

"Hi, everyone. We are right at 12:00, so we're going to get started. Welcome to the first event of the Making Soils data Actionable Webinar series. I'm Dani Gelardi, senior soil scientist at the Washington State Department of Agriculture. And I'm very excited to welcome you all today to talk about soils data in this space. You have probably noticed that more soil tests and more soil data are available to farmers than ever."

"And while this can be empowering, it can also be really confusing new information on soil chemistry and biology and physics can sometimes be difficult to translate into action on our farms. And so the Washington Soil Health Initiative has put together this series to showcase how useful and necessary soils data can be to making in-field decisions. Every Wednesday at noon for the next month, we will be showcasing projects from across Washington State that are using real data to make real world on farm decisions."

"And today we have Adam Peterson here to help us understand how Thurston Conservation District is making soil chemical indicators actionable. Adam serves as the senior GIS science specialist at Thurston Conservation District, and since 2020, he has spearheaded Thurston KDS Soil Health Program, overseeing the generation of hundreds of soil test. Interpretive reports for cooperators in Thurston County. Adam holds an MD GIS in Sustainable Management from the University of Washington and an MSC in Crop Science from WSU."

"And so for everyone in the audience, there will be a Q&A at the end. But feel free to post your chats into the chat feature as we go. Molly and I will be moderating that and you can find the chat feature at the sort of right hand of your Zoom screen screen. And so thanks for being here today, Adam."

Feel free to take it away.

"Awesome. Thank you, Danny, and thanks. Thank you for attending a presentation today on making soils data actionable. So I wanted to start off with a little bit about myself. I may be repeating some of the stuff that was just mentioned, but I'm the senior genius and science specialist at Thurston Conservation District. I do a lot of different things in my role from GSA work to drone work to irrigation water management."

"But soils is a big one and one we'll be focusing on today. Again, I have an interesting background, so I started off in crop science right? I started at Evergreen and then later at WSU, ready to make graduate research focused on domestic production of quinoa. And then later, did this work. I found myself teaching myself guys skills to review climate suitability for quinoa and ended up going back to school to to really dive into this."

"And so ever since I kind of found myself in this fascinating insight of overlap of agricultural and technology. And I'll be showing some kind of examples of how I've drawn on both those backgrounds for this CD. So our testing program. So my talk today focused towards technical service providers. I'm a technical service provider, and many of you here today might be as well."

"I'm guessing many of you are already familiar with conservation

districts. But just want to get a quick moment to go over PCD, what it is and what it does. Thurston, CWD Like all conservation districts, is a non regulatory agency that acts to serve the public towards conservation goals. There's approximately one per county. And so if you live in Washington State, you're very likely to have a conservation district that you can go to as a resource."

"So my talk will be talking from the perspective of a TSP in Western Washington. And so it's sort of knowledge that a lot of what I have to say will come from that perspective. I hope that whether you're working with small urban gardeners or wheat farmers farming a thousand acres or more, that some of my cover data will be relevant and useful."

"So I'd like to dive into certain CDs soil testing program and a little bit about our context and approach. And we're somewhat unique in that we're open to all members of the public. We currently process about 200 to 240 soil samples a year. We send out as many interpretive results, reports the results. And many people submit more than one." So we probably reach around 110 to 130 cooperators a year. Thurston County is really unique in that we serve a diverse mix of producers at all scales. We have ranches that are hundreds of acres in size and they're backyard gardeners with single raised beds that test with us. So we're working from that large acreage is 2/10 of the rates that it really makes it fun and never boring.

"We work with the diversity producers, diversity of soils. The glacier stop pathway through. THURSTON So we have both glaciated and glaciated soils and there's management consequences and needs for those. So there's never a boring day. I'll be talking about some of the ways we've been able to serve everyone in the county and that diverse mix of folks, no matter what their scale in an efficient and timely way."

"So the key to my presentation today is the main question of the series. How do we go from what we see here on the screen, a kind of a set of soil test results to this, you know, actual on the ground practice of nutrient management? And one common approach to soil testing is to provide a cooperator with the results and then an extension publication that will help them interpret the results."

"And kind of what I'm showing here is a common approach. So you have your results here in the last and then maybe a soil test, interpret, soil test interpretation guide. This one here is a great one from Oregon State University. Bush Advisor How you crop specific one? That's specific to your particular production area. And with this approach, you're really going through each nutrient and you're looking at tables and seeing here is my is my potassium."

"How does that compare to this recommendation? How much would I need to put on if I do need to put on any. And so we know once you've done that for for every nutrient that there's there's information on, the next step is to translate it in application rates. And so I'm going to kind of walk you through that process of what that looks like."

"And so in this case, let's just assume that we're working with an organic, diversified veggie farm here, and they're asking for fertilizer rates on a per thousand square foot basis. So we'll start

off with phosphorus. Let's assume we need £80 of phosphate per acre. We're going to have to translate that into square feet because we're going to get to a thousand square feet."

"Then bingo to some more available fertilizers is bone meal that 17% phosphate phosphorus. So they account for that and then multiply it by 100,000 square feet, gets it's about £10.8 of bone meal. The thumbnail also contains nitrogen. So now we have to do some math to account for the nitrogen contribution of those now and then let's say now we're looking at nitrogen and we we definitely need some of that."

"We want to adjust the amount of nitrogen methadone down there from the phosphorus fertilizer and do the same math again. And this is something that you would repeat for any nutrient that's that's low. If you're still with me, I want to say something about this approach. I think it works for certain folks really well. Many people love doing this."

"I'm one of them. I love scratch paper and unit multipliers, but in many ways it's really a form of accounting. And some people do prefer this approach. They just ask for the results only and they do this on their own. However, I'm not sure this is the most accessible approach for everyone. And so I want to bring this back to one of the main questions of the series is how do we make soils data actionable for for me and I think for a program, it is by translating this data into easy to implement actions."

"To borrow the motto from the recent soil on they participated in, we're providing diverse solutions for diverse soils and diverse cooperator contacts and so my approach is going to be as clear as possible and do as much work for the cooperator as you can. Here's a screenshot of one of the key sections of one of our interpretive reports."

"We break it down column by column, and the first column we see a locally common and available fertilizer. We explain that nutrients and nutrients are that that fertilizer supplies, and then we provide key information of how much of that nutrient is needed in the third column. And then in the last column, really importantly, sometimes this is hard to come by, but we explain what's the best way for them to apply it is and how to apply it."

"I talked a little bit about our role in that process. So the soil testing itself, like it used to be done in the past at the district, is now done by outside labs. So like many conservation districts, we're sending these off in bulk to outside labs. Our role is really one of interpreting the results in a meaningful and accessible way."

"So how do we do that and what recommendations, what guidelines we follow and everything we do? We want to find an approach that's locally appropriate and we want to be specific to. There are some very large differences between crop types. We do a lot of, as you'll see on the next slide, the primary guidance for us has and always will be land grant university guidance."

"And we turn to WSU primarily as well as Oregon State University, for some more niche crops. You might go a bit further afield, things like gift requests, things like Popeye's, you know, going to the Midwest

for that. And so we want to make sure that we're always basing our work on this land. Rain rescue guidance. And then we always want to take into account past practice results and experiences."

"We have people who've been testing with us for over ten years, and so being able to go back and see their journey off of their soil and soil testing results in their nutrient management over time can be really informative as well. And then last but not least, I always have my trusty copy of Radian and we all the quintessential soils texts the nature properties of soil by my side, which has been really handy, and then come in helpful at some key moments when I'm a bit stumped at what I'm seeing."

"So we ask a number of questions to make sure the recommendations that we're providing are meet the management preferences of the producer, whether that's organic or conventional, the scale, whether that's on the backyard scale or per acre, and the crop type. You can see in the center the many options we offer here, anything from vegetables, cut flowers, pasture fruit trees, blueberries, lawns."

"Those are probably our most common, but, you know, things as diverse as lavender Christmas trees ever bearing strawberries, some are bearing raspberries. The type of fruit production actually determines when you put the nitrogen on. So these differences really matter. And we try and cover these all these options, 40 perennials. We ask whether they're already established and whether they're or whether they're yet to be planted."

"That's a huge opportunity if you haven't planted yet a mixture of nutrients into the soil. And they you can't really after planting because there's there's roots in the way. Right. So if you can influence the future rooting zone, that's the time to do it. Things like limestone, things like more immobile nutrients like phosphorus, phosphorus or potassium, you can really add in larger quantities that after planting are a bit hard to get to."

The soil really can't serve this applications for annuals. We also ask what the soil source is. We have many producers who source local soil mixes maybe for raised beds instead of growing it in brown soils. And these often have very different characteristics than what you might see for typical western Washington soil. So just kind of knowing that this is why we're seeing this mix of characteristics rather than its because of past nutrient management can be really helpful in understanding how where they're coming from.

"So how do we get all this information from people without overwhelming them and ourselves? And there are a lot of ways to do this. But like many in the conservation district world, we rely on smart sheets. The smart sheets is coming in online. Excel that has very large spreadsheets, can be linked to online forms. And so it's been it's been really great for this."

"You could also probably use Google forms and there's other other software as well are online form if you look at all the options is massive. But thanks to something in smart sheets called conditional logic or form logic, the options are test your sees while filling up. The forms are only the ones we really want them just to see are they

need to see."

"So here you can see on the right there's three screenshots of somebody choosing vegetables, lawn and blueberries and depending on what choice they chose, only the questions we really need to get answers from them appear. I think another major limitation for technical service providers is time. How do we have the time to provide the service at the scale that we do?"

"That's a great question and adds one hour in the middle of March. So this is the middle of probably our busiest time of year. And the graph here, this is from actually two years ago, but middle of March was quite, quite busy and this is nearly full. I don't do this full time. And so it can be it can add up quite, quite quickly."

"And this is an early challenge that I realized when I took over today's program and it's one that we've largely addressed through automation of a lot of this work, which all kind of cover throughout the rest of this presentation. So TDs automate, what you see on the screen is kind of a rough view of today's automated workflow. And some of this is just change in the past month or so."

"So it is very much a work in progress but a very productive one that's continually upgraded. And this might look like a lot to do, but the parts that I really have to actively touch based on are fairly quick and they're all shown here in green and you'll see some of those more in depth here in a second."

"So we start out by gathering input from our online input form. You saw just a few screenshots of that. You can even go to CNN.com and look at it for yourself. And that feeds into an online spreadsheet or some worksheet, and that feeds into some Python scripts that I use to interpret the data. On the other end, we have our lab portal where we download the lab results in both PDF form and in a spreadsheet form, and then that's accessed by the Python script."

"And this does the bulk of the work processing the soils data and context of the management choices. So it's pulling in both the soils data and then the management choices and preferences and outputting that information into a spreadsheet. That script output comes in from a spreadsheet and that feeds into Adobe InDesign, which is an amazing program for automating report writing and other documents."

"And then when I'm in InDesign, I run scripts and InDesign that then does its formatting magic and outputs a pretty much almost complete report. And I'm told the last step is reviewing the draft template. This is this. This one is huge. I think one of the key benefits of this is it saves so much time that even though a lot of this seems really mechanical and automated, right, it's actually creating more time for me to personalize reports."

"Look at what our tip, our standard recommendation would be. Look at it and see, does this make sense to this person to test for this in the past, let me go in here and customize this. So it's actually freed up the amount of time I have to really get a personal touch on it and keep track of the degree management programs that the folks who test with us."

"So to go back to the Python script, each crop implant type requires

its own interpretive script. I think my first one was lawns and vegetables and flowers, and I've still been expanding. I haven't done them all. But here on the right you can kind of see an example of the many, many and statements that are in the code."

"And so the code primarily takes into account the soil testing data, but also even polls the current day. So if you run this script in winter or in spring, you'll get or in summer you'll get different output. That's seasonally appropriate. And then of course, through smart sheets, it pulls out information on the crop type fertilizer rate and management preferences."

"So it's taking in that important information into account. The short video that shows what this looks like and action and hope it shows through. All right. So the first step is to run the code and this little prompt here, you'll see some text appear shortly. This is talking to our smart sheets directly. And you can see there are four samples this is the vegetables code."

So there are four vegetable soil tests that are waiting to be written. I typed this little number next to the one that I want to write. So 839 next to my name. It's going to ask me for the lab number. This is just pointing to the data and then it's asking for the row number. Sometimes there are multiple samples in a report and then there's some custom scenarios where I can write in a number.

"We don't have any of those up at zero, and then it's done just in a flash of a second. It's already doing all the work and it tells me to open Adobe InDesign. So the Adobe InDesign templates before I show you exactly what that looks like and kind of see what the general format of the reports looks like here on the left, it looks quite empty."

"There's these little kind of placeholders in the text, and on the right is an example of one that filled in and we really customize them by crop type. So you see vegetables here on the right, there's a vegetable photo on the banner and all the customized information. They'll then flowers looks slightly different for pastas. We even have some additional pages that are retained and are pasture specific because you really need to change the nitrogen application rate to meet your storage productions."

"We really try to create guidance that that's really helpful, but also specific. And we also have specialized soil page where a little bit more on that later. So here's a video of the Adobe InDesign. But look at what things look like in the Adobe InDesign. As we have a number of pages, you can see one through eight here on the right."

"So I have a page for the narrative. This one is the results page, which has the page bar on it. It's got micronutrients. This is deleted. If there is if just a basic test. Some folks include a micronutrient panel. This next page is pasture specific. It's only retained if you're running a pasture test. So all you have to do is go to the scripts panel, right click it and run the script and then wait."

"It takes about 20 to 30 seconds. It's not quite as insta as a python, so I'm going to zip ahead here and any second now, the information that it's drawing from will appear. There we go. So there's auto

generated narrative even that's automated, but very often customized, of course. And you can see in the upper right there's the sample ID, the date of the test."

"So they have that for future reference, their preferences there, their address for reference, and I show it the later pages look like. So we're going to look at sorry, at this stage, as I mentioned, you can paint additional text, the narrative delete. Now there's opportunities to edit the stage and then here's the results page Any any nutrient where there's an action item that's always highlighted in yellow to point it out on the next page, because we did not get that, because we did test for micronutrients that's shown here."

So you see that the interpretation to that. And then finally there's the recommended Fertilizers page. So many people are taking this page into farm stores and and be able to point to the fertilizers that they need. And then the final page is just a resource page to help them understand editing ratings. Fertilizer concentration is really going to demystify some of the things they might see in the back of a fertilizer bag as they're not used to that.

"And then the manual review and I mentioned this like automation as a tool, but it's not a complete solution or even the end goal. Every single report is reviewed in close detail, but the time saving is allowed by this processing has really allowed for more opportunities to personalize and customize there. My favorite things to do is look back in time and see the progression of someone's soil over time."

"Nutrient management is always best done or as a long term process. And one of the most rewarding things as a technical service provider is see them make progress and really engage with that. So this is another quick review of what the Alpha PDS looks like. It's a little bit more dialed in or a little bit sharper looking at when you export it and design that you have your first page here, the narrative, second page with the results, micronutrients and recommended fertilizers."

"And then again that resource page at the end, as I mentioned, many cooperators have been testing for multiple years, regularly ask follow up questions, and these questions show real engagement with the soils data and nutrient management. Some of them are really great questions. Things like, you know, looking at seasonal variation, kind of stumping me as well, and then realizing that that's due to the soil texture and the timers that we sampled, people, you know, noticing patterns like, Hey, Barone's always slow when I test this time of year."

"What is buffer index mean? You're talking about soil, but I'm using this extra number here and it's different for my samples. And one thing I'd say too is there's a bit of a virtuous cycle in this. Automation was something I first started looking into over a year and a half ago, and it's resulted in a lot of time savings."

"Automation really helps speed up interpretive report writing, which really allows for additional script development or automation, which of course increases the overall level of automation in the process. So it's really kind of been a broad self-promoting process and also allows for adaptive optimization of these processes over time. So

there are certain situations we run into things like high sodium, high nitrates, some unusual alkaline soil or typically acidic here west of the Cascades or even elevated soluble salts, which I'll talk about later."

"And so sometimes when I'm automating things and I'll get unusual results that'll pop up in the output, I'll say flag it, and then I'm able to integrate those new situations. So so it's really allowed me to to make the code a little bit more comprehensive. One great thing with using a script approach as well is you can develop visual ways to represent data."

"If you're using a script based approach, this can be done automatically. And I really appreciate this because it allows people to interact with data in a visual way. So it's not just all numbers. I don't mind looking at numbers, but that when you do, we are able to make things visual. It really can help people and it's gotten a lot of positive feedback."

So here on the right you can see different soil fires from three different soil types. And of course those preferred ranges are all different because crops are different and diverse. And so what we do is we point out the current soil and then use colors and shading to indicate where that target is. Thanks to a python graphing library is also able to bring in things like the classic soil texture triangle.

"We had one person who is using a number of soil mixes and our version of the results as able to represent those results visually using this code so is interested in using some soil mixes or some perennials. And it turns out they're all kind of sandy loams, so are able to have a good conversation about just the water holding capacity, what that might mean for for his goals next."

"I'm particularly excited about using things like representing things like cation, exchange capacity and soil test reports. This is an auto generated pie chart showing how much of the cation exchange capacity is occupied by different nutrients. This is something we typically don't dive into into most reports because it's a little bit more advanced and we tend to more interpret that on our end."

"Usually some things like calcium and magnesium where you're looking at C, c thresholds. However, I'd really like to bring it in. So I think it's powerful. This shows that some things like the benefits of raising soil, you know, like adding soil is going to reduce the amount of acidity in the soil and the amount of ZC that's occupied by that."

"So something for the future that I stand by. Everything that I presented is simply one way to, to work some sort of workflow to, to work smarter rather than harder. There are others, and so there's some less technically involved options that can result in good quality output that can result in significant time savings, and also eliminate a lot of the risk of human error."

"After doing calculations by hand, you can make errors and things like this Excel spreadsheet I put together in spring of 2021 was really pivotal in helping me save a lot of time calculating fertilizer amounts. So here, you know, let's say you need 100 of potash, potassium, fertilizer for your crop. You just add 100 in this box. And



on the next page, auto calculates for three common fertilizer types, both the pounds and ounces you would need on an acre basis per thousand square foot or per 100 square foot."

"And you can also work on things like split applications, which are important for certain crop types like pasture. So you can make sure you're adding equal equal sub applications. There's like I said, there's a lot of different tools you can use if you're a technical service provider and want to build your own workflow, you can kind of mix and match and see what what would fit or, you know, really work with what you have access to."

"So we have smart street smart sheets for cooperative input, use Google forms and maybe even survey one, two, three for report processing. If you're taking a code approach, you use Python or even R, which you'll be presenting on the series. I'm really excited to put in that and then report generation. You can use our use Adobe InDesign. Just a few months ago we were using Publisher and I just switched this all over to InDesign."

"In the past two months or Microsoft Word. You know, just developing standardized templates can really help you provide the crop specific guidance in a way where you're not recreating the wheel each time. Another great benefit, I'd say, of the more scripted approach is you can aggregate your data and look at it and look at the whole picture to visualize trends."

"We have seven years of soils data and as a as a data nerd, I really enjoy kind of zooming out and looking at this data in aggregate and asking questions of it, looking at what trends there are in soils and data across the county. So here in right this just the table looking at correlations between certain soil factors."

"You know, one strong trend that's come out and that I think has been really helpful and understandings of the benefits of liming is adding limestone to soil is just the relationship between that and kind of an exchange capacity. So there's a clear correlation with higher soil gauge and exchange capacity. Correlation isn't causation, but you know, from what I understand from soil science concepts, it I suspect this is likely dependent on exchange capacity that's being freed up."

"So and we have many people who work with us over multiple years since I've been looking at their results to see if that's holding true to their scenarios and their results. okay. Another example is phosphorus. We have really high phosphorus levels, interesting county. And this is, you know, in many county counties and Puget Sound have this as well."

"We have a lot of phosphorus produced from kind of livestock that wasn't more livestock. So we have cropland to it to accommodate the phosphorus is produced. And so this imbalance has led to a lot of build up over time. And so this is really important with especially when considering things like sources of organic nitrogen, especially on a larger scale, manure is often the cheapest and most readily available source of organic nitrogen."

"But phosphorus is already high and may not be the best option. And I want to go over some challenges that talk a lot about process, but I

want to talk about some kind of on the ground common situations that we run into in Thurston County. And that may be common in Western Washington or even in eastern Washington as well, or central Washington."

"And so I mentioned we offer crop specific guidance, but we often run into folks where people are into planting many, many different types of plants in close proximity. And so they're really looking for one size fits all guidance for these really complex plantings. I think they're trying to increase diversity, which I think is great. And fortunately some of these mixes are plants just mutually exclusive soil needs."

A good example here in the bottom is soil chart. You see the ideal soil age for high blueberries in the west and then the soil range for lavender. And so if you plan to these right next to each other would be very difficult to create a kind of easy way to manage that. You could even easily swap out lavender with backyard vegetables and many of the solar mixes people plant in there.

"And so things like dying blueberries here are kind of a common challenge that we often find ourselves working with. Another good example would be fruit trees and vegetables. Vegetables often eat certain nutrients at a much higher rate than fruit trees, where you definitely want to avoid over application of nitrogen. For some fruit quality reasons, I'm thirsting health. All right."

"Another challenge is the many uncommon proper plant types. Thurston County is full of agricultural experimenters, and it's something I love about working here. I'm one of them, and I joke that I have half of these growing in my own backyard. But one of the hardest things to do sometimes is say, I'm not sure or I don't know, or we have we have incomplete guidance for what the nutrient needs are."

"And so in those situations, they really have to set expectations about what we can realistically do in these situations. I try to provide what I can and also ask that they let me know how how these crops are doing for them, what they're adding, and try to learn from their experiences. And the third, another, the third situation we commonly counter is elevated nutrient levels and alkaline soil."

"So that usually the 2 to 4 feet of rainfall that we get is interesting. County during the winter generally rinses a lot of the water soluble nutrients, things like nitrate and nitrogen from the soil and into ours. I'm sorry, that's the next slide. Sorry. So in greenhouses and high tunnels, we often have nutrient buildup. So because you don't have that 2 to 4 feet of rainfall leaching out any extra nitrate nitrogen in the soil you can build up over time."

"And so many times that soil test will come through. It will have extremely high nitrates and sulfates, elevated soluble salts as well, often above kind of one, almost four centimeter. That's going to be affecting sensitive plants like lettuce even higher, you know, can affect most other vegetables. In this case, the U.S. is 4.1, so quite high and sometimes a high boron and sodium."

"And so these require really special special nutrient management to get the nutrient levels back down. It's kind of like I say, it's like

kind of creating a little bit of a desert in what's otherwise a very rainy climate. So very different type of nutrient management scenario. And then finally, I skipped ahead to soil mixes. So another common challenge is that many soil mixes are generated locally."

"Many people want to make sure they're starting off with good soil and so they can purchase the soil mix. And I think this is great. This kind of crop specific choice is really important because each crop has its own needs. There are these mixes are often created for vegetables, which are like more of a neutral soil, slightly acidic taste and slightly alkaline."

"And so many people will buy these and they often have some very unusual characteristics compared to your typical typical soils in western Washington, where we tend to have more acidic soil. And so planting a blueberry in this might have been has actually led to declines, stunting or even death of the blueberries. So, yes. So any soil mixes, this is something that we've asked about, you know, just to make sure that, you know, if it is a soil mix, we understand it's not for past nutrient."

"There weren't wasn't past application of some amendment things like would ash or or calcium hydroxide or something unusual that that really that's where they're starting from. So yeah, this is just something we keep an eye out for. And I also wanted to give a short timeline of certain CDs soil testing program, or at least my time with it."

"I began managing the program in 2020th October 2020 and many ways distance to soil testing program has and continues to be a work in progress. There's still a lot that I'm working on. This is an active work in progress, and I think maybe as you've seen this slide, do you think, maybe we could do that, or maybe you could do that?"

"And there's just so many ways where we we could develop, you know, really meet the needs of the community. And so they're really excited for the ability to really develop this over time. You know, I mentioned the work with InDesign was just in the past few months previously you use Microsoft Publisher. So a lot of the work you're seeing was just done just weeks ago."

"They have we've come a long way, and I hope that some of what I've done here is useful for you listening. Now, maybe it can inspire you to think, Hey, maybe we could use this or use this resource that we have and maybe recreate some of this process so we can kind of expand what we can do as technical service providers."

"I think the public and how reaching the insights here. But I'd like to end on a kind of one note where I'd really like to develop future work. I really am interested in incorporating more of a biological approach. You know, I think we are focusing on the chemical side of things, but there's really a complementary role. So the biological, many things in the biological end have a chemical near to it."

"And I get a lot of questions about the biological end. For instance, you know, some of you may maybe through a cover crop of a legume and they're curious about what the nitrogen contribution of that might be in a second offset fertilizer here on the right you can see this is a

screenshot from an OSU publication called Estimating Planet available nitrogen from cover crops."

"And it's a great one and it has a lot of calculations and a lot of math, which kind of made my ears perk up because that's exactly the kind of thing that the soil testing that we've been able to handle with some degree of automation. And so I wonder if there's ways to incorporate calculations like this, you know, how much weight of a clover cover crop that you harvest."

"Could that be something that we can integrate? So what can we do in this area? So this is something I'm excited to explore. And then with with discussions around soil health, my mind goes to nutrient cycling in a bigger sense as well. I think the approach in a reports is often looking at what's low and then adding it back in."

"Right? But we know that with agricultural systems it's not just aero and aero out, we've got cycles. And so, you know, I just covered cover crops but what about nutrients return through prop residues or through composting? I think one of the big questions that or the way I see it is that in many ways I'm interested in bringing a quantitative accounting of these really qualitatively complex things like nutrient cycling."

"And is there are there ways that we can do that to where it's not too complicated and we can make that actionable? So this is one question that really put a lot of thought into, and it's kind of maybe one in the distant future, but but kind of one of the goals and maybe a good thought for my last slide."

"And so that concludes my presentation. Thank you so much for attending, and I think this might be a great time to start taking some questions. I see there's a number in the chat."

"Yeah. Adam, thank you so much. That was awesome. And you have quite a number of questions, so I'll just kind of order them for you and, and we'll get started. So the first one is if you have a preferred lab, you like to run your soil analysis through."

"I Sure, yeah. Yeah. In terms of lab preference, I mean, we've worked with two labs and Element West, I think mostly it's just, you know, making sure the price and the turnaround times are good. I would hesitate to make a recommendation for one commercial company over another as a, as a public employee. But those are the two that we've worked with."

"There are many other labs in the in the area that you can work with as well. So I would just say if you're trying to make that decision, always, it's always good to shop around and see see what what's out there."

"Awesome. And somebody asked if you would be willing to share resources from your workflow, like possibly the Python code or your Adobe templates."

"Yeah, so that's one thing. It's definitely more of a work in progress. I would say it's not quite in a state where it be easily shareable and I'd also maybe wanna have a conversation because it is so. Thurston specific. Where are you going to be using it? Are there ways you can be modified? I think there are some resources that I

think eventually, because I want to get it to a place where it's easily shareable."

"There's a lot of components to it as well. So gosh, I wish it was like a software, like, you know, XY file and I get to send it to you as an attachment. But there are other resources that I could share in the short term. One of them would be the Excel spreadsheet where I have get a tab for each nutrient."

"And so if you are going through and you know you need £100 of phosphate phosphorus per acre and you know, £1 of boron per acre, I think that one can, can realize a lot of time savings and it's a lot less complicated to set up. So and also with all the extension publications, if I like a resource list of where I'm trying to."

"Yeah. And Molly has been sharing the resources you've referenced in the reference chat or sorry, the resources of this Zoom portal, but she'll also send it out afterwards. And it sounds like for the person interested in the scripts and the workflow resources, perhaps get in touch with Adam directly. So another question somebody had is and you touched on this a little bit about biological soil testing, but there's a number of questions coming in about kind of the future direction of either biological soil testing or integrating remote sensed data or infrared spectroscopy."

Maybe you could kind of talk about emerging indicators and how you may incorporate them.

"Yeah, I'm really excited about those. I think of my backgrounds in research and so I really look to the researchers to provide, you know, a lot of a lot of that work, you know, And so I would say we're not doing any biological soil testing. Now. I do think I try to incorporate biological aspects as much as possible, especially from the nutrient management side of things, things like keeping your phosphorus well balance or my grazier happy."

"There seems to be a, you know, understanding that having to hire is, is not good for, for that I would say as soon as there's actionable guidance out there and there's testing that, that we can easily point to those factors. I'm going to be integrating as soon as I see it. Right now it's a bit difficult to get."

"It seems like we're still working our way to that point. So yeah, very much. I would love to, but I don't quite have those resources yet."

"Yeah. Things. And for people who maybe don't know, this is a series. So today we're talking about chemical indicators. Next week we'll be talking about biological indicators or specifically plant pathogen indicators. So stay tuned because we may repeat the series and do more biological series webinars as well. So, Adam, someone wanted to talk to you about the phosphorus test use in Western Washington."

"I know there's kind of a lot of talk about Olson versus BREY, and someone said that having looked at thousands of these results, they vary over 200% from one to the next and maybe you could talk a bit about that."

"Sure. Yes. So that's one thing I have seen a lot of variation in into the phosphorus from year to year. Even in my own soil testing. I

remember going to like 280 the next year and thinking like, what did I grow that used that much phosphorus? So there definitely is a lot of variation. What I would say is at least more implied sense."

"Many places we work with or many, many locations have really high phosphorus. It's kind of often I would say there's almost like a bimodal distribution of very, very low 1 to 2 to three parts per million kind of native soils. I have had an agricultural past and then something that's really high. So I'd say even with that variation it often seems silly, doesn't make it too difficult to see that variation on the upper end here."

"So you need to have a target of 50 parts per million and your your soil tests are varying between 90 and 140. You know, you're probably in a good territory despite that high level of the variation. Interestingly, we've used the Olson test because some of the soil mixes are alkaline. So it's an interesting one where we're using a test that's not quite too commonly used in western Washington, but, you know, soil gauges as high as 8.2."

So we also use that one as well. But the the less commonly so thinks.

"And then a few more questions about kind of emerging amendments. So if someone wanted to know if and how you make recommendations on sort of nonstandard additions like biochar or mycorrhizal fungal amendments, stomach acids, anything like that."

"Yeah. And we get asked about those a lot. And I would say once those become standardized, then I can make those recommendations. I think there's a lot of potential in a lot of those, and I think people are interested in application rates types. I think people would be really happy if I made a recommendation. My fear is, is that I recommend the wrong thing and that would do those those potential amendments a disservice."

"Right? Because many people coming to us like, you know, I just want to have a really good garden, you know, And if I said, put a bunch of biochar on and that it's the wrong type of biochar, maybe it adheres too much of the soil nutrients, then that that that's doing them a disservice. And then also bioterror which I think has tons of potential."

"So I'm really every time there's a new extension publication now on bioterror, I'm reading through it and getting excited about the emerging research. So so yeah, great great question that and when that frequently gets asked."

Yeah I think I was really excited to see your talk focus a little bit on it because there are so many emerging indicators and kind of new flashy biological tests you could take. And I think sometimes that kind of it makes people look the other way from tests that are just standard and maybe old school and perhaps not as exciting.

"But Paige, of course, is incredibly important to manage in soils for soil health and crop production. So I was wondering if you could talk a little bit about peach in your program and kind of how you think about it, how you talk to your farmers about it."

"Yeah, it's a huge one. And I would say, you know, being in western Washington, we typically have a general generally like slightly to

moderate acidic background or soil and anything I've seen things a little bit on like 4.8, 4.9 and certain kind of wetland kind of low land situations too, around like 6.0. And so what are the most common recommendations that we're making is having limestone, right?"

"Because a lot of people are growing crops that really are happier in the slightly acidic to neutral range, things like vegetables, things like many fruit trees and we know that some of the availability is highest in that kind of more moderate range. And when things are really acidic, you have to have certain nutrients that being said, and this is this is a great thing when I talk to farmers, I think many of them think, so acidic soil equals bad and not really."

"If you're going to blueberry, it's perfect. You know, I think many people think, so the blueberry, you know, or acidic soils are bad are going to go get us some soil from the outside and plant, you know, my plants and that and like actually know that our ground is really great for things like blueberries, things like wringing berries, huckleberries."

"Many people have questions about rhododendrons and azaleas. And so there's a whole set of crops that live in acid soils. So I would say this this really ties into the diverse solutions for diverse soils and diverse crops. It's really knowing what crop likes and making or plant types and making making that that's it. So and when I think of soil health, I think if you have happy, happy plants, you have strong living roots."

It kind of ties all together some awesome thing.

"So now we have a set of questions less about the the soil health metrics themselves, but about sort of the outreach and extension piece of this. Someone wanted to know if you've gotten feedback on the report and the graphics and whether or not those are different or if they're received differently between the farmers and the home gardeners, are there groups that have one preference or another for the graphics and the and the metrics that you're presenting?"

You know.

I actually.

"Haven't haven't I've gotten feedback, but I haven't noticed a difference between the two. I think one of the things I'm really interested in doing is doing like a survey and asking and especially do ask, you know, based on rate, say, okay, great, are you a better gardener? Are you larger scale farmer, smaller scale farmer, You know, getting some feedback on these new templates, Many of these, we're going to phasing them in."

"So I think once we've maybe raised a lot of this and have more than maybe providing that information, we also we've had two sets of pass templates. We've really kind of worked on the more continual feedback that we've received over time. So I think one of the universals is that visuals are really helpful. In fact, there's a great question here about red and green and color blindness."

"You know, that's one reason why we've added text to say optimal, not optimal, you know, focusing on hues. So some of the differences are still showing up and I think probably do a better job there as well."

But yeah, just trying to develop more visual techniques I think is a universal, universally appreciated thing so that the numbers are bad."

"I love I love tables of numbers. I think they're beautiful, but."

"So when I first heard about your project and one of the reasons that we asked you to be here today is because the number of producers you're reaching is quite impressive. And I, like you referenced, you know, capacity is always an issue, and so it can be hard to reach this many producers. And I was wondering if you could maybe give your thoughts or your recommendations for other technical assistance providers or other conservation districts who may be interested in doing something similar, even if they're starting from scratch?"

How do they use data to reach more people in their communities?

"Yeah I my hope and maybe, you know, finding ways to work smarter rather than harder, I think when I first kind of first spring soil testing season because, typically people will test in spring for the coming season or they'll test and fall kind of at the end of season. And so there were these two big bumps in the first one."

"I remember kind of running out of scratch paper, sort of, you know, multipliers and like, I can do this smarter. And so, you know, using Excel and just formulas, I was able to create kind of the sheet that I showed there. I think just finding ways to economize and that the more remote aspects of of conversion, finding ways to to to drill in those and create tools can can really make make your time as a technical service provider a lot more effective in providing as much guidance as we can."

"I think that's all of the questions I'm seeing in the chat. And so part possibly we can just end with a slightly personal note, and I would love to hear from you sort of why soils and what about this work interests you and why are you doing it?"

"Yeah, so soils is why I got the crop science which led to the research led to Python which led back to soils. I was fascinated by world phosphorus supplies and I actually went into crop science at WSU, kind of intrepid Dr. Kevin Rigby's lab, because I was interested in perennial grains, and I think I was really fascinated with this idea of nutrient cycling."

"You know, I think every time I realized the Evergreen program, I kept asking like, okay, where's your where's your nutrient inputs in nutrient outputs? And I create these little charts and, you know, and try and put together where the inputs and outputs were coming and then going out and so I think just kind of following that passion led me to do crop science and then finding ways to interact with that in a data sense."

"So for me, it's all tied together and that's why I really appreciate series like this for your pushing it from different angles because it's kind of an interdisciplinary approach gives you a way to look at it that is just so much more rich and holistic and comprehensive."

"So awesome. Well, thank you so much, Adam. I know Mollie has put a ton of resources in the chat and she'll also follow up with an email. This presentation will be recorded and added to the Washington Soil Health Initiative YouTube Library, and you'll get a link to that as



well. And finally, it looks like Mollie put Adam's email address in the chat so Adam can continue to be a resource for all of us." Thank you so much for your time today.