The Carbon Chronicles©

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Two hundred years ago the soil contained 3000 gigatons (Gt) of carbon. Now half the carbon in the soil has been released into the atmosphere as carbon dioxide, mostly by agriculture. Why is this important? It is a large cause of global warming and the prime cause of the earth's loss of 60% of its soil.

The current 1500 Gt of carbon in the soil is double the 750 Gt of carbon in the atmosphere as carbon dioxide. So, if we put carbon back in the soil we could reverse global warming. Can we do this overnight? No. Increasing the carbon stored in the soil as humic material will take both time, knowledge and investment.

To understand how we lost the carbon in the soil, we need to understand the carbon in the soil. The carbon in the soil is stored as soil organic matter (SOM). SOM is actually the remains of dead microbes. It contains all the mineral nutrients needed by plants and is carbon rich. The plants get their carbon from the carbon dioxide in the air, but the plants do need the minerals in the SOM. They get those minerals from the microbes that feast on the SOM. The SOM is the inheritance- as the microbes feed on it, they deplete it and they feed the plant. The inheritance is supposed to be repaid when the plant dies and the microbes digest the dead plant and then die and become SOM. In a grazing system or the world as it was 2000 years ago, an animal eats the plant but the animal feces and dead bodies are returned to the system. Now corn is sent from Iowa to China and the inheritance is not repaid; the microbes disappear as their food disappears, and the plant is not being fed.

So, we bring in chemicals to feed the plant. The result is massive loss of SOM, leading to decreased microbes, increased carbon to the atmosphere, soil erosion, inability of the soil to maintain water, increased need for pesticides (because the microbes once protected the plants from invaders), and massive chemical pollution, because chemicals cannot feed a plant the way microbes do. Microbes are

tightly bound to soil particles, so they remain near the plant and release their nutrients as they die and when the plant needs them. However, chemicals are dumped on in one or several feedings and the only way they can remain where they are dumped is to be taken up by microbes or plants. Since that is a slow process, half of all chemical fertilizer washes away to pollute ground and surface water. As we lose SOM, we lose microbes and we need more chemicals. The high level of chemicals we now use are toxic to microbes, so we lose even more microbes and more SOM and more topsoil. In this manner we have lost 60% of the earth's arable land and contributed to global warming. We have huge problems- global warming, a need to grow more food for the world's growing populations on decreasing agricultural land and massive pollution that threatens our water supplies. And we have a solution - increase the SOM. But this solution requires a disruptive change in how 95% of agriculture is practiced in the United States.

Since SOM is over 90% the remains of dead microbes, we must increase the soil microbial mass if we wish to replace it. This requires providing food for the microbes and decreasing microbial-toxic amounts of chemicals. Cover crops, organic fertilizers and circumspect application of chemical fertilizers can meet this requirement but the solution must be specific: each soil (and each soil crop combination) is unique in its nutrient needs and requires supplements that provide a balanced diet for the microbes. Some of the treatments researchers have used have been shown to increase microbes and SOM, but some organic treatments actually decrease SOM. Currently it is very difficult for farmers, who operate at 1-2% profit, to risk a switch in their practice. Further, organic farming has been shown to decrease crop yield by ~20%. In Europe it has been reported that this yield loss is offset by lower input costs, less fertilizer, pesticide and water and higher prices for organic products. In the U.S. there are farmers who have successfully implemented cover crops and other green initiatives as well as farmers who have paid a painful price for the same. But there need to be many more, and it will be hard to convert the larger agricultural community without new tools to assess the possibility of success of a given strategy.

Microbiometer® which measures microbial biomass in 10 minutes with laboratory precision, is one tool that shows promise in this regard. Worldwide microbes and the SOM contain all the nutrients a plant needs in the ratios that are required, but microbes respond in less than a month to a balanced nutrient load while SOM takes years to respond. Study after study shows a very high correlation between microbes and SOM and yield. Microbial respiration has also been studied for this purpose but high respiration can indicate both high microbial mass or high stress, meaning that SOM is not created and may even be depleted. Clearly, we need to devise rapid, simple, inexpensive methods of analyzing what needs be provided to ensure an optimized greener method of cutting back on use of high levels of polluting chemical fertilizers, to save our soil, to provide food for the world and to correct global warming.