

Anatomy of Soil Health

I have spent the better part of my 27 year career promoting better soil health through less tillage, better crop rotation diversity, sound management decisions and constantly trying to learn. Over the years I have watched as many scientists have wrangled over whether chemical, biological, or physiological features of the soil are the most important in measuring soil health. All are extremely important, but for me, this created a level of uncertainty supported by volumes of information that left me more confused than not. I have come to realize through my own inability to comprehend scientific research and data that there must be an easier way. If you look at the definition of Soil Health in a nutshell, it is “the ability of the soil to function”. Isn’t that the same for human health? I have correlated soil with human life. Firstly, we are both living things requiring the foundations for survival, food, water, and shelter. We also both have veins and capillaries that carry nutrients and water throughout our bodies. We also both function better when we have a well balanced diet (diverse crop rotations) and drink an adequate amount of water. When our diet becomes out of balance, like a monoculture in our rotations, we require vitamins (fertilizers) to meet our dietary needs. The healthier we are the less sick we get. As with the soil, when we do get sick, we tend to treat the symptoms. For example, when we get a headache, we take medicine. When we get weeds, we apply herbicides. Most ailments from which we suffer are a sign that something is out of balance in our bodies. The same is with soil. Different types of weeds, for example, can be an excellent indicator of problems in the soil.

Sheltering the soil- Humans and soil both require shelter for protection. Not all shelters are the same, but the most important thing is to provide as much shelter as we can to protect the soil from the elements that can damage them or expose them to things that can negatively impact ones health. Isn’t this the same for humans? Residues are the shelter for the soil. The soil does not like to be bare, exposing itself to the elements. That is why weeds are prevalent where we have bare ground. It is the soil’s way of protecting itself when adequate shelter isn’t there.

Feeding the soil- “Man cannot live on bread alone”. We require a diverse diet made up of proteins, fats, carbohydrates, and nutrients. Soils require the same diversity and nutrients to live in a healthy manner. When humans do not vary their diet to get what their body needs they often have to take supplements or vitamins to stay healthy. Soils are no different. If the soil isn’t getting proper nutrition through a diverse crop rotation with crops that vary in nutrients, supplements or vitamins in the form of fertilizers have to be used to bring the soil closer to a healthy state. This supports plant growth, which is, of course, its shelter. Carbon is an excellent example of this in the soil. A monoculture wheat rotation supplies a tremendous amount of carbon into the soil. It takes nitrogen to break down that carbon. If the soil is starved for nitrogen it slows down the breakdown of the wheat residues thus constipating the soil slowing down the process for converting residue into nutrients. When this happens we have to supplement the soil with fertilizers to bring them closer to a balanced, healthier state. Diverse rotations offer a balanced diet, especially incorporating legumes, such as peas and lentils into the rotation. These plants have a much less carbon/nitrogen ratio which gives the soil more energy to do its job. Annual legumes have a carbon to nitrogen ratio very similar to that of a healthy, functioning soil.

Hydrating the soil – Neither humans nor soils can function without proper hydration. Dehydration in humans can cause fatigue, weakness, malnutrition, and increased body temperature. Soils experience the same symptoms. Loss of soil structure, loss of the ability to promote plant growth (shelter), inability to break down nutrients into usable forms, and increased temperatures are all signs of dehydration in the soil. Over hydrating in humans, albeit rare, causes loss of brain function changes in behavior, nausea, and swelling, which limits blood flow to the central nervous system. These symptoms are similar to those associated with a lack of oxygen to the body. Soils exhibit similar symptoms when over-hydrated, and the system becomes anaerobic. The soil loses its ability to function properly carrying many needed nutrients away from plants. Excessive water can also cause other problems like saline seeps. Too much water in the soil will exclude the air that the Soil Food Web needs to function. Water standing on the soils surface indicates that soil is not able to breathe. We need to encourage proper moisture management through alternative cropping systems that rotate between cool and warm season, shallow and deep rooted plants that look to utilize the moisture we have in the most efficient way. On a hot summer day, plants can use as much as $\frac{1}{4}$ inch of water or more. In arid areas it is important to conserve what moisture you have available in the soil by having shelter that reduces soil temperature and maintaining soil structure, which helps the soils stay hydrated. Loss of soil structure and shelter by mechanical tillage can cause a loss of $\frac{1}{4}$ inch of water per operation and destroys the structure that allows the soil to hold onto the water it gets.

Measuring soil health does not need to constantly be measured scientifically to see an improvement. After all, we don't get blood work done every time we have a fever. As with humans, we know what practices will make us healthier; the right foods, adequate amounts of water, and shelter to protect us from the elements.

Soil health should be the foundation for conservation planning, or you will end up just treating symptoms without understanding the cause. Maybe we need a WEBMD for soil health, and we are the professional nutritionists.

Many articles I have read refer to a fourth need above food, water, and shelter; that would be companionship. Agricultural producers are the companions of the soil. Our job is to help producers take care of the soil, so in turn, the soil can take care of the producers, and the producers in return can take care of the world.