# GRDC PODCAST TRANSCRIPT

**Longevity benefits after soil amelioration**

[00:00:05] **Intro** This is a GRDC podcast.

[00:00:12] **Debra Bishop** Almost six million hectares of WA's sandplain soils in the medium and high-rainfall zones feature multiple constraints, including water repellents, acidity, and compaction. An estimated 250,000 hectares of those six million have been ameliorated, typically involving strategic one-off deep tillage. Now a GRDC investment is helping to determine the longevity benefits following soil amelioration. Hello, I'm Debra Bishop. With an annual bill of around four billion dollars, soil constraints have been the subject of many amelioration projects. The purpose of this latest GRDC investment is to identify management changes that preserve the benefits of soil amelioration and maximise profitability for growers. It's determining the most profitable crop rotations, species choice and seedbed preparation that maintain long term benefits of soil amelioration, while managing risks such as wind erosion and poor crop establishment. I spoke to Dr. Stephen Davies from WA's Department of Primary Industries and Regional Development, on the project's initial findings and the revelation that, although this practice is expanding, many growers with relevant soils have either not adopted the practice or aren't obtaining full value that soil amelioration can offer.

[00:01:39] **Stephen Davies** So in Western Australia, when we're talking about soil amelioration, we're talking about, often farmers doing strategic deep tillage with that. So, they might also be applying soil amendments like lime or clay or gypsum. But in a WA context it often involves this strategic deep tillage and that can be things like deep soil mixing, things like using a rotary spader or a large offset disc for that. It can be deep soil loosening with a whole variety of deep rippers that are out there now, or it can be soil inversion sort of with mouldboard or modified one-way ploughs. Can even be things like clay delving and that sort of thing. So, it really involves these one-off strategic deep tillage practices that are done just to overcome a whole host of constraints and trying to fix a whole host of soil problems in the one hit and then go from there.

[00:02:28] **Debra Bishop** So you're saying the reason we're doing it is to try to hit those constraints, but are there different ways to achieve soil amelioration through different soils?

[00:02:36] **Stephen Davies** Yes, certainly. I mean, you certainly target those different methods to different soil types and the sort of constraints that you might have. So, for example, if you have like a top soil water repellence constraint, you know, you either need to add clay to that and sort of mix that through, or you will need to do some sort of inversion or deep mixing where you actually sort of bringing out non-repellent soil from subsurface soil up to the surface, which sort of then gives you that wetable topsoil, for example. Certainly in WA, you know, we have a lot of subsoil acidity. So, most of these practices, we're almost always adding lime into that mix as well and trying to basically incorporate some of that lime and fix that subsoil acidity while we're at it.

[00:03:14] **Debra Bishop** So in WA, our sandplain soils feature multiple constraints, generally. I understand it's about a four-billion-dollar annual cost. The soil constraints bill adds up to an incredible amount of money. GRDC's invested in the project in WA, what are some of the key target points you're trying to achieve out of this, given it's such a massive problem?

[00:03:35] **Stephen Davies** Yeah, so it's a really huge cost, in terms of like the soil constraints, but it's also a big cost for the grower to do these practices. So, there's, you know, the expense of obviously purchasing and spreading the amendments, but then there's the expense of actually doing the strategic deep tillage. So, you know, its high horsepower tractors, it's high diesel use, it's the use of quite expensive equipment, you know, so for them, there's quite a high cost as well. So, this investment was a lot about, well, how can we make sure that, given growers are investing in that, they are getting sort of good yield responses. But how do we avoid some of the pitfalls and make sure we get sort of the maximum benefit, the maximum longevity out of those sorts of investments in soil amelioration? So, we were looking at sort of key things around, well, it can be quite difficult to establish crops on these sorts of loose softened soils so, we're really interested in saying "What can we do in the area of improving crop establishment?" We were also wanting to look at aspects of crop rotation. How's that important? Often, you know, we are going into the soils that have had problems and so they might be weedy, they might sort of have, you know, nematodes and things like rhizoctonia solani in there so, like these soilborne pests and diseases. What can we do, how do they influence that and what can we do in terms of management during the process of amelioration or afterwards to actually help with that? And then the other big one, which is really a massive issue for Western Australia is, soil wind erosion. So, you know, can we sort of look at when we do it and how we undertake these amelioration practices to really try to reduce that risk of wind erosion?

[00:05:08] **Debra Bishop** So you've mentioned soil amelioration being slow and costly.

[00:05:12] **Stephen Davies** Yes, yes.

[00:05:14] **Debra Bishop** You know, obviously our listeners would be relating to that. So, it is necessary, I suppose, to have those long-term benefits and a good return on the increasing investment that they have to put in. What stage of the project are you at in relation to that position?

[00:05:29] **Stephen Davies** So yeah, we're around three years into the project now and I guess we've really worked on each of those aspects of sort of crop establishment, timing of amelioration. And the crop establishment aspect, I guess I should say, you know, covers a whole host of things. So, it's not only about sort of the seeding process itself and soil preparation after amelioration, it's also even things like the pre-emergent herbicides that growers use. One of the key things that was identified was that those pre-emergent herbicides can actually increase their activity and so they can actually start to do more crop damage than they normally would do, and so that's been a really important area of research. And then the other aspect that progress we've made, I guess, is sort of starting to really understand what happens when you actually really mix up those soils and mix up the soil biology, if you like, including things like rhizoctonia and root lesion nematodes, you know, what's the actual impact of that in the longer term?

[00:06:23] **Debra Bishop** Because there are some good nematodes around, aren't there?

[00:06:25] **Stephen Davies** Oh, they certainly are. There's plenty of good nematodes. And I guess sometimes, you hope when you intervene in things that you're actually promoting the good guys and suppressing the bad guys a bit and giving the good guys an advantage, especially the ones that eat the bad guys, we particularly like them.

[00:06:40] **Debra Bishop** So in regard to the initial findings, are there any surprises that are emerging from the research so far?

[00:06:47] **Stephen Davies** In some respects, yes. I mean, I think we're a little bit surprised about in some ways how complex the interactions are with herbicides. And we feel like, whilst we've learnt a lot about it, we feel like there's still a lot more to learn. Initially, I guess we've started to look directly at what the direct impact of those pre-emergent herbicides might be on crops and the change in their bioavailability in the soil once the soil was actually being modified. But we're also sort of starting to think about, well, are there even longer-term consequences for carryover of certain herbicides or sort of longer-term residues, I guess? How does soil amelioration change those things? We sort of see some indications that that gets change for certain herbicides or even herbicide breakdown products. But it's still something that we need to learn a lot more about we feel.

[00:07:36] **Debra Bishop** And there are still some growers who haven't yet adopted the practice. Is that still the case or do you see that more taking this idea of soil amelioration on board? Or is there still some resistance?

[00:07:46] **Stephen Davies** Not everyone's doing it and often they have very good reasons to not be doing it. In a survey that the project actually undertook in 2020, so sort of referred back to the 2019 season, about 50 per cent of grain growers in that season had undertaken some sort of form of strategic deep tillage, so obviously deep ripping being the most common one. But really quite high levels, nearly a quarter of growers have done sort of some sort of deep mixing or soil inversion as well. So, you know, it is highly adopted. The reason that the growers gave us for not doing it. One was cost, obviously. One was that they weren't sure for their soil types that they actually needed to do it. So, you know, some people are sort of blessed with soils are actually pretty good and these aren't sort of the best techniques for them. They might just need other amendments or other practices. And then for others, soil variability in some parts of the State is a big issue. So, it might be that that amelioration practice is good for three quarters of the paddock, but it's another quarter where it will make a real mess. So, for them, you know, that variability in the soil is really a big issue, that it's actually pretty tricky for them to overcome.

[00:08:53] **Debra Bishop** Are there specific grower adoptable outcomes, if you like, you know, such as crop choices, soil pact pressure that you are identifying?

[00:09:01] **Stephen Davies** Yeah, there's quite a number, really, that we, that are coming out of this, I guess. A few of the key ones would be, we're trying to really identify, I guess, those herbicide packages that are safe on ameliorated soils. So, you know, what are the herbicides that growers can use with particular crop types when they're establishing different cereals on ameliorated soils, what are the safe herbicide options they can use and what are the packages, depending on sort of the make-up of weeds, they might have in the paddock too? There's been quite a bit of work that we've done in collaboration with other projects and with people directly on this project, sort of looking at which weeds survive, which weeds really get hammered and which don't. So, really just giving growers that sort of understanding is really important around, once you get some benefit from amelioration of weed control. And whilst the herbicides, you know, can do crop damage, they're actually also more active on the weeds as well. So, it's all an opportunity, but how do we, sort of minimise the downside and maximise the upside? So, that's a really key, I guess, focus for us. In terms of other aspects of crop establishment, yes, certainly, levelling the soil, packing the soil, potentially even using a dedicated seeder, some growers have built sort of quite light seeders that are good for travelling over these soft soils. They're very careful, the way the seeding boots are placed on these dedicated seeders that they don't go too deep and they're really trying to just seed into that moist soil, almost immediately after it's ameliorated. And we've done a bit of work recently, looking at, sort of, one-pass, I guess, spader seeding systems. So that's where, you're sort of, ameliorating the soil with a spader, but it could be with a plough, and you're actually seeding at the same time. So, you're really putting the seed directly into that moist subsoil that you brought to the surface. And we really found that, compared to, sort of, doing it as a two-pass operation, where you sort of ameliorate everything and then you come in with a sort of, a standard air seeder; compared to that, we actually increased establishment in the one-pass system by anything from 20 per cent up to almost a doubling of the plant numbers. So that was a really good outcome. So, that's a nice technique that can give you that better establishment and it can actually reduce the wind erosion risk. But one of the issues working with growers that we found was that, because they don't get the opportunity to use pre-emergent herbicides in that scenario, they did have some struggles with weed control. So, it's still, you have to think about the package, about the variety that you're growing and what your amelioration options are, and the weeds you've got, in the system. So, it really is, thinking about the system and thinking about "Well, how best can I make this work, where I minimise those risks, maximise the advantages?" We have found, I guess, the other thing that we're really trying to get across to growers is information around how these things interact with things like rhizoctonia and root lesion nematodes. So, one of the things this project has done for the first time, it's never really been looked at, is if you physically move these soils with a plough or with a spader, for example, deeper into the subsoil, what actually happens to them? Do they actually live? Do they survive? What does it mean for their predation on the crop roots and their damage to crop roots? And, what's the impact of that? So, it's been really exciting work, just because it's never really been considered before. And, you know, we've certainly found that, yes, they survive, but their impact on the crop seems to be less. So obviously, the crop can sort of establish without those things impacting on it initially and perhaps seem more resistant. We're still trying to fully understand the mechanisms. In some of the experiments, we sort of saw the nematodes sort of basically recolonise the soil surface, but potentially still do a bit less damage. And then, in some cases, the damage was still there. And so, another aspect we've looked at is crop rotation. So certainly, combining amelioration, you will still generally grow a cereal cover crop in the first year. But then, if you go into a break crop that isn't a host for your particular soilborne pest or disease, that can be a really good way of, I guess, an integrated pest-pathogen, you know, management approach that actually really keeps the numbers low and actually really keeps an advantage in, sort of, maintaining a benefit.

[00:13:05] **Debra Bishop** You're packing a lot into this project.

[00:13:07] **Stephen Davies** There's a lot going on.

[00:13:09] **Debra Bishop** Yeah, for sure. And GRDC, I mean they're investing here, it's a West Australian focussed project. Are there any impacts or outcomes that could be translated nationally, for our listeners?

[00:13:19] **Stephen Davies** Look, I mean I guess, certainly through the southern region, you know, they are certainly adopting these sorts of soil amelioration practices too, and the principles around crop establishment, the principles around the impact on weeds, and disease is certainly transferable to a fair degree. And I guess it's just really a bit of a reminder that, you know, when we undertake these practices, we're impacting on a whole host of components in the system. Even the way soil applied herbicides actually, sort of, react and how long they stick around for, and how effective they are. And so, we actually need to consider quite a lot when we make these changes and I guess, this was, this really came out of that, it came out of the fact that, you know, we still had a lot of unanswered questions. And I guess it's important to note too, that, you know, GRDC also invested in other work with DPIRD on crop nutrition implications and Dr. Craig Scanlan has worked on those about what does it mean when you ameliorate soils in terms of, you know, the supply and demand of crop nutrients. So, there's a whole host of aspects that we've been trying to understand more of.

[00:14:21] **Debra Bishop** Impacts on pests and diseases is sounding as though it's the new point of this particular project that you're looking at. Is there anything else that causes this project to be different to what we've done before in WA?

[00:14:32] **Stephen Davies** For the first time, we have sort of been comparing some of these different seeding system approaches. We've also did a little bit of work recently in collaboration with Dr. Greg Rebetzke, from CSIRO, where we sort of, did use some of his long coleoptile wheat lines on ameliorated soil. So yeah, kind of the perfect example of, you know, where a trait is identified that has, really, a lot of benefits in a lot of circumstances. But, ameliorated soil is almost the perfect scenario for long coleoptile wheats, because you put these implements through the soil, the soil becomes very loose and soft and so it's quite difficult to maintain sort of, an accurate seeding depth. It's quite difficult to stop your seeder it from sinking into the soil and sowing your seed too deep. So, these long coleoptile wheats that can actually sort of, just manage that and just come up any way and give you good establishment, good ground cover, sort of, start protecting the soil. It just worked really, really well so they were as effective on ameliorated soil as it was on non-ameliorated sandplain soil. And there really are quite a few challenges to crop establishment. So, not only do we have, sort of, those herbicide impacts, but the soils can move a lot, they're sort of loose and unconsolidated, so the furrows often fill in. So, wind will just sort of blow the soil and the herbicide into the furrow, affecting crop establishment. You can get scenarios where, if you bring up a subsurface soil, which sort of has more than five per cent sort of clay, even seven to 10 per cent clay in it, if you sort of seed it and then get a rainfall event and then it dries out, the surface actually forms a light crust. It's partly due to the fact we buried the organic matter so we've kind of just brought up, like, almost a bit more of a pure soil. And so, it's a bit prone to crusting and if a wheat seed or a cereal seed is sort of put in a bit deep and it's actually trying to push, its leaves sort of emerge from the coleoptile that's actually trying to push a leaf through that crust. If there isn't rain to sort of, soften that surface again, they can really actually struggle to break through. So, even that can impact on establishment. And so, all these factors of, whether it's furrow infill, whether it's sort of this soil crusting issue, whether it's just seeding too deep, you know, we feel that the long coleoptile wheats have a place. And so, this work on long coleoptiles will continue in a new national GRDC investment being led by Dr. Rebetzke on long coleoptile wheats and understanding their fit. So, we've got a small component where we're sort of looking, still, at this amelioration aspect, and trying to understand more of it. There's also questions about whether the coleoptile changes the way herbicides actually go into the plant during that early stage, but that's a complete unknown. But it's another really cool question to sort of understand.

[00:17:13] **Debra Bishop** So I suppose in closing, timelines, anticipated outcomes, that kind of thing, in closing for us, Stephen?

[00:17:18] **Stephen Davies** We're actually sort of coming into the final sort of season, the final 18 months of, you know, this GRDC funded project. So, we've actually been doing a number of presentations at the moment on some of the outcomes of our timing of amelioration work and some of these aspects of crop establishment. But we've got a lot more to come, you know, we're sort of, actually, sort of really starting to build up our, I guess, our messages with all the data that we've collected. We've got a final year for some of the projects, on looking at the final outcomes of some of our crop rotation choices and we really want to summarise where we've got to with the herbicide stuff and actually start to give growers some real clear indication of the sorts of things they need to consider and the sorts of options they have. So yeah, it's pretty exciting times to be sort of getting to the crunchy end of the project and really delivering some of those messages for the industry.

[00:18:06] **Debra Bishop** A lot of our listeners will be waiting on those outcomes for sure, given the stretch of this particular constraint across our growing region. Stephen, thanks very much for talking to us today.

[00:18:14] **Stephen Davies** Well, thank you very much. It was good fun.

[00:18:23] **Debra Bishop** And you've been listening to Dr. Stephen Davies from WA's Department of Primary Industries and Regional Development. More information can be found on the GRDC website. I'm Debra Bishop, and thanks a lot for listening.