## Episode 13 – Soil Health & Drainage - Complementary Tools from Conflicting Views

## Season 1, Episode 9

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**John McMaine:** Well, hello everybody. Thanks for joining us on Streamlines, your source for water knowledge. I’m your host, John McMaine.

**Anthony Bly:** And I’m Anthony Bly.

**John McMaine:** And this is Episode 13

[transition music plays]

**John McMaine:** Soil health and drainage. So today we are going to be talking about kind of the intersection of those two concepts and brought in Eileen Kladivko, Dr. Kladivko from Purdue University. I’ll just let her introduce herself.

**Eileen Kladivko:** This is Eileen Kladivko. I’m a professor in the agronomy department at Purdue University.

**John McMaine:** Dr. Kladivko has a kind of unique skill set and expertise. She’s an expert in both drainage as well as soil health.

**Anthony Bly:** Wow, that’s quite a combination.

**John McMaine:** It is! It’s a good one. And so that was, you know, perfect guest. Perfect interview for today’s episode. So, we’re going to dive in to kind of the relationship between soil health and drainage and dare I say, some of the misconceptions? I don’t know, maybe that’s a strong word.

**Anthony Bly:** Yeah, it’s, it’s, it’s okay.

**John McMaine:** Okay. So some of the misconceptions around water management and the, I guess, the limitations of what we can do just with soil health or just with drainage.

**Anthony Bly:** Right.

**John McMaine:** It seems like both sides think of soil health as a silver bullet or drainage as a silver bullet, but…

**Anthony Bly:** Correct.

**John McMaine:** Reality, we need to consider both of those.

**Anthony Bly:** We do.

**John McMaine:** I guess, what are your thoughts just off the bat, around soil health and relationship with drainage? What’s on your mind when we talk about that?

**Anthony Bly:** Well, you know too much water is too much water. I say that a lot and you know, there isn’t a plant system or a way to use sometimes use all that water.

**John McMaine:** Right.

**Anthony Bly:** And so, we have good tools, we have good knowledge about using tile drainage. And so, you know, we, we need to talk about that.

**John McMaine:** Sure.

**Anthony Bly:** And consider their use as a tool.

**John McMaine:** So, one thing I’ve seen since I’ve been in South Dakota is, it’s almost a taboo in some ways to, to even bring up tile drainage as a possible management.

Or on the flipside, that tile drainage is the only answer to the drainage problem and its likely that the truth is somewhere in the middle.

So, Anthony, you work with soil health a lot, maybe, could you just define what soil health means to you?

**Anthony Bly:** There’s so many good definitions and I don’t really harbor any one of those. But I think, most importantly is the, is the soil defined by its functioning capability.

**John McMaine:** Okay.

**Anthony Bly:** And so, that involves, you know, a good soil structure. It involves porosity. It involves a low loss rate, so low erosion rates.

**John McMaine:** Okay.

**Anthony Bly:** And that does not include being saturated.

**John McMaine:** Sure.

**Anthony Bly:** I mean, a healthy soil is the porosity is half air half water.

**John McMaine:** Sure.

**Anthony Bly:** We know that.

**John McMaine:** Yeah.

**Anthony Bly:** And so that’s a well-functioning soil. And so, if it’s saturated, it’s not functioning.

**John McMaine:** Yeah.

**Anthony Bly:** The way we would want it to.

**John McMaine:** Unless you’re in a wetland.

**Anthony Bly:** Unless you’re in a wetland and, and we have to, we have to decide how important they are and which ones are important and those need to be recognized.

**John McMaine:** Right.

**Anthony Bly:** More strongly. I do believe.

**John McMaine:** And, not to throw a wrench in your definition there. It just, it just came to mind that that is a well-functioning soil. But then there’s also other landscapes that, you know, soil health or a functioning soil for that purpose would be defined differently.

**Anthony Bly:** Sure.

**John McMaine:** Like a wetland or something like that.

**Anthony Bly:** Sure. Depends on its purpose.

**John McMaine:** Yeah.

**Anthony Bly:** I was more thinking towards agricultural uses.

**John McMaine:** Yeah.

**Anthony Bly:** Plant growth.

**John McMaine:** Yeah. I agree. I agree.

**Anthony Bly:** But no.

**John McMaine:** Unless, unless you’re a cattail.

**Anthony Bly:** That’s true. And, and I, or a duck!

**John McMaine:** Or a duck, yeah. So, going back to this kind of water use efficiency or how much water a plant can pump out of the ground and return to the atmosphere, would you say when we were back in a prairie system before, you know, any plowing was done.

It was native prairie, how much water that fell, say we had 22 inches of precip a year, how much did that can run off, how much is infiltration, how much ET in, in I guess, you don’t have to give me numbers necessarily, but would you say, we need to get back to that with our current agricultural system? Like is that a failure of our agricultural system because we’ve changed that hydrology?

**Anthony Bly:** Yeah. I, I think it is. When I speak and talk, I’ve learned from several that, you know, the prairie started using water early and it, and it late.

**John McMaine:** Sure.

**Anthony Bly:** And our warm season agronomic crops really only use it during two months out of the year.

**John McMaine:** Sure.

**Anthony Bly:** Realistically speaking.

**John McMaine:** Yeah.

**Anthony Bly:** And so that water cycle has been disrupted.

**John McMaine:** Okay.

**Anthony Bly:** Or some say broken.

**John McMaine:** Yeah.

**Anthony Bly:** And yes, I, I do believe that we need to strive for designing our ag systems so that they more mimic that original prairie capability.

**John McMaine:** Okay.

**Anthony Bly:** But we have to realize that ag, ag economics and social economics and the needs of our society are highly important.

**John McMaine:** Right.

**Anthony Bly:** And so, we just don’t go from one to the other in an instant. This is something we need to really motivate ourselves towards.

**John McMaine:** Sure.

**Anthony Bly:** But learn about it.

**John McMaine:** And there’s a continuum too. I mean you have the native prairie system and then you come back to maybe the other end of the spectrum, say maybe corn bean. I mean I don’t want to throw corn and bean under the bus, but…

**Anthony Bly:** No, you’re right.

**John McMaine:** If, if we go to the other, like, to the agriculture end of the spectrum you have corn and beans on one end.

**Anthony Bly:** Correct.

**John McMaine:** And you have the native prairie on the other end. But native prairie, I love native prairie, it does not necessarily produce the same caloric content if you will.

**Anthony Bly:** It doesn’t feed the nation.

**John McMaine:** Yeah. So, the reality is that it is likely somewhere in the middle of having agriculture productivity while also maintaining and this is not about ecosystem services this, this episode isn’t. But while also maintaining those ecosystem services that the native prairie provides.

**John McMaine:** Okay. We got way off script there. So, let’s bring it back to the first question I asked Eileen was kind of, what’s the relationship between drainage and soil health?

**Eileen Kladivko:** I do think that sometimes we have to make sure people are talking the same language when we say drainage. So, we have a lot of soils that are naturally poorly drained. So they have a high water table, not because of mismanagement but because there is some layer in the soil that’s holding water up, and it might be a dense till, it might be a fragipan, so therefore the soil naturally has a high water table, and so, at least at certain times of the year, and so you need to have a drainage system installed so that the water table is not quite so high, in order to grow crops and in order to improve soil health, and so, I see them as working hand in hand, in order to improve soil health and do a good job with conservation, you have to have an adequate drainage system, there needs to be good aeration in the soil, so I see them going together.

**John McMaine:** So back to your point, good soil health or healthy soil has adequate aeration, adequate pore space. Have you seen situations on your own farm or talking to producers where the limitation was a high-water table and because of that high water table, the soils maybe couldn’t function to even implement soil health practices?

**Anthony Bly:** Absolutely.

**John McMaine:** Okay.

**Anthony Bly:** Oh that’s, that’s very common.

**John McMaine:** And you have some tile on your farm?

**Anthony Bly:** Correct.

**John McMaine:** What was your through process when you installed that and then how did your management change, did it change after you installed the tile?

**Anthony Bly:** Well, that tile was installed in a targeted fashion.

**John McMaine:** Okay.

**Anthony Bly:** Where we had a problem and we tried to use tile as a tool to lessen that problem.

**John McMaine:** Sure.

**Anthony Bly:** So, these areas of the field were not drying out as soon as the rest of the field.

**John McMaine:** Okay.

**Anthony Bly:** And so, field operations, were either delaying the rest of the field or we had to come back and treat those areas of the fields that were wet when they dried out.

**John McMaine:** Sure.

**Anthony Bly:** And that’s not efficient.

**John McMaine:** So, then when we think about soil health practices, say no till and cover crops, were you able to incorporate any of those more effectively after you had tiled?

**Anthony Bly:** Absolutely! I mean, we found ourselves maybe doing targeted tillage on these, these wetter areas because a lot of the tile we would leave roots there, or you know, a mess. Some people would say, “Why wouldn’t you just leave them alone?” Well, they’re some of the most productive soils or have the capability of some of the highest productivity there is around.

**John McMaine:** Sure.

**Anthony Bly:** So, it’s just not that tempting to do that. So yeah, you use tile drainage as a tool to target those areas and to improve those and bring them along with the rest of the field.

**John McMaine:** I appreciate you bringing that up about kind of the perspective of just leave it alone. I mean that’s, that’s a valid management practice. To leave it alone. And from the agronomic perspective, you’re missing out on potential profit.

**Anthony Bly:** Absolutely.

**John McMaine:** So, would you say the converse of leaving it alone and okay, so you tile, you know, target tile, farm that and now you’ve introduced maybe cover crops and no till. Maybe grazing, whatever soil health practices or principles you want to apply there. How close do you think we could get to the function of that part of the field with soil health practices?

**Anthony Bly:** I think you’re light years off. I, I mean, I think leaving it alone, you’re giving up on it.

**John McMaine:** Sure.

**Anthony Bly:** And you have to bring in a different, different management style.

**John McMaine:** Okay.

**Anthony Bly:** To take advantage. That’s, that’s kind of hard, that’s kind of the wrong way to say that. But to use that resource.

**John McMaine:** Sure.

**Anthony Bly:** In its correct way. You know that would involve mixing management styles together.

**John McMaine:** Okay.

**Anthony Bly:** And, and, and there’s nothing wrong with that! A lot of people have time to do that.

**John McMaine:** Right.

**Anthony Bly:** But we need to decide, what, where we’re going to grow crops and where we’re not.

**John McMaine:** Sure. And then from the ecosystem services of soil health practices, if you tile and then implement soil health practices there, do we regain any ecosystem services that we would have had if we left it alone? Does that question make sense?

**Anthony Bly:** I, I, I don’t know. I think those soils that are tiled and, and, and we help, help the drainage out with the pipe, you know if we increase the productivity on the soils, we are, you know, in a sense, capturing more carbon that we would’ve if we left it alone.

**John McMaine:** Sure.

**Anthony Bly:** I think that’s, there’s that opportunity there. Whether that’s a direct ecosystem service or not. Probably lose some of the water filtering capability.

**John McMaine:** Okay.

**Anthony Bly:** But you have to realize that most of these targeted areas have huge amounts of erosion deposition.

**John McMaine:** Sure.

**Anthony Bly:** And so, they’re artificially created.

**John McMaine:** Yeah.

**Anthony Bly:** From the original landscape, you know, we’ve added alluvium.

**John McMaine:** Sure.

**Anthony Bly:** You know, sediments there and it’s trapped that high water table so it’s kind of, we’re actually tiling as a result of past plowing practices.

**John McMaine:** Gotcha.

**Anthony Bly:** Okay. So, one problem created another problem. And we really need soil health to stop that issue.

**John McMaine:** Sure.

**Anthony Bly:** Stop that problem in the first place.

**John McMaine:** And then in those areas, we need the drainage to implement the soil health.

**Anthony Bly:** Correct.

**John McMaine:** So, when we think about managing water. If you look at the water balance, the water can either go into the ground, infiltration, it can runoff the top, or it can be stored in the soil or on the surface, or it can go back into the atmosphere as evapotranspiration or ET. And one of the things we’ve changed about the hydrology when we converted from native prairie to crop land, was the ET. And like you’ve mentioned earlier, if we have corn, row crop, that, that use, the water use is maybe two months a year for really high, you know, pumping that water out.

**Anthony Bly:** Correct.

**John McMaine:** Versus a native prairie that maybe you’re pumping water out all year round.

**Anthony Bly:** Correct.

**John McMaine:** So, one of the questions I asked Eileen was are we able to within an agronomic system overcome this imbalance of water in an agronomic system, so we don’t have the issue of having too much water in the first place. And this is what she had to say.

**Eileen Kladivko:** I think in most of the situations I’m familiar with, in the Midwest, the highwater table is usually during winter and early spring when we don’t have crops growing. And even if you had a perennial, it would use some water maybe later in the fall, earlier in the spring, but it would not use enough to solve that high water table problem. So, I don’t think we can overcome the highwater table by changing the cropping system that we have, in any kind of normal-agricultural settings. I mean the highwater tables occur... and you’re a little further north, so some of yours may... I mean, I’m sure they’re there in the winter but you may have, you know, even more of the issue in the spring, but they come during the normally fallow season, so yes, if you had something growing, it would take up water during some of that time period, but it doesn’t take up very much water in February or march, when it’s cold, even if you had something growing. So, the ET, the potential ET at that time of the year is not great, it would not be enough to lower that water table enough for the kinds of crops that we grow. Like in Australia, when they changed some of their land from some of the... the salinity issues in some of those areas where the water table has risen because the crops, they grow don’t use the water as much as what the native trees did, the native trees that have roots that went down 20 feet. And so, when their water table rose, then they ended up bringing salts that had not been anywhere in the cropping root zone. And their crops simply don’t use the same amount of water as those trees that had roots way, way down. But I don’t think that’s the situation in the Dakotas either, right? The things that you could grow, unless you’re going to go back to native vegetation, which isn’t much of an agricultural crop, they’re not going to be able to handle any of that water table, by just by ET.

**John McMaine:** So.

**Anthony Bly:** There’s the problem.

**John McMaine:** And again, if we go back to this continuum and we have native prairie on one hand and agriculture systems on the other hand. From the ET perspective, from using the amount of water we have, we can’t. Would you say that’s true? That we can’t.

**Anthony Bly:** Use it all?

**John McMaine:** Use it all.

**Anthony Bly:** This year, we can!

**John McMaine:** That’s true. This is a dry year, so this year we could.

**Anthony Bly:** I, I think we have to think about weather extremes now and when we pile water up, yeah, we can’t. But when we’re short, we can and that’s why we had discussions on conservation water drainage. But yeah, I mean in ’19, there was no way.

**John McMaine:** Right.

**Anthony Bly:** That the system was going to use it. Even the native system, I’m, I’m convinced.

**John McMaine:** Sure. So even with a healthy soil structure, you can only infiltrate and store so much in the soil profile.

**Anthony Bly:** When it’s full, it’s full. Unless there’s something taking it away. A vein of sand or gravel or something like that, taking it away.

**John McMaine:** Right.

**Anthony Bly:** There’s only so much we can put in.

**John McMaine:** Which is a grain of, or a vein of sand or gravel is basically a natural tile system.

**Anthony Bly:** Correct. Yes, it is. I mean a lot of our outwash plains, you know, can do that.

**John McMaine:** Yeah.

**Anthony Bly:** But they fill up too.

**John McMaine:** Sure.

**Anthony Bly:** I’ve seen that.

**John McMaine:** So, in that situation, is there any alternative? I mean for an agriculture system, is there any alternative to tile on that situation?

**Anthony Bly:** I don’t know of any, unless you go in a full fledge grazing system but at some point, the wetland nature of the soil is going to take over and you can’t, you know, it’s, can you graze wetlands? You know.

**John McMaine:** Sure.

**Anthony Bly:** And the answer I think is no?

**John McMaine:** Right.

**Anthony Bly:** I mean, cows ain’t going, aren’t going to like that.

**John McMaine:** Yeah.

**Anthony Bly:** So, then we go back to the wetlands.

**John McMaine:** It could wear little water wings maybe and get out in their canoes.

**Anthony Bly:** Yeah.

**John McMaine:** That would be a nice agritourism thing. Come see the cows in the wetlands.

**Anthony Bly:** Yeah.

**John McMaine:** So, but then on the flipside, I think there’s also the, the misconception that drainage is a silver bullet. And so, thinking about if it is a high-water table versus if it is a well-functioning soil, if it’s not a well-functioning soil, and you put a tile system in, and then you just wasted a 1,000 bucks an acre on that tile because you’re, if you’re soils garbage then the waters not able to make it down to the tile.

**Anthony Bly:** Absolutely. That, that’s why we need education. That’s why we’re sitting here today.

**John McMaine:** And as we discussed, really these systems, although they’re pitted against each other, it’s critical to think of them as tools in the toolbox and kind of in conjunction. And so, Eileen discusses that, or describes that really well in this next clip.

**Eileen Kladivko:** So basically, again they go hand-in-hand. If a soil was naturally poorly drained, then various conservation practices like cover crops and no-till, won’t work very well, because there’s not enough aeration in the soil and that water table is too high. Once you install a drainage system and you lower that water table a little more quickly, then cover crops can grow really well, and no-till can work well. And so, you get much more benefit from the conservation practice, so I don’t see them as “either/or” I see them as “both/and”. Get an adequate drainage system installed, then you can do a good job with cover crops and no-till. And then, that improves the internal drainage of the soil, the internal permeability, but the water table itself, it doesn’t matter how good of a soil health you have, if you have an impermeable layer that holds water up at 3ft down, that’s another matter of management, that’s a matter of installing a drainage system, so I think they work very much together.

**Anthony Bly:** So, she’s talking about those poorly drained soils.

**John McMaine:** Right.

**Anthony Bly:** And I, you know, I think we have to think about whether they’re wetlands or not.

**John McMaine:** Okay.

**Anthony Bly:** Because we have, we have rules and regulations about those soils.

**John McMaine:** Right.

**Anthony Bly:** And, and we’ve designated them as, you know, soils that need to be protected.

**John McMaine:** Right.

**Anthony Bly:** For certain reasons.

**John McMaine:** Yeah.

**Anthony Bly:** For, for those ecosystems’ services.

**John McMaine:** Yeah.

**Anthony Bly:** So, we just don’t roll in and drain any poorly drained soil. I mean we have to; we have to get that.

**John McMaine:** Yeah.

**Anthony Bly:** That work done.

**John McMaine:** Yeah.

**Anthony Bly:** Before I was referring to soils that were poorly drained because of our past agricultural practices.

**John McMaine:** Sure.

**Anthony Bly:** That caused them to be that way.

**John McMaine:** Sure.

**Anthony Bly:** You know those are poorly drained because they’re just, they’ve got so much sediment in them that they’re holding the water back.

**John McMaine:** Sure. Yeah that, I appreciate you bringing that distinction up Anthony. I think that’s one thing we don’t talk about enough, at least we haven’t so far, is natural wetland systems. We talk about constructed wetlands in this season of conservation drainage. But natural wetlands, they provide a lot of ecosystem services, a lot of function to the landscape that we lose if we do drain those. We’re seeing that in the coast, and we definitely see it within the Midwest because you have systems that have evolved over time to cycle nutrients with these wetlands in place.

**Anthony Bly:** Correct.

**John McMaine:** And to manage flooding with these wetlands in place and so if we remove these and habitat too, I mean, you have flyways and breeding grounds for lots of waterfowl and things that depend on waterfowl. And so, when we remove wetlands, we do lose those ecosystem services. So, we gain maybe agricultural productivity, but at a cost. I mean it, it has a real societal, environmental, and economic cost. So, I do appreciate you bringing that up. That’s a very important consideration.

**Anthony Bly:** Absolutely. It’s all about land use.

**John McMaine:** Yeah.

**Anthony Bly:** And not applying the same paintbrush to the whole landscape.

**John McMaine:** You paint the landscape?

**Anthony Bly:** It’s fun.

**John McMaine:** Paint it green.

**Anthony Bly:** Well, every farmer who has precision ag in their tractor is, is painting the landscape.

**John McMaine:** This is true. This is true. Yeah, take out the yield monitor and, and the profitability map and see red spots, you see green spots.

**Anthony Bly:** And when you plant, you know, you’re painting the landscape with your planter, and yeah.

**John McMaine:** Alright, I’ll take that metaphor.

**Anthony Bly:** I, I think, I think it can relate to that very well.

**John McMaine:** Yeah. I like it. So, one thing you touched on earlier, Anthony, was I guess the ideal soil profile. Not even from a soil health perspective but the makeup, the composition and that includes air.

**Anthony Bly:** Yeah.

**John McMaine:** And that, and that is not, if you deal with soils, it’s something you think about a lot. If you don’t deal with soils, it’s not something you necessarily think about, but kind of that breakdown of mineral content, organic content, and then pore space or air, space for air. And then it’s filled up with water, well, then its tough for that to be a productive soil. And so, Eileen talks about how drainage or how freeing up that air space, that pore space, how that leads to either directly or indirectly improved or changed soil health.

**Eileen Kladivko:** So again, on a naturally poorly drained soil, some type of a drainage system helps us improve soil health, in a couple of different ways. First of all, it allows the crops that we do plant, to grow better, whether that’s our cash crops or our cover crops. So, when they grow better, we get more root growth, we get more root exudates that feed the soil microbes that help build soil aggregation. The roots grow deeper if we add a drainage system, and so, again that can help build soil aggregation, soil structure, deeper in the soil profile. We can successfully do some of the other conservation practices that don’t work very well when the soil is too wet and doesn’t have enough oxygen. So, no-till and a lot of our cover crops just don’t perform very well when the soil is too wet for too long and doesn’t have enough oxygen. And we know that both no-till and cover crops do a great job of improving soil health, but they have to work. And if it’s too wet and there’s not enough oxygen, they don’t work. So, then you have poor crops, poor cover crops, poor rooting, poor exudates, and so there’s not a way to improve the soil.

**John McMaine:** So again, it’s a hand in hand thing, it’s both, and

**Anthony Bly:** Correct.

**John McMaine:** Often in South Dakota we do have situations where we can do no till in cover crops without drainage. Would you say that’s true?

**Anthony Bly:** Sure.

**John McMaine:** Okay.

**Anthony Bly:** Yeah.

**John McMaine:** But would you say that failures or people that are wanting to try soil health practices, how often has that been thwarted by poor drainage?

**Anthony Bly:** Well. The last thirty years, more often.

**John McMaine:** Sure.

**Anthony Bly:** I mean, we started getting wet in the early eighties.

**John McMaine:** Okay.

**Anthony Bly:** And then kind of dried out. And then the nineties came and we had some years of wet, wetness. And then it just kind of primed the pump and it’s, it’s wetter and wetter.

**John McMaine:** Yeah.

**Anthony Bly:** So, it’s more frequent now.

**John McMaine:** Okay. 2019, one of the wettest years on our record.

**Anthony Bly:** Wettest ever.

**John McMaine:** If you decided that was the year you were going to try cover crops, then it wouldn’t have stuck because you would have tried it with poor drainage and then your cover crops would’ve all died and then you just lost thirty bucks an acre and you’re done with that.

**Anthony Bly:** Correct, in those wet areas. You couldn’t even drive in them. So, I mean, you wouldn’t, wouldn’t have planted a thing.

**John McMaine:** I guess, you would’ve gotten the cover crops out.

**Anthony Bly:** No.

**John McMaine:** Right.

**Anthony Bly:** No.

**John McMaine:** So, I’m sure there would be situations where someone would be wanting to try something and if they tried it, with the thought that just doing the cover crop would improve the water management situation. But then it would fail or potentially not do as well as they hoped and so then that would be the reason that they don’t continue with cover crops. So, I guess that’s one reason that I see, you know, drainage and soil health working together, that it accelerates success or has more potential for success by having good drainage that we, we have successful soil health implementation.

**Anthony Bly:** Well if you’re managing your access water with, with the drainage then the capacity to take in more water is there for, for the, for the healthy soil.

**John McMaine:** Sure. So, I want to go back to this point, or to this differentiation, in like we mentioned earlier, there’s kind of two pieces of water management. One is when the rain falls lands on the surface, it has to go into the ground and then the second piece is the subsurface and that’s what we kind of address with the tile. But again, tiling is not a silver bullet if the water can’t get into the surface, then it cannot make it to the tile. So, I asked Eileen to kind of expand on that. This is what she had to saw.

**Eileen Kladivko:** When we improve soil health, whether that’s by cover crops or no-till or other practices, we improve a lot of different soil properties that we kind of lump under soil health. But some of those are pore-size distribution, aeration, water-holding capacity, permeability, or saturated hydraulic conductivity, or whichever way you want to express that. Infiltration of water in the first place. So, by improving those... so sometimes people talk about something that’s poorly drained, they don’t really mean naturally high-water table, they mean that the soil is crusted, that it’s compacted, that there is a plow pan at 8 inches, and that’s holding the water up. So, when we improve soil health, we do improve all of those things, right? We reduce crusting, we improve the stability of the soil surface so water can get in, but air can get in, roots can grow, the pore-size distribution changes, so that we have some pores that are big enough that we can let water drain through, other pores that are medium size that hold water, so that’s how we’re changing... that’s how soil health can improve water relations in a soil, by allowing the water to infiltrate and percolate, and have air in there as well, John, “So you could install a drainage system and still... like it wouldn’t necessarily solve the problem if you had a poorly functioning soil, I guess?” Yes, correct. Sometimes people will say ‘well oh, I’m installing a drainage system so now all my water problems are solved’, and then, low and behold, a few years later, I remember one of my senior colleagues telling me this a long time ago, he said, ‘you know, they put in a drainage system and it work really good for a few years, and then it seems like they still have ponded water on the field, and then they say ‘well I’ve got to go put in some more tile because I’ve got ponded water.” Well, in that case, they didn’t change their management at all, right? They’ve got compaction, they’ve got crusting, and they’ve got erosion, and so their problem there is that it’s a poorly functioning soil and they need to improve overall aggregation and stability in soil structure, and soil percolation and things like that and that’s not solved by putting in a drainage system.

**John McMaine:** So, I want to bring up one more question and this is, I’m just, I’ll just ask it, then we can discuss. So, positives of having good drainage. So, at the bottom of the soil profile and good infiltration, and good flux or movement through the root zone is you can effectively move water. The downside is you also effectively move whatever is with the water.

**Anthony Bly:** Correct.

**John McMaine:** So, let’s say we have no till. We have awesome soil structure; you love to see it right? You got a nice cake consistency and aggregation, but that means water is getting to the drain faster. How do we address nitrate and other soluble nutrient issues with that?

**Anthony Bly:** Well, we look at when the crop is using those nutrients. We have to consider that, and we have to make our mobile nutrient applications more closely to that time.

**John McMaine:** It’s maybe one thing that we don’t think about a lot. Is when we change our soil health practices, we also need to change how we manage our nutrients. Because there is maybe more potential for loss because our soil is functioning better. Is that true?

**Anthony Bly:** That could be. Yeah. That, I, I see the potential for that.

**John McMaine:** Okay.

**Anthony Bly:** You know there’s, there’s a couple different ways, you know we can think about water moving through the soil, through the macropores.

**John McMaine:** Okay.

**Anthony Bly:** And also the micropores.

**John McMaine:** Sure.

**Anthony Bly:** And usually, the micropores are the storage tanks where we hold the water and then macropores really function as that deep water percolation. So, if our mobile nutrients are in the macropores, we can actually get water moving through the macro, macropores. And we call that bypass flow.

**John McMaine:** Okay.

**Anthony Bly:** So, we’re holding the nutrients in the micropores.

**John McMaine:** Yeah.

**Anthony Bly:** While the bulk of the water is going through the macropores.

**John McMaine:** Okay.

**Anthony Bly:** And I, I think that, that does happen in really healthy soil environment. Because that, that earth worm burrow or that old root channel is, is open.

**John McMaine:** Yeah.

**Anthony Bly:** And it’s conducting water through it. The, the nitrate isn’t in that pore, it’s in the micropores and so, so that’s when we have that chance, that bypass flow could happen.

**John McMaine:** Okay.

**Anthony Bly:** Right there in the soil itself.

**John McMaine:** So as long as we can apply nutrients in a way that they end up in the micropores or end up being stored, versus having nutrients that are applied and immediately, like that is there only path. I mean, the retention time or the residence time through the soil profile from top to bottom if the nitrates there, it’s going to move. But if we can apply it such that it stays in the micropores, that’s what we want.

**Anthony Bly:** Right.

**John McMaine:** Okay.

**Anthony Bly:** Exactly. I, I think we saw that in the, in the Lake Erie with phosphorus.

**John McMaine:** Sure.

**Anthony Bly:** The phosphorus was put on top, it tends to dissolve with the rain fall and go through the earthworm channels to the tile drain. And if it was incorporated into this soil, then it bypassed it, it did not pick it up.

**John McMaine:** Sure.

**Anthony Bly:** On the, on its way down.

**John McMaine:** And so, the same could apply for our nitrogen species, yeah. I guess, what’s your thought on that?

**Anthony Bly:** Well, it, it really depends on soil type and, and things like that. And, and the amount of rainfall we do get on average is less than, than it is in the high states and farther east.

**John McMaine:** Sure.

**Anthony Bly:** And so we tend to be more drier.

**John McMaine:** Sure.

**Anthony Bly:** And so those big rains that do come, stay in our soil profile.

**John McMaine:** Sure.

**Anthony Bly:** They don’t have the tendency to go right, right to the pipe. So, we do have that on our side.

**John McMaine:** So, then maybe it goes back to nutrient management, is important so we don’t hit those. I mean there are options available to make it stay in the soil, but we have to be thoughtful about that. Deliberate how we would apply nutrients so we don’t end up with bypass flow that also contains nitrate or other soluble nutrients.

**Anthony Bly:** Right. Absolutely.

**John McMaine:** Okay.

**Anthony Bly:** Yeah.

**John McMaine:** Alright, so we can have it all. Is that what you’re saying?

**Anthony Bly:** Oh, I, I think, I think we can get to a point where we’re doing the best job that we can.

**John McMaine:** Okay.

**Anthony Bly:** I don’t know if that’s having it all but, but it, we can feel really good about that.

**John McMaine:** Yeah, we’ll still, if we do everything perfectly, we’ll still leak nutrients?

**Anthony Bly:** Oh I think so because we are applying nutrients.

**John McMaine:** Yeah, yeah. We don’t have 100% nutrient use efficiency.

**Anthony Bly:** Right. Right. It’s not a perfect system.

**John McMaine:** Yeah.

**Anthony Bly:** But we can get as close as we can.

**John McMaine:** Right. Make it function, I guess, yeah. Make it move across that continuum of improved soil health that gets us maybe closer to the natural system. From a soil function perspective and then also from an ET perspective, we have more growing season in essence. And so, yeah.

**Anthony Bly:** I, I think it’s about protecting our natural resource.

**John McMaine:** And there’s no silver bullets, tile, soil health, it’s part of, it’s all tools in the toolbox. And then also thinking about how that effects other things, yeah. So, thinking about it from a systems perspective and thinking about implications across the system so tile impact soil health, soil impact infiltration. And in both of those impact to nutrient loss.

**Anthony Bly:** Yeah.

**John McMaine:** I think that’s a great place to stop for today and we’ll let you think about ways soil health can be affected by drainage, even if it’s not a water table issue. Today we covered the relationship between drainage, so kind of what’s at the bottom of the soil profile, and soil health, or what’s at the top of the soil profile, water table issues, and other potential issues related to drainage. Next week we’ll discuss solutions to these issues, newly studied aspects of soil health, potential benefits and more on Streamlines, your source for water knowledge.

[transition music plays]

**John McMaine:** If you’d like to learn more about soil health and drainage, find us on the SDSU extension webpage and we’ll also be posting links to more resources from Dr. Kladivko and her great work in Indiana, but for now, I’m John McMaine.

**Anthony Bly:** And I’m Anthony Bly.

**John McMaine:** And we’ll catch you next time.