STEVE:

Good afternoon. Thank you for joining the first of a series of webinars for growers from innov8.ag. We're really glad you could be here today. We've got people from all over the world. (sharing screen on innov8.ag) My name is Steve Mantle. I'm founder and CEO of innov8.ag, based out of Walla Walla, WA. Today I'm going to be joined by Todd and Jeff Tucker of AgriNET, also based out of Walla Walla, WA, and Lance Kirkham, as a grower here on this side of the state as well. Our focus today is talking about AutoWATER from AgriNET, and Todd Tucker will get into that as the bulk of the focus today, around irrigation.

Let me just give you just a quick background on innov8.ag to get started, and then we'll switch gears and let Jeff, Todd, and Lance talk, and then to wrap up I'll share a little bit about the smart orchard project we've been doing with Washington State tree fruit commission and Washington State University and a handful of other partners. What innov8.ag is about is, we're an ag tech startup that is focused on pulling data from many different sources. And what we've found from talking to the growers is that there's lots of different silos of data from sensors, from equipment-- for weather, for imagery, whether that be satellite imagery or grown imagery, market pricing, all that type of thing-- and so we bring all of these different pieces together so that the grower can make more informed decisions and empower their crews to do so on things like equipment, imaging, pest management, orders, and irrigation. That's really our focus today-- to delve right in on the irrigation side. With that said, I'll hand over to Todd Tucker to take off with the rest of the webinar.

TODD:

Thank you Steve. We're going to talk about AutoWATER, which is automated irrigation, closed-loop irrigation, basically it uses (sharing screen on the AgriNET app) soil moisture data from a particular depth to determine if and when irrigation turns on, and if a set should occur. You can see in this very simple drawing here, we have a depth chosen on this moisture probe, that data is coming into the autoWATER algorithm, and then it's kicking out a decision whether to irrigate or not. So today I'm going to cover soil moisture monitoring in general on our system, the AgriNET app in general, and navigation through it as it pertains to soil moisture monitoring and AutoWATER, and then I'm going to get specific about AutoWATER at the end.

First of all, I'd like to bring on Lance Kirkham, vineyard owner and crop advisor, who ran AutoWATER this year on six blocks of his vineyard, so he can tell you a little bit about what that experience was like. How did AutoWATER go for you this year?

LANCE:

Thanks, Todd. Thanks, Steve, for having me here. Just want to give a little background on my vineyard, it's in Sunnyside, WA, about 25 acres. (a few seconds were lost due to sound quality)

After switching over to AutoWATER, I was very pleasantly surprised about how quick we could get the irrigation under control, how fast the soil profile responded. We were able to do less water more frequently. I really liked that, and I found the system to be very reliable-- you can kind of just set it and pay attention using the app. I would watch it every morning to take a look at the soil probes and verify that everything was working properly. I don't think I touched my irrigation system for almost two and a half months. It just ran constantly, so I was very happy with that. I think there are cool things in the future with it, and I'm very happy.

TODD:

Well that's great Lance, that's exciting and I'm really glad you're able to endorse us like that. I'm going to move ahead here with soil moisture monitoring which is the core of AutoWATER. I'm going to jump right in.

You can see I'm in a graph here, this is one of Lance's blocks. It's the whole season that we're seeing at once here. I'm going to start by talking about how we set the system up, and how we start to make the settings how we want them. First of all, we run a couple of irrigations that the irrigator would normally run. And you can see out here, these three are sort of the test irrigations. I'm going to zoom in on this guy right here, and what we're looking at is, these are the different soil moisture values at the different depths. We don't ever allow the lines to cross each other, because we think it's more intuitive to view them vertically, and so the idea here is to use percolation, and understanding its timing, to adjust your irrigation, so you're getting water down to the root zone or wherever your target is without going past that or flushing the oxygen out of your soil or pushing nutrients past the root zone. This first irrigation here is a pretty good example. It's a 5 hour set, and we can see that we've got water all the way down to 20 inches, and we didn't really affect the 24 inch depth. Basically, it's just kind of watering all the way down to 20 inches, and it's a pretty good irrigation. We used this as the starting point for the setting. We turned AutoWATER on right here, and there was some tweaking going on, which you can see if you look at the 20 inch and 16 inch depths, you'll see they start to go down. That's tweaking AutoWATER down. I was trying to lower the target as much as I could until it got to the point that it would level out. So we kept doing that, and Lance would go out every once in a while and take soil samples and see what it felt like until we dialed it in. Then we dialed it in here late June, and as you can see, things are sort of flattening out. We stuck with the 5 hour set, and changed to a 2 hour set, and you can see the 2 hour set is more of a pulse in early August and September. It's coming on more often, but for a shorter set. That

seemed to work best. You can see that it's very flat there, coming up and down with each irrigation but not really adding or subtracting, so we are maintaining an even soil moisture there. Here in the app, you can zoom in easily and highlight, or change the number of days. I can put in 28 days and hit update and you'll see, now we're just looking at the last 28 days. Obviously not much is going on in the winter here. I'll show you one more interesting thing while we're here.

One unexpected advantage we noticed this year was when we got that, in early September, that dense smoke layer from the west coast fires-- I'm going to zoom in on an area before and during that smoke event-- I want you to see, obviously, these spikes at 4 inch, that tells you when the 2 hour sets occurred. And you can see we've got 5 or 10 irrigation events in just a few days. You can see right here, on the 8th with that dense smoke, we slowed down to three and two irrigations. The system automatically adjusted itself, because the plants were slowing down and we didn't have as much evapotranspiration occurring. And you can see the 20 and 16 inch depths really flattened out. That was something we didn't plan for, but it was a good example of how AutoWATER does a really good job of adjusting to whatever environmental challenges are occurring.

I want to show you a couple other features we have. In the app we've got soil data, so we can pull up the GPS location of the sensor unit to get information on what kind of soil is there and the different layers and what kind of holding capacity they have. There's a lot of stuff we can go into more detail here, but we don't have time for that. All these things are explained if you click on them. Another option we have here is to look at the available data set. This shows us when the probe was operating in the green, and in the red when it wasn't, so you can see last year we put this probe in the middle of August, ran it to winter, then put it back in in April. It was working very consistently during this time here. So we use the percolation depth to determine the length and frequency of the irrigation, and then we get soil samples to compare the numbers that we're seeing there.

We've also got this comment situation-- we can put comments in anytime we see something in the field, and we can categorize them. You can make a lot of different kinds of comments, or leave the category empty. If you need a new category, it's easy to add. At the end of the year you can collect them by type or date and look at them that way as a good method of record keeping. This can all be done on iPhones or Androids or tablets. Also you can export data, if you wanted to pull it into a spreadsheet. That's basically the system we have here.

There's a tool here called compare mode. You can toggle the comments, so I'm going to turn those off. In compare mode I can take an irrigation and highlight length of time, and I'm going

to look until I see the last effect-- the green depth there is about how far we're going to get on irrigation, so I'm going to release, and what this tells me is the deltas, or the amount of change at each depth, and how long that took. At 16 hours, I got 5.5% increase on the 4 inch. On the 12 inch depth, I got an increase of 2.4% in 16 hours. It took 16 hours for it to penetrate down to the 12 inch to the point that it didn't add any more water. That's a two hour set. So we can see that it takes a while to see. Any questions?

STEVE: Yeah, Jenny from WSU has a question ("The soil data showed in the left side of the graph. Where is these data come from?" [sic]) on the soil data shown on the left side, and where it's coming from.

TODD:
We're getting that feed from the geological survey that was done in the 60s and 70s, from government sources. It's based on the lat-long. All these probes have a lat-long associated with them. This is all map based. I wanted to start with soil moisture monitoring since it's the core of AutoWATER, but it's a quick dive in.

With that said, I'm going to move onto the app. I'm deep into the app, so I'm going to back all the way out. If I was to first log into the app, I'd end up right here. You can see I've got all these choices. I'm not going to go through all of this because there's too much here to cover, but we're going to do more of these later and delve into each one of these items. But we'll start with the map. It opens up the growers' site, and shows a marker for each sensor unit in the field here. You can zoom in and zoom out. This is a layer based methodology, so on the left we have valves, temperature, moisture, flow meter-- we can turn these on and off if we aren't interested in seeing them at the moment. I'm going to turn the valves off for now. If we're interested in seeing something else, we may not want to see all that clutter. This is also where third party sensor data can come in, and be a layer on this map, or imagery-- or all sorts of things. We've built our app to be able to accept and display third party data. We're using markers here that are giving you a short term look at what's going on right now with budget lines. You'll see that these with the blue, green, and red are moisture probes, and it's boring since they're flat in the winter. These are sum lines. It's just so you can get a quick feel-- you can see if it's all in the green, or if something is in the red, or the blue, and you may want to take a closer look. I turned the system on without turning the pump on and what we;'re seeing here is a pie shaped blue area. This means an irrigation occurred. Imagine this is a clock face. Here's the time. If they're dark blue like this, that means they already occurred. If they're light blue, they're currently happening. You've got the flow meter here, which is important to show if everything's alright, and then a pressure sensor here on the line, which will tell you pressure information to know if AutoWATER is running right. That's the layer philosophy we have here.

Also, we're showing the health of these units, or maybe the freshness of data, so if you see these green frames, that means all is good. It's recent data, and you can bet on it. If this frame turns yellow, you'll know something is going on. We haven't gotten data recently, so you'll know that you shouldn't make decisions based on it. This one here was pulled from the field, so you can see a skull and crossbones-- so we're telling you there's nothing running here. If I hover, you'll see the voltage of the unit. These are all solar powered with batteries. This helps you understand everything going on. We don't have an issue with batteries-- we have enough sunlight, and we can even make it through the winter. Once in a while you get a bad battery. These markers are here, so when you click on them, it takes you back to where we started; the more in-depth view of the data. I didn't talk about this because it doesn't apply to AutoWATER, but here's the sum depths. We can also show soil temperature graphs here, and battery graphs if we're concerned about charge/discharge. Here's the temperature sensor, it's the same sort of thing. We'll pull up a graph. It's got temperature, relative humidity, and dew point. You can set alarms. We have alarms right now for 33 degrees and 90 degrees. You'll get SMS alarms if you reach those thresholds. That can be done with anything on the app. So you can see, it's a similar situation here as with moisture probe-- that's basically how all our devices work. If you went into a valve, it would be to schedule it. You can create a manual schedule, but if you have AutoWATER, you don't really need that.

That's basically a general overview of how our app works.

Let's move on to the exciting part to me, which is the AutoWATER. I'll get more specific about that now. If we show you first, getting back to that graph page, for folks who only have moisture probes, they can still use AutoWATER. You need hardware to run it autonomously; those are remote valve control units. If you don't have a continuous water supply, it also turns the pump on and off with the valve. Those are pieces of hardware you have to install to run the system. However, if you only have moisture probes, we can still run those through the algorithm and give you the feedback. So if I click on the AutoWATER button here, it says the last three hours average of soil moisture on sensor 6 which is a 24 inch is 36.85. So our irrigation set point is at 38%, and you can see here this is Lance's winter water after harvest, so we crank it up to 38 on the 24 inch depth to make sure we have water all the way down. It's trailed off a little since then. It really doesn't need water right now, but that's an example of the result. And then your irrigation for 170 minutes is preset, and your drainage time.

Now I'll show you how you would actually set this up. I'm going to go to 'edit parameters', and we're in that same block, you can quickly turn this system off without affecting settings by disabling it so it won't run automatically. If you want to switch to manual because you have a problem in the field, and you don't want pumps and valves transitioning, you won't have to

worry about that. Priority is if you had lettuce and alfalfa, you'd probably want to prioritize your lettuce. In this case, they're all the same crop, so it doesn't matter. Here's our irrigation set point. We have 6 sensors in this circumstance, a 4 inch probe down to 2 feet, 4 inches apart. So wherever we want to irrigate to, based on looking at the graphs and previous irrigation, we can set that depth here. The moisture set point is the percent we're targeting. I'm going to lower it back down. The duration, this is how long the set will run in minutes. Average hour, how long are we going to look at to get that target number. And a start delay, you can set that if you want. And then water drain time, which is important because this amount of time locks the system out from irrigating again. From looking at those moisture graphs, you can see that it takes time for that water to get down to the profile. If we try to average it too soon, it won't even moon. We need that drain time as a lock out feature to make space for the whole percolation to occur.

So let's save that with our new set point and then we'll go back and clear out AutoWATER and run it again, and now we don't need irrigation because we're below the set point. So that's how to set this up. Very simple-- it can be done on your computer, phone, or tablet, and you can make these changes as you see fit. Lance and I found at Tuctronics, you know, we've been doing this for years in different situations-- Lance was the first commercial application, and we found that the original tweaking point could have been altered sooner, but once we got that set up we didn't have to mess with it too much. If you're going to do something like deficit irrigation, or try to give stress to your crop to make more sugars like in apples or vineyards, you might be tweaking it for seasons or plant stage. Other than that, once you get it down, you won't be changing the settings much.

I'm going to back up and show you one more thing and then I'll be done with my spiel. Resource mitigation, Jeff will talk about more, but this is a nice quick look at all your blocks and what's going on. They're automatically ordered. These are the irrigation orders that are going to come next. The first one is 1.3 low, so that is the most meaty field we have right now. Number two is 1.1 low. What we're seeing here is our target moisture percentage, and then the actual, which is calculated from whatever the average time is set. That's why this one is the preferential irrigation. This one will be next on the list. And block two will follow it and we can see the same thing. The reason we have resource mitigation is because you might look at this and need to get more water to a different field for whatever reason. You can go in here and click the up arrow, and you'll see we moved block 2 to priority, and block 5 is second. And if we want, we can clear them all the way to the top, so if I want block 4 now it'll move all the way up by clicking here. This will reset after the irrigations are done. It will reorder based on what needs water most at that time. So this is kind of a morning check thing. You can take a look in the morning and say I like this, or we need to tweak this a little based on circumstances that go

beyond soil moisture. Also you see here start and end times, and you get a situation where you can turn stuff on and off quickly. You can enable or disable on this same button from the valve page. You still get to see disabled buttons and their stats, but they aren't in the active list.

So that's our resource mitigation feature, which we think is really important, and there's a brighter future on that which Jeff will talk about. Everything I've shown you here today is in existance and has been working for, in some cases, three years. This has been going for a year and a half here with Lance, and it's come off without a hitch so far. It's worked well. Any questions about AutoWATER specifics?

STEVE:
You're saying again that all of this, including the resource mitigation piece, is available? And I can do this on the go, on Android, or IOS, or a tablet?

TODD:
That's right. It's all cross-platform. Some features work best to use on a PC simply because you have more space to see it, but all the settings pages are great on phones. They're big enough to see everything with no problem. We think you can operate this whole system from a phone, really. Sometimes you may need to take a deeper look at a graph on a PC.

STEVE:
So Lance was hands off from May on, basically, is that right?

TODD:
Lance didn't have to do a lot this year.

STEVE:
That's a grower's dream!

TODD:
You know, I was watching it closely for quite a while, but there was a point where I even backed off and stopped worrying about it. We had the alarm system and everything, and we didn't have a problem. It went well. We didn't expect any problems. We've been doing telemetry and agriculture for twenty years, so it's a new system, but the communication stuff is all stuff we've been doing for a long time. Jeff's an excellent engineer, and with that, I'll pass it over to him. Jeff Tucker is owner of Tuctronics, and my brother, and a fantastic electronics engineer. He knows a lot about agriculture. We grew up in an ag family, and he's been doing this for a long

time, basically telemetry and control systems in agriculture. Jeff, you want to talk about some fun things around the corner?

JEFF:

Sure. Thank you, Todd. Appreciate that. Really what I want to talk about is what we're going to be doing into the future and also some refinements of what we're doing now. The first thing I wanted to show you was a little more detail on the mitigation system. Todd, if you could pull up that slide. Really what my whole goal was initially, when I started this company, was to give growers the ability to see their moisture. It was all about the Sentek technology that had come onto the market, and what I realized was people were not really instructed on what to do with the data. In many ways, they were just given the data and asked to sort it out. So that's what we've made our mission. To make sense of this data and present it in a way that it can be acted on, and now in this modern age, we're actually taking that data and putting it into an irrigation prescription. This graphic is basically that. The heart of the arrangement by priority of your particular moisture graphs. For example, you've got B and T and J, those are the field names, and as you can see they're resorting themselves based on proximity to wilt.

The other thing I want to point out on this graphic is the ability to utilize your pumping capabilities to the maximum. For example, A and J came on together because they are below the max rate the pump can deliver. We can't turn P on, because there wasn't enough capacity in the pump. Once J turned off, P could come on. When A went off, B could come on. So this is how you can take a very complicated needs requirement, because we're doing pulsing from AutoWATER prescriptions. We're trying to do a partial irrigation so AutoWATER can drain, come back, examine, and irrigate again in more of a pulse fashion as opposed to one big bucketfull that would spike a lower level. So this is the heart of that. I want to make it clear that what we're going to do in the future is to maximize on that technology so it can handle any irrigation system-- multiple pumps, booster pumps, and flow meter feedback. Really, the future of this is just more feedback, more refinement on how we evaluate.

We have a concept called signature analysis. What that is, is basically creating an expectation on how your pump pressures up. We take that pressure data over time and it's 1000 pressure readings in one second, and we compare that to what we expect, and if they match up everything's good. If there's a mismatch, we need to contact you and let you know what the error is. It's an automated message. There's a lot of data embedded, just on off data. You can see the fluctuations in pressure. It tells us things-- we can analyze those bits of information to see how long it takes the valve to fill. In summary, what we're trying to do, is derive ways to feed back into AutoWATER and modify the settings to produce a better result. Specifically, we would be modifying the duration and drainage based on soil response. I'll show you a tool I built to analyze that. (shares screen) So this is a web page I use to analyze percolation and if you

watch over here on the edge, you can see these blue boxes. They're colored according to their absolute water amount. The lines on the chart are presented in a relative manner. I want you to watch these blue boxes as this chart goes across this irrigation demarcated by this green zone. You can see the transit of water through the profile and you can see there's a whole lot of water moving right now, but it's not dropping clear down, it's just deeply irrigating the first four levels but the water is all staying there. You can actually see that from the absolute values of moisture. This is one tool I use to figure out how to take this information and feed it back into the AutoWATER algorithm to improve that delivery system even more. That's the goal of my current work: to improve the algorithm and take in all these data sources. So the future is really just to improve this thing. For decades, I've calculated ET for people-- ET reference, ET theta, ET crop. Maturity level, accumulated growth degree, soil water holding capacity, all to try and model something we've always had right in front of us: the soil moisture. So instead of trying to create an irrigation model based on things that get more and more abstract from the moisture content, we decided to focus on just that. When we did that, we found all those variables flatten out and go away. Every plant has one thing in common: they all like low water stress, except maybe rice and cacti. Other than that, I think AutoWATER was an intent to create a crop independent, weather independant, soil independant management system. With that, I think I have my work cut out for me for the rest of my life.

TODD:
Well said, Jeff.

STEVE:
Thanks both of you. I continue to be impressed by the work you guys are doing. It's worth noting, you guys have over 1000 sensors deployed on farms. You've been doing that for 20 plus years. A lot of smarts between the two of them, and it's great to see it all coming together.

And that leads in, to close things off here, we've partnered as innov8.ag with a number of different folks including the tree fruit research commission and WSU to build out this smart orchard pilot last summer. AgriNET has a number of different sensors out there. The intent was to pull together many different sensor providers and sensor types, and again break down data silos so the grower can have new insights. It was great to work with Jenny and her WSU counterparts on the soil science side of things and water management to better understand how this data could be used together, so we see everyone from Meter Group, Flight Tech, Aqua Spy, Davis Instruments, and a soil nutrients company called Terralytic, so over the coming weeks we'll ask these different providers to share their perspectives on what their sensors do, and then we'll work to show how we can tie more together than what that one figure platform has. Ultimately we believe that's what growers are looking for-- bringing together a

consolidated view, so you have more than just soil moisture or weather and AutoWATER capabilities as an example, but maybe you're tying it into crop yield projections and views.

So quick summary of our capabilities today, because again this is a photo of the 20 acre block where we have the smart orchard and it's about pulling together data from different sources, particularly on the imagery piece, which is where we compliment each other with AgriNET. It focuses on AI predictive offerings. In the coming weeks, we'll bring in capability with green atlas and give you a demo on how to use an ATV travelling 20 mph up and down orchard blocks to come up with a view on crop density and tree mapping across all your blocks. Basically it looks like Google Maps street view. You can do that at bloom count all through full sized apples, to plan for labor, chemicals and water. We'll talk in the future about a dashboard we're working on for people who aren't quite ready to jump into the deep end with AutoWATER, and then the premium capabilities are really about insight with automation. AutoWATER is an example of that. We're also feeding data into smart sprayers, which we'll talk about in the coming weeks as well. You can see down here in the corner, all these data sets, and the intent is to bring these all together so the grower has a nice consolidated view in the app. We're using the AgriNET app for that.

That's more or less all of it. Again, I'm Steve Mantle with Innov8. Thank you to Todd and Jeff and Lance for coming on here tonight. I encourage you to go to our website, and if you scroll all the way to the bottom, you'll see all our upcoming webinars. Next time we'll have a partner that works closely with the AgriNET crew, Sentek will come out and their CTO will come to talk about soil moisture probes. It's definitely considered one of the gold standards out there with soil moisture probes and sensor providers. They'll talk about what's coming next down the road for innovation. We'll hear from others like Davis Instruments, Aqua Spy, Meter Group, the lidar driven smart sprayer, and Green Atlas will talk about some of that imagery analysis we've talked about.

So that's a wrap. Feel free to follow up with us on email with any questions. On the AgriNET side of things, we're looking for a handful of new growers for the next season, so now is the time to reach out to us if you're interested in trying AutoWATER for the next season. We can schedule time to plan things out.

Appreciate your time. Everybody have a fantastic night.