Transcript of Episode 022 of the Plants Dig Soil podcast – "Potatoes, Tillage, & Soil Health."

Hello! This is Scott Gillespie and welcome to the third season of Plants Dig Soil. In this podcast, you will learn how to think critically about regenerative practices as you work to incorporate them into your agricultural, horticultural, and home gardening systems.

[Transition Music]

Dr. Martin Entz was my thesis advisor when I was doing my master's degree at the University of Manitoba. He was always all about natural systems and so I found it a bit surprising when I read an article[1] about him where he said "Minimizing tillage is good for soils. But eliminating tillage is not necessary for a healthy soil." Further in the article a professor at the University of Guelph, that I had when I did my undergraduate degree, went a step further. Dr. Bill Deen says "Martin is correct…. If you move towards a reduced till, no-till system it doesn't impact total soil organic carbon in a (soil) profile. There's lots a data to support that," he said. "(The) data may be transferable to Western Canada, as well."

If you have been listening to the podcast this summer, you will notice this sounds very similar to the argument about cover crops. I had always thought that the more you include cover crops into your system the more organic matter would be produced. However, similar to the emerging studies on tillage, they are showing that cover crops do not impact the net organic matter in the rooting zone. At the surface there may be more, however, when researchers look through the entire rooting zone – 1 to 2 metres in most cases, the net amount does not change. In fact, cover crops in the long term will actually have less organic matter at the lower depths than non cover cropped land.

Please check out episode 019 Carbon in its Proper Place[2] if you want to explore this more. To recap, the idea I put forth is that cover crops are putting organic matter in its proper place. The surface layers, that is the top 15-30cm, will have the most favourable temperatures and will have more moisture as they will always get the rain or irrigation water first. Roots are concentrated here and so is the soil life – the microbes and soil fauna. Cover crops pump this to the surface and this is where it is concentrated.

The reason it does not accumulate is that it is being used. Organic matter will build to a certain level, but it is not there to sequester carbon dioxide for us. Carbon is energy. It is constantly being cycled as plants put it down into the soil and the microbes and fauna use it to make their structures and use it for energy. Putting more carbon into the soil increases the rate of cycling, it does not store it. Every soil and climate has its optimal amount.

The biggest drivers for the steady state organic matter in a soil is the texture, the annual rainfall, and the temperature. As an example, a sandy soil in the semi arid area where I live in has a lower potential organic matter steady state than a soil in a more northerly area where there is more water and less heat. If the soil has more clay or silt in it there is potential of capturing more organic matter. In the short term we may not see much difference but over 10,000 years of soil development the differences become clear.

Now to bring tillage into the picture. Earlier this season in episode 017 The Long View on Regeneration[3] I talked about the early agricultural pioneers in the place where I live and work – the Canadian Prairies. While we tend to think of European settlers as the first farmers, there were farmers in the area well before settlement. I am still learning about the extent of farming so the only example I have is of a

farmer just south of the Canadian border in the Northern Great Plains of the United States in what is now the Dakotas.

Buffalo Bird Woman[4] talked about clearing river bottom flats, burning the trees, and tilling the land in preparation for growing crops. She said the first crop was always the best, the second was close to the first crop and all subsequent crops tended to diminish unless the land was left for a few years to rest before resuming farming again.

The settlers, like Seager Wheeler[5] in what is now Saskatchewan, Canada, talked of a similar process. The land needed to be plowed and the grass turned under. A series of tillage events over the year proceeding the start of farming the land helped to release nutrients needed for the crop. From then on, a year of fallow was cycled with a year of farming. Seager saw this system work for many years and believed it would work indefinitely. He wrote his book a decade before the dust bowl of the 1930's showed the fallacy of the system.

Unlike the settlers, who had no where to go, the indigenous tribes were able to move when the soil could not produce what they wanted it to. A plot of land that had been farmed for generations could be left for centuries to recover and then farmed again. The settlers used up the fertility of the land in a matter of decades and were only saved by the newly available chemical fertilizers. The indigenous had been sustainable 700 years and were only stopped due to colonial expansion.

It seems obvious that tillage destroys organic matter but when I think about it now, I see it does not cause the damage in and of itself. Tillage only speeds up the process. The export of the nutrients is what degrades the organic matter, not the tillage event. If instead of growing a crop and exporting the grain the land instead had grasses re-established and buffalo graze it, the organic matter would be restored. In the case of agricultural production, the soil is left without some of the nutrients it had in it. To restore the balance some of the organic matter needs to be used to release nutrients and energy or fertilizers need to be imported to replace what is exported.

Cycling back to the article that started this conversation, it turns out studies that look at depth, and not just at surface layers, find the same thing in tillage as in cover crops. The surface layer of no till fields does indeed tend to have more organic matter. However, when the full profile is looked it, between one and two metres deep, the net amount of organic matter is the same whether you look at tilled land or no-tilled land.

[Transition music}

I spend a lot of my time thinking about potato production and how it can be brought into alignment with the principles of a healthy soil. The toughest principle to follow when growing potatoes, or any other high disturbance crop, is to minimize tillage. By the fact they grow the edible portion of the plant underground we need to disturb the soil. Potatoes also make it tough to keep the soil armored as they need to be planted 15cm below the surface and they take 3-5 weeks to come out of the ground. After harvest there is also a period of very little soil armor as they need to be dug out of the ground and they leave very little residue on the surface.

Given this new idea that tillage does not cause organic matter loss and my idea that cover crops are basically just putting carbon in its proper place, it follows that potatoes are not inherently bad for the soil. Their problem is they disturb this layering of organic matter that protects the surface. The goal,

then, is to do what we can to keep as much organic matter in place as possible while growing the potatoes. In the same way that areas that regularly experience hurricanes are better equipped to weather the storm and rebuild, we need to prepare the soil for this extreme tillage event in order than it can come through the other side intact.

Current equipment constrains some practices from coming to be in the potato industry but there are innovative farmers out there trying to make a change. Chad Berry is a farmer in Manitoba, Canada that is trying to plant potatoes with the least amount of tillage as possible[6]. Current planters are designed to work best in well tilled soil. He modified his to help him accomplish the goal. To learn more, check out an article on Spud Smart about his experiences last year. Be sure to watch potato news or search him out on Google to see updates from this year.

An idea that I have had for a few years, and was talked about in the first season of this podcast, is to relay seed a cover crop between the hills after the potatoes are growing. In my experience, these areas tend to get wet, and the plants have a hard time accessing this moisture. If a cereal crop were growing there, it would be ready to take over when the potatoes are harvested. The added benefit might be that equipment driving over the field will encounter solid ground rather than wet tracks between the hills.

Of course, there are two big hurdles to this. First of all, most potatoes are top-killed a few weeks or more before harvest to help with maturity, skin set, and ease of digging. Traditional top kill products are week on grasses so this may mean they survive, and the crop does not. Perhaps we just need to find species that have better resistance to the products. Even if you are successful in not killing the relay crop there is still the digging.

I have seen potato harvesters with large metal wheels to push down the interrow lumps and facilitate only the potato row being dug. It may not work as is, but I think it shows there is potential. Imagine having a field with green strips after potato digging. You will still need to get something growing where the potatoes were, but you have a head start.

Looking back to what makes a healthy soil and given that tillage may not be as bad for the soil as once thought, what can we do right now to make potato production more in line with the soil health principles? Organic matter is always cycling, and tillage helps to speed up this process. The way to counter this, I would argue, is to get ahead of the curve.

Going back to the example of the settlers, if you tilled the soil and then established grassland again, it would recover. What if, instead, you supercharge the system ahead of the potatoes so that after the potatoes it is back to where it started?

There is work in the Pacific Northwest area of the United States that shows that incorporating high amounts of biomass from a green manure gives a temporary boost to the soil's ability to withstand erosion[7]. The reason for this is speculated to be because of the spike in biological activity as all the fresh residue is chopped then immediately tilled into the soil. In the long growing season areas of Washington and Oregon this can be grown after a winter cereal crop but in most areas of potato production an entire year would need to be taken out of production for this.

The erosion control alone may be tough to justify but if you add in disease suppression, higher potato production, and/or higher quality potatoes it will likely pay. Using the best species for the job, in this

case mustard, is the key in making this work. If you are looking to control a specific disease you may even need a specific variety of mustard to do the job.

Let us say you do the work and have a full season mustard cover crop that you chop and disk into the soil. You then make the rows for potato production for the following year and immediately seed a cover crop onto these hills. Yes, you have tilled, but as we have learned, it is not so much that tillage is unnatural as the fact that we need to be ready to help the microbes recover. They need some new food, and we have provided it. It is not a perfect solution but as long as the next cover on the soil gets a foothold before the mustard decomposition loses its effectiveness, you will have your soil armored and held in place.

The following spring you are ready to plant potatoes but now you have a new problem. You have residue on top and through the hills. Potato planters are not usually designed to work with this. This is where new innovations, like Manitoba potato grower Chad Berry, need to be tested. Perhaps using winterkilled species and a planter that can handle the residue will help put the potatoes in the ground with minimal disturbance and hold the soil in place.

For now, using a powerhiller or a hiller that can fluff the soil and allow the planters to do their job is an effective means to get the soil ready. Perhaps not ideal, but until the equipment catches up this is the best we can do.

There is potential at this point of another cover crop to bridge the gap of the 3-5 weeks it takes for potatoes to come out of the ground and anchor the hill. Perhaps this is only needed on highly erodible land. Over many cycles of supercharging the system, in potato years and in rotational crops, you may have a soil that is more resilient and can handle this better.

After the crop is harvested, we again come up with vulnerable soil. Potatoes leave very little residue, and the digging process again exposes it. As I mentioned earlier on in this episode, I have some ideas for relaying a cover crop, but they have some limitations to work through first. In the meantime, the best solution that I see is to plant fall rye immediately after harvest or spread it on top ahead of harvest and let the diggers plant it.

Fall rye has the advantage of germinating in cold temperatures, growing in cold temperatures, surviving the most extreme Canadian winters, and resuming growth in late winter or early spring. It will give the best protection, but one disadvantage to it is controlling before the next cash crop. In this case you may want to use a winter killing spring cereal or less aggressive winter cereals such at triticale or wheat.

[Transition music}

There is a lot to learn yet in this space of tillage, soil health, and potatoes. If you want to dig deeper into this (pun totally intended) I suggest you check out a Spud Smart webinar called “Are Cover Crops Worth the Work?” I start by presenting the case for cover crops and Dr. Judith Nyiraneza follows with results from her studies on potato yield, nitrogen cycling, and chemical & physical changes when using species such as pearl millet, sorghum sudan grass, brown mustard, and mixtures of legumes and grasses.

If you are listening to this in the first week of the episode being published you have a chance to see it live by going to the link in the transcript.[8] If you are listening to this after September 9, 2021, the link should still point you to a way to listen to the replay. If it does not, check future episodes as I will be sure

to have a link. You can also check the media page on my website for a link to the recording by going to www.plantsdigsoil.com/media

[Transition Music]

Remember to get local advice before acting upon this information. If you do not know who to talk to, get a hold of me and I will help you find someone. If you are in my local area and need help, contact me. It is always free to chat. If we get to the point that the scope broadens to consulting work, we can work out a plan that fits your budget.

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If you are still listening, you are probably like me and like to know what the catch is. Why am I putting out this information for free? The reason is that I love to learn, and I love to share the information. My knowledge has been built up from experiences in my own garden, advising clients in my consulting business, and from reading the latest books and articles on agronomy and regenerative agriculture.

I have a B.Sc. (Agr.) with an agronomy focus and a M.Sc. with a focus on Plant Science. Beyond my formal education, I have attained, and maintained, my Certified Crop Advisor designation and am a member in good standing with the Alberta Institute of Agrologists.

Nearly everything I talk about is from free resources posted to university and research organization websites. Books that used to be hard to track down are available to buy or borrow for nearly anyone with an e-reader. The information is out there – sifting through it all is what takes the time.

I make my living entirely from consulting. I do not sell any products, software, or systems. I strive to be as independent and as unbiased as possible so I can provide the best advice to my clients and help as many people as possible move from conventional to regenerative agriculture.

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