



CORN STALKS TO CLOVER: CONNECTING CROP RESIDUE AND SOIL HEALTH

Featuring Dr. Jeanette Norton

Professor at Utah State University

DJ May:

Welcome to the Decode 6 Podcast, where we take your questions about carbon and ecosystem services and match them to the experts with the answers. I'm your host, DJ May, and today our big question is about residue. That is, what does crop residue do for your soil? And to answer that question, we've brought on Dr. Jeanette Norton, who goes by Jenny. Jenny is a soil microbiologist and professor at Utah State University where she's been working since 1993. Her research focuses on understanding soil and carbon cycling on different levels, working from individual, itty bitty organisms, all the way up to big picture ecosystem services. Plus, Jenny works with teams to address the challenges of agriculture under global change while promoting environmental sustainability and social justice. So without further ado, welcome Jenny. It's great to have you here.

Jeanette Norton:

Yeah, thank you for having me.

DJ May:

So I'm really excited. We're going to jump straight in. What is crop residue and what happens to it when you leave it on the soil?

Jeanette Norton:

Well, crop residue can be a lot of different things. It can be remnants of the crop that was in the field, like corn stubble, especially if you're harvesting corn for grain, everything else gets put back on the soil. It could be green manures, which are crops that are grown just for enriching the soil or to keep the soil covered. It could be root residues, so it's not all above ground. It could be the roots and carbon containing compounds that are given off by the roots into the soil. So those are all crop residues, and things like compost that you might add to the soil.

DJ May:

Okay. So maybe something that wasn't grown on the field, you bring it in, add it into the soil. What are you trying to do when you leave crop residue on a field?

Jeanette Norton:

Well, first of all, you're getting rid of things that you don't want anymore necessarily, the parts of the plant that aren't harvested. But more importantly for soil health, you're building the soil organic matter in the soil, and it's really the basis of the soil food web.

DJ May:

Talk more about that. What happens with the soil food web when you leave crop residue? What's the next step?

Jeanette Norton:

Usually the bigger soil fauna, bigger compared to microbe size, microscopic size, so things you might not be able to see them without a little bit of a magnifying glass or something like that, so these are called soil fauna. They include small insects and bigger insects, even earthworms. So those you can see, of course, they're big enough. But those kind of animals and insects chew up the residues and make it into smaller pieces, and that really helps the next stage of the soil food web, the fungi and bacteria that are microscopic, to have access to that energy and food for them in the residue.

DJ May:

Okay, so you start with your big chunk of leftover corn stalk or whatever. You have your bigger soil fauna that come and chew it up a little bit for the smaller guys. And then how do you go from that to maybe improved soil health? I feel like we're missing a step here.

Jeanette Norton:

Well, and when you have the soil microbial biomass, the total amount of microbes in the soil, as that's growing, it has to have food to grow, it has carbon food and nutrient food too as well, both of those go into building more and larger amounts of microbes in your soil, and they're more active too. So as those things are more active, they're churning through that residue through their bodies, actually. So even though microbes are very small, they have a lot of enzymes that they put out into the soil that help break down those residues into smaller and smaller pieces until the pieces are small enough that they're either dissolved in the water or microbes can attack them until they're small enough to take up and grow their own biomass. So once you're doing that, then the microbes are adding... They're part of the soil organic matter. So part of the soil organic matter are the living microbes.

But then they die also and they add a lot of good nutrients and carbon to the soil that's stored. But during their growth, they also give off some of the carbon as carbon dioxide that goes back to the atmosphere, and that trade off between how much ends up in the soil and ends up into the soil organic matter versus how much leaves as CO₂ is part of research that's still ongoing in soil microbiology and soil ecology fields. How to get more to stay in the soil and less given off as CO₂. There's always going to be some coming off as carbon dioxide.

DJ May:

Yeah, okay. So it sounds like maybe as you start leaving residue on a field, you're not just adding that plant matter, but it's kind of growing microbes too. You end up farming a little bit underneath the soil? Okay.

Jeanette Norton:

Yeah, that's a good way to think of it, but growing your microbial biota and activity is really important for improving the soil health.

DJ May:

Okay. So terrible parallel, I'm thinking of human nutrition. I just wouldn't want to eat cornstalks all the time. Does it make a difference for your microbes if you change up that residue, that food source, for them?

Jeanette Norton:

Of course. Yeah, it does make a big difference. Particularly one area that's been known for kind of a long time, but is really important, is how much nitrogen goes along with the carbon that's in your plant material. So something like corn

stalks has a lot of carbon and not as much nutrient in it, nitrogen particular. So when microbes are eating that, they have to eat more of it to get enough nitrogen for their bodies, and tends to be a little bit more will come off than as carbon dioxide. And that maybe even make the nitrogen temporarily less available for plants. But eventually, as that keeps turning over and as those microbes that grew on that corn stalk, when they die, they give off a lot of nitrogen, and that can become available for plants. So even if you start out with something that's not as easily degraded, eventually it will degrade, and each round that it goes through, the nutrients become more available for plants over time.

DJ May:

Yeah. So with corn, it sounds like your microbes are carbo loading a little bit for-

Jeanette Norton:

Yeah, right.

DJ May:

If you left a different kind of residue, would it give them different nutrients? What's a good foil for maybe leaving corn residue?

Jeanette Norton:

Well, something like some of the green manure crops, cover crops, like clover or even some of the grasses and stuff, but particularly nitrogen fixing cover crops. Those crops have a partnership with bacteria in the soil, and so they can get nitrogen actually from the atmosphere and bring it into their plant material. And then when that plant material degrades, it tends to have a higher amount of nitrogen and nutrients in it, so that degrades faster, and also it releases more nitrogen that can become available for plants more quickly. So it's a good thing. It's one of the reasons why farmers plant cover crops like clover, or after an alfalfa field that's been growing for several years, then when that residue gets turned into the soil, there's usually a lot of nitrogen can be released in the next year or so, next several years actually can keep going.

DJ May:

Okay, so there's kind of a little bit of a delayed release of nutrients as these microbes cycle as well, or is that just a-

Jeanette Norton:

Yeah, it can be delayed. Something like the cornstalks that are not so rich, there the nutrient release is more delayed, takes longer to break down. The microbes are a little bit slower to break them down. So the kind of residue really does have an influence on the rate that it is broken down. But things like those soil animals and earthworms can really help breaking down the residues as well.

DJ May:

Great. Well, long term, if you started doing this maybe five or 10 years ago, I guess, how does the soil change over time as you start leaving crop residues or incorporating green manure?

Jeanette Norton:

Yeah so really you're building the soil organic matter. When you're doing that. You're probably also increasing the live microbes and their activity in the soils, so things are moving through the system maybe a little bit faster. But also the dead microbes and the residues that are left at the end, they all go into building the soil organic matter, and some of the soil organic matter is very active and some is more long term. It stays in the soil for a longer time. And having that range of soil organic matter is really important for building soil physical structure. You want your soils to be, they call that well aggregated, or farmers call it having good tilt in your soil sometimes. It's that crumb structure. Think of a crumbly chocolate cake or something with the soil particles stuck together by microbial glues and the microbial hyphy and the root fragments. All that helps to make larger aggregates, and that makes for better water holding capacity, better aeration movement and water movement, importantly, through the soil cores.

So you have a better physical structure. You can hold more water in the soil, higher water holding capacity. So that's helpful because we have increasingly periods of drought followed by large amounts of rainfall happening, high impact rain events. So having more organic matter, and that crumb structure really helps to buffer that water. It can hold more water. It doesn't run off and erode your soil as easily. And then it also can last longer as if you then go into a period of drought. So it makes the reservoir of water in the soil last longer if you have that organic matter in there. So that's kind of physical things, but biologically, as I said, increasing microbial activity and turnover in the soil. So that's releasing nutrients potentially to the plants that you're planting the next time. So just keeps that soil food web interrelated and churning along.

DJ May:

Excellent. Well, just to wrap everything up, is there any advice you would give to a farmer who's interested in trying to leave crop residue out on a field for the first time?

Jeanette Norton:

Yeah, pay attention to the carbon to nitrogen content of your materials that you're leaving. If you have some option to diversify it, if you have something like wheat straw or the corn stubble that's very high carbon, remember that it's going to take a while to break down. And if you have something that has a little more nitrogen in it, like manure or something, that might be good to put on at the same time. So kind of try to balance those residues so that you're not depriving your crops of available nitrogen early on. Eventually it would kind of catch up. Or plant maybe a nitrogen fixing crop following your more straw based material, so that way it's helping to change up... Rotating your crops is changing up the type of nutrients that the plants need from the soil. So that's always good advice too.

DJ May:

Excellent. Well, thank you so much. That was great. I'm really glad we could talk about microbes and food and what you can do with your soil. I really appreciate you being here.

Jeanette Norton:

Okay. Yeah, thanks for having me. If anyone has any questions, they can email me.

DJ May:

Excellent. I will put your contact information in the show notes.

Jeanette Norton:

Okay, thanks.

DJ May:

If you enjoyed this conversation about the impact of crop residue on the soil, soil health, and microbial community, and you want to read a little bit more, check out the show notes. And if you're interested in carbon and ecosystem services and how all of this is fitting together with new markets and climate goals, check out decode6.org to learn more.