I would now like to formally begin today's conference and introduce David Lamm.

Thank you, Emily, and as Emily said, my name's David Lamm, and I work out of the East National Technology Support Center here in sunny Greensboro, as part of the National Soil Health and Sustainability Team. And I want to welcome everybody today for this unique opportunity that in my long career, I've never had-- the chance to hear our Deputy Chief for Science and Technology make a presentation, and I'm really looking forward to that.

But before we get started, I want to make a few housekeeping-- take care of a few housekeeping events. I want to remind folks that all our webinars here at the tech center are part of-- found at conservationwebinars.net, which is to be sponsored, it's sponsored by the Southeast Regional Extension Forestry. They're the folks that host the site, and if you go there, you can find not only webinars put on by the NRCS, but other technical agencies here in the southeast, and we really appreciate that partnership.

This is the start of our 2014 webinar series, which I like to brag a little bit about because if you go to conservationwebinars.net, you can find 164 replays that are available to you plus those that are coming up. In the 2014 series, we have our 11 monthly webinars that occur on the last Wednesday of the month, starting here and in the next few weeks. We're also going to have series-- a soil health series -- the second Tuesday of the month for the next eight months, starting today, although this is Thursday. We had to accommodate a schedule.

We also have six organic and sustainable ag series webinars, which will be held the first Tuesday of the even months, so if you can figure that one out. And then the last thing, there is an energy webinar series under development that will fall somewhere in the month itself. But the best thing to do, if you want to find out about our webinar series, is go to conservationwebinars.net, click on upcoming webinars, and you'll see a list, a running list, of upcoming webinars. You can click on the link there, and it'll give you all the information about who's the speaker and what the-- a little overview of what the topic is. So go there, and I think you'll find it a useful tool.

Second thing. Today, you can earn CEU credits for conservation planning and certified crop advisers. Once the webinar is over, you need to go back to the portal page and take a brief post-test. Enter your

certification credentials, and then just follow the instructions to get that submitted. Again, you can get up to one hour credit for that.

And then the last thing I want to mention is that a copy of today's PowerPoint presentation is available at the webinar page that was used to join today's webinar, under Related Files. So if you want a copy of Dr. Honeycutt's presentation, get it there. So housekeeping done. Let's move on.

Let me give a little introduction to Dr. Honeycutt. He received his Bachelors degree in forestry and Masters degree in soil science from the University of Kentucky. And he earned his Ph.D. in soil genesis from Colorado State University. He served as a research soil scientist for 14 years and a research leader for 10 years with the USDA ARS, the New England Plant, Soil, and Water Laboratory, where he led and conducted interdisciplinary research on nutrient cycling, sustainable cropping systems, and so forth.

He's done a bunch of writing. He's co-authored or authored over 80 publications in peer-reviewed scientific journals and nine book chapters. And we've had the pleasure of working with Dr. Honeycutt when he came on board with NRCS as the Deputy Chief of Science and Technology in 2010. And in that role, Dr. Honeycutt leads the agency's programs in technology acquisition, development, and transfer. And he ensures that NRCS conservation practice reflects the latest scientific advances for addressing the nation's soil, water, animal, plant, air, and energy resources.

And he's got a passion for soil health that I think you'll find out today. And again, I am going to say this. He may be embarrassed, but this is-- in my 37 years, I've never heard of a deputy chief of science and technology do a presentation like this. So I just thank him right up front and look forward to what he has to say. And with that, Dr. Honeycutt, I'll turn it over to you.

Thanks, Dave, for that very kind, very generous introduction. And thanks to the entire National Soil Health and Sustainability Team for sponsoring today's presentation and for the entire series and the good work that you all do. Thanks, also, to everyone that's joining us today. It's my pleasure to be with you.

I would like to just start out by saying we have many powerful examples that are really surfacing on how individual farmers have benefited from their soil health promoting practices. But one of my goals in the role that I have with NRCS is to also ensure that we have a real sound scientific basis for the practices

that we are advocating in our soil health campaign. And of course, we're doing this in a number of different ways.

We're doing it like, for example, working with developing scientific literature reviews. We have a group at the ARS that's developing one. Sisters and brethren in the soil science and resource assessment deputy area, they're also working on one for us. We have an agreement with the ARS, some of you know about, with what's called the Haney soil health nutrient test. We're using our conservation innovation grants program to help identify and then, hopefully, fund some of the projects to fill in some of those that demonstrate gaps that are out there. So those are just a number, a few of the ways that we're trying to ensure that scientific basis.

And today's presentation is really offered with that goal in mind-- to present a scientifically and statistically rigorous study that demonstrates how soil health can impact plant growth and yield. And I first want to start off acknowledging some of my coworkers when I was with ARS. Dr. Tim Griffin, who's now with Tufts University. Bob Larkin, Modesto Olanya, John Halloran, and Zhongqi He, that are still with ARS.

The reason for this study is really this graph right here. We essentially looked at historical yields of potatoes in Maine, shown by the red line, over about a 60-year period as compared to what was going on in the rest of the United States. You can see by the blue line there, in the US, yields kept increasing, but it stayed relatively constant in Maine. It was bouncing around from year to year, but the question was, why? What is it that's limiting productivity and sustainability in these systems? Is there some soil-related property? Is it some disease-related issue? Is it simply water? Is it some combination of those?

So we set up a project that is where we identified a number of different cropping systems that were designed and managed to reduce or remove one or more of those potential constraints that we are hypothesizing could be limiting productivity. So one of the systems was a status quo system, where barley is just inter-seeded with clover, then followed by potato. And in that case, the status quo in that part of the world was for fall tillage, so that's what we were doing as part of that status quo system.

And then to start to address the question, could soil be one of the limitations, we introduced a more soil conserving type of cropping system and management practices. So in that case, we had barley that was inter-seeded with timothy, and then the timothy was allowed to grow for a full second year, and then potato came in. So any time we were growing barley, we were essentially no-tilling into that barley.

And then of course, again, the timothy we're not tilling that particular year. And then potato, instead of going through the fall tillage, we were doing a spring tillage because again, that's a little bit more of a soil conserving type of tillage practice.

And then for the soil improving system, we essentially took that same barley-timothy-potato cropping system and added composted manure each year to those plots. Now, so this was not really done where we didn't realize-- we realized it would not be necessarily an economically viable type of practice to add composted manure, let's say, to all the potato land or anything like that. But our goal, again, was to remove a potential constraint to productivity by improving that soil. And by adding composted manure was a way for us to immediately start to accrue some of those benefits, to immediately start to improve that soil. And so that's what we did in that particular system.

And then for our disease suppressive system, to again see to what extent diseases might be limiting yield, we had mustard that was grown as a green manure, followed by winter rapeseed. Those mustard and winter rapeseed, those are Brassicas. Brassicas have a compound in them called glucosinolate, which decompose into another compound called isothiocyanate.

You can hear the word, the formative elements of the word "cyanide" in there-- isothiocyanate. And that's essentially like a natural fumigant that can be used for controlling the number of soil-borne disease organisms, and also sometimes nematodes. And so we used that in the first year, followed by sorghum-sudangrass-winter rye, that mixture. Winter rye is fairly well known for its allelopathic impacts on controlling diseases or pathogens, plant pathogens. And then followed by potato. So that was our disease suppressive system.

And then for a control, we had a non-rotation control, potato-potato. Now, I mentioned that one of the things we were also interested in looking at was whether water was also a potential limiting factor to yield and therefore and whether or not it was limiting and how it changed regarding some of these other potential constraints. And so what we essentially did is we had all of these systems that were evaluated under both irrigated and non-irrigated, or rainfed, management. So that allowed us to look at all these different potential interactions.

For example, if we increase the organic matter to a point, will we still need to irrigate? If we increased organic matter, and we did irrigate, then what would that do to some of the soil-borne diseases that might now start to show up in that type of situation? And I should say that all the potatoes and all of

these were managed the same way in terms of the tilling practice that's used, the insect control, the nutrient management. All those practices were the same, so we did not have confounding across each of these systems.

So that's the basic gist of the systems, and this is what it looks like in the field. You can see here some of the potatoes are in four-row plots. This is, I believe, some of the timothy right back here that's growing. This is canola that's growing. This is potatoes here. This may be a little bit of clover. It's kind of hard to tell from this picture if that's clover right there.

And the thing I should point out here is our lateral irrigation system. So it's not quite as simple as this, because things are randomized, but you could envision it as this linear irrigation system moving across the field, up and down the field. And it may irrigate part of it, but then not irrigate the next block. It may irrigate a block, but then not the next block. And that's, of course, the way that we did the irrigated and non-irrigated types of interactions with all these different cropping systems. So that's the set up in the project.

So let's take a look at some of the soil properties and differences in soil properties as influenced by our different cropping systems and management practices. Now I'll tell you right off the bat, probably most all of you know this. Not all soil organic matter is created equal. There are basically different fractions of carbon and nitrogen in the soil, with different levels of availability, or what's called lability, to the soil microorganisms.

And that Haney test that we are going to be evaluating that I mentioned a while ago, largely does that. It's looking at those active fractions, those fractions of carbon and nitrogen that are more readily available to the soil microorganisms. And so here we have three different types of measures of the labile carbon and nitrogen compounds. Let's call it active carbon evaluation. And what's called a particulate organic matter carbon and particulate organic matter nitrogen. That's a size fractionation. But the bottom line is, these more labile or relatively available carbon and nitrogen compounds are considerably higher in this soil-improving system, compared to the other systems.

And then another question that we evaluated was the impact that these systems might have on soil aggregation. Aggregation, of course, being extremely important. The individual sandstone and clay particles, they can get aggregated together. In many respects, it's because the microorganisms and their exudates and their root exudates provide the substances that help bind the sandstone and clay

together into aggregates. And that, of course, is important because the more aggregation you have, then you can reduce erosion. You get more water infiltration. You get more ease of root penetration. And so this is a real nice physical measurement.

You may recall that we had timothy in both our soil-conserving system and our soil-improving system. And timothy, of course, being a strong grass with a lot of roots, is probably the reason why we got such good increases, substantive increases in soil aggregation in those systems there. But the bottom line is that we were able to increase soil aggregation with our systems-- the soil-improving and soil-conserving systems.

Another measure we took was soil bulk density. And here now, I probably ought to point out that some of these values may look quite low to some of you. That's because we were in glacial till soils in northern Maine. And so we felt like the best way to measure soil bulk density is, after we make the calculations and we draw things down and weigh things, then we also sieve all the rocks and determine their volume and weight, and subtract that out of it. So this is just the less-than-two-millimeter fraction. And that's why, probably, the numbers look low to you, because generally, you see soil bulk densities around 1, 1.2, sometimes up to 1.5. But the bottom line is that we had significantly lower bulk density in the soil-improving system compared to all the other systems.

And it really got to where very soon, our gentleman that we had managing our plots, it got to where it took him longer and longer to maintain those plots. Because he had to get out and change the equipment when he would go from one treatment to the next. Just because of the tilth of the soil that was changing as a reflection of our management practices and these systems that we put in place.

Probably all of you are familiar with this when you see something like this on this slide and subsequent slides. When you see a different lowercase letter, then that means those are statistically different. So 0.887 is not statistically different from 0.874. The b's are the same. But 0.771 is significantly different than all the others. So significantly reduced bulk density in the soil-improving system compared to all the others.

And our microbiologist also looked at some of the bacterial populations. Significantly higher bacterial populations in our soil-improving system. And then he also used something called soil substrate diversity index in this BIOLOG system, where essentially, you have these little plates in the laboratory with different types of substrates in it. And you take an extract of the soils from the field plots, and you

see what those microorganisms in there can basically eat on, what types of substrate that they can essentially consume. And the soil-improving system and the disease-oppressive system had higher diversity of the substrate that those organizations could consume.

Another physical measurement that we made is called soil penetration resistance. Probably many of you are familiar with that, and that's a very simple measure. It's just basically pushing a probe that measures the resistance as you're pushing straight down into the soil. And it has a little reading on it that allows you to take readings with depth as you're going down. There were not real major changes. Pretty much very similar in terms of resistance as you're pushing down through the soil, down around 12 to 15 centimeters. 15 cm is about six inches. And pretty much our break there came from our continuous potato system-- the red line with the PP system. That basically gave higher resistance as you pushed through that soil. But many of the others were not real different from one another in terms of that particular measurement.

So a bottom-line question here is we were able to show all these differences in soils as a result of our different management practices and cropping systems that we implemented. So the real question that we would want to take the grower is, what does this mean for how well your plants are going to grow. And of course, what they're really interested in is their yield, too.

This is just a photograph. These, again, were 4-row plots, and this is our continuous potato system, potato after potato. This is in rainfed conditions, and you can see back here on September 6, 2007, the potatoes are already starting to senesce. They have senesced quite heavily, actually. They've all already died back.

But taking a picture on the same day, the status quo system, where we had barley inter-seeded with clover, followed by potato. Again, here's a 4-row plot. One, two, three, four. These rows right here. This is another plot over here, so please don't look at that. You can see that it's pretty dark green, but we are still getting some yellowing. We are starting to senesce. The plants are starting to lay down, and some of the senescence has begun.

But then if you look at the soil-improving system, those plants on that same day are still very vigorous. Again, this is 4-row plots. One, two, three, four. Those four rows right there. Very dark green, very lush, very erect. Those plants are still photosynthesizing. They're still very actively bringing in carbohydrates to help be translocated to those tubers in the soil to increase the yield. There's a little gap in the plot

here, but that's where we had been in there messing around and sampling.

Now, we can put some numbers to that. The concept of leaf area index is basically like if you were essentially hovering over the plants and looking straight down. Leaf area index is the relationship between how much you're seeing that is ground and how much you're seeing that is covered by leaf. That's essentially what leaf area index is. It's a dimensionless measurement, but it's really that kind of relationship. And you can see here, this is under rainfed conditions. This in 2006. Much higher leaf area index in the soil-improving system compared to the other systems. Our continuous potatoes, the red line here. The status quo system is the white line here. So that's, again, under rainfed conditions. Quite a bit of separation and difference between the different-- or among the different systems there in terms of leaf area index.

But then if we irrigate that, those collapse fairly well on top of each other. So what that is indicating to us is that water was a limitation. Water was constraining productivity. So by irrigating, we essentially removed that constraint to productivity, so many of those curves fell very closely upon one another at that point.

Now another measure that you can take from this kind of data is called leaf area duration. And I'm going to go backwards here a slide just to show you. Can see that, not only do you have, say, a higher leaf area index for the soil-improving system, but essentially, it's higher, and it's higher for a longer period of time. It doesn't just peak up here and then drop down. And so what you can do is, you can essentially integrate the area under each of these curves and come up with a single value to represent the leaf area on each of these treatments, each of these types of systems we're evaluating. It's a concept called leaf area duration.

So again, it's just a calculation of the area under each of those curves that allows you to evaluate leaf area. So it's not only how much leaf area you have, but how long it is there. It's essentially that measurement. So there's the irrigated again, and here's the leaf area calculation that I just described. So here are all of our different types of systems. Under rainfed, you can see that the soil-improving system had significantly higher leaf area duration than these other three systems here. This is similar, not statistically different, than the disease-suppressive system.

So that's one message, but then the other message is once we irrigated, all of these leaf area durations were essentially the same. So again, we've identified that water was the most limiting, and we've

overcome that limitation by irrigation here. OK, so that's 2006.

So then the next question is OK, you showed me changes in leaf area, our photosynthetic capacity. How does that impact yield? Those of you not familiar with potatoes, this is a funky measurement. That's hundredweight per acre. That's the way that potatoes are traditionally measured for their yield. Used to, actually, be related to barrels, when they picked things and put them in barrels. But now it's generally referred to as hundredweight per acre. You can translate that into megagrams per hectare, but it doesn't mean a whole lot to farmers. And so I usually just present it as hundredweight per acre.

But now the point here is that the soil-improving system had a higher yield. There were some similarities here with the status quo system and also the disease-suppressive system in this particular year. This was pretty early in the study. But then also, the point is that when we irrigated, we only got a very small irrigation response. Really, these numbers were not different. The 371 and the 386 were really not significantly different from one another. But generally, only about a 4% response to irrigation when we had the soil-improving system. Much more demonstrative responses to irrigation for the other types of management systems.

So that was 2006. I want to step you through, perhaps a little more quickly here, some of the other years. In 2007, I'm just going to show you some of the similar data. So here's what it looked like under the rainfed conditions in 2007. Again, this is leaf area index. And again, we see similar relationships among these. Now, the curves look different than they looked in 2006. I mean, that's because the weather was different in 2006.

But what I'm really pointing out is the relationships among these different management systems. So the soil-improving system peaked relatively early for leaf area index and maintained much higher leaf area index throughout the rest of the growing season, compared to the other systems. So this is rainfed. And again, same year, 2007. We irrigated, again, those curves pretty much collapsed on one another. So again, that's telling us that water was a real limitation to productivity. We overcame that by irrigating.

And so then, how does that translate into the leaf area duration? So we're looking at, not only the leaf mass that's there, but how long it's there-- how long it takes before it starts to senesce and die back. And again, you can see our soil-improving system, significantly higher leaf area duration than all other systems that particular year. And then when we irrigated, there was no significant difference among these.

But again, the take-home message is by improving the soil, we were able to get that higher amount of leaf area, and it was able to last longer in the growing season. So it was able to keep that photosynthetic factory churning for the plant. So then what impact did that have on yield? How did that translate into yield?

Here again, we have our different cropping systems under rainfed conditions. And you can see we got significantly higher yield-- 394 hundredweight per acre --on the soil-improving system, significantly higher than all the other systems. And also, not only that, but we again, we did not get any increase when we irrigated. So what that's essentially telling us is that we can overcome this water limitation to yield by either irrigating or by improving the soil in this case.

Doesn't mean it will happen in Arizona, but here in this particular case. And that's why I titled the talk "A Case Study," because this is one case study. But in my mind, it's quite a revealing case study of the impact of improving soil properties on soil health, and what benefits that can have on plant growth. And so this is very similar to some of the other slides that I showed you, in that they were able to get some responses, in many cases, to irrigation on these other types of systems-- anywhere from 18% to 26% yield increase by irrigating, but no yield increase by irrigating the soil-improving system.

So here comes 2008. That's the final year that I have data available to show you. And this is again rainfed conditions, 2008, leaf area index. So this is what the plant was seeing. In the soil-improving system, very similar story, just different shapes of the curves, but similar relationships among the different systems, where you had higher leaf area index in the soil-improving system compared to the others. And as one would expect, the continuous potato is doing poorly.

And then we irrigate that, again, many of those curves fall along the same line once we irrigated to overcome that water limitation. And again, here's the leaf area duration-- how long those leaves exist. Again, significantly higher leaf area duration in the soil-improving system compared to the others. And really no change compared to the rainfed and the irrigated conditions for the soil-improving, although we did get some real changes there for the other systems.

Same with yield, 2008, how that translates into yield. Significantly higher yield in the soil-improving system again. So this is the third year of data that I've showed you here where it's a real consistent impact where improving the soil health by the way that we developed and manage that system, led to

significantly higher yields compared to all these other systems. And that even when we irrigated it, you did not get an additional increase in yield.

And so when you start-- those of you that have done field studies, I'm sure you have-- would suspect, anyway, that you've experienced this. Many times when you do a field study, things are different year after year. And so many times, you get very different types of results year after year. Here we have three years in a row of evaluating these cropping systems and management practices where we have very consistent positive benefits of our soil health improving practices on plant growth and yield.

And so I would just pretty much end there. Just a quick summary on some of the impacts on soil properties that we saw. That our soil-improving system had more labile carbon and nitrogen in the soil and higher soil bacterial populations. The soil-improving and the disease-suppressive systems had the highest soil substrate diversity. And that the soil-improving system had the lowest soil bulk density. And the soil-improving conserving systems had a higher soil aggregate stability. So constant here is that soil-improving system has all these beneficial impacts.

So our techniques-- our development of that system and the way we were managing it, adding the materials we are adding to it --did have those enhancements in the soil, as measured by many of these different types of evaluations here, like the labile carbon and nitrogen, substrate diversity and the bulk density, the aggregate stability. We were able to achieve those changes that we are trying to achieve in many of our soil health promoting types of practices.

So those are some of the impacts on soil properties that we observed. And then we observed substantive impacts on plant growth and yield-- that the soil-improving system increased the leaf area index, the leaf area duration, and yield in all three years. And also that the differences in those values of index and duration and yield that could be attributed to the cropping system, could essentially be reduced or essentially replaced by irrigation in all three years.

So our conclusions from that research project, and some of it hasn't been studied. I mean, it hasn't been published yet. I'm sorry. It has been studied. Has not been published yet, because for a number of reasons. One of them's because I left and came to NRCS, but other folks have some of the data, and they are starting to publish some of it now. But a number-- some of it hasn't been published yet. But our conclusions that we consistently came up with is that these management systems that improve soil health can significantly enhance plant growth and yield. And that these systems that improve soil health,

in this particular case, can be as effective as irrigation for enhancing plant growth and yield.

Now again, I would not necessarily want to say that in a semi-arid region, but I do think that we could significantly enhance the resiliency of our production systems by enhancing soil health in those systems. I think that if we just look as recently as last summer, the cover crops survey that was presented to us. And that was what, from the 2012 actual year, I guess, is the sample year, where they found about a 10% to 12% yield increase in corn and soybeans following the cover crops.

One would think that if those cover crops had been there quite a while, they may have increased the soil organic matter, and therefore the available water-holding capacity in the soil. But it's also very likely that more immediate effects were realized, where the cover crops in those particular cases could be very useful for reducing runoff, for capturing and holding snow melt, basically for help getting more water infiltration and percolation into the subsoil. So basically helped recharge the upper horizons and also the reservoir for water for plant growth roots as those roots go down through the soil.

And so, even in those types of regions where some of that data was collected-- in the West, the Midwest --that I have to think that maybe soil health types of practices that we are promoting in our soil health campaign can significantly enhance the resiliency of our production systems.

So I would just take this opportunity, I guess, to get on the soapbox just a little bit more and say that I think the-- in my mind, the work that you all are doing to enhance the health of our nation's soils is really some of the most important work that we could possibly do for this generation, and particularly for future generations. And I say that not just because of all the additional mouths that we need to feed going from currently about seven billion people up to around nine billion people just by the year 2050. And because we have these additional constraints with reduced land available to even do that.

But it's also because by addressing soil health, it allows us to simultaneously address so many of our natural resource issues. It allows us to address water quality. It allows us to increase carbon sequestration. It allows us to reduce greenhouse gas emissions. It allows us to provide wildlife habitat. It allows us to provide pollinator habitat, for which we rely well what? About 35% of our food supply require pollinators for their assistance. It allows us to also not grow all this food for this burgeoning population on a shrinking available land base, but it also helps us reduce our dependency on foreign sources for our fuel, because of our bio-energy production.

And I think that we just cannot lose sight, also, of the yield and the economic benefits of our soil health promoting practices and what that is going to do just for keeping farmers farming and ranchers ranching, so that we also are not dependent on other countries for our food supply. And I happen to be one of those people, I guess, that takes a little bit more of a global perspective on some of these relationships. Because I've seen firsthand how richness of soil influences socioeconomic conditions of a community.

I saw it mapping soils in Eastern Kentucky, the Appalachian region of Eastern Kentucky. It was a very strong relationship between the soils I was mapping there and the quality of the house that they were living in. It was very, very strong. It's not just obvious to me, but it was obvious to others there. And so I happen to feel that all of these efforts that we are doing for enhancing soil health also really gets translated, at some point in time, into the rural economic opportunity and social fabric of our rural communities. And so that's why I say that I'm just really appreciative of the important work that you all are doing for enhancing the health of our nation's soils.

So Dave Lamm, thank you, all of you, for the opportunity to visit with you, and I'll turn it back over to you, Dave.

Thank you, Dr. Honeycutt. I was most interested, I wrote down a few questions, and we've had several others come in here, so if you don't mind answering a few things as we go here. We've got a few minutes left. But one of the things that struck me so much was, this happened pretty fast. I mean, did you-- 3-year study, which is not very long, but yet we're noticing some pretty significant changes, especially in your active carbon and the other measurements made. Was that something that was a surprise to you as you went forward with this?

It was a surprise. It was a surprise, but I also say we instituted treatments in order to achieve that rapid response. By adding composted manure, you're already adding organic-rich material that is going to really stimulate a lot of biological activity in the soil and comes with biological activity itself. And so we did think that we would have a fairly rapid response. It did surprise us how rapid. But I do think that it's these types of levels of response we can achieve in many of our systems without adding things like composted manure.

But you're right. It would just take us considerably longer to achieve them. And I do think that that's one of our challenges, actually, and one of the things that I have been trying for the last two years to get

people to do work on through our CIG program. I've had that as a priority. Is for evaluating, not only the determinants, but the rates of increase in things like organic carbon and available water-holding capacity as a function of different inputs, like different quality parameters. Like not only the different amounts of the residue, but different qualities of the residue, like different cellulose, hemicellulose contents, carbon and nitrogen ratios, lignin contents, those types of things.

OK, thank you.

Let me read a couple of questions that came in. There were several questions related to the fertility, what kind of program was used, and were there any adjustments made when you're putting this composted manure. You're going to get a little out of that. Did you adjust the nutrient amounts put on there? And maybe speak to what you were using as far as material.

We did not adjust the nutrients, the fertilizer amounts based on that. And that's one of those things that you have to just make a decision and then go with it. We did decide, after about-- I believe it's about four years into the study --that then we needed to start making that change when we get to a particular part in the rotation. That we did need to start making that change, particularly to account for some of the phosphorus. So our approach was just to make sure that we had plenty of nitrogen, phosphorus, and potassium by applying fertilizer to each of those in the same amounts. So we did not back down, recognizing that we were providing more in the compost.

But I think the data that I just showed you clearly showed that it was a water type of limitation, constraint that we were overcoming there. And by-- I guess there have been nutrient-rate studies that have been done in that climate zone and in that, actually even in that soil series there with potatoes, that showed you could essentially peak. But if you kept adding more, it's pretty flat line. It's not a relationship that really starts to drop off where you are harming yield by adding more. And so our approach was to just to make sure that we had enough. And so that's why we did not back off on the nutrients at that time.

But whoever asked the question is exactly right. You would eventually get to that point here, where you would want to reduce your nutrient applications for those soil health management systems. And I do think that that is one of the opportunities and challenges that we do need to have in our soil health promoting practices. Is that we evaluate the nutrient management and have that be a component of that soil health management system.

OK, we've had a request for you to scroll back up to where you describe your various treatments. And if you could do that, then I have a couple questions that came in related to that. One of them is which one of these treatments do you think follows the basic four principles that we've been advocating-- maintaining a living root, minimizing disturbance, getting diversity, and maintaining coverage throughout the year?

That's a good question. I think if one had to say which of these particular systems met all four of those the most, it would probably be the-- it would be between these two-- the soil-improving-- well, the soil-conserving, soil-improving, disease-suppressive all did that fairly well. But I will say none of them do it completely because of potato.

Potato is something that is tilled, so you're disturbing it quite a bit. I've never no-tilled potatoes, but I'll tell you I've been very tempted to. And then the potato harvest itself is a very disruptive process, in that you're essentially going in there with-- it's kind of like a sled blade a few inches under the surface that essentially lifts all the soil up and shakes it. Shakes the devil out of it on chains. And so you're breaking down aggregates. You're exposing the surfaces to microbial attack. You're oxidizing organic matter. So it's a very destructive process.

So none of these systems in potato here completely meet those four. But I would say that those three were an attempt at doing the best we can within the potato system.

Well, the likelihood of Americans giving up French fries is not very great, but I think that points to the fact that you need to work within the system you have, the crops you're trying to grow, and then adjust it as best you can to meet those parameters that we're trying to advocate. We've had a lot of questions about economics. Did you do any work looking at that at all, or was it just strictly looking at the soil and yield and that type of thing?

Well, first of all, I guess I would just comment that I am glad to hear that there are a lot of questions on economics. And I say that because I think that is actually a gaping hole that we really have in a number of our soil health promoting practices, is that basic information, not only on how that could affect potential profitability, but also how it could affect grower risk. And I think grower risk could be measured by yield variability. And I think these are just extremely important measures, because they will really influence adoption because that's the bottom line to a grower, is potential profitability.

But I think related to that is that we have the-- I believe we have the opportunity here. If we can demonstrate a risk reduction by some of our soil management systems, then I guess I'm optimistic that we should be able, then, to go to lending institutions if we show them reduced risk, and say these people that implement these conservation types of practices should be able to be offered a lower loan interest rate, or they should be offered a lower premium on the crop insurance, because they are a lower risk. Here is the data. And so I think its an extremely good question.

We did have an economist working with us on some of this. I do not have his data with me, and I did not have access to it to pull it open before I gave this presentation. So I can't tell you what it was in much concrete terms. I will tell you that the point that I made earlier about compost not being a necessarily economically viable addition or amendment, that is true here in this case.

Now, if one were to work in, let's say, an integrated animal and crop-production system, where you had a ready source of manure close by. Because manure, so much of it is water. So you're not transporting water. You've got it real close by. And particularly if you can compost it then it would become, in those situations, much more economically viable. This particular case, it would not have been economically viable. But again, that was not our goal. Our goal here was to quickly and significantly enhance soil health by adding this organic amendment.

I guess I would also just point out that our Conservation Innovation Grants program in 2013, we awarded to the Conservation Technology Information Center a CIG grant to conduct an economic evaluation on cover crops. And I have-- I'm working with the National Association of Conservation Districts right now to identify demonstration sites all across the country. And the economic evaluation of those soil health demonstration sites is going to be a part of it.

And then I also, just this week, was in St. Louis meeting with the Nature Conservancy, Environmental Defense Fund, National Corn Growers, and Monsanto. And they are proposing to set up approximately 20 soil health promoting demonstration sites per year for the next five years in Iowa, Indiana, and Illinois, and then, hopefully, grow out from there. But their first focus is in those three states. And we were talking about two major categories. One is what types of practices, or evaluations I should say, you make and measure in the soil, but also, what type of economic evaluation. And so it is really widely recognized that we need that economic evaluation for helping us to work closely with farmers and to get that adoption that we need.

I wholeheartedly agree. I know that's one question that we get asked all the time as we go around the country talking. I got a combined question that was the person noticed that there really wasn't a whole lot of difference between the status quo, the soil-conserving, and the disease-suppressing systems compared to the soil-improving and wanted to know what your comments are on that. It probably revolves around the compost. And there are people wanting to know how much composted manure that you were applying.

You know, I think the comparisons among those three treatments-- the status quo, soil-conserving, and the disease-suppressive --I think those did vary from year to year. And so it's a little bit more weather dependent. And I think that the soil-improving, it was standing out among those others because of that slug of organic material that we're adding to those. I'm trying to remember, but I believe, and I apologize for not knowing with 100% accuracy, but I believe it was a 20-tons-per-acre rate of composted manure that we were adding to these.

So is that kind of a normal thing for potato crops up that way, or was that excessive?

No, it's really not normal at all to be adding composted manure to these potato plots.

I was referring to the rate there.

Oh. I guess I'm not aware of enough people that have been doing it to know just how common it is. But it didn't seem like a whole lot, I'll put it that way, when we were putting it on.

OK. I got a question from-- actually, this one came from somebody in Maine who wanted to know about if you could speak to some of the barriers to adoption in the Northern Maine area and across the northern part of the country here, especially related to cover crops and equipment and that kind of stuff.

Certainly. Yeah, each climate and each soil and each cropping system and each tradition of this is the way we've always done things. I think we find those types of commonalities all across our country, whether it's Maine or California or Washington State. Many, I think, folks say we can't do it the way they do it over there because they have 40 inches of rain, and we only have 20. And so all that is true.

But I think it really gets back to your point, Dave, is that by applying some of these soil health management principles, they just really need to be tailored within the context of those constraints, of those climates, of those cropping systems, of the way things that people do things. But maybe we just

need to bring them along a little step at a time. Sometimes we can bring them along a leap at a time. It's generally the more progressive growers that are willing to take that bigger step.

To get to the specific question about constraints in Maine, things like cover crops is a real constraint, just because of the short growing season. It doesn't mean it's impossible. We grew them in potato rotations. We do have a challenge. It generally meant that we grew potatoes that were a shorter-season variety, so therefore, we would have that opportunity to get in there and seed a cover crop that would germinate and would survive the winter. There are some cover crops that winter kill, some that do not.

I had a lot of luck with hairy vetch early on up there. And so there are, I think there are a number of those types of opportunities. But yeah, obviously, there are a number of those constraints also, and we just have to work within those systems. But I think following the principles that you described earlier, Dave, is our guiding light, really. And just now, that's where the creativity and where the intelligence comes into play of our individuals that we have in the field, working with farmers and ranchers across the country, so that we can try to apply these principles, but within their context of their constraints.

OK. I got one more question, and then we'll let you make a closing comment. Someone asked about-- you mentioned the cover crop survey. Somebody was asking about that in a little more detail, where you might be able to get access to a copy of that.

This was a survey that, I believe it was CTIC-- Conservation Technology Information Center -- conducted in collaboration with the-- I guess the Midwest, I believe it is, SARE-- Sustainable Agriculture Research Education group. Dr. Rob Myers at the University of Missouri was the lead author on that survey. And they provided survey questionnaires at a number of different farmer meetings and asked them about their yield comparisons for those that did have cover crops. They asked about what types of cover crops they used, seeding rates, the knowledge, perceived barriers, these types of things.

And that is readily available. It's online. I can send you the link, Dave, and you can send it out afterwards, if that works. Or I know we have sent it out before, and I've presented it. Actually, we had Dr. Myers in and presented the information to state conservationists and provided links and stuff to them, too. But is the best way, Dave, for me just to send you the link?

I've got the link, Dr. Honeycutt. We can make that available, or you can just Google. It's actually the

North Central Sustainable Ag Research and Education. It's their group, there, that's got it. And you can find it on their website. So I think that's good enough.

And also, I think as a follow-up, I think they're conducting another survey for 2013 cropping season. I believe that's correct.

That's what I understand. You're right.

And one closing comment, Dr. Honeycutt. Do you want to mention anything about the National Conference on Cover Crops and Soil Health that's coming up?

I'm glad you brought that up. Certainly. Thank you. Just several months ago, I had the opportunity to spend a day with Howard Buffett down on his farm in Decatur. And that's where I learned that the North Central SARE unit there, Dr. Rob Myers, was working with the Buffetts and putting together a cover crop conference in Omaha. And so, after spending a day with them and schmoozing them a little bit on the benefits of soil health, that it goes beyond cover crops. That cover crops are obviously a very valuable component of soil health management system, but they're not the only one. Then they decided that maybe it would be a good idea to expand that to cover crop and soil health conference.

And so Dave Lamm, here, has been working very diligently-- he and Ron Nichols and others, particularly though, Dave and Ron --have been working very closely to that group to put together this National Soil Health-- or it's actually National Cover Crop and Soil Health Conference. It's going to be February 18th and 19th. And at the time, I thought wouldn't it be nice, because the Buffetts are essentially funding it, and so that means, although it's very generous of them, it does limit the number of people that they can bring in. They're bringing in about 300 from around the country, different walks of life, different farmers and different types of farmer groups and implement dealers and scientists and et cetera.

It is limited, and so at the time, I said I was wondering if we could use our VTC system to essentially broadcast it, or at least the opening presentations of Howard Buffett and the farmer panel for that morning session, the first morning session. And then we explored that. We realized that we didn't really quite have the capability that we needed, and so they went to a webcast. And at this stage, we have about, I believe it's 170 NRCS locations that have already been identified, where they will have a facilitator there for farmers and ranchers to come in and do this webcast. And there's about another 50

extension offices that are also going to be doing the same thing.

And essentially, what we're asking our folks to do is to identify some adopters and non-adopters and invite them in for a couple hours that morning to view this webcast, to view Howard Buffett. And we're hoping to get the secretary there, but we don't have that confirmed yet. That then would give a short talk but then open it up to farmers, kind of a farmer panel that will be there. And listen in and then close out in each of these 220 locations across the US, and then have their own facilitated discussion on what do you see are the barriers to implementing cover crops and some of these soil health management practices.

And so that's why I'm saying it would be good to have some of the non-adopters there. If you see folks in the field that look like they would really benefit from this, please invite them in. Invite them in to that site. And I believe these are already identified on the website. If not, Dave Lamm could tell you where these sites are going to be. Now, they will be posted soon.

But anyway, my point is if we can invite them in, along with those in that have already adopted some of these, it would be a way for us to facilitate that dialog between the two on identifying barriers and how they overcame those barriers to adoption of those soil health promoting practices. So we're really hoping that during the course of just that day period, we can significantly influence and enhance adoption just by doing this type of webcast in these facilitated discussions all across the country.

So it's just a huge opportunity, I think, for affecting that positive change in the resiliency of our production systems.

OK. And just to follow up with a closing comment on that, if you Google on North Central SARE, you can find lengthy information about their conference. And they actually have a map that's got all the locations. You've got to do the zoom-in thing, but it's got a location identified where the meeting will be, and also a contact person, which can either email or give them a call and let them know whether you're wanting to participate and get more information about that. So that's your best source of information, and that is available currently right now.

Well, listen, Dr. Honeycutt, our time is up. Again, I appreciate your effort, and I know the 300-plus people that signed onto this will appreciate the effort. And I thank-- firstly, I just thank you for your leadership and seeing the significance of soil health as been being what it is and helping in the capacity

that you can to make it happen and help improve the nation's soil.

So with that, we're going to let you get back to your other job, managing all those other things you do all those other meetings you go to. And we do appreciate you taking the time out of your busy schedule to participate in that. And with that, Emily, I think we're going to draw this webinar to a close.