**Plants Dig Soil | Season 4 | Episode 6 | 030 Biochar, Biologicals, & Biomass | August 2, 2022**

Hello! This is Scott Gillespie and welcome to the fourth season of Plants Dig Soil. In this podcast, you will learn how to think critically about regenerative agriculture claims so that you can apply proven and profitable practices that benefit your farm now and in the future.

[TRANSITION MUSIC]

I first heard of biochar about ten years ago when some research in my province, Alberta, Canada, was talked about at a local conference. All I remember from it is that it did not really do much and may have even made the land less productive. There was a company trying to get going but with these results and with very little interest in regenerative agriculture at the time, it did not take off.

As I understand it now, the likely issue was that our soils tend to be neutral to high pH. Typically, I see values from 7-8 with the most common being in the 7.6-7.8 range. Biochar tends to have its greatest effect on acid soils.

When it is added to soils it slowly dissolves into over a period of about a month. Over the coming season, it reacts with the soil chemistry and entrenches itself more fully into the soil. Most of the components of it resist decomposition and it is expected to last decades, if not centuries, in this state. That is the carbon sequestration promise of it. It is also reported to reduce the release of greenhouse gases such as nitrous oxide and methane.

Some studies show that it primes the system for more carbon capture[1]. In other words, it seems to help the soil store more carbon than the input from the biochar. This is promising. However, the opposite has also been found. It may also rev up the biology and lead to more losses of carbon and release of nutrients from the soil. Understanding the factors that contribute to capture or release still need to be determined before we can count on it for carbon sequestration.

The productivity promise for the farmer comes from what it can do for the soil[2]. When you have neutral to more acidic soils biochar can help to unlock nutrients that would otherwise not be available. It also increases the charge space, the cation exchange capacity (CEC), in the soil and so more nutrients can be held and released than the soil was able to before the biochar addition.

Some studies show it can help to hold onto metals and other molecules detrimental to plant growth. How it holds the ones we do not want and releases the ones we do want is beyond my understanding but for now, I will go with this. With sufficient quantities added, it can help with soil structure, water infiltration, and water holding capacity.

So, what is biochar? The most basic answer is that it is the product of combustion of biomass in the near or complete absence of oxygen. There may be energy captured from the process as well. The lure of this process is that if done properly it can release more energy than is put into it and produce a product that sequesters carbon, the biochar, and this product could help make more productive farms. As you can imagine, it has great promise.

When biomass is left to decompose naturally the gases for energy and the stable carbon for agriculture do not necessarily divide out. The carbon rapidly goes back into the atmosphere as microbes digest the biomass and the nutrients go back into the system. A small portion, around 15%, of the carbon would stick around in the soil and become long term organic matter.

If you think of biochar as interrupting a natural cycle, you have the best picture of it. Imagine a forest, or a grassland, or a mixed area of both. The plants grow and make leaves or woody stems. Typically, at the end of the season the leaves will fall the ground and get decomposed over the coming years.

In the case of grasslands some of these leaves would have been eaten and passed through a ruminant, thereby speeding up the process. Historically, in my area, this would have been accomplished by the buffalo. In modern times, this is accomplished mainly through cattle. Trees and other woody plants will eventually die and will end up on the ground and get decomposed.

The natural process for biochar formation is an intensive fire. We must expand our timescale to millennia here and think of fires moving across the prairie or consuming forests. Instead of thinking of large areas consumed at once, it is more likely that there were patchworks of lands in various stages of growth after fires. By random chance, or by Indigenous decisions, some areas may not be burned for millennia. Some areas may have been burned many times over the centuries.

While it would not be a huge amount, some of the leaves, stems, and trees that were burned would have been burned in this near or complete absence of oxygen. The black carbon (basically biochar) that is produced from this is very resistant to decomposition. Some estimate that up to half of the carbon in Prairie soils could be from this process[3].

This is not what has inspired the modern interest in biochar. The inspiration was soils that were found in the Amazon region of South America. Most of the forest soils are incredibly old in geological terms. However, wherever humans have lived, the soils are much more productive. It was found that the products of using biomass for cooking along with the food leftovers and, of course, the excrement from humans eating food and passing it through their bodies, made for a more productive soil[4]. Again, we must expand our timescales. This is not something that is accomplished over a few years. This comes from generations living in the same areas for centuries.

If you take a bird's eye view of the globe you can see that the modern interest in biochar is similar in principle but at a vastly different scale. We are not looking at small fires cooking food for families. We are looking at large buildings specifically built to burn biomass under controlled systems. We are not collecting forest debris or harvesting a few trees from the neighbouring forest. We are hauling in truck loads of biomass daily for processing. We are not just spreading the ashes, excrement, and leftover food scraps in the periphery of the village. We are taking this product, and possibly other nutrient sources, and spreading it on thousands of acres hundreds of kilometres from the source.

This can be a good thing for processing organic wastes that would normally end up getting put in a landfill. However, I wonder how sustainable this is if there are specific areas harvested for biomass to make the biochar, which is then spread on agricultural land? If it makes the land more productive, I think it can be justified. If its just a scheme that transports carbon from one area to the other, I am not so sure.

As always, if you want to learn more, check out the references in the transcript. This is where I have learned most of what I know on biochar and these references are packed full of more references if you want to dive deeper.

[TRANSITION MUSIC]

I want to shift now to biologicals. Biochar is mainly for the soil. Biologicals are mainly for the plants. I have found many definitions and many divisions of what they are but fundamentally they are a product of biological origin that has some promise of helping plants to grow better. The product may have the actual organism (or organisms) present to do the work, or the product may have the output of these organisms.

The easiest biological that we are all probably familiar with are inoculants for legume plants. When planting a new legume or planting one that has not been grown on a piece of land for a while, we usually add these in. They have a direct effect on a specific plant and lead to great increases in yield by allowing it to make its own nitrogen in nodules in its roots.

There are some new free-living bacterial products hitting the market that claim to be able to make nitrogen for any crop. I have seen conflicting results from these so for now I am waiting to see the results from third party trials until trying them.

Biostimulants are products that helps make plants do something it normally would not do. Most of use biostimulants every day, if we consume coffee or tea for the caffeine kick it gives us. Biostimulant products may help a plant gear up for a stress event ahead of the event happening, helping it to skip the lag phase.

The first time I heard of this was on an episode of a technology show that was looking at the future of farming. Cricket farming was being profiled as a new protein source. Yeah, it is not really for me unless it is hidden in something I am already eating. The fascinating part was that once the crickets have been processed there are vast quantities of their shells. It turns out if you spread these around plants it makes them think they are soon to be invaded by insect predators and they up-regulate defense mechanisms that help them to be ready when an actual pest is present.

The final major division, at least the way I see it, is biopesticides. We all know of Bt crops that have a toxin genetically engineered into the seeds. The origins of this is a type of bacteria that produces the toxin and that had been used for decades as a spray. Due to its natural origins, it is an approved product under most organic systems.

While Bt is a specific chemical for specific pests, some biologicals work on the idea that you just need the right combinations of organisms to outweigh the bad. I see with the many seed treatments coming out that claim that by using their product the biology in them coats the seed and the roots with the beneficials that fight off the pathogens. Early results look good, but I want to know what is going happen in a challenging year.

Biologicals get a bad rap in the marketplace. I often hear of them referred to as “bugs in a jug” or “snake oil.” This comes from many, many products coming and going as people promise great returns, farmers apply them, find nothing happens, and the company disappears. Personally, I have found very few studies from third parties that show these products working. There are usually studies from the companies that show how well they work, but oftentimes they have cherry-picked only the ones in which they win.

Be careful, too, about scientific articles that show their promise. One review article[5], that I will link to in the transcript, cautions that though their results show an average of an 18% yield increase, this could be inflated because studies that show no effect tend not to get published. In other words, it can seem like

new studies are coming out all the time that show great promise, but you're not seeing all the other ones that show nothing, or perhaps a yield decline, from using the biological.

[TRANSITION MUSIC]

Let us pull it all together with my favourite topic: biomass. Long time listeners will know that I talk about this the most. One episode I highly recommend you review is 012 Simplicity in Cover Crop Mixes[6].Biochar and biologicals do very little for you unless they are also coupled with increasing biomass or preventing biomass from being lost from pests. This should lead to greater yield by producing more or losing less.

In the case of cover crops, biomass is critical for the work they do. Suppressing weeds is mostly about taking up the space. Suppressing disease is mostly about quantity of biomass, not just the presence of a plant. Similar to cash crops, the more that that's there, the greater the effect; except that in this case the effect is not greater yield, it is a greater impact on your soil.

If you are looking at using biologicals, make sure to ask yourself: What problem is this solving? Look for a 2:1 return on investment (ROI). For example, if a product costs $20/ac, you should expect $40/ac in additional crop yield or prevention of its loss. If you just get a 1:1 ROI all you have did is help a salesperson, make their targets for the year. For a more in-depth discussion on this, go back to episode 008 No Stats. No Effect[7].

ROI needs to be looked at year over year as well. If you use it one year, and you solve a problem, you have made money. If you continue to use it year over year you might be losing in the long term. For example, if you make nothing extra for 3 years and gain one year, you have lost over the long term.

If you are looking at biochar, you need to expand your time horizons to years. You are likely to not see the results from it for a few years. You may be able to gain quicker ROI by putting it near the seed to concentrate its effect and help pay for it quicker. Just be sure to ask yourself: Does this have a high probability of working? If your pH is neutral to alkaline and you are growing good crops already it is less likely to pay you back.

The future holds great promise for the "bio" products. I am excited to see what will happen in the next 5-10 years. With some caution in adopting and placing them in the right situations, they could be a great addition to your farm.

[TRANSITION MUSIC]

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I always like to know how people that give out information for free actually make money. The podcast is free so that you can learn something new and get to know how I work through issues.

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If you live in Southern Alberta, Canada, I can provide scouting services throughout the summer with weekly field checks for crop staging, pest presence, and, under irrigated fields, soil moisture and weekly irrigation plans. I go beyond the standard crops of wheat, barley, canola, and peas to include things like potatoes, quinoa, and hemp. And of course, I love taking on cover crops.

My expertise is centred around the Canadian Prairies. 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.

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See you next time.

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[1] Joseph et. al. 2021. GCB Bioenergy. "How biochar works, and when it doesn't: A review of mechanisms controlling soil and plant responses to biochar" https://onlinelibrary.wiley.com/doi/10.1111/gcbb.12885
[2] Joseph et. al. 2021. GCB Bioenergy. "How biochar works, and when it doesn't: A review of mechanisms controlling soil and plant responses to biochar" https://onlinelibrary.wiley.com/doi/10.1111/gcbb.12885
[3] Jeff Schahczenski. April 2018. ATTRA. "Biochar and Sustainable Agriculture" https://attra.ncat.org/product/biochar-and-sustainable-agriculture/
[4] Jeff Schahczenski. April 2018. ATTRA. "Biochar and Sustainable Agriculture" https://attra.ncat.org/product/biochar-and-sustainable-agriculture/
[5] Li, Gerrewey, & Geelan. April 14, 2022. Frontiers in Plant Science. "A Meta-Analysis of Biostimulant Yield Effectiveness in Field Trials" https://doi.org/10.3389/fpls.2022.836702
[6] Scott Gillespie. August 30, 2020. 012 Simplicity in Cover Crop Mixes. https://www.plantsdigsoil.com/podcast/012-simplicity-in-cover-crop-mixes
[7] Scott Gillespie. April 21, 2020. 008 No Stats. No Effect. https://www.plantsdigsoil.com/podcast/008-no-stats-no-effect