Matthew Warnken:

Welcome everybody. I would like to welcome you to our seventh and final episode in our webinar series on how to grow top soils, the science of soil carbon. Begin by acknowledging the traditional custodians on the land we're gathered wherever we're watching this webinar, and pay our respects to their elders past, present and emerging. My name is Matthew Warnken. I'm managing director of AgriProve. AgriProve is a soil carbon projects' developer that enables landowner participation in carbon and other environmental markets, creating the potential for farmers to access those revenues. And we are hosting this seven, or we've hosted, now we're at the end of this seven part webinar series.

Matthew Warnken:

We've been very fortunate to have Declan McDonald, principal source scientist with Regen Soils here to help unpack that journey on how to improve soil health and how to grow soil carbon. Declan, certified professional soil scientists, vast range of experience in soils and agriculture, spanning both private and public sectors, and is very well placed to provide those insights into growing soil carbon.

Matthew Warnken:

So, this is the pinnacle. The previous six webinar episodes have been on starting with how soils work, how plants grow, looking at organic matter, investigating soil biology, moving on to mineral management, then also how to manage fertility to build soil carbon. The previous episode was on management practices to build soil carbon, and I think fair to say, and Declan, I think you're looking particularly relieved we're now at the end of this quite momentous journey in terms of the terrain that we have covered on soils.

Matthew Warnken:

So, certainly some highlights from my perspective, and hopefully you will pick up on some of these, and then maybe correct or clarify just my thinking in terms of that cash. I know you mentioned a lot about cash, credit cards and lumps of gold, and then how that related to the labile, resistant and recalcitrant soil carbon pools. As that stuck in my mind, I'm not sure it stuck the right way. So, hopefully you do pick up and clarify that, but the intent here on mimicking nature by design, that biomimicry, is giving considerations for each individual farm systems conditions, and also those structural elements such as the brittleness of the Australian landscape. There's been some great graphics and visual representations. Hopefully they'll make an appearance in this wrap-up episode.

Matthew Warnken:

The ball of string graph, the Mulder’s chart, the sponge, the Harbor Bridge, the rainbow nitrogen graph. I think that was one of my favorite types. I hope they do make an appearance. But certainly overarching, that's the main comment that sticks with my mind here, Declan, is that every farm has the potential to build more soil organic carbon, and at its heart that focus is on that reducing farm risk and building more farm profit.

Matthew Warnken:

So as I said, this is the final webinar, bringing it all together, monitoring and evaluation. Before we start, some housekeeping. We are recording these webinars, so they will be available. We will keep them available on our website, so you can catch up. And now we're at episode seven, you can even binge on all seven. We'll be running this session for an hour. Declan will speak for around 40 minutes. We'll have a final wrap up with a Q&A at the end. We are streaming on YouTube Live. There's a chat panel on

YouTube Live for questions and comments. And then please use the Q&A for questions if you're looking live through Zoom, and as always, feel free to post comments and to follow up with the emails to ourselves if there's anything that we missed. Declan, now hand over to yourself as you breathe a sigh of relief to turn that final stretch, and then bring us home in terms of this final webinar.

Matthew Warnken:

So, if you're there, and we did hopefully do a check and we'll see whether the technology is working with the screen chat.

Declan McDonald:

Hopefully it is, and hopefully that's what you're seeing Matthew.

Matthew Warnken:

That's what we're seeing. Shout out to the neighbor's dog, we hear a dog in the background. But there is a bit of a sweep stakes going on in the office whether it's going to be a dog, a drill, a lawnmower, or anything like that interrupting. But let's cross fingers, and happy now to hand over to you and look forward to picking up the Q&A session later on. Thanks Declan.

Declan McDonald:

Thanks Matthew. And thanks everybody for checking in for this final webinar in the series. This is just a quick back glances, as Matthew has just said, I've tried to structure this, I've tried to tell a story really as we've gone through the seven weeks, starting with at a fairly rudimentary level, but incredibly important level, which is around about how soil works and how plants grow. And then the importance of organic matter and soil biology and the role of minerals then in that equation, and how we manage that fertility to build soil carbon. So the early part of the series was very much focused around what nature was doing for the millions of years, minus about 80, before we suddenly decided that we were going to take over and really show the soil how to produce.

Declan McDonald:

Unfortunately we've done that at our own cost as we've kind of discussed going through. So looking forward from here, it's very much about how do we how do we continue to extract the kind of value that we want out of our soils, but without depleting them? And in fact not only without depleting them, but building them. And certainly as you would have heard me say so many times, the core to that is about soil carbon, it's about growing soil organic matter, and that's what this fresh approach to production is really all about.

Declan McDonald:

So, last week we talked about management practices, and today I want to focus on really bringing all of this together. Monitoring and evaluation are two words that tend to send me to sleep, but I've kind of learned that I have to embrace these terms and these concepts, because without proper monitoring and evaluation, we really don't know where we're going. And because we're on this journey and hopefully most of you have followed this journey over the last seven weeks, you're caring about actually making progress. And today we're going to talk about how you can prove that to yourself really, is at the end of the day what we need to do. So, how do I know if I'm making a difference? Well, as I've said before, most farmers will say that they want to leave the land in better condition.

Declan McDonald:

And I've often said, "Well, what does that actually mean? What is better?" And we can point to things like our fencing is in good condition, we've got some nice trees, there's no weeds, the land is productive, and it probably will look better as well. But is the natural capital of the farm really improving? And for that to happen, my take is that the soil has to be better. And you're not going to be surprised by the next thing that I say, improving soil with organic matter, because that's what better really means. It's easy enough to adjust the nutrient status of soils and we're very good at doing that, but we've got to do it and improve organic matter at the same time. And we have to be able to measure and monitor that improvement.

Declan McDonald:

So, the next question is, "Well, what do we measure?" So the relatively easy answer to that question is soil chemistry, and we're very good... well, we have very good capability in measuring soil chemistry. I was going to say we're very good at it, but actually we're not very good at it, because not nearly enough soil testing happens. An awful lot of people continue on a wing and a prayer, or what I did last year seemed to work and so I'm going to keep doing that, and people balk at soil testing, because they say it's a little bit expensive. But as I'll talk about a little bit further, what we waste on fertilizers is your orders of magnitude above what we would have saved on soil testing and by using soil testing.

Declan McDonald:

But part of the problem as we've discussed going through with soil testing, is difficulty with understanding and interpreting the tests. And most farmers will need some assistance with that. So, it's about finding somebody that you can trust to help you interpret those, and independence is key there. So, anyway, with soil chemistry we're looking at things primarily pH and EC, cations, nutrients, organic matter of course. And most of these tests, these are the empirical tests, and we have a couple of levels of accreditation. NATA is the highest level of accreditation, the National Association of Testing Authorities, and ASPAC. ASPAC testing looks to get uniformity across labs, so you all have heard stories about different labs testing the same soil and producing different results. The ASPAC protocols are really about trying to make sure that every lab is doing the same thing the same way.

Declan McDonald:

But we've talked about soil chemistry, physics and biology, and when it comes to physics we haven't got the same battery of tests available to us that we have for soil chemistry. And that's really because agriculture, as it's developed over the last 80 years, has been chemical agriculture. So we've gotten very good at measuring the chemistry of agriculture. We haven't paid the same attention to soil physics. So, probably the easiest physical test that can be done in a lab anyway is bulk density, and that's a measure of compaction in a sense. It's a measure of soil structure, how well the soil is structured, or how well it's squashed. In some places you can test aggregate stability, which is a measure of how well the aggregates, the structure, stands up under the stresses and strains of normal agriculture.

Declan McDonald:

That's not available everywhere. So really we've got a problem with soil physical testing in terms of easy availability and affordability. And of course the next category, soil biology, we probably have even more challenges around testing, as I'll talk about going through. But principally we've got microscopy where we're looking down the microscope and seeing what's there. We've got PLFA, which is phospholipid fatty acid testing, which uses biomarkers to tell us what's in the soil.

Declan McDonald:

And there's a new little tool called the microbiometer, which I'll tell you about that's just come out, which seems to be gathering some interest. Anyway, when we're talking about nutrient forms in the soil, nutrients exist in the soil broadly in three groupings. Here we've got soluble plant available nutrients in the middle. Out here we have exchangeable nutrients, and these are the nutrients I guess that are held on the exchange complex in a way that's offering them to the plant.

Declan McDonald:

And out here in the yellow realm we've got total nutrients, and these are the component that's really locked up in the mineral component of the soil, or is complex with the organic fraction in a way where they're not particularly available. And as you'll see here, we've got a couple of processes. We've got chemical binding and we've got biological nutrient release. So the chemical binding and chemical binding out here, are two examples.

Declan McDonald:

So, that would be your phosphorus tie up in certain soils where it gets locked up and unavailable to plant roots. And the biology in the soil have critically important roles, as we've discussed in earlier seminars on the role of biology, to release, for example, that phosphorus that's bound up in the soil. And we've got biological nutrient release out here from the mineral component of the soil as well. And as we've discussed previously, the microorganisms have a particularly important role here and fungi in particular, in terms of biological nutrient release either from organic and mineral complexes, or even from the mineral component itself.

Declan McDonald:

They have a strong role to play there. And as you can see, many minerals are moving between these different pools, between different levels of availability. And some of those processes are chemically driven, but mostly they're biologically driven. And this is where traditional soil testing kind of lives, if you like, as an indication. So the broad end of the pyramid is in here. Traditional soil testing very much focuses on soluble and exchangeable nutrients. If we want to know what total nutrients are available, we have to request separate testing, which is generally a total elemental analysis test, which tells us what's in the locked up unavailable form. And usually if we do that testing we'll find that there's really high levels of nutrients, but unavailable. And that gives us some indication of what may come through to us if we can fire up biological nutrient cycling.

Declan McDonald:

So, when we talked about understanding soil tests, to me there's two broad components, pH and EC are critically important. Cation balance is really important too, and the cations are the positively charged elements you'll recall. Calcium, magnesium, potassium, sodium, hydrogen, aluminum are the principal ones. And the cation exchange capacity, we use this as an indicator of the soil's nutrient holding capacity. Then I should say too, you'll recall when we talked about Sydney Harbor Bridges and things like that, these components here, pH, cation balance, which are related, have a really important role to play in the soils structural integrity. You'll remember these are bridging elements to help sustain poor structure in the soil. And here we have plant nutrients, and this is what we have traditionally focused on. Let's make sure the plants have enough food, rather than do the soils have enough food.

Declan McDonald:

I looked at this soil test and I'm reminded where the soil test came from. It was the farmer that I was working with a few years ago and they had a routine of applying two-in-one fertilizer every year, because it seemed to work. It was one of those. And when I looked at the soil test, the two-in-one was phosphorus and potassium that they were applying every year. Above about 70 parts per million, about 70 milligrams per kilogram of phosphate, you're not really going to see much of a plant response.

Declan McDonald:

So, anything over 70 would be regarded as both an environmental risk and also a waste of money. And potassium in the soil, we probably don't need potassium much above 250, 280 milligrams per kilogram, and here we've got 480. In contrast, nitrogen, which wasn't being applied, and sulfur, which weren't being applied, were both way low. And it's interesting to note that nitrogen and sulfur have got really important roles to play in plant protein formation. So, this particular farmer was spending all this money in an area where it just did not need any further investment at all, and the two essential elements that were going to drive plant quality were being really neglected. An example of where a small outlet in soil testing would have saved a huge amount of money in unnecessary fertilizer purchase. I just wanted to make the point too, that when we do focus on soil chemistry, we tend to focus on the top 10 centimeters of soil.

Declan McDonald:

And this is some work that a colleague did when I was at the Victorian Department of Ag, where we looked at soil properties down through the horizon down to 105 centimeters. What they showed here is if we took a soil test and just looked at the surface soil, we'll see we've got a pH of 6.7 and an exchangeable sodium percentage of five. All looks very good. We say, "This is a nice soil. I'm going to be able to do great things here." But when we look a little bit deeper in the soil down to less than a foot deep or two feet deep, we see that suddenly the pH has jumped up enormously and the exchangeable sodium percentage has jumped up even more. And what that tells me is that the subsoil here is hugely dispersive, and for that reason the likelihood of plant roots actually being able to grow down into this medium are greatly constrained.

Declan McDonald:

Now I'm not advocating particularly that we soil test subsoils, because that can be a little bit more challenging. But understand that soils are not what you see on the surface, and getting down deeper into the soil, even if you identify that there's a higher clay content in subsoil, which there is in this soil, it means that that is going to shape your strategies around what kind of roots you need to get into that material.

Declan McDonald:

Enough about chemistry, let's talk about physics. So as I said, when we're looking at soil physical testing, we're primarily concerned with the structure of the soil. And the structure of the soil, as we've talked about, is about the ventilation and drainage system of the soil. How easy it is for plant roots to grow into the soil, how well that soil is going to drain, how well a big rain event is going to infiltrate and infiltrate deeply into that soil. And bulk density testing can help us to a degree, but it's not really looking to depth into soil. I mean we can do bulk density testing as deep as you like, but that's something that may only belong to the research realm really. So when it comes to physical testing, I think we need to look more at hands-on tests. And some of the best around, I think, is this visual soil assessment. And this was a method that was developed by a New Zealand soil scientist called Graham Shepherd.

Declan McDonald:

And in fact so good was it that the FAO ended up picking it up, and you'll see there's a link there to the FAO. And in that single docent there are guides for a visual soil assessment, for propping, for olive orchards, for other orchards, for pastures, for a whole range of different land uses. And these are very much hands-on testing, hands-on assessment, which is really helping you to understand what are you looking at and what is good and what is bad in what you are observing.

Declan McDonald:

There's also soil health cards, and this one from Northern Rivers has been around for quite a while, but it really is one of the better ones. And this has been designed very much around not wanting to spend any money at all and being able to do the tests with whatever you have in the shed. So for example, some of the tests for compaction is done with a bit of two or three mil heavy duty wire. Can you push that into the soil? And if you can't push that into the soil, obviously your roots are going to have trouble doing the same. So, that's particularly useful and there's a link there to it as well. And the third one that I'll highlight, and there really is quite a number of these available on the web, but the Cornell Health Assessment Training Manual is about as comprehensive as they come and it's really an excellent resource as well. And this is from Cornell Uni in the United States.

Declan McDonald:

And even though it's American, just about everything that they talk about in there is going to be relevant to really any Australian situation. And as I said, there's lots of really great photographs, particularly in the VSA and in this document, which helps you to understand what you're looking at and how to judge whether your soil is in good condition or not. And the third thing I wanted to talk about was soil biological testing.

Declan McDonald:

Now, one of the best ways to go about understanding soil biology is to get yourself a microscope. And these days, like so many things, the cost of microscopes has plummeted and new or second hand you can generally pick one up for a few hundred dollars. And it's quite easy to train yourself and there are tutorials on the internet to help understand. So really what we're trying to do is saying, "Okay, I'm going to prepare some soil, I'm going to put it on a slide, I'm going to look through the viewfinders, I'm going to focus it and I'm going to go, 'Wow, there's a lot of stuff moving around down there.'"

Declan McDonald:

Assuming we're looking at a reasonably healthy soil. And with the use of these online tutorials and the like, you can really go a long way towards figuring out, "Well, am I looking at a fungus? Am I looking at a bacterium? Is the fungus I'm looking at likely to be a good fungus or a bad fungus?" So there's an awful lot of information that we can access in this way, and the really good thing about it is that the results are instant. You go and pick up a piece of soil, or compost, or whatever, from the back paddock and take it in, prepare it, put it up. You got instant feedback. Now alternatively you can go and get this done professionally. You can get it done professionally, and the soil food web institutes, they use principally microscopy to tell you what's there.

Declan McDonald:

So, it's going to be more accurate. I've put a little question mark about more informative, simply because in the time that it takes a sample to get from your farm or your compost heap to the lab, it

might dry out, it might have been exposed to higher temperatures. A lot of organisms might have gone to sleep during that time. Of course it's more costly and the feedback is a little bit slower, but you do have somebody who's probably a fair bit more experienced than yourself actually looking at your sample.

Declan McDonald:

Now, the other soil test that's growing in popularity these days is the phospholipid fatty acid test, PLFA, and you may have heard a bit more talk about PLFA these days because it's used in a range of applications, not just soil analysis. So, this test tests for a range of target organisms and it can be relatively quick and quite accurate. But there's a few issues with it. It can be confused by plant tissue, and that's because some plant roots share similar phospholipids as bacteria and fungi, and in particular these days soil health tests are popular in assessing the effects of the use of cover crops for example.

Declan McDonald:

But cover crops, because of all the good stuff that we've talked about cover crops, they significantly increase fine root hair presence in soil and that's where the additional phospholipids can come from. So, it's just difficult to tease that apart. We're certainly going to have higher biological activity if we grow a good cover crop, but whether we can attribute all the increases just to biological increase or not, can be difficult to pull apart.

Declan McDonald:

And so that's what I mean that some of the information can be a bit flawed and some of the additional information that's extrapolated such as a diversity or stress indices, they're based on good information, but interpretation can be the challenge with this particular method. And of course it can be costly. I'm not saying don't use this. In fact, I think they're some of the best tests that we have around, but the best way to use them, I think, is to use the same lab and to test the same soil at the same time of year at the same moisture content, and just monitor trends in changes in the soil microbial populations going forward.

Declan McDonald:

And the other thing, this microbiometer that I mentioned, this is a pretty new development and it's this gizmo that's come out of the United States, and you can do this test out in the field. And there's instructions about how to prepare a small sample, you whiz up the sample, you let it rest for a little while, and then you put it on this scorecard, you take a photograph of it, and the software, the app that you use interprets it and tells you what your microbial biomass is and what your bacterial fungal populations are.

Declan McDonald:

I say it, "Could be useful??" I've used this, I got one of these units and I've used it in the field, and I got particular results. And I got the same samples tested using the PLFA and got really vastly different results. I think at the same time this company puts out information about how well this machine correlates with lab testing, as they would, but I say it may have a place on the farm and I think probably the best use of it is to just compare like with like. A little bit like the PLFA, test the soil, take the soil from roughly the same place in the paddock, and test it for responses to different management practices. It's not cheap, it's not expensive. I think the whole thing to buy is maybe $300, and then individual tests

might be, I can't remember, $10 or $20 each, something like that. And then you buy refills essentially going forward.

Declan McDonald:

So, stand by on this one. I think it'll be interesting to see if this one stands up or it fails the test of time. We'll see. Now, I wanted to talk about this concept of natural capital. So, I mentioned at the start when we're talking about how do I know if my farm is improving? How do I know if I'm really going to leave it in better condition? I think the language we're beginning to use now is around natural capital. And by natural capital, I think we're principally talking about ecosystem function on a farm, how the farm is functioning as an agro ecosystem. So that requires multiple levels of habitat on the farm, so from tall trees, to shrubs, to diverse pastures and everything that responds under the ground to that diversity of root architecture that we've talked a lot about.

Declan McDonald:

Now, when we're talking about natural capital, we need to have systems to be able to measure that. And Accounting for Nature is an organization that has its origins in Wentworth Group of Concerned Scientists. And their systems, their approach measures condition of environmental assets. So, whether it's native vegetation, soils, waterways, fauna, it provides information on the health of those assets on a property, but also on a much larger scale in a region across a whole state it can be done.

Declan McDonald:

Now, most of the work that they've done so far has been on native vegetation. There are methods under development for soils, waterways, and fauna. The beauty of this is it provides independent assurance and certification for regenerative agricultural practices for natural capital conservation et cetera. And interestingly there's considerable interest from the banks. And the banks have been really quite heavily invested in this space for some time, because what they want out of this is some measure to know what's the difference between farmer A and farmer B. Is the natural capital on either farmer's farm appreciating? Because if it is, that's the farmer I want to lend money to. If it's not appreciating, that farmer is probably not such a good risk from a bank's point of view.

Declan McDonald:

So, if we want to have access to finance or access to finance at preferential rates, if we can demonstrate that we are really good custodians and stewards of the land and the natural capital of our land is appreciating, then from a financial point of view that's got to help. One of the things that's under consideration at the moment is the soil protocol. And when we talk about soil protocols, we're talking about levels one to three.

Declan McDonald:

So, level one is a really high level, very high level of confidence, very high level of statistical rigor. And levels two and three are slightly less levels of statistical rigor, but also their more approachable levels. And I have just finished preparing a method for Landcare, which we have developed up as a level three method. The intention here is that it's a method that needs to be relatively user friendly, and we hope that that's going to be accredited by Accounting for Nature next month.

Declan McDonald:

So, in this model, in this Landcare model, and hopefully you'll all hear a lot more about it because Landcare are planning communication and trials on this method over the coming months. We're using five key indicators of soil condition. pH, EC, soil organic carbon, phosphorus and ground cover. Now I can't spend too much time going through this now, but I'll try and give you just a brief insight into how this works.

Declan McDonald:

So, I'll just pick out pH for the moment. So under this table here we've listed the soil property. Soil orders is what kind of soil it is. The land use category is how is the land being used. Sampling depth, rainfall, in this case with pH we're saying any rainfall. Now the reference condition value for what's called Econd and Pcond, this is the environmental condition and this is the production condition.

Declan McDonald:

So, Accounting for Nature wanted to be able to compare the result to what the original condition of the land pre-European colonization would have been like, and that really needs to be determined on a local level. But the reference value for productive condition is really taken from industry best practice. So we know that generally for pH we want it to be between 5.5 and 7.5 for 95% of our crops. And if we're in this range, that's a good thing. If we're out of that range, it kind of puts up a red flag and says, "You've got an issue on your farm here." I hate putting up slides like this, so I apologize in advance, but really what this is showing is that on this farm we have a ferrosol, a single soil type. There's four land uses on this farm, native vegetation, grazing, cropping, and there's an olive grove for argument's sake.

Declan McDonald:

Here's our indicators, we've got soil organic carbon, pH, EC, extractable phosphorus, and ground cover. And against reference benchmarks and industry benchmarks we have what they should be, the tested value, and then a reference score. So if it's spot on, if it's right on target, it gets a reference score of 100. If it's out by varying degrees, it gets scores of 90, 80, 60, 40, 0.

Declan McDonald:

And then this is average out into assessment units and you end up with a final score, which is what I'm showing here. So you walk into the bank basically and you say, "Hey, look, the condition of my land based against pre-European settlement is only 64.5%, but I've had to change it an awful lot because I'm an olive grower, or I'm a wheat farmer and it's not relevant to wheat. But this is relevant to wheat and it shows that my condition score is 87%. I'm doing a pretty good job here. This is a high distinction." So, the bank will go, "Yep, that looks good to us. Preferential interest rate coming your way, or we'll lend you money," or whatever they're going to say. And whether this is about banks or just your own satisfaction, this is your measure of how well you're appreciating. And if you're this good, you're going to be looking to achieve a score of 90% plus over the next five years.

Declan McDonald:

So, when we talk about natural capital, fundamentally for me we're talking about soil organic carbon. All the other bits are kind of easy to fix, but soil organic carbon takes a fair bit of work. It's the most important component of healthy soil. It's key to combating climate change, it's key to profitable and sustainable agriculture, to ecosystem function, and to chemical and physical aspects and biological health as well.

Declan McDonald:

And I love this little graph, because I think it tells a whole story. So with a focus then on just soil organic carbon, so in the Landcare example, we have five indicators. Under the federal government's emission reduction fund, they're looking at soil carbon only because they want to reverse decades of misdirected effort by taking atmospheric carbon and putting it back into the soil. And soil carbon projects pay farmers to do this. The process is slightly involved and it is quite exacting, so specialist assistance is usually required. But the beauty of this is it's a win-win situation. Farmers who sign up to an ERF project are working to be paid twice, once by the government for carbon that's sequestered in the soil, and many times over in improved production from increased soil carbon for all the reasons we've been talking about.

Declan McDonald:

So, this is Matthew's realm, so I'm not going to talk any more about it, but for anyone who is interested in chasing an ERF project, I really would advise some assistance because it's not for the faint-hearted. So to sum up, and this is my final slide after seven weeks, how do I know if I'm making progress? I can summarize it by saying dig a hole. Dig a hole. I can't tell you the amount of times I've gone out there with 30 plus years of experience and all my academic training and everything else, and someone says, "There's something wrong."

Declan McDonald:

And I go, "Okay. Have you dug a hole?" And they go, "No." I say, "Okay. Let's dig a hole." We dig a hole and I say, "Can you see what's wrong?" And they go, "Yeah, soil is dry," for example. So you can tell. You don't have to be an expert to get a real insight into what's going on. Dig a hole. The more holes you dig, the more you're going to understand your soil, the more you're going to understand the variation in soil across your property, the more you're going to engage with your soil.

Declan McDonald:

And the more you engage with your soil, the better your management of your soil will be. Okay, back to you Matthew.

Matthew Warnken:

Thanks very much Declan. I'll get the systems back online. Look, it was a great way to finish on that. To make some pun there too, just how do you know where you're going? How do you know if you're making a difference? The answer being beyond 42, digging a hole, and I thought there was going to be a punchline in terms of at some point though stop digging, because of the impressive size of the hole.

Matthew Warnken:

Some points to just pick apart there, just that focus on the importance of monitoring and evaluation. Without that testing, that monitoring, and I think what you're alluding to, Declan, too is that trendline sampling. So it's almost like I think it's too much hung up on whether one testing regime or sampling regime is better than another, but the importance of consistency and going back to the same lab, with the same test in arranging that consistency over time.

Matthew Warnken:

It's good that you've thrown in some more tongue twisters for us in the soils journey, phospholipid fatty acids. And again, highlighting that commercial focus too in terms of commercial driver for testing in a testing regime to ensure that nutrient programs are being applied correctly. I thought that it was brought out quite nicely. And then interesting, the work you're doing with the Accounting for Nature protocols.

Matthew Warnken:

So, measuring natural capital, and that Accounted for Nature, that's the framework that the Queensland Government's Land Restoration Fund is actually using. And that land restoration fund for farmers in Queensland is a good program, because there the Queensland Government are looking at the market side as well as that measurement metrics. And you can certainly see that benefit of that sort of snapshot in terms of how the overall farm is traveling in terms of their natural capital.

Matthew Warnken:

And I think soils protocol, as you alluded to, would be useful in terms of going to that next step. And increasingly these measurement metrics and the measurements I can't highlight enough in terms of obviously our businesses is soil carbon, importance of measuring soil carbon is that you get paid for it. We're also looking at those other markets such as natural capital, and in order to get paid for those natural capital services or those ecosystem services, there needs to be that robust measurement.

Matthew Warnken:

It's kind of two-sided, that is not only the practice change and the benefits that are happening on the farm, but in order to sell it, you need that integrity and robustness of that measurement, because ultimately that's what people are paying for. People are paying for the proof that those benefits have occurred on a farm, but we're seeing more sophistication, more measurement frameworks like the Accounting for Nature, and more markets in terms of being able to sell these additional co-benefits.

Matthew Warnken:

And more in terms of the access for market. So you move to there the access for finance, and as Declan showed himself as the eternal optimist in terms of banks handing out even lower rates, but that proof point is what you need to be able to access more finance rates. But, Declan, I'd be saying there's also that access to other markets too that better measurement, better metrics about that land stewardship story is going to be fundamental as well.

Matthew Warnken:

And that's all built around this monitoring and reporting aspects. So start to look in some of those questions, Declan, and maybe go and look at... you had a graph there in terms of the measurement of nutrients, and the nutrients on farm and different states of those nutrient availabilities. So total nutrients, exchangeable nutrients, and soluble plant-available nutrients.

Matthew Warnken:

You made the comment that these nutrients can change states and that it wasn't so much chemically driven, but biologically driven in terms of that change of state. So from that, does that imply that improved soil biology can actually change that state from total nutrients that might not otherwise be plant available, to then actually access them? Or to turn another way around, if you did do that sort of

testing and mapping of your underground soils and also look at a whole bunch of totals, does that then present as a way to make them accessible to improving soil health, improving soil biology?

Declan McDonald:

I think, Matthew, I suppose the short answer is I'm not sure. But what I think is happening is that even if we greatly increase the biological activity of our soil, I'm not sure that we're necessarily going to see a great increase in the available pools. Because the available pool, we tend to measure most readily the soluble pool and exchangeable pools.

Declan McDonald:

If we think that in a highly biodiverse and high biomass soil, so much of the nutrients in that soil are going to be tied up in the biological component of that soil. Not all of that is going to show up in a soil test. I mean depending on the nature of the test, some will, and it depends very much on the strength of the extract. So when we do a total elemental analysis, for example, that's usually using a fairly strong acid, so that's going to fry every bacterium and fungi within cooee.

Declan McDonald:

So, they're certainly going to be giving up all their nutrients. So, we'll have an idea of what the bank is, but it's not necessarily going to tell us how well those nutrients are cycling. But I think if we can demonstrate high microbial biomass and high biological function, that is the evidence that we need to... at least they're the components that we need to drive that nutrient cycling.

Matthew Warnken:

Cool. Any comments about how frequently we should be testing those different elements, different pools, the chemistry, the physics, the biology?

Declan McDonald:

Look, I think there is a cost to these things, and what I generally recommend as best practice is that a farm should be tested over a three year cycle. So the farm should be divided up into thirds in whatever way the farmer chooses to do that, and a third should be measured each year. That way there's a certain investment in soil testing each year, and because certain properties don't change very quickly, a three-year period is okay to wait between tests, unless it's a very high productive farm like a vegetable farm where it may be an idea to test every year.

Declan McDonald:

But I know that on a lot of these farms, particularly on a lot of production horticulture, that's not done even there. What happens is we go in with the same recipe the next year, and it's going to result in a lot of these soils having way too much fertilizer applied and a big waste of money as a result. In terms of physical testing, I think if I can just share my screen again briefly, Matthew, I'll just show... I've got up here, this is a page from one of the visual soil assessments.

Declan McDonald:

I trust you can see that okay. And this is the scorecard that's used for assessing soil pastures, and it identifies here the soil indicators, invites you to identify your soil textural group, whether it's a sandy or

a clay soil. But these are the things that we're looking at, soil texture, structure, porosity, color, models earthworms, potential rooting depth, surface bonding, surface relief et cetera.

Declan McDonald:

There's different weightings to each of those, and the visual soil ranking goes in here and you end up with a score. So what that means is that next year you go back to the same place and you do it again, or even two years later if you want. But what you're doing is you're comparing that soil against itself, and that's by far the best way I think to use these soil health cards, or these visual soil assessment methodologies.

Declan McDonald:

And in terms of biology, that's even more difficult, because biological populations are going to change with the weather. If we have a warm and wet period, all other things being equal, we'll see microbial proliferation. If we have an extended cool dry period, we'll see the opposite. So that's why when we're doing microbial testing, we really should try and test under the same conditions if we're going to compare like with like.

Matthew Warnken:

And it's been a bit of an interest in terms of that microbial testing in the microbiometer. So there's some feedback there on the chat from Peter McFarlane just on that microbiometer. And so there I'd be suggesting to Google microbiometer and go to their website in terms of how that might be applied to Australian conditions.

Matthew Warnken:

Then a question in terms of can you compare, or do you compare the microbiometer results to soil chemistry on different sites, and over time to see any trends as you are using it?

Declan McDonald:

Well, I think so. I would certainly expect so. As we're improving the soil chemistry, if we have, say, really acid soils or soils that have high salt levels, and if we're able to correct those over time, what we're trying to do in adjust and optimize soil chemistry is we're really trying to optimize the environment for soil biological function.

Declan McDonald:

So, if we can address some of the constraints on production as we conventionally think about it, so it might be very low pH, it might be high EC, it might be low organic matter, it might be low phosphorus. If we can adjust those and bring them into an optimal, really what we're doing is we're trying to provide the currency and the bricks and mortar for the microbes to proliferate.

Declan McDonald:

And if we do that, and then we have a corresponding measure on the soil microbes, we would expect to see improvement there too.

Matthew Warnken:

And then staying on the biological theme, Declan, so the question is whether there's any biological options for control of soil pathogens? One example was a verticillium wilt, the exotic defoliating strain, so that's now present in Australia across a number of crops, cotton, potatoes. So, the question, no apparent available chemical control options. Are you're aware of any biological options for the soil pathogen?

Declan McDonald:

Look, in the way that we have now got some weeds that are so supremely adapted that they're very difficult to control. So also we have some diseases or some races of particular diseases that are very difficult to control. I think our chemical control options for most soil borne diseases are really counterproductive, because they're shotgun approaches and there's so much collateral damage associated with their application that they tend to do more harm than good.

Declan McDonald:

For me the only long-term and sustainable way to manage these kinds of pests and diseases is through biological suppression, and there's been a lot of interest in suppressive soils for many years. And the Victorian Department, I think, has been leading the way in investigating things like take-all disease of wheat in South Australia, and I think rhizoctonia as well, where they've identified two paddocks.

Declan McDonald:

They both got rhizoctonia, for example. In one paddock we've got an economic loss, in another paddock we don't have an economic loss, and they've identified that there are control factors in the paddock where there isn't an economic loss that are controlling the proliferation of the pathogen and allowing it to coexist. And this is what happens when in diverse ecosystems, diversity equals stability across any ecosystem, whether it's above or below ground.

Declan McDonald:

And the greater the diversity of a system, someone coined a thing called the Elton principle years ago, and the Elton principle holds that basically the more diverse the community, the more stable that community is. So we stop disease organisms running out of control, we've got brakes on their proliferation. So, I think that's the only kind of long-term sustainable management strategy apart from growing resistant crops if it comes to that.

Matthew Warnken:

In that context, did you see a case for say larger applications of composts to say kickstart microbiology and then also build soil organic carbon, have these beneficial protective aspects to soil management?

Declan McDonald:

Yeah, I think certainly. I talk to a lot of growers and they say, "Oh, yeah, I use Seasol, and I use this and that." And a lot of those things are used kind of with a huge chunk of optimism, and that's not to say that Seasol is a bad product, but I think there's a time and a place for all of these things.

Declan McDonald:

One of the good things about compost, and particularly if it's well made compost, is that it's putting in the energy to grow what's there. Things like Seasol and even Charlie Carp for that matter, or a lot of

these other products, they can maybe stimulate a part of the soil ecosystem, they can help the strip plants with stress responses and the like.

Declan McDonald:

But a compost, I guess, is always going to be in a league of its own, because it's putting bulk substrate out and helping to grow what's there. And in conjunction with greater diversity and what's actually being grown, is going to increase the diversity of what's happening below ground.

Matthew Warnken:

I'd be interested, Declan, to get your opinion in terms of the mechanical nature, the environmental condition score, the productivity condition score, the Econ and Pcon, and then the potential application, the use of that by banks. And in particular whether or not you can see that as a scorecard or ability to borrow money to actually change practices now, even though they might be at a bad baseline as opposed to showing that you're a top performer. Is there a funding gap that could actually be unlocked through these accounting frameworks?

Declan McDonald:

Look, in spite of my talk about cash, credit cards, and gold, Matthew, that demonstrates the depth of my understanding about the whole economic system. So I'm not going to go too far there, but I think it's really interesting to note that there's a lot more corporatization of agriculture in Australia, both from corporates and also from family farms or family businesses that are expanding and buying out their neighbors and everything else.

Declan McDonald:

Because there tends to be a lot of money tied up in these much bigger farms, they're being managed much more as businesses. And because they're being managed much more as businesses, they're paying much more attention to natural capital and saying, "Is my resource base holding up under the demands of production? Is my resource base appreciating?"

Declan McDonald:

And these are conversations, I think, that are increasingly being held in the boardroom and with bank managers. And I can only see those conversations becoming more commonplace. So for me it's a bit of a no-brainer, and it's amazing in the sense that it's taken the banks this long to kind of twig that, "Who do I want to invest in? The person who knows, understands, and best manages the resource that I'm investing in."

Matthew Warnken:

Great. Okay. Thanks Declan. I know we're just approaching the top of the hour, so maybe just to round this webinar out, indeed the whole series, of you had to recommend one form of soil sampling would it be physical, chemical, microbial, that would give the most value for money, what will that be? And also, what advice would you give to, say farmers, who haven't really started a program of soil testing before?

Declan McDonald:

I'd probably say start with soil chemical testing. And the reason I'd say that is because we've got really good methods, they're really proven, and the challenge though is to get it well interpreted. Because I

want to use that chemical data to tell me how far my soils are from optimal. What we're trying to do in shifting towards a regenerative approach to agriculture, we're trying to get away from concepts of feeding the plant instead, and moving to feeding the soil.

Declan McDonald:

So, chemical tests, they're traditionally interpreted by saying what does the plant need to grow? I want to use chemical tests that tells me what does the soil need to grow? Because if I can grow my soil, and what I mean by that is grow it in terms of its health, its capacity to produce, then I'm going to be much more confident about what I can produce, I'm going to have more resilience in my system, I'm going to have more stress response in my system and less stress response in me.

Declan McDonald:

So, I think that's a really good way to start, provided you can find somebody to help you interpret your soil test in that way.

Matthew Warnken:

Great. So again, that key thing, it's not just the data, it's interpretation, how do you then use that data to change practices. Declan, I'm not sure what I'm going to be doing next Wednesday. I think it's going to be a big hole, bigger than what was done in your previous slide. It's been a great series. If you had to, in a final wrap-up as to how to leave everyone with the thoughts on how to grow top soils in 10 words or less, how would you bring the whole seven webinars into that short succinct summary? What would that be?

Declan McDonald:

I guess it would have to be feed the soil.

Matthew Warnken:

Feed the soil. And as always, it's very eloquent and some great feedback coming through to Declan, which we would certainly echo just in terms of the wonderful seminar that you put on today and the communication skills that you do bring to the topic. So we do thank you very much.

Matthew Warnken:

This webinar was bring it all together monitoring and evaluation. It was the final episode in our webinar series on how to build top soils, the science of soil carbon. Thanks to our team, to Mel, putting the webinar together, Stephen on tech support. Once again, Declan, thank you very much for your input and insights.

Matthew Warnken:

And a reminder to everyone watching the webinar, please respond to the evaluation email that we'll be sending out as part of this series. This feedback is really important in terms of where we can head in the future in terms of developing additional resources to assist farmers in their transition to growing top soils.

Matthew Warnken:

And as always, feel free to contact us at AgriProve team@agriprove.io with any other feedback or queries or questions, because really our motivation here in hosting this webinar, is that this becomes part of how to build a soil carbon. We're obviously on hand and very happy and eager to talk to any of the specific questions that anyone might have in terms of what are those logistics about actually starting a soil carbon project for soil carbon credits.

Matthew Warnken:

And we do hope this webinar series has been of value. I've learned a lot, I hope everyone has too. Just a reminder that all the previous webinar episodes are on our website, and so they are available, the transcripts are also available there. If you prefer to read through that content, that's also accessible. And please keep an eye out on our events page as we do hope to be bringing other informative webinars and sessions over the course of the year.

Matthew Warnken:

So, for this webinar series, once again, thank you, Declan, thank you everyone for your attention and time, and we do hope to be chatting further in the future on how to build top soils. And as Declan put it, how to feed the soil. Thanks Declan, and bye for now.

Declan McDonald:

Thanks everyone.