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Cooley Ludtke: That's Joe Scrimger, multi-generational Michigan farmer and agronomist. On today's show Joe explains how too much nitrogen damages soil life and our waterways. We'll investigate Joe's strategies to improve soil vitality, crop health, and your bottom line. This is Farms for Tomorrow and I'm Cooley Ludtke.

Cliff Scholz: And I'm Cliff Scholz.

Cooley Ludtke: Let's get into it.

[00:00:43]

Part 1: Nitrogen, Water, and the Farm | Length: 6:44

Cliff Scholz: Joe, we've had a number of conversations over these last few months and one of the big things I learned is that good nitrogen management is key to solving many problems farms are having right now.

So, where's a good place to start this conversation?

Joe Scrimger: Well, at this stage of the game there's conventional ag that I moved back to focusing on. In the last how many years, I was more focused on organic and biological. And then some new conventional farmers.

But in dealing with the water quality issue, all farmers need to address that, 'cause there is some problems on some of the organic farms, too. The problem in water quality systems in the conventional world is pretty much focused on phosphate.

And it's measurable: it's there. It is a problem. But it's been caused by the overuse of nitrogen. And I'll say that's been a gradual process that, for lack of better words, I'll say it sort of snuck up on the farmer. I'm not sure some of 'em realize this progression that they've made, where, I've been at this long enough and my hair shows it in having grown up on a, sort of a

conventional dairy that was doin' some biological things because they always did that. And they were doin' a few organic things, but they didn't call it that back in the '60s.

So I've had early exposure. I mean I know a lot of researchers at Kellogg Biological Station in Michigan State and at other universities, that are very good, educated, might be master or doctorates, but they don't have the past experience and they haven't seen the transition.

And so they're takin' it from today or maybe the last ten years and, you really gotta, in agriculture, because these changes are slow, you have to look at it over a broader time. And in respect to the food part of it, I like to look at it on a 100-year basis, even though I've only seen 50 but I try to research that other 50. And on the nitrogen side of it, that problem's been there for quite a while.

I'll give you one example. There was a lot said recently about, lead pipes in Flint and the problem with their system. When I was a young boy, I stayed with my aunt in Flint, my dad's sister. And I was probably early teenage, 12, 13. And we fished the Holloway Reservoir. And that was a reservoir that was put in for energy production. And there was turbines there.

But it was put in as Flint's water supply. And it's actually just northeast of Flint. And that water comes from my neighborhood that I grew up in, in the Thumb. But by the time they go to the '70s, and this was never mentioned in the Flint water crisis, what happened was the nitrates got so high in that water that Flint, after they'd invested in the Holloway Reservoir, moved to other sources of water.

And they weren't actually as good. And the reason was they thought it was gonna cost too much to have the farmers better manage their nitrogen. And that was happening in the '70s already. And actually, the farmers were only putting on half as much nitrogen then as they are now.

So that's an attention-getter to me, where some of this new breed of researchers hasn't saw that. And even Dan Wyatt, who lost his job over that, who I know personally, 'cause he was the head of the Department of Ag, he doesn't understand it, either. He's younger than me. So I see those

examples.

But then now, I track with Lake Erie and track with Saginaw Bay. And the Nature Conservancy is doin' a huge project that's financed by the USDA on those watersheds and the Raisin River.

So I've worked with the Raisin River watershed. I did a program for them couple years ago online, for the Raisin River growers. Although the big farmers didn't show up, the small farmers did. Small farmers don't tend to be the problem, it's the larger farmers that are puttin' on the heavy dose of nitrogen.

So again, the nitrogen's not the issue. It's putting on too much at one time. Plants need nitrogen. And plants can handle nitrogen up to a certain point, which happens to be about average of 70 pounds.

Cliff Scholz: Okay, so just for our non-farmers out there, “70 pounds” means, 70 pounds per acre per application.

Joe Scrimger: It's just that most of 'em are usin' 150 and a lot of 'em are puttin' it on because of the size of their farms.

They're puttin' it all on at one application. And then some of 'em are trying to use 200 pounds to beef up their yields and lower their cost. And nitrogen's fairly expensive now, so it's getting their attention because of price. And we've been through two or three price hikes in the last 50 years of me doin' farmin'. So we've looked at it really heavily before.

But even organically, we have to have nitrogen from someplace. Whether it's manure, whether it's a legume in the rotation. Could be alfalfa, could be soybeans, could be peas. Or, what I have to work with the farmers on is getting their inherent organic matter to release nitrogen.

Most of those farms when you put on those heavy rate, the system in the soil, which I would say is, it's much more advanced than any computer we have on our desk, that system realizes there's too much nitrogen so it doesn't produce any. And then the farmer has to put on more.

And, the trick is to lower that amount of nitrogen, get that organic matter

back building and back releasing nitrogen again. Because in order for the rest of the nutrients to release properly, to feed the plant properly, to have a plant with proper cell structure for proper nutrition, the nitrogen from the soil has to be working. And the fact is, on most farms it's not.

Cliff Scholz: Wow, that's a comprehensive answer. And with all that, background material about Flint, I had no idea that history.

Joe Scrimger: Most don't--

Cliff Scholz: That's amazing.

Joe Scrimger: sometimes I say I've been working on connecting dots, you know? But I've been at that for quite a while.

Cliff Scholz: Yes, that's the whole idea. That's why we invited you're here. That's why we wanted to hear from you, Joe.

[00:07:27]

Part 2: Nitrogen Management for Soil Biology l Length: 8:26

Cliff Scholz: You shared something that I think may be less well known among growers, even organic growers, which is that, poultry manure in particular, even though it's a natural product and is used extensively in organic because it meets organic specs, that it can affect the soil negatively in many of the same ways as does the chemical fertilizers that you've been sharing about. Can you give us a quick little piece on why that is so?

Joe Scrimger: If you go into a poultry barn, the big barns, used to be 20,000 chickens on the floor and now there's usually 100,000 chickens per building, at least. Even in the organic buildings in Michigan, now. You always have some ammonia smell, coming off.

And the ammonia smell is not odd. If you go to the woods, pull back the leaves in the summer, take a handful of soil, part of the thing of the soil test, of smelling that, is the musty ammonia smell. The ammonia represents a conversion of nitrogen in the soil.

And so, ammonium nitrogen's hard to test for. But when ammonium

nitrogen, which is slow release, and things get converted to that in the soil, and you can buy it, like, ammonium nitrate.

But, when it's converting to nitrate, it releases ammonia. So in our testing lab, back when I run one, we followed nitrogens, we didn't, test ammonium, which is more in reserve. But we tested the ammonia, which tells you if it's converting.

And when you get a soil that's got good nitrate and moderate ammonia, you know you're gonna have more nitrogen coming from the soil. A lotta soils have very little ammonia from the soil. They have it from anhydrous ammonia being applied to the soil, which speeds up that process.

And it definitely works. Makes the crops get big. But it's hard to control the release. And one of the things they do to stabilize that is to put a bacteriostat in it to keep the bacteria from converting it. Well, that's killing bacteria in the system.

But it doesn't kill 'em all. That's why they call it a bacteriostat. That's the wrong way when you're trying to build biology and you want those microbes to work for you, specifically the bacteria and the nitrogen-producing ones.

But when they get low, there'll be a burst of them when you add that nitrogen, which most people at one time they called urea fertilizer organic 'cause it's, quote, "close to urine," but it's a white pellet that's 44% nitrogen.

And very quick release, quicker than release than anhydrous ammonia. Anhydrous ammonia has to be converted. But it does tend to give quite a boom. So feather meal is only one example. But most all manures, when they get put to the soil, if you don't use too high of a rate, some of that'll release and some of it will go into the reserve organic matter and the reserve ammonium nitrogen. And then release later on as nitrate. And it gives you more slow release throughout the year.

And that's the key. What we try to do in the conventional world is get those farmers to use at least three different sources of nitrogen that release at three different times.

Then we've got the ability to spread that nitrogen release out. And hopefully,

then, the soil kicks in a little more when we do that. And we can get those type of releases even from the conventional, man-made chemical products. So that's a start.

Then in the organic world, the poultry manure, which we like to get in the system because it's not that it just has a lotta nutrients. And it does. It's one of the most concentrated manures.

But it has these aerobic bacteria that will go on and produce more nitrogen for you. And I haven't figured all the negative out, but near as I can tell from guys overusing the poultry, is that you start to get a reserve and you're puttin' on more.

So you put on that first application, and it works. So the guys do that again. But there's always residual. And they don't allow for the residual from the previous year's application. Well, then they start gettin' too much. And if nitrogen leaches, it doesn't make any difference whether it's an organic source or not, it makes the soil get harder.

And it takes other needed minerals with it. The soil will try to tame the acidity of that nitrogen leaching by taking other, quote, "soil cations" with it, which could be potassium, magnesium, could be calcium, with it. And so you're losing nutrients. You're makin' the soil more acid, and you're oxidizing organic matter.

Cliff Scholz: You mentioned the residual. Is that the residual of the nitrogen itself? Or is that the residual of the microorganisms in the soil from the poultry manure application? Or is it both?

Joe Scrimger: It's a measure of both. And on the start, you need a certain amount of upfront nitrogen. So we want some of that quick release from poultry. But as we start to charge the slower release and the, quote, "organic matter," then we gotta slow it down.

And most farmers, after they see how poultry works, they don't wanna slow it down. They wanna put on more. And it's too bad. I was taught early on that you have to monitor the nitrogen and make sure you don't get it too high. Because if you get it too high, it'll leach.

Now, there's two or three really big things here. But the one thing is it interferes with other mineral uptake by the plant, consequently putting too much nitrogen on it. Which creates the situation of nitrate poisoning. But you're not feeding the plant at the early stage so you don't notice that. But that plant doesn't have good cell structure. That means it'll be more exposed to pest. Consequently, using more pesticides. And that's a downhill slide.

But what happens in the soil when it leaches, in order to get a situation to leach, you have to be supersaturated. And if you're supersaturated, that plant's overfed. It's mathematical impossibility for it not to be overfed.

And so farmers know they're leachin'. I'm sayin', "But do you know you were supersaturated?" And they're really havin' a hard time understanding that.

So there's a lotta other things that are problems. But I see the main problem starting with overuse of nitrogen. And part of that was because of the economics on the farm. They just felt they had to get more yield. And yeah, we have a little different situation with pricing right now.

Corn price is up. But they're still goin' for more yield 'cause they know they gotta put money in the bank. 'Cause they know it won't be long and that graph'll go the other way and corn price will be down twice as long as it was up. That's the way that commodity graph works.

So I hope I'm gettin' at it. So poultry is an asset, it's a good product. It just needs to be controlled. And so some of the guys that were sellin' it, tell me, "Wait, you mean I gotta tell these guys to shut it off?" And I'm sayin', "Yeah, tell 'em to slow it down."

And if their neighbors see that they're not usin' as much and their crops are gettin' better, they'll want some too. You won't lose customers. There's still a whole lotta fields out there that haven't seen poultry in close to 50 years.

And for the products that they've used that were negative to the soil, the odds that they have nitrogen-fixing bacteria still there are very, very low. So this poultry needs to be spread out. It’s a very nice resource. And this Dr. Reams that we schooled under, one of our initial schoolings, was really

keen on that early on.

And he didn't talk much about organic. He was biological, somewheres in between. And he didn't worry about using a pesticide. But he didn't wanna have to repeatedly use it. But he knew the answer was focusing on crop nutrition, makin' plants healthy, makin' animals healthy, and makin' people healthy.

[00:15:53]

Part 3: The Risks of Damaging Soil Life | Length: 8:48

Cliff Scholz: Tell us about how you got to these understandings. This is a completely new approach to thinking about agriculture.

Joe Scrimger: If you come up Telegraph, outta Detroit, you go by where I grew up. If you come up, M-53 or Van Dyke, you go through Imlay City and you go by the Imlay City muck on the east side of the road.

And I was out there in the '70s. And partially because of my history: I sold some of those guys farm equipment. And then I left the farm equipment business and farmed and did some other jobs, but when I started the organic thing, I started doin' soil testing. 'Cause we needed to show soil improvement. And some sort of tests were required. And then we started sharing that with the group.

But I ended up back on the muck, soil testing for some of those farmers. What I learned in that process was they had this nematode problem. And they were using fumigants to kill the nematodes, but in the process they killed all the biology, consequently taking more fertilizer and taking more nitrogen.

And the soil got harder. And muck isn't characteristically hard. It's characteristically soft and spongy. But it changed. Then they went to fumistats. And some guys were sayin', "Well, we're just usin' a fumistat. We're not usin' a fumigant."

Well, meaning they're only killin' some for a shorter period of time. It's a step. But it's still goin' in the wrong direction, if we understand the dynamics

of biological populations.

So it's a little bit of calculus. And understanding that when you decrease those numbers, the bad numbers always go up. But when you increase the numbers, what we call “bad numbers,” or disease and all that, always goes down.

And so we shouldn't focus on killing a section of the group. In the short term we might have to a little bit 'cause the farmer needs to get a crop. But they've gotta understand that they need to bring those biological populations up.

And some of the vegetables guys have got onto that. Because they had quite an extreme, even by the time they were comin' out of the '70s.

Cliff Scholz: By “extreme,” I’m hearing that they’d done things or applied products that damaged their soil biology. Do producers of other crops, like fruit maybe, see similar problems?

Joe Scrimger: Now, I didn't work with fruit early on. I worked with it in the later years. Fruit growers may use $600 an acre worth of pesticides, where a crop farmer may only use $60 back then. Now with inflation, it might be $120. But the degrading in the crop soil on the crop farms has been slower than what happened in the fruit.

Because I worked with fruit growers pretty intensively, I've been able to see some things happen with fruit and see it full cycle before it happened in farm soils. So it puts me ahead working with the farm soils. They're comin' at this later with some of the same problems.

Cherry leaf spot is a disease that hits the cherries bad. Sugar-beet leaf spot hits sugar beets. But it came later. But it's the same family of disease and it's caused by the same process.

Corn has been getting a fungal disease recently. So now the airplanes are comin' in to spray the corn. And what I'm sayin', the cherry growers would tell you that we did that for 25 years and it doesn't work. The problem gets worse. But the corn growers don't have any concept of that at all.

But it still comes back to the lack of biology in the soil. And once you put the fungicide on to kill the fungal in the plant, most of that goes to the soil and you got less biology and you got more of a problem next year. And so it's a heck of a good equation. And I'm sure I've mentioned this: If you're sellin' the product, that's a pretty good deal. If you're buyin' the product, it's a pretty bad deal.

Cliff Scholz: You mean the fungicide product?

Joe Scrimger: The-- the dynamics of that--

Cliff Scholz: Yeah, yeah--

Joe Scrimger: —because it makes it so you have to apply more. But that's a short-term equation. Eventually, the microbes win. And their population dramatically increases on the bad side.

Cliff Scholz: Uh-huh. Wow.

Joe Scrimger: And that equation, it's a tough one to grasp. I mean, organic farmers don't beat the biology down. They culture and work with the biology.

You don't have to do all the tests. You just gotta let them grow. And they've seen the results.

Cliff Scholz: So you mentioned about the muck soils near Imlay City. Now this is a question that I think we could go a little deeper on, ‘cause it's going to how the soil responds to water, which gets to an area that I know you're passionate about, the health of our lakes and rivers.

So nitrogen management can affect soils both chemically and biologically. That means that it'll affect soil structure. What is the dynamic in the compaction or the hardening of the soils that you described, from the Imlay City example? 'Cause that's more general than just the muck soils. That happens in other soils too, right?

Joe Scrimger: Yeah, so again, I'm gonna go back to my early organic farming. And early on, we figured out that, for organic farming to work well, initially you gotta have about 3% organic matter, at least. If you're under 3%

there'll be some challenges.

And you can get through it if you make up for it. But you have to address that low organic matter. And a lot of people don't. In the Thumb area there's soils that were naturally 4% and 5% organic matter.

But a lot of it had got down to 3%. So we can still make that function. In this region from Battle Creek towards Chicago, the organic matter was lower and then they decreased it. So they've got a lot of organic matters down to 1.5%. Consequently, you don't find a lot of organic farmers there,

Then I was goin' back to these friends and customers that I had, on the Imlay City muck, that soil was 60% organic matter. And I was havin' a hard time. Why do these guys have all these problems?

It's like… but I had to, had to do a lotta talkin' with 'em. And then there was that question and there was the question of what happens with this anaerobic liquid manure.

And I took both of those questions to Dr. Reams early on. And, he got through to me fairly quickly, in respect to what happens. When that muck starts to turn compact and it starts to plow out in chunks, which it had – and they can run bigger tractors on it now where they never could back in the '50s – it's switchin' to anaerobic.

And anaerobic, there's biology there. It just tends to be the wrong biology. It still produces nitrogen, but it's not controllable. On the muck you'll start out in the spring, you won't have hardly any nitrogen. And so they put some on.

But mid season, that muck, because there's 60% organic matter, and even though it's compact, will still release 150 pounds of nitrogen by itself. It just releases it at the wrong time. Where if it's mellow and working, that aerobic system builds it in such a way there's more of a continual release that peaks mid season when that plant is in its maximum growth stage and can soak it up. But it doesn't peak as high as it does as when it's compact when you're dealing with 60% organic matter.

And while I was figuring that, I was also workin' with some potato farms up in the Thumb, that I knew personally, that had irrigation. And I think I've

talked about the dead spots showin' up. And these were dead spots that would start out as big as a desk. Then they'd get as big as a house. And then they'd get maybe an acre. And then they'd maybe get to five acres.

But I saw that happen on regular loam ground in the Lapeer area that was only 3% or 4% organic matter, maybe, on cash crop farm. I saw it happen on Imlay City muck that was 60% organic matter. And I saw it happen on the potato farms in Silverwood that were 1.5% organic matter. That they had these dead spots showin' up.

And that was a challenge. And it took a while to get through that process. We could do some liming, adding calcium and get a little spurt. But if they didn't change what they were doin', that spot would come right back again. What we had to change was the nitrogen and some of the chemical use.

Cliff Scholz: Okay.

Joe Scrimger: Those were forewarning systems. Those were the canary in the mineshaft that was telling those farms that somethin' they're doing overall is startin' to show up here. And I don't think they ever really identified it like that.

[00:24:41]

Part 4: Low-Till, Biologically-Informed Erosion Control | Length: 12:45

Cliff Scholz: Joe, you've told us about a couple of farmers down in Ohio called the Spray brothers and the results they got in erosion and runoff control. I think our audience would love to hear about that.

Joe Scrimger: I met Rex Spray probably back in the early '80s. He came up and spoke at one of the Michigan programs. Later on I went down to Ohio Ecological Food and Farm Associations, toured his farm. But in the meantime, I talked to him on the phone 'cause my dad, way back when, was on the Soil Conservation Committee.

I went to meetings, but I never sat on the committee. Where Rex Spray was on the committee for I think it's Knox County, Ohio, on the way to Wooster.

Pretty productive area, but rolling land. And, they did soil conservation, minimum-tillage yield contest. And they measured erosion and they measured yield.

Rex, at that time, was a certified organic farmer. He was doin' pretty well in his marketing, one of the first guys to really have, a marketing system. A lot of his production sold as food, certified organic food.

So he was planting different varieties of corn because he was planting varieties that were known for nutrition. But some of these varieties responded better to this slow-release fertilizer concept. But Rex was not a no-tiller, he was a minimum-tiller.

He used conservation tillage, disk, and a field cultivator. Maybe a chisel plow every now and then. So he mainly mixed the residue into the surface of the soil.

And there's a book called *The Ploughman's Folly* that a lot of people talk about. Even the current no-tillers talk about *The Ploughman's Folly* by Edward Faulkner. And I read that book way back when, and I switched. The most expensive piece of equipment on my farm was the rollover plow, meaning it would plow both ways. It had eight bottoms on the back of it, four one way, four the other way. You just turn around and go back. I set that aside and went and bought a chisel plow, even though I didn't have money, after I read that book. Edward Faulkner was an extension agent from Ohio.

Well, Rex Spray read that, too, earlier on. And he had got his tillage figured out, and the residue, and the decay. But when he entered these contest first, he did well, but he was quite a ways off the top. But what they noticed is he was doin' tillage and he was havin' less erosion than the no-till guys.

Well, he worked himself all the way up to the top yield of corn in Ohio, a very progressive county, using 0-0-0 for fertilizer. I mean, he didn't put any fertilizer on. He had used some things in the past like humates and whatever. And he had a little manure. He didn't have a lotta cattle. But he did a good rotation. Did his clover cover crops. But he managed this residue, and he was watchin' his tillage. He didn't work the soil wet. Very, very cautious.

So by the time he got to first place, there was only one no-till farmer that beat him on erosion. And that guy was no-tilling into alfalfa sod, and Rex wasn't. Rex had a rotation. So alfalfa sod, we know that holds things together better.

But Rex was maybe working up a wheat stubble or whatever. Rex got it figured out early on and it was a very profitable farm. Now we're on the next generation. Rex Spray family's still there. But it's two brothers, Rex and Glen. Very, very good farmers.

But tilling, and there's a lot of people in the Soil Conservation, and USDA, and some of the new regenerative farmers are suggesting that tillage is the problem.

Tillage can be a problem. And we do want to till less. But tillage is not the problem. If it was, we'd have to fire those earthworms. 'Cause those earthworms, in theory, if they're in proper numbers per square foot, they will till about one-seventh of your soil per year.

So every seven years they till it for free, one full cycle. And it's tillage, the way they do it. They're moving residue down, and holes, and whatever. So, they're tilling. And I have to bring it to those farmers' attention.

But the bigger thing, after I saw what Rex did, I saw so many other examples. And one of 'em I'll show at this program that I'm doin' end of the month is on how we build up blow sand that wouldn't produce anymore, that Saginaw Valley farmers, some of the most progressive farmers in the world, give up on, burned it out, set it aside. And we brought that back into production organically over a six, seven-year period. And made it produce better than some of the irrigated ground.

And we did it with tillage. If tillage was the problem that the USDA suggests, that would be a mathematical impossibility to happen. And I don't mean to keep reverting back to that, but that's how I look at things.

At the Michigan AgriBusiness program, one of the Soil Conservation speakers talked about the Dust Bowl. Back in the '80s, I drove into Imlay City and the streetlights were on at midday because there was a cloud of black soil from the Imlay City muck blowing into town.

Why they get called the Dust Bowl is on the start, they spring up in certain spots. So there was a dust bowl literally starting at the soil, like a little tornado that keeps gettin' bigger and is sucking up dust.

But these were huge. These were not a little miniature tornado. These were huge dust bowl deals. They were happening north of Marlette on the light ground. They were happening on the Imlay City muck. And they were happenin' on both sides of North Branch.

The key was, I grew up in that area. I knew all those farmers. And I figured out why it happened on some farms and it didn't happen on other farms early on. But if the weather hits right, we still have that potential to happen, even in the Thumb.

Cliff Scholz: So you're saying we might go along for a few years and not see any big problems, but then we get a real wet year, or a real dry year, or just badly timed rains, and all of a sudden these underlying problems can show up. But really, they were there all along.

Joe Scrimger: In the same way that the last few years there hasn't been a problem in Lake Erie, but all those conditions are there. We just haven't had the right weather combination. Which what it takes is early spring rains after the have applied all the fertilizer to put that into the water system. And then the algae grows.

And the spring rains have held off. Some of that's become more stable and it hasn't been as bad. The problem's there.

Cliff Scholz: Overall what I hear you saying is that there's a number of things that are causing erosion and runoff, not just tillage. Too much fertilizer and chemicals will damage the soil and its ability to handle these kinds of weather impacts. But, over-tillage is a factor, and it is very common.

So, is it the depth of the tillage or the frequency of the tillage that matters? Or the timing of the tillage relative to rain events or soil moisture content? What are the big pieces that people should be aware of if they want to use tillage in a way that works better with their soil biology?

Joe Scrimger: Cliff, you're doin' a pretty good job of hitting the points, so all of the above and we can go on.

Cliff Scholz: Okay, it's all those things--

Joe Scrimger: All those things. So yes, depth as farmers-- now this deal of moldboard plowing, which a lot more conservation tillage and no till has done now, but still farmers still moldboard plow. I saw a field today that had just been moldboard plowed two or three days ago.

And that's where you invert the soil. Amish farms tend to still moldboard plow, but they don't have, quote, "high horsepower." They don't plow as deep. Amish farms usually always function better. They don't function perfectly in all cases, but they do function better. They don't plow as often and they don't plow as deep.

What happened on the, quote, "English farms" was that as they got more horsepower and as more nitrogen caused more compaction, specifically down deep at seven, eight, nine inches, they went from plowing five, six inches, which was common back in the '60s, to plowin' seven, eight inches, to plowing eight or nine inches to take out the lower layers of compaction.

Every time they did that, they were starting to create another layer lower. You see what I'm gettin' at? So then the plows got bigger so they could plow deeper. But it didn't work. In the short term it alleviated some compaction and caused other.

But it's not the moldboard plow. It's plowing too often, too deep. And if you got a wide rotation of, say, five different crops, and moldboard plow one or two of 'em not too deep, probably won't have much negative effect.

If you got corn and soybeans or corn, soybeans, and sugar beets, and are plowing deep for the sugar beets, which a lotta guys in the valley are, and plowing deep after corn to bury the residue instead of manage, they— they're burying what they call “the trash”.

That's the leftover corn stalks. I call it surface tillage to manage the residue back into the system. The residue will decay the best close to the surface or in the top three inches mix. You get it deeper than that, and some of it starts

to not decay properly.

But there's some exceptions. Alfalfa, because it's got this really big root, and this root can be the size of my thumb and it can go down five foot, so a lot of cases it'll go through the compacted layer. But because of the nitrogen and the nitrogen nodules on that root, you can moldboard plow that and mix it. And then, even the green stuff on top because it's alfalfa, it's high protein, high nitrogen, it always relatively decays properly.

But if you can picture corn stalks are high carbon. And they have a tremendous mass of roots underneath 'em. And it's all high carbon, very little nitrogen. If you plow that down too deep it can't access enough nitrogen to decay properly. And if it decays improperly, you don't get conversion.

So here's a real key that happens on the muck, happened on the sand, happens on good soil. If it goes too deep and doesn't decay properly in the presence of some oxygen, it decays anaerobically. And that material that was supposed to be building organic matter, and it's sort of a carbon but it's not the end carbon. Vegetable matter that's higher in carbon converts to ash versus converting to humus.

And so the ultimate ash is potash out of a stove, it's wood that's been burned up. But that process can happen in the soil. So you lose that organic matter from those residues if they're put down too deep and don't decay properly. But the confusing thing is, ash is still high in minerals. So the soil test picks up the minerals and thinks you're great. And it doesn't watch the organic matter.

Organic matter is important to track, but you can't catch the change in one or two years. You gotta go ten years or so to catch the changes. And you have to have records.

So if it's there as ash, in the short term it looks, it's got minerals. And it looks like organic matter, and in some cases is tested as organic matter. But ash doesn't function like humus. Humus functions as a sponge. See what I'm sayin'?

Cliff Scholz: Oh yeah. Sometimes you can get by with adding a little actual

ash to your soil if it's biologically active. Those minerals can be built into the biology of the soil.

But I wouldn't count on it if I were working with a biologically inactive soil. I would avoid it.

This is me as a gardener just goin', "Hm, I got Joe Scrimger here. I should ask about gardening practice."

Joe Scrimger: You've got it, though.

Cliff Scholz: Oh.

Joe Scrimger: You're in the ballgame, yeah.

Cliff Scholz: That's good to know. Thank you!

[00:37:26]

Part 5: Balancing Soil Biology for Crop Health | Length: 13:41

Cliff Scholz: Well, we've been talking about soil biology and how it fits into all of this. One of the things that you have shared about is the importance of the relative proportions of bacteria to fungal organisms in the soil and how that affects phosphorus availability.

I'm wondering if you can share why getting the fungal proportion where it needs to be relative to bacterial, 'cause it tends to be the one that gets depressed by most of the practices that we're talking about like tilling and adding, nitrogen in soluble form and so on. Explain the phosphorus metabolism of the soil and the role of fungi in it, if you could, please.

Joe Scrimger: Well, and here I have to give those regenerative farmers a little credit, too. And specifically to Gabe Brown. 'Cause I was seein' pieces, but he got onto it a little faster.

And a little later, I was learnin' it over time. But those pieces weren't coming together. I had pastured-based farms that were working with some broadleaves. New broadleaves like chicory, and whatever.

Even dandelion is a decent feed, and it's a broadleaf. The broadleaf that I

was workin' with that I really liked was buckwheat. But buckwheat you had to plant every year, where these other broadleaves are like a weed. They come up every year. They're perennial.

And Gabe got onto that. Where what happens in most organic farms if they get doin' the soybean thing to Japan, which most of 'em do, and then they're selling corn to the big organic chicken farm in Michigan, and they might be doin' some spelt.

But think about this: The corn takes a lotta nitrogen, whether it's manure or whatever, or clover. The soybean is a legume. It puts nitrogen back in the soil. The spelt, they're fertilizing it. It's a grass. They're fertilizin' it like corn. Just not as much nitrogen as corn.

But all those components of nitrogen in that three-year rotation, and then they may leave one year of clover to give 'em a wider rotation. But even the clover is a legume: All those things feed bacteria.

None of those really feed fungal organisms other than the mature carbon from the corn stalks or the spelt stubble or wheat stubble. But if they put nitrogen on those crops in the way of poultry or even feather meal, but feather meal is not as bad, but any manures, and those legumes keep those bacteria established.

So we've come to the conclusion that legumes are very important in the transition. But as your soil improves, you actually want to move more to broadleaves.

And that brings that fungal balance out. That starts to have a multiplier effect on your building of organic matter, and your water moves better. And broadleaves do a better job of covering the soil than legumes do.

And they're not recharging the nitrogen. Meaning this is after you've got your nitrogen system started. You got a nitrogen cycle started. And then you lighten up on the nitrogen, but you go a year or two with broadleaves in the equation without keeping that bacterial dominated, let those fungal organisms catch up.

And some people would say that if you're gonna raise grains you gotta

have a little more bacterial than you got fungal. But if you look at a woods, and I don't know if this is good or bad, but when I grew up, I did wood off some land that we turned to farmland. I mean, I went in and helped my dad cut the trees, lumbered it off, and then turned it into farmland.

And I saw how that produced. That produced tremendously, with very little inputs. And that was relatively a one-to-one bacterial to fungal balance when it comes out of the woods. And I could see the potential of that.

Now, when you're takin' a poor soil and puttin' it back, yeah, you gotta feed a little more nitrogen. But if you can get your soil back to the good state, you want more of a one-to-one balance.

And Gabe Brown he goes by diversity. And I like the diversity. I don't argue with that at all. It's just that most of the organic farmers I work with have diversity already. And the soil, the less diverse you've been in the past, the more it responds to bringin' in diversity. The more diversity you've had in the past, the less response you get to more diversity, 'cause you've already got diversity.

And that diversity comes in crops. That diversity comes in different types of fertilizers. That diversity comes in different tillage practices, and not tilling, at certain stages. That diversity comes in the variety of animals you expose the soil to.

And the type of farmers, quote, "organically and biologically" that I work with already have a lot of that diversity. Conventional agriculture, where Gabe Brown's history was, was more based on fertilizer and a couple cash crops.

And so consequently, when he puts in more diversity, he gets a bigger response. And a lotta those farms do. And I'm in favor of that. But I'm sayin' the farm shoulda had the diversity to start with. That's the point they're missing.

And so consequently, I target the cover crop to the next step we need to make in the system. If it's weed control, I would go with somethin' like rye as a cover crop because if it's broadleaves that are a problem, lambsquarters and pigweed, rye will suppress them.

If we're low in trace minerals, I'd like to use buckwheat. If we're low in phosphorus, maybe use a little buckwheat depending on time of year. If it's early or late in the season, we use oats 'cause they will bring phosphorus up.

So I wanna target where we need to go next because my job for the farm has been to be out there in the field, bein' observant, takin' my time. Trying to become in tune to what I'm with, and figuring out their next step. And how to do that, as much as we can. naturally. But I'm not against some inputs. Because we can do it without inputs, but some soils will raise a crop if you get 'em enough nitrogen. But they won't have the proper nutrient density.

I wanna establish the input as an amendment, not as a fertilizer, to fill the void in the soil so we get proper nutrient density in the crop. We gotta have nutritional density. And we've gotta get the density up and the pesticides residues down.

It's a challenge. And not understanding controlling bacteria cost me quite a few years out there and even some of the farms transitioned because some of them had too much liquid manure and they were tryin' to compost it. But they had too much alfalfa, which most dairy farms wanna feed alfalfa.

We were tryin' to switch 'em to grass. We were tryin' to use the liquid manure to make the grass grow. And we were keepin' the system too bacterial dominated, even on some organic farms. The whole thing wasn't working.

Again, the broadleaves, Gabe got onto that and he expresses it fairly well, because I'm one of those stubborn farmers too, that's maybe hard of hearing at certain times. But he got through to me.

And when I took that back and started lookin' at the history, and started to looking how broadleaves are used, the light come on for me. But that was more recently, actually, that those last pieces come together.

And then, I was onto the thing in the Lake Erie basin, 'cause I've traveled Ohio since I was a kid, watching those changes. But Gabe's process will change that, too. But I'm also sayin' we not only gotta change the water,

we've gotta make people healthier.

And we've gotta decrease this outbreak of degenerative disease that we're dealing with. And it's actually a little bit epic, and it's a little bit epidemic in degenerative disease. And that relates back to the nutritional density. And I work off the principle that most all degenerative disease is mineral deficiency.

Cliff Scholz: From what I'm hearing you say, in order to get the phosphorus working in the soil, you just covered the piece about adding broadleaf crops and/or cover crops into your rotation. We heard about reducing nitrogen inputs from fertilizers and plant sources, even.

There's the piece about adding higher-carbon compost sources and higher-carbon manure sources, which would be more on the cattle side, for example, than the poultry side. Is there anything that I missed there? Did I hit the main points for raising the organic matter / fungal component to bring the phosphorus in again and raise that nutritional density?

Joe Scrimger: I think you're hitting the right points. In the phosphorus cycle… we all know about a nitrogen cycle. The nitrogen cycle makes growth, and we have to have that for a certain percentage of that protein. But part of that protein is supposed to be made with the phosphorus system working.

And the phosphorus system actually mobilizes other minerals into that plant. It's used and reused. But you have to have a certain amount of that, especially in the colder climates of Michigan. Especially to start in early spring.

You don't have to overdo it. But you've gotta have it addressed, otherwise we end up relyin' on nitrogen. And too many farmers are doing that across some of the organic deal and across some of the regenerative. And it's real. And in the short term, it's a crutch we do.

I admit I would recommend extra nitrogen on the start to get the farm goin' and then wean it down. And then don't work on the phosphorus first because you'll stall the soil out. If you try to build fungal first, you won't have enough bacteria to do the base digestion.

So you gotta get those bacteria up. And when I make that statement about minerals, some people will say, "Well, that's not the problem, digestion is." And I've made this statement about digestion. It's just that if you have a digestion problem, you're not metabolizing the minerals properly.

So it ends up bein' a mineral problem. It's sorta like we got this phosphorus problem, and yes there's a phosphorus problem, but it's because we're mismanaging nitrogen. But really, the soil has a digestion problem.

The U.S. public, what's the number one drug by weight, volume, dollars, et cetera, used in our United States, what's sold by drug stores? What is it?

Cliff Scholz: Tums. Is it antacids? Or is it—

Joe Scrimger: Yeah--

Cliff Scholz: Laxatives? It's gotta be one of those two.

Joe Scrimger: Yeah. Well, it's antacids.

Cliff Scholz: Uh-huh. Figures…

Joe Scrimger: There's more money spent on antacids than there is on heart medicine.

Cliff Scholz: Uh-huh. Yeah, that totally makes sense—

Joe Scrimger: So the problem is digestion in the farms and in humans. And you end up with a mineral problem. You end up with a mineral shortage. But that problem started because the minerals are goofed up. You see what I'm sayin'? You gotta go back to when that problem started. So that's why we have—

Cliff Scholz: You know, hardly anybody's gonna talk about soil digestion and its parallels with human digestion, and the fact that you end up with parallel problems in both those systems. Or very few people that you're going to talk with in any world.

Because the medical world isn't lookin' at this and the agricultural world is trained not to look at it this way, too.

Joe Scrimger: I see what you just said. And the medical people, the soil scientists, I appreciate them. I get quite a few pieces from them. Just they don't understand the whole thing. So right now it's very key, the things you're workin' on, and others, and those biodynamic farmers.

We need better leaders. And one of the things they discussed in the Michigan AgriBusiness program the other day was leaders. And, a leader has to be able to deal with a volatile situation, figure it out, come through it, and be able to share it.

And I'm only getting part of that process right. I sorta have a lot of it figured out. How to share it is a challenge yet. But, I'm gonna continue to work on it. And I know I'm ahead of other people that… I'm not begrudgin' their degree.

I appreciate it. But some of 'em are just too specialized to connect all the dots. I had Eliot Coleman come into Michigan State to speak way back in the late '70s the first time we had him in.

And he made that statement. He says, "Well, the problem here is that the only thing the connects the departments at most ag colleges is the septic system," you know? They are not connected above, you know, on a human basis.

They're competing for dollars. They don't share things. And so I was never in that world. I don't have to fight for grants. I had to fight to survive. But I figured that out quite a few years ago. And I don't have to wait until I get another grant to do this.

And I don't have to delay the process for 15 years. I'm not the only one that's ready to do this. I'm very capable of having other professional contact, and good associations with other professional people that we work together with. And we're gonna lead ahead of a lot of the other system. It's our job.

Cliff Scholz: Yeah, and it’s an incredibly important job.

[00:51:07]

Part 6: Soil Building for Hydration, Crops and Nutrition l Length: 16:07

Cliff Scholz: So let's take a look back, Joe, at something that we've talked about ,which is how soil responds to changes from dry to wet, and how this affects soil biology and crop health.

Joe Scrimger: Part of the natural aeration system of a soil is when it dries in the summer, if it has a higher clay content, sometimes you will get a crack in the soil that you can literally put your hand into. You know, your hand will fit into that crack.

Sandy soils don't relatively do that 'cause they don't have a high clay content. But some people in the conventional world would say, "In the heavy ground you gotta put in more tile. And down here in the lighter soil you gotta irrigate it more."

Kellogg Biological Station did an irrigation experiment when I was testing for them back in the '80s with Dr. Harwood, who was the Sustainable Ag chair. He passed away just this last year, was just a super person, from Michigan State. He had me doin' plots down at KBS. And he started some long-term plots, too, that I worked with initially.

But I looked at what they were doin' on irrigation, and they were trying to figure out how much you could irrigate soil. Well, it worked really great for the first couple years. By the time they got to the third year, their yield started goin' down.

And what they figured out is that they were keeping the soil wet, consequently, the soil didn't have a chance to dry and shrink some, and get little cracks in it, even though it was lighter soil. Little cracks that let the air in. So they started losin' biology just because they were irrigating too much, and that soil started to become more anaerobic. And they documented that, but they never really printed it.

I was there. I asked the right questions at the right time, and got the answers. So what I'm sayin', there is some soil that needs to be irrigated. Don't hesitate. You're doin' a intensive vegetable operation, get some irrigation if you're on that type of soil.

There is some soil that needs to be drained. Don't hesitate. Put the tile in before, as you're a young farmer. Put the tile in, get it drained. But if you work with the organic matter, and if you work with a more diversity of crops, you can take low soil, poor drain, and raise canary grass on that without tilin' it.

And understand how you feed the canary grass. It's a natural to low wet soils, and it'll grow on productive high soils, too. But that canary grass harvested right, most people harvest it too late. You gotta harvest it at the right time.

And sell it, and guarantee it in the market, most people want to buy alfalfa. They don't wanna buy canary grass. So you have to tell them, "No, this canary grass is different. Try it. I'll guarantee the first load. If it doesn't work, I'll take it back."

They always buy the second load. But he saved $600 an acre 'cause he didn't have to tile it. And the canary grass was starting to grow, and he wasn't putting much fertilizer on. And because this low, poorly drained ground, it's higher in organic matter and higher in nutrients. And you can touch up the deal. But canary grass functions real well in that environment. So we saved the deal.

And the other thing that I mentioned to you was building sand and getting sand to produce better than irrigated sand that hasn't been dealt with.

I'm not against the irrigation. But there's a certain cost. When they turn on the electric motors to run that irrigation, the electrical bills zoom up. You're irrigatin' a quarter of a section, a mile section with those irrigation units.

A tremendous electrical cost. If we can cut that by two-thirds, we've saved them a lotta money, too. Plus, we let the soil breathe more. And if we've inoculated the culture in the soil, we get it to grow, and we become more efficient, and then in the future we can cut that irrigation again.

Cliff Scholz: By that you mean inoculated the culture with the healthy mix of fungal and bacterial organisms—

Joe Scrimger: Yeah. I'd do that with a little poultry on the start, get the

nitrogen goin'. Then go to a, like, a dairy compost that's got more straw into it, that's a medium carbon. And then in the end, go to a cheaper high carbon, which may be leaves and grass clippings.

It's just that most leaves and grass-clipping operations don't understand composting. They just understand getting a tipping fee to receive that product. And they say they compost it and send it back out, and there's all different forms of composting. But if we're gonna have disease suppression, and if we're gonna get that high-carbon compost to work in the soil, it has to be composted properly. And if it is, it's pretty valuable stuff.

Cliff Scholz: That'll do two things. It'll add the microbes in a healthy proportion that'll generally support crops. It'll also add carbon base to the soil that'll help to raise that organic matter content a little bit, incrementally, while giving those, microbes a little something to munch on, so to speak, while they're getting established. Is that a good way of talking about it?

Joe Scrimger: And it's high carbon. It brings up the fungal organisms. So it brings up your fungal balance and gets you those things, without havin' to raise quite as many broadleaves in the short term. But in the long term, you wanna raise the broadleaves too.

Gabe did it by skipping the compost because the amount of acres the animal does out there is really spread out in those western states.

Where here, we can do about an animal per acre. Out there it might be an animal per 20 or 30 acres. They're just more spread out. And too many farms have went just to grains and got rid of the animals. And the animals ended up in a feedlot, where a lot of the manure gets wasted. Meaning it gets put on and causes problems 'cause they're putting it out way too high of a rate.

Cliff Scholz: Here's another important one: How do you raise a higher-protein crop? You mentioned the role of phosphorus in that. And we know that nitrogen is gonna factor in also, 'cause protein is nitrogenous. But, if the feed, whatever it is, alfalfa, grain, whatever, is lower in protein, it's lower-quality feed, and that's gonna affect a farmer's bottom line because he'll have to buy more of it or pay higher prices for better feed.

How can you raise higher-protein crops?

Joe Scrimger: Two pictures here. One picture is what's happened conventionally. Another picture is those that choose to raise higher-protein crops. So what's happened conventionally over time, as we raised more wheat yield, and wheat was our largest volume of grain in the United States back in the '60s. Now it's corn.

As we raised more wheat yield, the yields went up. As we changed the genetics the yields went up more. But what they didn't note was the protein was going down and the mineral was going down. But we can supplement minerals. And why we see more soy is that's concentrated protein.

That's 44% protein, when you process the oil out of it. Or you can roast it and leave the oil in. It's much better feed that way. And the corn, the Indian corn, now we're goin' back in time, might run as high as 18% protein.

Open-pollinated corn will run in the high 12%s if you're managing it. But it'll at least be 10%, depending on your variety. Hybrid corn, if you're planting one that's really a feed grade, that's noted for feed, might be 8%. Most people are just planting corn.

They're not planting a feed grade. It's 7-8% protein. And I was into a feed store watchin' where some of the family buys show feed and buys corn. And one of the ag box stores, only were guaranteein' 6% protein in their corn.

Well, compare that to what the Indians used, theirs was 18%. Now, what kinda yield do they have to get compared to nowadays to have the similar protein per acre? It's one-third the yield. So it's not all about yield.

Well the old farmers knew you should not plant beans on over about a one-seventh of the farm per year, because they're hard on the soil. They didn't know what, they just knew it was. And they know you eventually get more disease.

When I started growin' soybeans in the '70s, and I was one of the first ones in our area. We grew navy beans before that and we continued to grow navy beans. But we started growin' soybeans. Was one of the first guys to

do a quantity of them in the North Branch area. There was more farther east in the Brown City area, and I picked up on it from the Brown City conventional guys. They did really well and there was no such thing as disease.

Now, soybeans have a page and a half of diseases that they could get, literally a list 25 on a page, and another half, and it's still growing. And so the old farmers would say, "Don't plant beans after beans and don't plant that much of your farm."

The young farmer would ask him why. And he'd say, "I don't know why, I just know you shouldn't do it. We're not into the why, we don't do it." Well, the young farmers say, "You don't know why? I'm gonna do it." He did it, and it works really well in the short term.

Beans after beans have good yield for about three years. And then it starts faltering. Then the disease starts and then there's a take-all disease that'll knock the field out. White mold, gets worse. Spray a fungicide, knocks it back.

Then it comes back worse again. Roundup Ready beans are one of the most susceptible to grow white mold. Noticed that back when they were first introduced, 'cause their weak genetics. And most of these other genetically modified things are strong in the pesticide area and weak in the nutrition.

So that was a twofold question. How do the organic farmers deal with that? So Mike Bronkema up at Zeeland, who was a Roundup Ready guy when I started with him, now focuses on an open-pollinated corn that raises over 10% protein.

And he doesn't put anything on it. And he's got 30% more protein. And the animals really like it. Well then, you don't have to raise as many beans. You see what I'm sayin'?

So you can start to put more broadleaves in your hay. And then as the soil gets better, you graze more grass. Grass in history is known as the best feed. There is a book out that I have on my shelf about soil, grass and cancer. And it was wrote in Europe back pre-1950. And they understood

about the value of grass. And then as the soils got poorer and as they quit producing nitrogen, people moved away from grass 'cause it wouldn't yield high enough and it wouldn't make enough protein.

So they went to the legumes, which are naturally higher in protein, make their own nitrogen, and they do better on poorer soil. So it's made us look good while the soil was getting poorer. Where if the farm can raise grass, they've got better soil. And so the old timers used to raise grass because they had better soil.

And somehow we missed that. And I missed it too. I was a big alfalfa guy. I even combined seed and sold it to my neighbors. And, most guys wouldn't bother with that. I grew up combining seed. I understood how to do it. Clover seed, alfalfa feed, Timothy seed, all those small seeds, which are a challenge to set the combine for. I was taught early on how to do that. And I've taught other farmers.

So once you get your base feed higher in protein, you start to come up with many options. And some of that's variety, some of it's soil balance. The thing is, you only get so far with the variety. I think the example I used in the past was super-sweet sweet corn.

I've raised a couple different batches of really good sweet corn. Didn't keep good enough records. But I didn't do it just with the breeding, I did it with the breeding and the soil. What they do now is, it's all through breeding. And you get the super-sweet sweet corn.

The thing is, the corn I raised was pest and disease resistant because it truly had the sugar. And there's a thing that you have to get onto, is depth of flavor. Sugar is right up front. And that's what the super-sweet sweet corn has, and you wanna eat more and more.

If it's got depth of flavor, it'll eventually fill you up. And that's the mineral side. So that's what the phosphorus does to the system. And I did that even when my soils were lower in phosphorus, but I was high in mycorrhizae and fungal organisms. And I was able to get that depth into the sweet corn. And I used some some clay-based phosphates too, that work a little bit like lime, really slow.

So the organic farmer starts raisin' his base deal with more protein. And gettin' away from alfalfa, starting to raise higher-protein grass, starting to raise higher-protein corn. But in the long term, he may move away from corn. And I've said, and I'll repeat it, and this is a shocker for most of agriculture: there's been more dairy farms put out of business with alfalfa and corn than most any other factor.

'Cause that's what they got narrowed down to feeding. And actually, to keep that animal gut presence, it needs more diversity for long-term herd health. Average age of a dairy cow in this state has got down to close to 40 months. They don't even make four years.

Takes two years to have the first calf. They don't even make two lactations. And nobody figures that into our efficiency equation, and that's part of the efficiency.

Right now with chickens, we are doin' the chicken flu cycle. We did the swine flu one, too. We're doin' bird flu cycle. And the price of eggs are goin' up. I tried to talk to my state rep about that, 'cause he was on the Ag Committee quite a few years ago. And I'm sayin', "We're gonna have a problem with chickens. We've got to lighten up on this confinement."

And, he couldn't get it through his head. He's a nice guy, but what has happened? Well, people are notice it now 'cause the price of eggs are goin' up. We're doin' things that some of those old timers wouldn't have did.

But the point I'm makin' is somehow they inherently knew what not to do. And they had a pretty good system. Most of them were pasturing back at that time. What they didn't know is when we went West and just plowed ground that shouldn't have been plowed.

And then plowed it every year because the price of wheat was high, and put it back to wheat again. And then summer plowed it to get rid of the weeds, meaning they worked it all summer to conserve moisture to kill the weeds, and then planted a crop.

Well, you can do that once. You can't do that repeatedly. And they did it repeatedly. But it wasn't the tillage, it was how the tillage affected the biology. And it's the life-and-death cycle of biology in the soil, specifically

more so bacteria than fungal.

But if you get the bacteria populations up, and it's not a matter of improving them 20%, it's a matter of improvin' them 500%, from where conventional agriculture is. Then you have a process of protoplasmic decay that's measurable in the soil.

And that's the glue that holds the system together. And that's the glue we get when we get the biology right. So consequently, the phosphorus can't leave the soil. It can't blow and it can't leach. And the phosphorus system will work. You have healthier plants, healthier animals, less veterinary bills, and you can even get to the point of very little veterinary bills. And we've seen that on active dairy farms.

Cooley Ludtke: That was Joe Scrimger. To learn more about Joe and Farms for Tomorrow, visit our website at farmsfortomorrow.org and follow us on Instagram, Facebook and X. Thanks for listening.

* * *END OF TRANSCRIPT* * *