Transcript of Episode 018 of the Plants Dig Soil podcast – "Three Pillars Propping Regen Ag."

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]

In the previous episode, I took the long view on regeneration. I returned to 10,000 years ago to trace the development of the soil with which I currently work. If you live outside of the area now known as Southern Alberta, Canada, then you will need to learn about how your soil formed. The soil in this area is young, in geological terms, even though its age is almost unfathomable in human terms. If you were to condense the 10,000 years of soil development down to an hour you would only see agriculture, as we know it, developing in the last minute.

I specifically mention "agriculture, as we know it" for a reason: humans have lived on this land and have been shaping it for millennia. The current type of agriculture has only been around for about 150 years in my area. Not far from where I live and work, in what is now the Dakotas in the United States, agriculture was practiced for nearly 700 years before the Europeans arrived. Buffalo Bird Woman was one of the last farmers in the late 1800s to farm this way. Fortunately, her story was recorded before that way of life ended.

Contrasting her story to a first-person account of a settler farmer, Seager Wheeler, showed that there were not many differences in the way that they approached growing crops. Seed selection, weed control, and land preparation, were all remarkably similar. Both ways were extractive – each admitted that when clearing the land, the first crop was always the best. Subsequent crops equaled but usually never surpassed the first crops. Eventually, the land needed to be left alone for a year or two to regenerate.

I argue that the indigenous way was truly regenerative because it was able to support humans for millennia; And the reason for this is in the time scale. Imagine the tribes moving up and down the river valley for centuries. A site could be used for a few generations and then left for 10 or 20 generations. In that time, it would have a chance to regenerate and could be ready to support a few generations of human habitation again. There was also no export off the land. It would be what is now called a circular economy – everything lived and died in the same area and eventually went back to the earth.

The settler mindset was different. It is best to hear it in their exact words so I will read a direct quote of Seager Wheeler from his book "Profitable Grain Growing" published in 1919:

> The argument is put forward that there is so much fertility in the soil that every bushel of wheat or other grain removes a certain amount of this soil fertility and that in time, by continually growing heavy crops of grain the fertility will be used up. Theoretically this seems a good argument, but it is not true. The soil is inexhaustible, providing we husband its resources, and it is a fact that we may, by good sound methods of tillage, replace in the soil what the crops have removed.

I ended the episode contrasting this statement to the claims of some in the regenerative agriculture sphere today. The only difference is that they see cover crops as being the way to provide all the nutrients that the crops will ever need. Seager Wheeler was making this statement before the dust bowl of the 1930s showed that his system was not as sustainable as it first appeared. In this episode I will be arguing that we will be seeing the same thing show up in the 2030s – Only this time we will not be seeing soil blowing, we will be seeing crops fail as the nutrient supplying power of the soil is once again depleted.

[Transition Music]

So, here is where I want to become realistic in expectations for what regenerative agriculture can do. The current hype in regenerative agriculture has been based upon experiences in the past five to ten years, possibly up to twenty years. Recall from the last episode that if you condensed the soil development timeline of 10,000 years to one hour you would see agriculture, as we know it, only show up in the last minute. Regenerative agriculture would only be seen in the last few seconds.

From my perspective, there are three pillars that are propping up regenerative agriculture right now: Dr. Andrew McGuire from Washington State University's Center for Sustaining Agriculture and Natural Resources department was a key person that clarified my thinking in this area[1]. These pillars are largely based on one of his articles, but the concepts are built through many of his posts. There will be a link in the transcript for this episode if you want to read Dr. McGuire's article.

The three pillars that I see are:

1) Inflated expectations of microbial mining of soil particles
2) Mining of the legacy nutrient applications
3) Faulty accounting of nutrient flows

Let us start with microbial mining of the soil particles. I hear the phrase "get the biology working for you" a lot. The idea is that if you just get a healthy population of microbes working for you in the soil, they will provide everything you need to grow a crop. They will often cite stats such as there are 6,000-9,000 lbs of phosphorus[2] in your soils that plants can not access but the microbes can.

While it is true that there is a massive quantity of nutrients available, the rate of their release by microbes is greatly overestimated. Two years ago, Dr. Monika Gorzelak was speaking at Agronomy Update about the new research program that she was setting up at Agriculture and Agri-Food Canada in Lethbridge, Alberta. She highly recommended a book called "Functional Diversity of Mycorrhizal Fungi and Sustainable Agriculture"[3]. I have read the book cover to cover. I did not find any reference to the rate of mining anywhere throughout the book.

I emailed Monika to ask her if she was aware of any numbers. She was not, but she kindly did some searching of the databases that she has access to. She was not able to find any studies that gave numbers to the potential amount that microbes may be able to mine for us. The best answer I have been able to find is in Dr. Andrew McGuire's article where he references a 2004 study that shows it may be higher than previously thought, but still nowhere near what we export in agriculture[4].

[Transition Music]

Last year, Bruce Barker posted a download link on his site, Canadian Agronomist, about a long-lost print publication from 1993 generally referred to as "The Red Book."[5] The full name of the publication is "Impact of Macronutrients on Crop Responses and Environmental Sustainability on the Canadian

Prairies". It is a title that only an academic could come up with, which is why it is known as The Red Book. It gives a great picture of fertility research from the beginning of agriculture as we know it in the late 1800s and right up to its publication in the 1990s.

Research on nitrogen response was not initiated until the 1950s. Nitrogen was not the main limiter in the early fallow systems. It only became limiting in the early to mid-twentieth century. The first research was into phosphorus deficiency. That was the most limiting nutrient there was on the prairies.

After millennia of grass growth and grazing, there should be excess supplies of phosphorus, but there was only enough there to supply a few decades of farming with moderate exports of nutrients. Remember that yields were much lower, and most fields were only cropped every other year. If microbial mining could indeed supply all that was needed, do you not think it would have kicked in and supplied the needs of the crops?

In one of the summary articles the authors found that prior to 1970, research published in Saskatchewan found that in over 90% of the trials a significant yield response could be found by adding phosphorus. This led to a boom in phosphorus application and farmers benefitted greatly.

In the decades after 1970, researchers were puzzled because they could not get the same level of response. It dropped to only a 30-50% chance of a response. The reason for this decline in response was that phosphorus was building up in the soil. It is not as mobile as nitrogen and tends to get weakly bound with soil particles not long after application.

Dr. Cynthia Grant estimates that only 15-30% of applied phosphorus ends up in the current cash crop. Some claim the rest is lost, never to seen again. In fact, most of it will eventually make it into your cash crops. It just takes time. So where did the other 70-85% of the crops needs come from? A small portion may have come from newly mined soil particles. Some were from the readily available supply that shows on the soil test. The rest came from the weakly bound supply that does not show on the soil test and is not tightly bound in soil particles. It is not easily available to plants but it is not so tightly bound that it can not return to the soil solution in time through chemical exchange, or microbial action.

So how can it be that we see pictures of diverse cover crops growing without any applied fertilizer? It may be true that the diverse cover crops are revving up the biology and stimulating microorganisms that normally would not be thriving in a monoculture cash crop, but it is not because they are mining the soil particles. There are, in fact, using this legacy phosphorus, built up over decades of fertilizer application.

This is the second pillar propping up regenerative agriculture: Mining legacy nutrients under the belief that they are unlocking large stores of new nutrients from the soil particles.

It is not wrong to rely on this legacy phosphorus. In fact, it may be a good way get started in regenerative agriculture practices. Using these nutrients instead of applying more nutrients may offset the costs of the seeds for the plants required to do this.

Having roots in the ground keeps these cycles going past cash crop harvest and into the shoulder seasons. Any plant is better than no plant but adding some diversity helps tap into different microbial communities and captures nutrients from varying depths. If the root mass and above ground mass break down fast enough, then they can supply this previously weakly bound phosphorus to your cash crop without it having to do the work to find it.

Just to back up a bit, I want you to think about something: Even if we were mining all new nutrients from the soil and we could grow all we want from this: Is this sustainable? 6,000 lbs of phosphorus would grow about 100 irrigated crops and about 200 dryland crops in my area. But then what happens when that runs out? We have only taken from the generations that are yet to come.

This leads me into the final of the three pillars that is propping up regenerative agriculture – faulty accounting of nutrient flows. The soil particles can only produce a small amount of the nutrients that we export in a year. The legacy nutrients can prop you up for a little while, but eventually you need nutrients brought back into the system.

To put some numbers to this, consider a dryland four-year cycle of peas, wheat, canola, and barley. Nitrogen[6] and phosphorus[7] are the most limiting nutrients in Southern Alberta so for simplicity I am only going to illustrate using them.

The peas will make their own nitrogen if properly inoculated and so the only nutrient export per acre in the form of the grain (assuming the straw is left on the ground) on a 50bu crop will be 35lb of P. A 40bu wheat crop will export 60lb N and 25lb P. A 35bu canola crop will export 65lb N and 35lb P. Finally, a 60bu barley crop will export 60lb N and 35lb P. Over the four years you will have exported 185lb of nitrogen and 130lb of phosphorus. On average, this means every year you must replace 47lb of nitrogen and 33lb of phosphorus.

Comparing this annual system to a perennial system with grazing animals shows a drastically different level of export. The Alberta Forage Manual says that a cow-calf pair will remove 11lb N and 4.5lb P in a grazing season[8]. At a stocking density of 5 acres per cow-calf pair this means you are only removing approximately 2lb/ac of N and 1lb/ac of P per year.

From these numbers you can see that the way that most of the celebrity farmers and ranchers have made this work is to change their operation to a grazing based system. When you are only exporting meat, you can make that legacy phosphorus last for a long time. If you were, in fact, mining the soil particles, you would make that 6,000 lbs of phosphorus last for 6,000 years. If we only ate meat this would work, but we need grains, oilseeds, and vegetables for our diet as well.

At commodity prices, it is hard to make a grazing system work. However, the other key to seeing how the celebrity farmers and ranchers make it work is to understand they are direct marketing their meat to nearby cities. Some have even vertically integrated – now controlling the processing, distribution, and wholesale side of the business. They capture a large portion of the consumer dollar which allows them to run only the amount of cattle that the land can handle. They have matched the exports to the regeneration of the land.

[Transition Music]

The past has shown us that many ideas that initially appear to work turn out to be wrong in the end. A hundred years ago it was believed that plants took up the actual particles of the soil and humus and so tilling the soil to a powder was what was needed to grow a crop. What they did not know what that they were in fact speeding up the microbial processes in the soil and allowing nutrients that had been locked up for centuries, or possibly millennia, to feed their crops. It took many generations to understand this was not working.

Today we hear that cover crops are all we need to provide nutrients to our crops. This is working on many acres, but it is being propped up by legacy nutrients. As the real microbial rates kick in and the export creates too big of a deficit for the import of nutrients, crop yields will decline. It may only take a few years to a few decades in the case of cash crop systems. In grazing systems, it could take decades to centuries to see the decline, but it will happen.

So what is the value in regenerative agriculture? I hope I have not deflated your expectations too much. There is a lot it can do, and I will be exploring this more over the rest of this season. I still believe it is beneficial to move towards. However, we must be realistic in how we approach it so we build a solid system that will truly benefit the generations to come.

[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.

Would you like to keep up with me through a free monthly newsletter? Go to www.plantsdigsoil.com/contact and select the newsletter option. If you have not subscribed to the podcast yet please make sure you do that in your favourite app. If you are a long-time listener – will you consider leaving me a review? This helps others discover the podcast. If you know of someone that would enjoy this, please be sure to share it with them directly or through your social networks.

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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[1] Andrew McGuire. 2020. How does regenerative agriculture reduce nutrient inputs? http://csanr.wsu.edu/how-does-regenerative-agriculture-reduce-nutrient-inputs/

[2] John Kempf. 2021. Kind Harvest post. Supplying 100% of crops N requirements. https://kindharvest.ag/discussion/supplying-100-of-crops-n-requiremnts/

[3] Michael J. Goss, Mário Carvalho, and Isabel Brito. 2017. Functional Diversity of Mycorrhiza and Sustainable Agriculture. https://www.sciencedirect.com/book/9780128042441/functional-diversity-of-mycorrhiza-and-sustainable-agriculture

[4] Andrew McGuire. 2020. How does regenerative agriculture reduce nutrient inputs? http://csanr.wsu.edu/how-does-regenerative-agriculture-reduce-nutrient-inputs/

[5] Canadian Agronomist. 2020? The Red Book. https://canadianagronomist.ca/resource/the-red-book/

[6] Government of Saskatchewan. Nitrogen Fertilization in Crop Production. https://www.saskatchewan.ca/business/agriculture-natural-resources-and-industry/agribusiness-farmers-and-ranchers/crops-and-irrigation/soils-fertility-and-nutrients/nitrogen-fertilization-in-crop-production

[7] Government of Saskatchewan. Phosphorus Fertilization in Crop Production. https://www.saskatchewan.ca/business/agriculture-natural-resources-and-industry/agribusiness-farmers-and-ranchers/crops-and-irrigation/soils-fertility-and-nutrients/phosphorus-fertilization-in-crop-production

[8] Arvid Aasen & Myron Bjorge. 2009. p 241. Alberta Forage Manual. https://open.alberta.ca/dataset/077326082x#summary