Interview With Ed Huling

Zoom recording: https://www.dropbox.com/s/k9ftchhncywdk3v/audio1914190116.m4a?dl=0

—---------------------------Transcript—--

Kim: (00:03)
All right. Hi Ed, can you hear us?

Ed: (00:27)
I can hear you. I can't see you, but…

Kim: (00:29)
That's okay. I'm Kim Goddu-Alexander. I'm one of the directors of Bethesda green, and I will let Andrew and Alex take it away.

Ed: (00:37)
Hey, your name is Kim?

Kim: (00:39)
Kim. Yes. K I M

Andrew: (00:43)
Hey Ed. So Alex and I are both seniors at Bethesda Chevy chase high school. And we're both interns at Bethesda green. We're doing a project, as I've told you about where we're creating a garden to maximize carbon sequestration.

Ed: (01:07)
Is it a garden, like an experiment to produce carbon sequestration or you've got a vegetable garden and you're gonna measure carbon sequestration as kind of an adjunct. I mean, is it an experiment to maximize carbon sequestration or is it a garden?

Ed: (01:27)
It's an experiment. So we're basically including a variety of plants. So mainly trees, some shrubs and some native grasses. We don't have a definite list yet of what we'll use, but we're trying to include a few strategies such as not really tilling the soil and just kind of not disturbing it at all to try and maximize sequestration as Andrew said.

Ed: (01:58)
Okay. And Kim, can you tell me a little bit more about Bethesda green?

Kim: (02:05)
Sure. Uh, so, uh, I'm Kim Goddu, I'm one of the directors of Bethesda Green. We are a nonprofit organization based in Bethesda, Maryland. We've been around since 2008. Um, I've been with the organization for six years. We are the brainchild of Seth Goldman, who is the founder of Honest Tea and chairman of the board for beyond meat. Um, and we have several different programs that we do in terms of environmental, um, environmental policy work. We have environmental education, including for adults and youth. Um, and I also do a number of environmental projects, um, including two stormwater projects that I have going on right now. And I also run our environmental leaders program, both of which Andrew and Alex are a part of.

Ed: (02:49)
Cool. Um, okay. So how, how can I help you?

Ed: (02:57)
Well, we had a few questions we came up with that we thought you might be able to provide some insight in.

Ed: (03:03)
Sure.

Ed: (03:05)
So, uh, I guess I'll just start with our first one. Could you walk through the process of carbon sequestration on a scientific level and touch on how much carbon is stored in plant biomass versus the soil and inverse, how much actually gets released directly back into the atmosphere?

Ed: (03:24)
That's a pretty, all tall order. My friend

Ed: (03:30)
Yeah. Um, so there isn't like a set of universal rules where anywhere you go, you can see the same thing happening. There are variables that affect carbon sequestration, and I'll give you a few examples. One, just one alone is the composition of the soil- microbial ecology. In other words, what microbes are down there in the soil? Are there more bacteria or are there more fungi? And this is an evolving science that you know, we're learning more and more about over time on a really fast learning curve, but for example, one of the key actors in carbon sequestration is mycorrhizal fungi. Mycorrhizal fungi. We wouldn't have life on earth without these critters. Um, and basically what they do is they insert themselves, um, with the willing participant of plants, into plant roots, into the kind of the intercellular spaces of plant roots. And there, there is this elegant handshake that happens between the mycorrhizal fungi and plant roots where they sort of say, Hey, I'm here. And the other one says, okay, come on in. And literally the root will allow the fungi to infect it. The reason that the plant does this is because the plant genetically knows that these mycorrhizal fungi are going to go out, extend the gathering capacity of roots and gather all kinds of resources for the plant that the plant is not able to get

by itself, uh, including water, probably at the top of the list, is phosphorus because phosphorus is generally tightly bound up chemically, um, with other minerals in the soil like calcium.

Ed: (06:27)
And so phosphorus is generally not soluble. So with something like mycorrhizal fungi, they have enzymes and synergistic relationships with bacteria that actually live on the fungal mycelia and between the fungi and the bacteria, they will solubilize phosphorus and bring it back through the mycelia to feed the plant. It's just one nutrient. They also can do that with nitrogen and other trace elements. Um, so you just have this literally ecosystem with mycorrhizal fungi, with associations, with other bacteria, the bacteria are getting sugars and nutrients from the fungi, and the fungi is getting them from the plant. So basically it is photosynthesis providing carbohydrates and other nutrients, and transferring it through the roots to these microbes in the soil. And then the microbes in turn are gathering all these other nutrients to bring back to the plant. So it's a true symbiosis. The reason I'm bringing mycorrhizal fungi in particular is because they are known to be integrally involved with carbon sequestration. Um, and I'm sure we don't know all the ways that they're doing it. But one of the ways there's a substance produced by mycorrhizal fungi called Glomalin. And this is a kind of sticky, gluey substance that's produced by the fungal mycelia. And we can find in the literature where this Glomalin converts to humic material that ends up being stable in the soil and provides... I mean, I don't know how familiar you are with, humus, humic materials. You know, you have organic matter and then, these glomalin and humic materials that are a form of organic matter, but they're very stable and unreactive- relatively unreactive in the soil. When they do carbon dating of humic materials and soil, sometimes they find that they're, you know, they may be a thousand years old and that it's because these complex humic molecules are relatively unreactive. In other words, it's difficult for bacteria to eat them.

Ed: (09:47)
As long as they're in the soil and you're not plowing, you don't have a lot of oxidation. Now let's look at the reverse of that process- what can destroy humic materials in soil is plowing, and I'm sure, you know, that humans have been plowing the soil for millennia. So that has been highly disruptive to the soil sequestration process or the carbon sequestration process. Because number one, the plowing physically disrupts the fungal mycelia. It's just literally macerating them, right? So, year after year, these fungal mycelia- they may extend out for a foot or two feet. So you can have as much as a hundred times increase in the nutrient gathering capability of a plant, but, you know, the plant roots from all these fungal mycelia that are extending out from the plant roots. So now when you plow the soil, you are just literally ripping up and macerating all these fungal mycelia, which we know are a huge resource for plant nutrient gathering and water gathering. But it also has implications for carbon sequestration because all the Glomalin and the organic matter of the mycelia themselves- every time you cut back, the mycorrhiza, the density or population, you are reducing this whole synergy between plants and the carbohydrates that are being produced by plants that are feeding these fungal mycelia. So you're just basically interrupting and ultimately stopping that process. There's something else that is destructive of carbon sequestration. And that is nitrogen fertilizers. And the reason that is,

is because when you provide a concentrated source of nitrogen, bacteria are roughly 20% protein, and, you know, the largest component of protein is nitrogen.

Ed: (12:33)
So when you provide a concentrated source of nitrogen to the soil, you spike bacterial populations, and when you provide a concentrated source of nitrogen, then the bacteria will look to the humus as a source of carbon to kind of complete their physical growth. So over time, you'll find when you apply commercial nitrogen, you will oxidize the bacteria that you're feeding and thus will be oxidizing the humus. Another factor that I would suggest that you pay attention to is, if you want to maximize carbon sequestration, you need to maximize what's called net primary productivity. You need to maximize plant growth per square foot per acre, per whatever, because carbon: most of the carbon that you're looking to sequester is coming in the form of root exudates. You do get some carbon from roots, and some of that will ultimately break down and be transferred to a stable form of humus. But over time, the real engine for carbon sequestration is this plant root exudate: mycorrhizal Glomalin. So if you want to maximize it, then you need to make sure that you have the right biology in the soil. You need plants that are inoculated with mycorrhizal fungi, and you need to have fertilizers that are friendly to fungi. Stay away from commercial nitrogen fertilizer, as it promotes bacterial growth, which consumes carbon in the soil. You want to be promoting fungal growth, which actually increases the amount of stable carbon in the soil. What I found over the years is that manure based composts are what they call highly bacterial dominant. And so basically, fertilizing your soil and introducing mass amounts of bacteria- and basically bacteria in general- not every bacteria, not every fungi, but in general bacteria consume organic matter, and don't leave anything for the future of soil. Fungi on the other hand, consume carbon for their own metabolism, but they are much more efficient. And I guess just genetically, they know that in the long run, the better the soil, the more organic matter, the more the minerals in the soil, the more fungi there can be. Bacteria don't seem to operate that way. So the fertilizers you use, because they have such an impact on the balance of bacteria and fungi, are gonna have a lot to do with whether you're successful in sequestering carbon or not. Now, with that said, soils are highly depleted, pretty much everywhere on the planet.

Ed: (16:46)
I mean, with a few exceptions, humans have depleted soil nutrients between plowing that's oxidized soil organic matter. Once you extract, once you oxidize the organic matter, the minerals that are chelated onto that organic matter simply wash away in the rain. So, the organic matter, the humus and the soil is your storehouse for minerals. So the capacity of the soil to produce plant growth is highly dependent on both the amount of minerals in the soil and on the balance of those minerals. I can give you the names of some books, if you wanted to do a deeper dive in what these mineral balances are. But again, since soils almost universally have so destroyed the amount of organic matter in the soil, then soils are depleted of organic matter, and they're also depleted of minerals.

Ed: (17:54)

So the productivity, now, you pick a plot out in your backyard, um, you know, you can send a sample of that soil to the testing lab, and I can almost guarantee you that the amount of calcium and magnesium and potassium and zinc and copper and other elements are going to be extremely low, a tiny fraction of the minerals and organic matter that were in that soil before humans started growing things in it. So again, you want to sequester more carbon, you have to go back, you really have to start with the soil and say, what do we need to do to this soil, to dramatically increase plant growth. And that's basically what I've been doing for 20 years. When I started out, my central focus was looking at soil from the standpoint of how to produce more nutrient dense food.

Ed: (19:01)
I spent a year at the department of agriculture, doing all kinds of trials on plants and soil, and looking at the nutrient uptake into food based on the nutritional profile of the soil and found that there was just a dramatic correlation between the nutrients in the soil and the nutrients that food takes up into it. So just as an aside, the same phenomenon that is making it very difficult to sequester carbon is also making the food that we eat every day have just a fraction of the minerals and other nutrients in it that we evolved eating because the soil is just a shadow of its former self. Um, why don't I stop? And , uh, let you guys, uh, you know, react or ask some questions or redirect me how it would be useful to you.

Ed: (20:09)
Okay. Do you mind if I have a follow up question, Andrew?

Ed: (20:12)
Yeah,

Ed: (20:13)
So about the fungi; how naturally occurring is it versus do you incorporate more fungi or help it grow.

Ed: (20:28)
Again, pretty much what agriculture does everywhere, suppresses or destroys mycorrhizal fungi, fungi in general, but mycorrhizal fungi in particular. You know, there are thousands of different species of mycorrhizal fungi. So, you know, I'm not gonna say if you go out into your backyard and take a soil sample and send it to, you know, a biology lab, there, there wouldn't be any mycorrhizal fungi, but the likelihood that you have any kind of robust fungal ecology is very low. So if you're going to be doing an experiment, you are gonna want to reinoculate the plants that you plant now. Trees require a type of mycorrhizal fungi called ectomycorrhizal fungi. Not all trees and some trees are also symbiotic with arbuscular mycorrhizal fungi, which is, you know, a whole different class of mycorrhizal fungi.

Ed: (21:55)
80% or more of the plants on the planet are symbiotic with mycorrhizal fungi. So, you know, there's some that are not, but most plants are, but you can purchase mycorrhizal inoculants. I

can give you the name of a company that has really reliable mycorrhizal fungi. So I don't know what your budget is for, you know, different plants and microbes and fertilizer, but, are you planning to do any applications of fertilizer materials or pretty much just start with whatever you have got?

Ed: (22:51)
I think we're, I mean, we're still, everything's up in the air still for what exactly we'll be doing. So we're kind of just looking for different options now. Mm-hmm

Ed: (23:00)
okay. Um, well, I would say those are kind of the three areas for you to focus on is, you know, one is in order to maximize carbon sequestration, you need to maximize plant growth in order to maximize plant growth, you need to maximize your soil, nutrient density. And then more particularly in order to maximize carbon sequestration, you're gonna want to make sure that everything you plant is inoculated with mycorrhizal fungi. Those would be the three broad categories of advice I have for you if you really want to have a demonstration of carbon sequestration.

Andrew: (23:52)
And so would in picking a plot of land, should we aim for a certain kind of soil like structure or, like clay type soils, and also, should we be searching for a specific location?

Ed: (24:16)
You know, I would find someplace convenient and where you guys have control over the plot. And in terms of specific oils, I work with clients and partners that have the full gamut from heavy clay, compacted soils, all the way to to sandy soils in Delaware and in Maryland and New Jersey that are so depleted that it's hard to imagine how anything can even grow in them. And they don't grow very well. So it's really more, whether you want to push the boundaries of what is possible with soil. I mean, if you're serious about this, we are not going to get a lot of carbon sequestration in soils the way they are, you know, with the level of imbalance between bacteria and fungi, with the level of nutrient depletion, and the low level of organic matter. We are not gonna get much sequestration in that scenario.

Ed: (25:42)
So if you really wanna push those boundaries, I mean, that's basically what I'm doing too. I have developed a farming system that is a grazing system where we apply a blend of fertility materials that I've developed over a 20 year period. And the project we did in partnership with some professors at Princeton this summer is to increase forage production by 700%, compared to the control plots. So that's how depleted soils are, that one application of minerals and organic matter and biology. And three months later, we have, in this case, 14,000 pounds of dry matter per acre of animal forages, compared to 2000 pounds on the entire farm where we didn't put this fertility application. So with all that much biomass being produced, you have all different plants partition, more or less of their total photosynthetic output to the above ground plants, to their roots and to root exudates. But, you know, in general, maybe you have just ballpark 50% of

the total biomass going to above ground plants, and then you have another 50% going to roots and root exudates. So that's where your real potential is for carbon sequestration.

Andrew: (27:41)
All right. Well, that's a lot to think about. So how long do you suppose it's gonna take till we can get that soil up to nutrient, or not necessarily nutrient rich, but not depleted levels? Like how long will it take to get to that point from the soils we currently have.

Ed: (28:09)
Um, well, let me ask you two questions. One is how big a plot are you talking about doing?

Andrew: (28:17)
Probably 15 by 15 or more.

Ed: (28:28)
I may be able to give you guys some soil, and then you can do some experiments. You can put my soil on part of your plot and, you know, take two or three other fertility protocols and put them on others and give you some reference points in terms of plant productivity and soil biology. The application materials that I put on this summer, on the 1st of May, we tested the total biomass production. We planted in June and then two and a half months later, we had 14,000 pounds, with that single crop. Most pastor farms put out a total of 4,000 pounds of dry matter, hay per acre over the entire year. And we put out 14,400 in two and a half months.

Ed: (29:43)
So that really shows you the capacity of the land to produce food and biomass in trees. We also did a project this summer, where we applied my fertility to a two year old reforestation project. And within two and a half months, we had increased the growth rate of those trees by 71%, and they were healthier and had bigger canopies. 70% of all the trees in that reforestation project had died before we did this experiment. Many reforestation projects are failing because the soils are so depleted and you don't have this mycorrhizal association. So the combination of those two things, you have a large percentage of trees in reforestation projects that are dying, when, you know, we're depending on them to sequester carbon and cool the planet. So we've developed a reforestation system now, with the extra fertility, where you can have higher density of trees and faster growing trees.

Ed: (31:06)
And in our case, we're sequestering carbon in both the aboveground, trees below ground roots, and the soil carbon sequestration. So the most cost effective and powerful way of sequestering carbon is with a forest, like what we're talking about. So, you know, you guys, if you want to, we have some trials planned for this spring, and if you guys want to kind of stay connected, I'd be happy to share data with you so that you can see what's possible, you know, on a forestry project also.

Ed: (32:03)

Yeah. I mean, that first off sounds extremely interesting and also I think would be greatly beneficial to us. So thank you for that.

Ed: (32:11)
Yeah.

Ed: (32:13)
I have one more question I'd like to follow up with about maximizing sequestration, but still since I discussed, we'll have different shrubs, trees, and grasses, most likely. How do you create a diverse ecosystem while keeping in mind sequestration rates?

Ed: (32:37)
Yeah, so now we're gonna shift into a subject that may be a little bit, we'll just say controversial with the founder of Bethesda green. Since he's on the board of, did you say Beyond Meat?

Kim: (33:05)
Yeah, but Seth doesn't have access to a direct operation, so feel free.

Ed: (33:09)
Okay. Well, you'll find a lot of press about grazing animals are destroying the planet and they're producing all this methane and using up all the water and et cetera, et cetera, et cetera. But the reality is, is if you look over the history of earth and, and life on earth and plants on earth over the last, you know, millions of years, you find that grasses evolved with grazing animals, and where you have other than peat bogs, which are their own amazing, system up in where you have low lands in Northern parts of the world. Where you have the greatest carbon sequestration is in this whole ecology with grasses and grazing animals and predators.

Ed: (34:18)
And you just have this virtuous cycle where the grasses grow to maturity, 60 million Buffalo come through, eat the grasses, but the predators are on their heels and keeping these animals from staying in places where they would eat the grasses too low. So you have plenty of grass still above ground to start photosynthesizing again. So as soon as the animals move off, getting away from the predators, then the grasses grow back again. And you just have these, you know, maybe three week, four week, six week cycles of grass growth animals coming back, consuming the grass again. And what the significance of that is, is that the grasses are not senescing. They don't go to seed because what happens when grasses go to seed, basically the plant has completed its life cycle for that year.

Ed: (35:29)
It produced the seed. It no longer has to keep photosynthesizing. Whereas, when you have grazing animals that are consuming the grass, it's never completing its life cycle. So you have photosynthesis happening all year, all summer long, and that photosynthesis is producing huge amounts of roots and root exudates that are feeding the mycorrhizal fungi and producing massive amounts of soil carbon. You know, there are places out in the midwest where you had

like the tall grass prairies, where the symbiosis produced thousands of pounds of carbon per acre and thousands of pounds of carbon. I mean thousands of tons of carbon, I'm sorry, thousands of tons of carbon per acre. And so, there were periods in history where there were so many grazing animals eating so much grass that we literally brought atmospheric CO_2 down, you know, in the 200 parts per million range.

Ed: (36:46)
And through research I have found that it has actually triggered ice ages because it cooled the planet so much. So it's a very powerful dynamic of the grazing animals, the photosynthesis of the grass and the carbon sequestration in soil. So the comparison with that and why what's happening is so destructive and the whole industrial meat system uses GMO corn and soybeans, which are annual plants, leaving the soil bare much of the year, not photosynthesizing, leaving soil open to erosion, and putting all sorts of chemicals on that are destroying the mycorrhizal fungi completely. So you don't get any carbon sequestration. You minimize the total photosynthesis over the course of a year, and then you feed this to animals that are herbivores. They're not grain feeders. So the animals get sick, they need antibiotics. It makes the meat of the animal unhealthy. Anyway, the whole system is just an incredibly devastating cycle. I happen to think that the answer is putting animals back out on pasture and managing them properly so that you have this virtuous grass growth and carbon sequestration.

Kim: (38:23)
Yeah. Thanks for that, ed. Unfortunately, we've got less than 60 seconds, so I wanna make sure that Andrew and Alex can follow up with you via email or set up another time to chat with maybe with a little bit more?

Ed: (38:35)
They have my text, they have my telephone. Perfect.

Alex: (38:46)
We really appreciate you taking your time to talk with us. It's been very helpful, this insight.

Ed: (38:51)
All right. We all are in, we're all in this together. We need to fix this. Yeah. All right. Good luck. Thanks.