar with any cover studies being done in the South west region at high elevation where water is not so abundant.

» I can't say that I'm totally familiar with the literature but I know that water a availability has circled around cover crops because the last thing you want to do is stress out the middle ground, bring water stress to the crop that you're growing to pay the bills. It's a tricky topic. I mean the key issues are if you can get residue that it can help conserve moisture but timing for us is important for managing availability.

So, it's a localized thing but I can't speak to the Southwest but it's usually tide to the active cover growth versus the water replenishment cycle. Cover crops do take up some water, so you have to be careful. I wish I could answer more.

» Thank you. What would you say are the biggest misconceptions about cover crops?

» Biggest misconceptions? Wow that's a big topic. I think the misconception, and this is sort of spanning 30 years of dealing with this, when we first started Maryland every one worried about the spring cover crops. And 30 years ago the planters weren't what they were and we don't have the understanding of the herbicides and herbicide control, and so, I think early on, I would say decades ago the cover crops were a nightmare for spring management.

Very many of our farmers are familiar with how you manages cover crops in the spring and are not fearful of cover crops sort of taking over in the spring.

Now, as we move forward, I think the other misconception, that it's going to hurt you on the nitrogen side. I think a lot of people think there's going to be a nitrogen deficiency, which can happen, spring management is going to be a nightmare is a miss contention and that it will hurt you is a misconception.

» We have time for one, last question, this one comes from the chat, what is the best stage kill rye in spring for maximum nitrate attention?

» So, a little depends on the following crop, so, there's always sort of local management details that you have to take in so you have to be careful with hard and fast rules, it

makes me a little leery with talking to a audience because everyone has their own soil and irrigation and do they have their own crop or don't they?

So, all of those have to be in the equation so but in general, especially now that we have the planters that do so well in handling residue, we have people that don't kill their cover crops until after they plant them, they call it planting green which is taking it to a whole other level but the longer you have something growing there, the longer the nitrate is suppressed.

So, if the key goal is to suppress nitrate loss, then you'll let it grow, you want to have that window between when the cover crops stop taking up nitrate and the Maine could have crop starts taking up nitrate you want the window as small as possible of the so as late as you can manage it 1 fine so it's going to be easier because you don't have to worry about the B nitrate competition. Because when the nitrate is super low in the soil you have to make sure that you have enough nitrogen for the corn. If you kill the cover crop right at the end so again there's a lot of details but, basically the bottom line on nitrate is, having something growing there is going to keep the nitrate levels low and as soon as you kill it, the temperature are warm the nitrate levels start to pop up again. But you have to balance your cropping situation and what you try to do from a production standpoints.

I would say if you encourage farmers to use cover crop make sure that they start with a conservative approach that has a minimal chance of hurting their crop production.

» Thank you Dr. Williams for inviting Dr. Staver to be our guest presenter today, and Dr. Staver, we appreciate you sharing your excellent presentation and insights today.

Thanks also to Dr. Tupas for your opening comments today, and I'd like to recognize my NRCS communication partner Elizabeth Creech for her technical support during the webinar.

We will post the recording of today's webinar on our NRCS Conservation Outcomes webpage and you can find that link in the Today's Links box below. We also have recordings of past webinars on that page, and details on how to subscribe to the GovDelivery emails we mentioned at the beginning of this session.

We hope to see you again for future Conservation Outcomes webinars.

Have a great afternoon, everyone. Thank you!