Now again, I want to welcome everybody. Again, this is David Lamm. I'm the team leader for the National Soil Health and Sustainability team that functions out of the East National Technology Support Center. And again, I want to welcome everybody to today's webinar.

First, I want to take a minute to introduce our speaker. Then I'll introduce his topic. Mike Kucera, who's an agronomist on the Soil Ecosystem team out of the National Soil Survey Center in Lincoln, Nebraska.

Mike's an old-timer like me. He's been around a long time. He's served in a number of capacities-- range conservation, soil conservation, FDC, those types of things.

He's got a tremendous amount of knowledge in the practical aspect of it. And then he's also done some work as a State Agronomist Water Quality Specialist, and he was even a State Resource Conservationist in Nebraska for over seven years. Anybody who could survive that kind of a work career has done a lot.

Mike's got a particular interest in soil health. He's, again, worked a lot out there on ecological site descriptions. He's developed the Soil Quality Bucket, which is, I guess, a poor man's version of the Soul Quality Test Kit that's getting a lot of use out there.

And most recently, I've been able to work with Mike as part of the training cadre for the Soil Health 101 effort that we just wrapped up, that we went out and trained over 20 states plus the Caribbean area. We trained almost 3,000 people between the NRCS, farmers and partners. So we're really proud of that effort, and Mike participated in two trainings sessions.

Not only has Mike been a NRCS career person, but he also does it on his own personal farm there outside in the central Nebraska. And I'll let him describe where it's at. And I had the privilege of visiting Mike's farm last year as we were doing some soil health training there for the employees in Nebraska.

So I say that because today's topic is one-- I'll be honest with you folks-- this was voted on by you folks. Every year, Holli does a survey, and we try and list the top 10 or 12 topics for this upcoming webinars. And this one linking RUSLE and soil health together was ranked right up there. And I was quite surprised, to be honest with you.

But anyway, when we went to seek a person to do this presentation, Mike's name came right up. And I think Mike is going to-- his background as an SRC, and using RUSLE and then his involvement in the soil health movement has really linked the two together. So we're really fortunate to have Mike.

And I'm going to introduce the topic and then turn it over to him. He's going to talk about Using RUSLE2 to Evaluate Soil Health Planning Principles. And what that, Mike, I'm going to turn it over to you.

OK, thanks, David and Holli. I appreciate the support, and I thoroughly enjoyed doing the soil health training, getting around to some different states. And like David said, I do have a dry-land farm in central Nebraska. We've been in no-till for about 24 years.

And to give you an idea how long I've been around SCS, NRCS, when I started doing soil loss calculations with USLE, and the wind-erosion equation, I had the old red and green slide rule. So that's how I started and learned, using that with conservation planning.

The first slide here just shows Gordon Mickel, the State Agronomist in South Carolina and I in Georgia a couple weeks ago doing Soil Health 101 training. We went around to the four areas around the state, and I learned a lot about health management systems in the Southeast. That was awesome.

Then on the right, we worked with 150 VoAg educators here in Nebraska, and put together soil quality buckets for them, looking at soil physical, chemical, and biological properties. And then how to simply and quickly assess that in the field. And then they, in turn, would work with their students. So that effort has blossomed, as David mentioned, where states have picked up bits and pieces of the bucket as they see fit.

Also, before I get started, I'd like to thank-- I did work with Giulio Ferruzzi and Linda Scheffe the people who work with RUSLE support, both from a database and a technical end. And so they have been able to review this as well. So if you get into those deep questions, those two are the contacts.

OK, just quickly, we're going to go through the Soil Health Planning Principles. And as I tie this back to RUSLE2, I'm going to show how each planning principle is covered in RUSLE2 and in your soil loss calculations and the other outputs we get. So the first, again, it disturbing soil less. And we'll talk about that more specifically. There's different types of disturbance.

Using a diversity of plants to add diversity to soil microorganisms, growing living roots throughout the year-- and that one is really crucial for soil health and in accelerating that-- and keeping the ground covered as much as possible. And then I have two footnotes at the bottom. The one I added there, on Manage erosion and compaction is huge, because really managing erosion and compaction go right along with those four planning principles and are very important to achieve our ultimate goal, which is have the most favorable habitat for the soil food web that makes the soil function much more efficiently for all of the different functions the soil would have such as nutrient and energy cycling, water partitioning, et cetera.

As you get into soil health management systems and the soil health planning principles, those principles are tied directly to erosion and erosion prediction in many ways. And here you see a field day that I was at where we are keeping the ground covered, and also on the right we have some growing living roots. And you can see on the far right, we have very little runoff and erosion.

Those are basically native-- even the second one from the right is the native good aggregate structure where we still have virtually no runoff, even without residue. So you can take a look. Really it ties together.

Outputs in RUSLE that we have-- currently there's actually four. That's the erosion rate sediment delivery, soil conditioning index-- which I'll cover more with organic matter trends-- and then STIR, which is a disturbance rating for operations. Those three directly relate to soil health planning principles I talked about earlier. The other two-- fuel energy use, and then grazing tool would come in the future for doing basic grazing planning.

To start out, the Field Office user or other general public can actually download and use RUSLE and also get our soils database that goes with whatever area you're working in. But they have to select those five things or build-- in the case of crop management-- they may build them on their own, but their climate, their soil map component, their slope length and steepness, and then build their crop management system, and then supporting practices that they may have such as contouring, terraces, those types of things.

The next screen that will come up here is in the profile view in RUSLE2. Again, that ties to that previous slide where we have to the five steps, and it shows you what it looks like-- the location, the soil type that we'd bring in. And the example that I did here was in a county that I was a soil conservationist in just to the east southeast of Lincoln in Otoe County.

And then our management-- I'll talk about that more-- and then modifying or building that sequence, your different operations, and then your supporting practices. The way that RUSLE2 works is I'm showing that what's called the CMZ map, which is Crop Management Zone map. And the zone that I built my example in was in Crop Management Zone 16. Lincoln is in the far west end of Crop Management Zone 16. And the Otoe county just to the east southeast of Lincoln.

Within those Crop Management Zones, we build similar rotations and planting dates and all of those that were set up based on similarities within those zones. This just shows the example here that I did in Otoe county for a corn, soybean, wheat, with a cover crop of hairy vetch following our winter wheat operation. So again, both the operation and the vegetation are built into these crop management sequences with common yields, et cetera.

Kind of the nice thing-- if you've heard about soil health management systems, they're basically a group of conservation practices and could be other measures you use to achieve those four planning principles I mentioned earlier. They directly relate to management systems we build in RUSLE. And this is what's called a worksheet view.

And in this worksheet view, I've got three different systems in there-- corn, soybeans, no till. We've got corn, soybeans with cover crop. We got corn, soybeans, wheat with a fall cover crop following wheat harvest.

In this screen, we can show or compare soil loss. We can show or compare soil conditioning index and our STIR value, and our fuel use. So it's a nice way to compare. And then if you want more information, you click on the folders, and drill down into that information for what you want to know more about.

The first planning principle-- there are three types of disturbance. Those of you that have been to the soil health training that I helped to assist with across the country-- those include physical, chemical, and biological. And the two that I have in red there directly tie to RUSLE.

So we build in our physical disturbance through all our different operations. And then the biological, the grazing part of it, we can build grazing and removal of those biomass, either growing or our crop aftermath. They chemical is not built into RUSLE, other than when we do fertilizer application-- the actual operation itself.

So all three of those can be a disturbance of sorts. And in the physical is obvious. We do tillage. Chemical can be in fertilizers and pesticides. For example, if we over-apply fertilizers, it can affect our soil food web and then of course biological.

Start out with the physical, and how does this relate to RUSLE2? In our no-till systems, or if we've got a perennial vegetation, the soil block diagram on the far left side shows what's ideal for our entire soil food web, especially when we get to the earthworms, and some of the macroflora that's in the soil.

As we start doing disturbance, for example, the second block or the middle block shows a chisel plow, which-- in case of a chisel plow is going to be primary tillage. And then we go to the far right, where we do lots of different secondary tillage, maybe with a rototill, a disc, et cetera. We slice and dice and create that artificial porosity and reduce our bulk density temporarily. So as you move to the right, it's less and less favorable for a soil food web. And all of those are simulated in RUSLE.

OK, again, physical tillage-- we talked about that. Two things that are in RUSLE is the operations databases. We have all types of equipment-- includes harvest equipment, includes tillage equipment, includes cultivation, post crop emergence, even spraying and fertilizer applications. Then, of course, STIR-- I'll talk about that more. That simulates the amount of disturbance for that particular rotation.

Biological and physical-- how is it modeled in RUSLE? The first item listed there is the impact of flattened residue versus standing. So RUSLE predicts based on the type of harvest equipment you use and the tillage equipment, how much of the residue is flat versus standing.

That's very important, because if we have residue that's flat and on the surface of the soil, the soil microbes are going to decompose that residue quicker than if it's standing. So if you want to manage to keep your residue from breaking down as quick, you'd want to keep it standing, or for snow trap, that type of thing. But RUSLE2 would predict the amount of each.

The impact and type of residue is very important, and that's directly tied to the carbon and nitrogen ratio. I'll talk about that, so our residues that have a lower carbon to nitrogen ratio will break down quicker. Also, the climate impacts the decomposition rate tremendously. So if we're in a humid, moist setting like southeastern US, we're going to break down residue quicker. If we're in a dry and cool setting, then of course, for climate, it's going to break down slower.

Chemical disturbance-- again pesticides and fertilizers talking there-- the only thing that RUSLE evaluates relative to chemical disturbance is the field operation itself. So it doesn't give us any prediction, for example, if I over-apply nitrogen fertilizer-- say I apply twice too much-- what does that do? It speeds up your organic matter mineralization, your residue mineralization.

So it doesn't predict that at this point in time. Also, of course, if we over-apply pesticides, it can favor certain soul microbiota. So it does not do that.

Of course, it does look at the biological aspects relative to removal of biomass. Also, we can use grazing to terminate crop growth and the impacts on the root systems as well as above-ground biomass.

OK, RUSLE2 uses STIR, and we have this applied to our standard. For example, I believe the no till standard has a minimum STIR rating of approximately 20 or less. So it models that based on four primary parameters.

One is how fast do we go through with our tillage equipment? Second is the type of tillage equipment that we're doing. I'll talk about that more. The depth-- how deep do we pull the equipment through the field?

And then, of course, the percent of soil area disturbed. And that includes splash. And what splash is, is as you go through a field and the soil particles are dispersed across the row, it includes areas that have sail splash as well.

This is just a list of a few different types of equipment that are in RUSLE. And what we have is the recommended operating speed in miles per hour. We've got the tillage type, and we have four different tillage types.

We've got mixing and inversion. We got lifting and fracturing. We've got compression only, and then somewhat less mixing and inversion.

And then it also lists the recommended depths. It also lists the surface area disturbed. And with that, the higher the number, the higher disturb value, so the more disturbance that you get for that planning principle-- so disturb the soil.

Also, obviously, as we increase our surveying, it's going to impact residue cover, and the planning principle of keeping it covered. Here's an example of a two year rotation. From the database, you've got a STIR value. A field user would pick the operation that fits as close as possible to what the farmer's using.

And then you simply total those up. In this case, we have a two-year rotation, so we divide the total of the STIR values for all the operations by two, because we have a two-year crop rotation. So we have an average of the 51.3 STIR value, which is fairly intensive tillage system compared to what our no-till standard would be, which would be less than 20.

Everybody remembers the early days of CSP. In Nebraska, when I was SRC, we had the CSP sign up, and we had some producers put together a field day for Dave Lightle and I and the State Agronomist in Nebraska. And this is a stock slicer. Sometimes they're referred to as a stock puller.

And in case of a stock slicer, it's more slices. It goes down the ridge. A stock puller would have a little flatter disc blades and actually pulls the stump out. And they do that either in the fall or the spring on ridges that have been built.

That's just a photo showing it. So what we did here was take a look at a lot of different tools similar to this, and rate them or go out and measure in the field, and compare that to what values we had in RUSLE2, to see if we're somewhat accurate.

In this case, the stock slicer, which more slices the corn, for example on the top of the ridge, has a tillage intensity of 0.4. It has a recommended depth of one and a half inches. And then it's got a total of, I believe, 40% of the surface area is disturbed is what the estimate is.

So when we were in the field, we also measured ridge height. And then we measure horizontally as well, to see if that 40% disturbance is similar to what the database has in it. OK.

Disturbance continues, so keep the planning principal of disturbance. We're looking at, in RUSLE, we can adjust the burial rate. For example, if that producer runs his tillage deeper or faster, we can adjust up or down 30%. Again, if you have agronomist privileges, you can adjust the speed. That can impact it as well.

In addition, other processes that affect how much cover we're going to have, and how much disturbance we have, is kill vegetation. So we can kill vegetation various different ways. I talked about grazing. I talked about herbicides. There's other ways to kill vegetation, such as rolling, et cetera. So you can build that into your operations.

Also, your operation flattens standing residues. That's important for either increasing ground cover, or enhancing how quick some of that ground cover could break down. Also begin growth, and harvest.

Here is, in the database, each operation. As you go through the field, it will give you a prediction on how much of the existing standing residue will be flattened by that operation. As you go through with your tractor, you're going to knock down standing residue with the tires, as well as the type of drill.

And this example is a single disk. So a double disk would open, or, for example, would flatten more than a single disk. And also it depends on the type of residue, so wheat, soybeans, and corn-- corn 15% of the standing and flattened, soybean 30% in this example.

Biological disturbance-- talk about root growth and that, and how that impacts. That's built into RUSLE, both at a four-inch depth and the total depth. This shows some grazing operations where you can do grazing stubble or grazing perennial cover-- heavy, light hoof traffic, so you can get different levels of disturbance.

Grazing disturbance in RUSLE-- some of the things that you can adjust or use in the RUSLE2 software is aftermath grazing, forages-- removal reduces your canopy height, which is important for keeping it covered as well-- also the impact of root systems and regrowth of vegetation. So as we graze off that vegetation, you're going to have some of that vegetation grow back. So that's built into it, and of course, to terminate, and in the future for forage balances.

Increasing diversity-- this shows you just some ways of doing that. At soil health planning training we did recently, these are some of the things that look at for benefits for diversity, and rotations, and how you could accomplish it, either with rotation or by adding cover crops.

Mike?

Yeah, go ahead.

I got a few questions that came in, so you [INAUDIBLE] before we move out of that principle. And I just want to remind folks, again, if you want to ask some questions, go ahead and type of them in down in there in the notes section, and I'll try and read them as we go along here. But I apologize for interrupting here, but there's a couple questions.

The decomposition-- is there a way-- one of the realities of healthy soils is, because of the biological activity in the soil, it seems to accelerate decomposition of organic matter. Is there any way within the RUSLE to adjust or account for that type of activity?

Right now-- and Linda Scheffe is here with me as well, but what RUSLE2 does is, basically the decomposition is tied to some standard values for the climate you're in. It's also tied to whether you irrigate or not. If you irrigate, you speed up mineralization.

And then it's tied to what's called a decomposition coefficient for the residue, which is directly related to the carbon-nitrogen ratio. So as far as adjusting it for-- in my case, where you have a diverse rotation and long-term no-till where I've got more biological activity, it does not do that at this point in time.

OK, and then CO2 emissions-- is there-- with all this estimated decomposition, is there any way to link or estimate how much of that residue as being decomposition is actually being lost into the atmosphere as CO2 emissions?

Really, the only thing we have in RUSLE that would somewhat directly relate to estimating CO2 emissions is our soil conditioning index. So our soil conditioning index just gives you an indication of whether we're building soil organic matter or not. And the only way that you can sequester carbon is by building soil organic matter, and/or slow down the amount the residues themselves, how quickly they decompose. So that's really the only thing in RUSLE right now.

OK, and then one last question, and I'll shut up and let you keep going there-- a question about related organic matter levels. Is there any way to adjust for higher organic matter soils versus low organic matter soils? Is there any way that RUSLE can accommodate or measure that difference related to infiltration and water holding capacity and those types of things?

At the very end of my presentation, I've got a slide on variable k factors. So if you had a soil scientist or somebody out there that could evaluate those specific conditions, you could use something other than the default soils, to basically use a soil with a different k factor, which reflects soil organic matter, permeability structure, et cetera, which is what we [INAUDIBLE]. So that's really the only way to do that.

OK All right, well listen, again, folks who want to ask a question, don't hesitate to type them in, and

Mike, I'll let you get back to your presentation.

OK, this is a screenshot showing you all the different databases that are in RUSLE. And I'm just showing some vegetations. So we have various things in there, as you can see.

Planning principle two-- diversity and how does RUSLE model that and relate back to that planning principle? One, we got our crops. They're perennial, annual, and we could even have a biennial crop, for example, or double cropping. All of that ties into our cropping intervals or periods, keeping the ground covered, keeping a diverse root system, et cetera.

Planting tillage maturity dates-- we can adjust those, so if we have plant a 90-day corn versus 120-day corn, we can work that into our harvest dates and our maturity and our growth curves.

Termination-- we might be planting a cover crop we only want six to eight weeks of growth, especially here in the semi-arid areas as you get further west. We don't want to let too much vegetation grow, so we can terminate, and it'll stop that growth.

Climate-- we talked about that-- affects growth and decomposition, your rainfall amount, and of course, your temperature affect decomposition as well as growth. And then diversity is a major part of our soil's conditioning index rating. I'll talk about it more later.

This just shows you a brilliant feed packer that was used in the southeast. They're using it in this case to roll down this rye cover at same time they're spraying the cover. So we can build these different operations into RUSLE, and how does it impact?

In this case, obviously, almost all of our standing residue is going flat, and we have green residue that's being terminated. So we would build those operations into the RUSLE2 operations for that management system.

Cover crop role in diversity-- and I've listed-- item one and three-- we can build those into RUSLE, so we look at cropping periods within RUSLE2. Also, we can terminate that cover crop-- for example, in getting the amount of growth that we want. And then, of course, it shows all four of those things are the benefits to cover crops.

Within RUSLE2, we look at plant morphology. We look at whether it's a broad-leaf grass, how that plant grows. We look at growth habits for cool season, warm season. It also predicts the root mass that we have, and when that root mass and biomass occur within that growing season, depending on your planting date.

So that would cover principle two. David, do we have any more questions on principle two?

Yeah, we actually do, Mike. The question about how would you account, with all the interest in multi-species cover crops, how would you even begin to piece something like that together in RUSLE?

That's a very good question. I haven't thought about that that much. But what you're going to have is you're probably talking about a cocktail mix, where you might be planting cool season/warm season mixtures. There are some examples, or there are some of those mixtures built into the RUSLE2 database.

So you would need to work with your State Agronomist, and make sure you get those vegetations added to your RUSLE2 database. And what you should really be doing is going out to the field, doing some clipping and monitoring of those cocktail mixes on what kind of growth you have, so we get growth curves that fit those.

And also, this is Linda Scheffe. There's a national plant materials center cover crop study going on right now. We have the first-year data that we're going to be incorporated into RUSLE2. But we would welcome any kind of local data like Mike said, as you go through your State Agronomist. And we appreciate hearing any requests for additional cover crops that we don't have in the database.

Well, OK, thanks, Linda. One more question-- the idea, I mean some of these multi-species mixes you're hearing, seven or eight tons of biomass, is that something that could be adjusted in the model? Because that is probably a little higher than what maybe you're used to using or seeing in your cover crop selection. Is that something that could be adjusted?

Yeah, you can adjust yields. And also the growth curves, and that's part of the plant material study is to predict some of that. But we try to generally go with averages, rather than doing it for every-- my experience, for example, we had huge CSP sign-up in Nebraska, and we had thousands and thousands of these runs to do. We use templates, but just time will kill you if you do too much of it.

Again, it's a model. We're trying to estimate, not necessarily get exact measurements. All right. Thanks, Mike.

OK, there are some of the benefits of keeping living roots throughout the year. And this is huge when it comes to soil biology because of the exudance. And if you don't have living roots, you don't have a living plant out there. You're missing all that opportunity to sequester, to take carbon, and the energy, the photosynthesis process-- you're just sitting there idle. And the microbes aren't as happy as if you're feeding them and making those plants work for you.

Living roots-- how do we do that within RUSLE? Again, we talked about a climate, which is growing season temperature and precipitation. So we use that climate to help us predict what kind of growth and growing season we would have based on those variables.

There are types of root production as well as our biomass, so RUSLE2 accounts for both living and dead roots throughout the year within that four-inch level as well as the entire profile. So the four inch is important, because that's more important for erosion prediction.

Again, I talked about growth curves. Also, we have growth curves for biomass as well as root production, and again termination dates and grazing impacts on root systems.

How to keep a living root throughout the year-- this is just some strategies. You could probably add your own. If we have a corn-soybean rotation here in the Midwest, where we'd add a winter crop or cover crop like wheat or cereal rye, double cropping as you get further south and that works. We can adjust our varieties, do all those different things.

Root systems are also built into RUSLE2, and I'm just showing a nice shot from the Phillips Petroleum book that I got as my first job as a Range Conservationist with SCS. And you see the different root systems-- the fibrous, the tap root systems. RUSLE2 has that built into for the annual crops as well.

And just to drive that point home, this is a slide shot that shows a cereal rye, hairy vetch cover crop, both the time of year and the amount in pounds per acre within that top four inches. RUSLE2 will also predict this for the entire profile.

So we get something like cereal rye with a highly fibrous root system, you can see the production is over 2000 pounds in that top four inches if you let it grow long enough, and you get it planted right. If we plant it too late in certain climates, we're not going to get that growth. We're actually going to be a negative impact on the amount of cover we have if we go out and try to grow it too late. So you need to know your vegetation, when it's likely to grow and that thing.

Look at soybeans versus corn. Soybeans-- there's another fibrous rooted crop. So you don't have near as much biomass in that top four inches as you would corn or for sure cereal rye, a small grain.

What are we trying to do? Think about this in the erosion standpoint, but also other things like off-season nitrate losses. We're trying to keep that living root throughout the year so we avoid those losses in those early spring and in late fall, winter time periods.

Here's just some photos. This is a photo from Pennsylvania. This shows RUSLE2's going to predict your growth.

You can see we have more growth when we got the hairy vetch planted a little more timely. Here is a photo of when I was SRC, my no-till specialist Dan Gillespie, his farm. We blew on cereal rye . And he has center pivot, so he could put the water on, and get good germination. And you can see what it looks like-- a nice, green mat when he's harvesting his soybeans just a couple weeks later.

Cotton defoliation-- we can build that into RUSLE, in this case trying to get a little more growth on our cover. OK, so that's planning principle three. David, any quick questions there?

Yeah, I got a couple here, Mike. One, so let me get this straight-- so we can use RUSLE to estimate root mass and vary the planting date of the cover crop to show the difference between a, say, September 1st versus October 1st or October 1st versus November 1st?

Yeah, what you will do is RUSLE2 has a growth model built into it. And if you plant later, for example cereal rye, you're not going to get as much vegetative growth, or you're not going to get as much root mass by planting later.

Now that just seems like that could be a powerful tool for selling folks on the importance of that earlier planting date, just to get, like you said, those roots and get the exudates and those types of things. And kind of related, I think I can get this question. This is actually a user out there, and they said when they enter in the drilling a cover crop of a rye grass in RUSLE, oftentimes your soil loss is worst in a no till situation. And they're wondering if the short term benefits of loss of residue should be outweighed by the benefits of the long-term cover crop, or are they doing something wrong?

Yeah, it makes sense. They're not doing anything wrong, but in some cases, you can actually-- if you plant too late, what you're doing when you run the field through with the drill, you're actually taking the standing residue, making it flat, so you're speeding up the mineralization of the residues from the previous crop. In addition, you're losing some of your residue cover, your ground cover.

And then if it's planted too late, and you don't get enough growth or canopy cover, then depending on when that starts growing again in the spring, you may gain or you may lose. But quite often, in most cases, in most climates, it's a huge benefit to have a good growing rye cover in the spring when we're likely to get spring rains and more erosive rains where we don't have a crop canopy. So in most cases, it's going to be a positive. But in some cases, it could be a negative.

So all the more reason to get it seeded in an earlier fashion there. And then one more question. I'll let you move on. And the question is, is the root mass information displayed in the RUSLE output anywhere? Is that something they have to dig somewhere and find?

Yeah, you can go into profiles, and you can do a right click and create some nice little graphs. I'm going to show you some examples here in a second. I've got some nice examples. And I did that. Any user can do that. So I'll show you the graphs you can pull out.

Let's jump into planning principle four. And there's the pros or the benefits of keeping it covered. Keeping it covered means both live biomass and dead crop residues. So both provide benefits for various things.

Bottom line, both are both food sources for our total biology, which is important to healthy soils. OK, I got quite a list there, but these are all the things from the top of my head. And Linda's here. There's probably some I missed.

But these are the different things built into RUSLE that relate to keeping it covered, either through that living biomass cover or the residue cover. So climate-- we talked about that. We got erosion index. More erosion is likely to occur in different parts and times of the year, depending on rainfall.

Growing season-- you have different climates across the country, temperature, precipitation-- all of that impacts our cover, our growth. It also impacts how quickly residue breaks down.

Biomass production-- the amount and timing of that biomass-- do we have the biomass growth when we need it to keep it covered to prevent erosion and run-off? Or do we have that biomass out there when we're less likely to have erosion and run-off? That's all built into it.

Irrigation and water inputs-- this is one a lot of people haven't thought about, but if you add irrigation water in RUSLE, it actually increases your growth. It also increases your decomposition of your residue. It also can increase erosion, because you're changing your antecedent moisture conditions. So you're more likely to get erosion and runoff if you're closer to field capacity.

Canopy and residue cover-- I talked about that. It predicts flat versus standing, and that's huge in my case where I've got wheat stubble. I want to keep it standing. So if I'm going to go out and put a cover crop in the wheat stubble, I want use a drill or something that minimizes how much of that standing residue goes flat.

Drilled versus wide rows-- RUSLE2 well predicts the canopy cover. If I go with drilled, narrow row spacings, I'm going to get that canopy, keep it covered quicker. We've also consider canopy shapes for different crops, which can be important. Some crops have a better canopy to prevent that raindrop impact.

Growth curves-- we mentioned that. We can add residue inputs, like mulch or manure. And it's got different types of manure that have different decomposition rates. For example, chicken litter is very high in nitrogen. It'll break down much quicker than feedlot manure.

All the different operations and timing of those, and of course our disturbance rating we talked about earlier with STIR-- so quite a few different variables in there to consider. I got this right out of RUSLE. I'm just using this as a simple user. I can go into canopy shape for my different vegetation, and it's got different canopy shapes. That impacts keeping it covered and the impact of raindrops for erosion purposes.

In RUSLE, if you drill down into your canopy cover, you can do a right click, and print out a graph like this. This just simply shows for corn in Otoe County just east of Lincoln, the percent canopy cover for 150 bushel corn. You can see 75 days through 135 days, I have close to probably 95% canopy cover. And then when my corn starts to go dormant, I start to lose that canopy cover, and then I lose it entirely when I harvest.

That's the residue database. There's a whole list of residue types. And again, they all have different carbon to nitrogen ratios, which are reflected in their decomposition coefficients.

This is the graph, David, you were asking about. I did these myself working with RUSLE2 on my laptop. And so I took that corn, soybeans, wheat rotation with a hairy vetch cover crop planted after wheat harvest.

So you can see on the top part-- that shows the total root biomass production. And for example, for corn we're close to 2,000 pounds of total biomass production. For soybeans, it's a little over 800 pounds. Wheat we can get up close to 3,000 pounds.

And then of course that varies during different times of year. So it shows you. And it's really closely correlated with the second chart, which is biomass production or canopy cover.

In this case, instead of percent canopy cover, I did total production in pounds per acre. So you can see they relate. There's a little bit of a lag there.

So both of those are really important for soil health and keeping a living root. You can have an idea of when those plants are actively growing, and also keeping it covered for the biomass. And then at the bottom is the residue cover.

And so this is flat residue cover. At RUSLE2, you can get estimates of those. And you'll see, for example, when I put anhydrous and planted my corn into my wheat stubble slash cover crop residue, I had a slight spike or increase in flat cover.

What I did there is I flattened some of the standing cover, so you'll see some spikes. Also you can see, like in the soybean year, where I plant my wheat into soybeans, I lose my residue real quickly on soybeans because it's got a very short half-life compared to something like wheat. Wheat stubble has a very much longer half-life.

OK, so also you can pull up a graph like this in RUSLE2, which is called Water Erosion Index for your specific county. This is for a Otoe County. And you see how the most erosive rainfall events-- this is a daily graph, so it spikes in the middle of the summer. So very, very little potential in the late fall through the winter.

Also, this is from the vegetation database. I pulled up the amount of residue, the total residue on the right, for my 55 bushel soybean, 60 bushel wheat and 150 bushel of corn. So you can see corn has nearly 8,000 pounds versus my soybeans and wheat, about 3,000 total pounds.

But then you take a look at that. The soybeans, which is smaller residue-- it only takes about 500 pounds to get 30% cover. It takes about 3,500 pounds to get 90% cover, versus a larger residue like corn, it takes-- to get 90% ground cover, it takes almost 7,000 pounds. So the smaller the residues, the more ground cover you're going to have to prevent erosion. So wheat will give you more coverage just because of the size of the stubble.

That doesn't tell the whole story, however. You also need to know how long that residue's going to last to provide that protection for erosion control, and keep it covered for keeping our soil temperature down. So what do we have here? We have soybean residue. It's got a very short half-life, so it disappears quickly.

Cotton residue would be similar, versus wheat stubble, which has a high lignin content, will last much longer. So the half life of that is about 80 days, and then corn residue is kind of in-between, because we've got the fines and then we've got the corn stocks as well built into that.

What happens to residue? And this is going to depend somewhat on your climate, your tillage system, but ideally, the more of it that we put into the organic matter, which is the living microorganisms, the non-humic. And then, of course, the very stable humic compounds that give your soil the good dark color.

And then the more tillage we do, the more that we're putting carbon dioxide into the air. OK, so that's kind of tying back to David's earlier question. Also in the database, we have soil temperatures or temperatures that are built in. This is for Otoe County, which gives us an average temperature throughout the year. So that's important for growth, et cetera.

And this is just an example of keeping it covered. These are about 40 feet apart where we have a good cover crop cover versus somewhat of a bare soil with a little bit of residue cover. You have 20 degrees soil temperature difference. And there's the reasons why it's important.

And this graph is awesome, because it gives you an idea of we can keep our soil temperatures down there in that green area. It's much more efficient. Our crops are much more efficient. Our soil microbes are much more efficient.

More of that moisture is being used for growth. Our nutrients are cycling better. In the heat of the summer, that's why it's very important.

We get up into that red area, even our bacteria began to die. And we're losing more moisture through evaporation. That's the bottom line.

OK, David, should I plug on away? I got basically soil conditioning index to go through yet.

Well, we did have a couple questions there. One, back to the temperature and the evaporation, is there any way to compare one system versus the other in the soil temperature that you might achieve in RUSLE?

No. The temperature is pretty much strictly climate related in RUSLE2, so it would be important for your growth, your biomass, and root mass growth. But right now, we don't have any way of building that into RUSLE, no.

OK and then there was a question about-- you got a lot of interest in your root biomass production graph-- whether you have time to explain how you got that or maybe you would put together some instructions that we could work on. I'm not sure how you want to handle that, Mike. But there was several questions related to how can they do that back there at their office?

Rather than get into all the gory details, I will get you something. And it's very simple. You can get both your four-inch root mass, and you can get your total root mass, and also you can break it down between living and dead root mass.

And it might explain how you got that nifty graph, so if that's something that you can generate.

It's simply just going into your vegetation. You click on the folder for the vegetation. You open it up, and then you can right click and open, and there's an option to View Graph. And it's fairly simple.

OK and then--

I figured it out, so--

Well, yeah, I won't comment on that, Mike. The last thing is again, does RUSLE in its erosion prediction, does it factor in just the roots, the impact of having that root mass in there, and holding the soil, and all that kind of stuff?

Just the four-inch depth of roots, yes.

OK, and one last question. Then I'll let you go. Is there a difference between, in salt isobars that are anaerobic or saturated condition versus non-saturated condition?

Now, really it's just decay factor that we look at for that. If you have better structure in your soil, again, you can work with your soil scientist and use soil with the correct k factor for the conditions. That would be how you'd have to work around it.

OK, well, I'll quit asking questions and let you go on.

OK, soil conditioning index-- so this is a neat indicator for soil health-- probably the best thing we have right now that's at the field level. This graph here is just to kind of show you as we start improving our soil quality, our physical and biological properties, for example, the other benefits start occurring before we actually increase soil organic matter. So one of the first things to improve as we practice our four planning principles is improve our aggregation and infiltration.

And that's-- no till, for example, that's one of the benefits across the board that I've seen in some of the-- we've been doing some research articles recently. The next thing is your water and nutrient holding capacity starts to increase and improve. And then as we move through time, then your productivity comes along with that.

This is a graph that shows you as we increase, this is in a foot of soil depth, we go from 0% organic matter up to 3%. We go from 1.1 inches to almost to 2.5 inches of soil water holding capacity, and that's available water.

Soil conditioning index-- three items there-- we can use that to evaluate our conservation systems or soil health management systems that give us the best or improved soil condition. This directly relates to our soil health. Also the effects of the system on organic matter trends, which is really the hub of soil health.

And then we use three major variables on those trends in organic matter. Those variables are the organic material-- that would be like your residues or biomass. And that's 40% of the model.

And then our field operations, which the more disturbance we do, the more we break down our residue-- that's 40% of the formula. And then lastly is our erosion-- as we remove sediment either from sheet and rill, wind, or even irrigation-induced erosion-- we can build all of those into the model within RUSLE. And that would be 20% of the formula.

So the organic materials-- it shows that the formula is used there and RP is the annual amount of above- and below-ground biomass. So again, it counts for our root mass here. And it's expressed in what's called Residue Equivalent Value, REV, which is our corn residue equivalent.

And then also we can predict how much we need to maintain the existing level of soil organic matter, which is called the maintenance amount of REV. And you just see some examples here of some screenshots.

OK, to compare the climates and how much residue corn equivalent or what they call REV, residue equivalent values-- you can compare, for example, Raleigh, North Carolina is almost 6,000 pounds. You've got a little warmer, moister climate compared to Las Vegas. That's a very dry climate. It's about three times as much. And you see how Lincoln compares. Renner, Texas is listed there because that's the research that it's based on is the equivalent amount in Renner, Texas.

OK, so the field operation component accounts for the operation, so the more tillage we do, the quicker we're going to break down our residue. This is from that same field study the Dave Lightle and I were at. We had a farmer running a, basically, a roto-till tool there. And again, we account for all forms of erosion. We've got a center pivot on a steep hill, so we can account for irrigation, sheet and rill, and wind erosion.

This is just a screenshot that Linda Scheffe provided me. And on that screenshot, the new version will have-- the SCI value will show up in red, and red is bad. So if we have a negative 0.2 or less, that means we're losing soil organic matter, and our soil quality is going down. If it's green, it means it's above 0.2, so it's positive. It's going in the right direction.

If it's yellow, it's in between. And the values aren't as accurate in that yellow range.

We had some biomass for ethanol production wanting to come in, or various other uses for biomass to remove corn residues after fall harvest. So we ran-- I worked with my GIS specialist in accounting and in central Nebraska. Here you can see the HEL. The yellow and red are basically HEL for Platte County, Nebraska.

And then we used the GIS and used the SCI to run the entire county with different cropping systems. And here we've got a steeper slope, Nora-Crofton soil, continuous corn, corn-soybeans, continuous corn that's irrigated so we have higher yields, and we have a corn-soybeans that are irrigated. And these are all mulch tillage systems. So we're doing mulch tillage, and you can see that the only one that had somewhat of a positive SCI, with removing 50% of the corn stover the year we have corn is the continuous corn irrigated scenario.

OK, this shows you graphically depicting-- now, we ran various systems with mulch till, no till, continuous corn, irrigated dry land yields, and you see all the red area showing up with the corn-soybean mulch till system. That's to be expected. Even a mulch till system without removing the residue is probably going to show up in the red or negative area.

Here's one that looks a little better where we, instead of mulch till, we're doing no till. We've got some areas that have a low risk. However, I would say with almost any of these systems, that a corn-soybean system really was not sustainable. Continuous corn, however, was in certain flatter fields.

OK, about done with my slides, David. I put this up here just to show time variable K. So you can take a look. We've got California, South Dakota, Massachusetts, and Tennessee.

So you see how, if we've got a base value of K which is looking at permeability or soil structure organic matter, all go into the nomograph to build your K factor that you pull out of your [INAUDIBLE] database.

So it varies throughout the year. In South Dakota, early in the year it's very small, versus you get in the middle of the year, it's much higher. So it's just something to be aware of as far as keeping it covered. Your soil conditions, your structure, all those things important to soil health will vary depending on the area of the country you're in.

Some of the things that are being worked on with K factor-- Linda and Giulio and others are working with ARS to improve the K erodability prediction for a higher clay organic and other soils. Some of those, they're not as comfortable with how they fall out, so they need a little more work and research.

Also, we've been you've heard the term DSP, which is dynamic soil properties. We've got some projects going on that we're working here at the center, and others are working on, the CIG, to predict the impact that management has-- these four planning principles-- on dynamic properties, which are things like infiltration, structure, organic matter, and erodability factors.

Also we are working with Joel Poore and others to do RUSLE and wind erosion prediction system runs, to also aid in that evaluation on those impacts of systems. David, that's my last slide. So I'm about a minute over, so if there's any last questions?

OK, first, Mike, I just really appreciate it. It's been really informative. And we do have a couple questions here, and then I'll sign off. There's a new piece of equipment comes out, such as a lot of these vertical tills, or I've got a question here about different corn heads, chopping head versus a stripper head. How do those tools enter in or who does the work to get that data incorporated into RUSLE?

The basic process is, with that they should probably work through their SRC or State Agronomist, and make sure that they have the field operations in the RUSLE2 database. And then they would feed that on up to Linda and Julio, and they'd make sure that they get that in their database.

For example, a stripper header is a good example. We use that for small grain harvest, and that leaves very tall stubble, which is very important, as I talked about earlier for keeping cool soil temperatures and reducing moisture loss, versus something like a rotary combine that brings everything through the combine, chops it up into small pieces. That's going to have smaller residue, and as it hits the soil, it's going to break down much quicker. So that impacts your keeping it covered, keeping your soil temperatures down, and all those principles we talked about.

OK and one last question-- it's related to organic matter. So soil conditioning index doesn't necessarily predict an increase of organic matter over time, correct?

Well, if you have a positive-- I didn't get into that that much, but that soil conditioning index is based on various studies and the impact that management systems have on soil organic matter. So yes, it does. If you have a very positive or higher SCI, what they're predicting is yes, there will be an increase in organic matter.

To say exactly how much that will be-- I don't think it does that. But the higher the SCI, the more likely you are to have an increase in soil organic matter. That's the premise that it's built on.

Maybe in the future, as we incorporate these dynamic soil properties, that's something that could come down the road to help substantiate some of the-- when you hear some of these claims that farmers are increasing it a 10, 15 hundredths of a percent a year, which would be great to have a tool to help support that.

So OK, Michael. Again, I really appreciate your effort. I learned a lot. Hopefully everybody else did. We had a huge crowd out there. I appreciate everybody joining in.

Again, thank you Mike for your excellent presentation. I want to remind folks of two things-- one, if you want your credits, go back to the beginning and do what Holli told you to do. I don't get credits, so I don't remember the process.

And the second thing is we are next in this soil health series. It will be on June the 10th, and we're going to have a farmer from the Piedmont region of the southeast discuss managing soil health and improving soil health conditions in these very tough conditions down here in the southeast. So be sure to join us at 2 o'clock then. And again, Mike, I appreciate that.

And people can get a copy of your presentations off of the Science and Technology Training Library if they so choose to. So with that, I'll call it a day.

Thanks a bunch.