



TILLAGE ADDICTION

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Introduction:

Human life and soil are deeply intertwined. In many cultures, soil is considered as a central aspect. It is also viewed as sacred as the majority of the food that is eaten comes from the soil. Besides growing crops, soil also plays other important roles in sustaining our ecosystem. Properly managed soil can help rainfall to recharge underground aquifers rather than runs off. This also releases and transforms different types of essential nutrients for healthy crop growth. The soil also provides favorable environment for diverse microorganisms, many of which are vital for producing key antibiotics. Soil can also act as a carbon storage when rich in organic matter content. Throughout history, many civilizations have worked in the fields and degraded their soil. Since the first agricultural revolution occurred about 10,000 years ago, many great civilizations have fallen down due to unsustainable agricultural practices. But, we need not repeat this history anymore. The problem of agricultural soil degradation remains the least recognized, but it is one of the most solvable problems the humanity is facing today (Montgomery, 2017).

Humans have overcome many agricultural challenges and produced abundant food. At the same time, these intensive agricultural production systems slowly destroyed our rich layer of soil. One of these practices is known as “tillage system” which is plowing of the soil. Globally, soil loss from plowed lands averages one millimeter per year. This statistic sounds very low, but when we consider all of the other negative effects, the value is much higher. If we continue to till our agricultural land in the same pace, then it would only take a few centuries to lose all of the rich and productive agricultural topsoil. Scientists realized that “worn-out” soils, whose productivity had drastically declined, resulted mainly from the depletion of soil organic matter due to “tillage addiction” (Magdoff and Van, 2009).

What is tillage addiction:

Tillage addiction began early in human civilization because of all the short-term benefits that our ancestors gained from tilling the soil. Soils that have been tilled for centuries in order to produce good yields, and as a result soil got “addicted” to tillage system which is known as the soil’s tillage addiction. This is a result of practicing tillage operation generations after generations. For centuries, tillage was primarily practiced for short-term benefits like controlling weeds, preparing the seedbed for planting, mixing fertilizer into the soil, exposing organic matter to air and stimulating decay. This represents the drug and the associated high output can be considered the addiction that farmers experience because of adopting tillage operation. If there is poor soil structure, reduced water infiltration, poor water holding capacity and lower soil organic matter, the farmers need to use more soil fertilizers and pesticides (due to broken soil food web) to get higher yields. Thus, tillage becomes an addiction for the soil just like alcohol or drug users become addicted to the alcohol or drug. Tillage addiction can be a hard habit to break: for the grower and the degraded soil (Hoorman, 2019).

Causes of tillage addiction:

There are many causes of tillage addiction. First, tillage has generational effect, meaning it has been followed and passed down from old generation of farmers to the new generation. The new farmers generally follow the footsteps of their parents when it comes to farming traditions. This is one of the main causes of tillage addiction today. Second, tillage can easily break up weed roots and disrupt weeds from growing. Farmers hate weeds in their field, and think that weed can be effectively controlled by tillage operations and require fewer herbicides. Third, also, tilling the soil with high horsepower tractors and large heavy iron equipment is seen as a status symbol to many farmers. Thus, they continue the practice as a symbol of pride. Fourth, many farmers also believe that tillage is imperative in producing a good yield. Most of our modern major crops have been developed and bred for high tillage conditions, high fertilizer, and high pesticide usage which is one of the key causes of tillage addiction. As indicated earlier, the tillage system has some short-term effects, but unfortunately all of their actions are counterproductive (Hoorman, 2019).

Problems caused by tillage addiction:

For centuries, tillage was primarily practiced to control weeds, prepare the seedbed for planting and mix fertilizer into the soil. Tillage also exposes organic matter to air, stimulating decay that releases nutrients immediately that promote crop growth. Though, tillage operation provides some short-term benefits, but in the long run, it destroys soil fertility through soil erosion. This happens as it creates severe soil compaction which results in several other complications. For example, poor water holding capacity, low infiltration by blocking

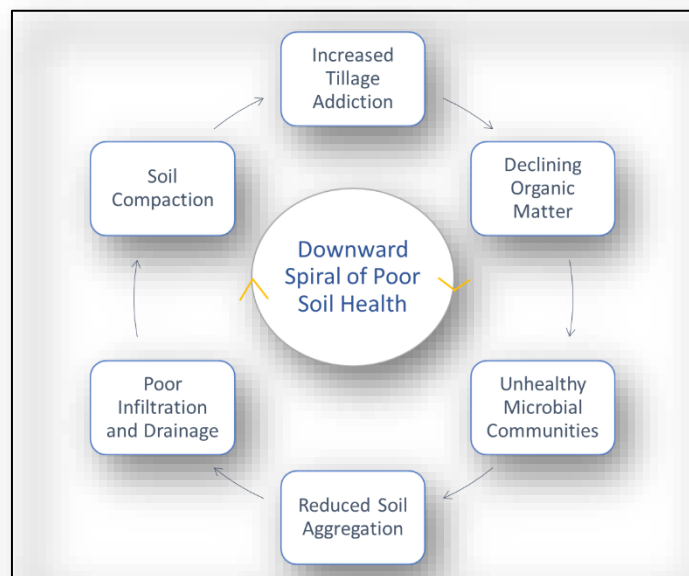


Figure 1: Downward Spiral Effects of Tillage Addiction (Source: Modified from USDA, 2017)

of pore space, and most importantly damaging the habitat of beneficial soil microorganisms by destroying organic matter content. Farm machinery was getting larger when farmers and scientists were placing less emphasis on the soil's organic matter during the last half of the 20th century. As a result, large mechanical tractors allowed farmers to do tillage operation when the soil was wet, creating severe compaction which included surface crusting as well as plow layer compaction, increased bulk density and sometimes leaving the soil in a cloddy condition, requiring more harrowing than what would be needed otherwise. The tillage operation broke down soil structure and left no residues on the surface. Soils were left bare and were very susceptible to wind and water erosion. This, in the long run created the potential for significant amounts of soil compaction. The problem caused by tillage addiction can be better understood by (Figure 1) diagram (Montgomery, 2017; Hoorman, 2019).

Solutions to tillage addiction:

Despite the ongoing debate about tillage addiction and how to improve soil quality, most of the stakeholders agreed that we need farming methods that are less detrimental if not beneficial to soil health. In order to find solution to tillage addiction for long-term sustainability, we have to focus on the principle of conservation agriculture. Firstly, we have to move from traditional tillage to no-till farming practices. No-till practice leaves plant parts, crop debris after a crop is harvested in the field as soil cover. Soil microorganism increases rapidly after conversion to no-tillage and helps in decomposing the crop residue as well as in building soil organic matter contents. It also decreases soil erosion by wind and water. Secondly, cover crops can act as a good weed suppressor if planted in seasons between commercial crops. They are mowed down or killed before or during subsequent plantings which help in suppressing unwanted weed and provide nutrients to the soil as they decay. Thirdly, incorporation of crop rotation can help prevent insect pests and other plant pathogens. Complex crop rotation helps to break up the plant-pathogen cycles and competition, thus helping to reduce the need of pesticides. The benefits of adopting all the three-conservation

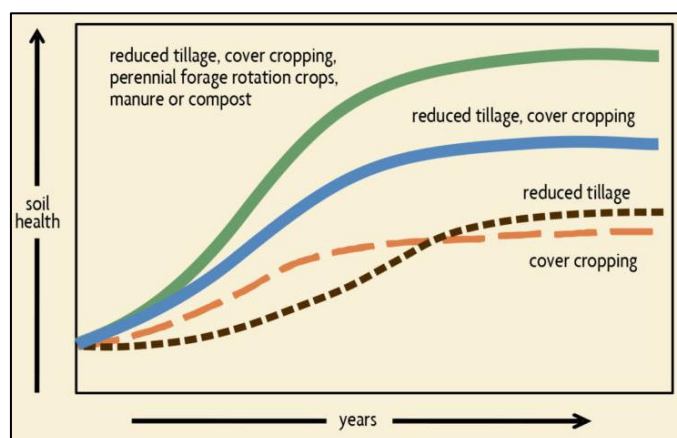


Figure 2: Effects of Reducing Tillage Addiction
(Source: Adapted from Magdoff and Van, 2009)

agricultural technique is to increase soil health which include building soil organic matter, reducing compaction from rooting, decreasing erosion, rebuilding soil aggregate, increasing water holding capacity and infiltration. Ultimately these practices can help to increase crop yield with lower cost and lower energy thus helping the environmental sustainability. From (Figure 2) we can see how combining various management practices help build soil health in the long-run (Magdoff and Van, 2009; Montgomery, 2017).

Conclusion:

Is the concentration of poor organic matter, low water-holding capacity, high soil compaction, susceptibility to erosion and soil microorganism damage really due to the effects of tillage addiction? Perhaps they are better viewed as symptoms of a deeper, underlying problem. The ability to tell the difference between what is the underlying problem and what is only a symptom of a problem is essential in deciding on the best course of action. What many people think are individual problems may just be symptoms of a degraded, poor-quality soil. These symptoms are usually directly related to depletion of soil organic matter, lack of a thriving and diverse population of soil organisms, and compaction caused by years of soil's tillage addiction. A new approach is needed to help develop farming practices that take advantage of the inherent strengths of natural systems. In conclusion, the principle of conservation agriculture could be the answer to tillage addiction, which has the potential to dramatically and rapidly reform conventional tillage to no-tillage practices.

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