Improving Farm Efficiency and Soil Health Through the Adoption of new Techniques

Executive Summary

Soil health is important to every farmer regardless of the product they are producing whether its corn, cattle, or something else. Although, crop producers are more aware and concerned about the state of their soil. Ecology of the soil is an often-overlooked area of conservation of production resources. Farmers understand that the state of the soil is important and has effects on their production, but they often underestimate what they can do to improve soil and the effects that has on their bottom dollar. Farmers can improve their soil through changes in practices in tillage, cover crops, and microbial activity.

Tillage Practices

Conventional tillage is the most commonly used method for preparing the soil for seeding. There are advantages and disadvantages to tilling the soil before every seeding. Conventional tillage leads to increased erosion to wind and water. The exposed topsoil is susceptible to runoff and strong winds, but this practice also helps alleviate the issue of weeds. Tilling the weeds under will kill them due to lack of carbon dioxide. This practice also results in higher fuel and labor costs because more passes are required over a field versus a method of conservation tillage. Most corn producers have more success by tilling the fields prior to planting corn. America is the largest producer of corn in the world, so a large

chunk of American soil is tilled using conventional methods. There are two other methods of tillage: strip-tillage and no-tillage.

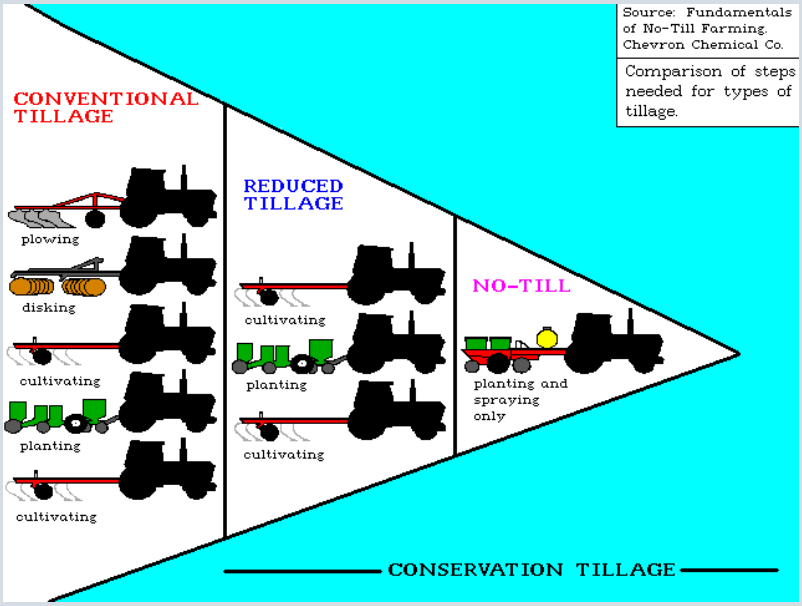


Figure 1

Strip tillage is the least common and is essentially tilling right in the path of the seeder, stripping a few inches across, where it is followed by the placement of the seed into the soil. Strip-tillage is not as popular as the other two methods of tillage because of the cost of specialized equipment needed to till and plant simultaneously. Crop producers mainly use strip tillage to dry out wet soils, warm up cold soils by removing residue, fertilizer placement, and to relieve soil compaction. Strip tillage dries out wet soil by opening six to eight inches of soil to the air resulting in drier soil. Tilling soil can increase soil temperatures. Warmer soil temperatures mean that the seed will germinate sooner. Strip tillage also allows for the near perfect placement of fertilizer next to the seed simultaneous to planting. This results in more efficient use of fertilizer, which can lower costs dramatically. This method of tillage can also relieve soil compaction by cutting through pans allowing for less restricted root growth leading to possible higher yields.

No-tillage is the practice of harvesting a crop, then following the harvest by planting a new crop in the soil without ever tilling. No-tilling cuts down on time

spent in the field, meaning less time and money spent on fuel and equipment. The soil also builds organic matter from the waste of the previous crop. No-till, unlike conventional tillage, is not as susceptible to erosion because the soil structure is still intact. Soil moisture also increases with no-tillage. A disadvantage to no-till could be a heavier reliance on the use of herbicides (Jasa). Tillage practice choice comes down ultimately to what is most effective and efficient for each farm.

Cover Cropping

Farmers have become over-reliant on the use of herbicides to rid their fields of weeds. This crutch has led to the development of super weeds or weeds with an adaptation in their gene code rendering an herbicide useless. This happens because some weeds might have a tolerance toward an herbicide. When the farmer sprays, those weeds with tolerance survive and breed resulting in seeds that have a stronger tolerance for the herbicide. Eventually, all the plants of that species in that field do not die from the herbicide which hurts the producers crop yield and quality significantly. Weeds cannot be combatted by balancing usage of herbicides and more conventional methods of tillage. However, this can damage soil health in the long run. Another approach to

Figure 2

improving soil health and fighting weeds is the technique used by many organic farmers. They plant cover crops between crop rotations such as wheat between corn and soybeans the following year. The producer would go in following harvest of their crop and plant a cover crop such as wheat or hairy vetch. The cover crop would protect the soil over the winter and prevent from weeds from exploding in population prior to planting of the next crop in spring. Cover crops can be cut for baleage, haylage, grazed or killed prior to planting of the next crop. Harvesting or grazing the cover crop can increase income for the producer. Cover cropping pairs well with no-tillage systems drastically reducing time spent in the field and improving soil culture. Another advantage to cover crops is the nitrogen fixation ability of legumes. Cover crops also help reduce erosion and add organic matter to the soil (Wittwer). This is where the microbial population of the soil comes into play.

Improving Microbial Populations

The microbial population of the soil consists of protozoa, bacteria, fungi, nematodes, actinomycetes, and algae. There are more microbes in a teaspoon of soil than humans on earth (Hoorman). Microbes break down soil organic matter (SOM) at varying rates and they release different gases and nutrients

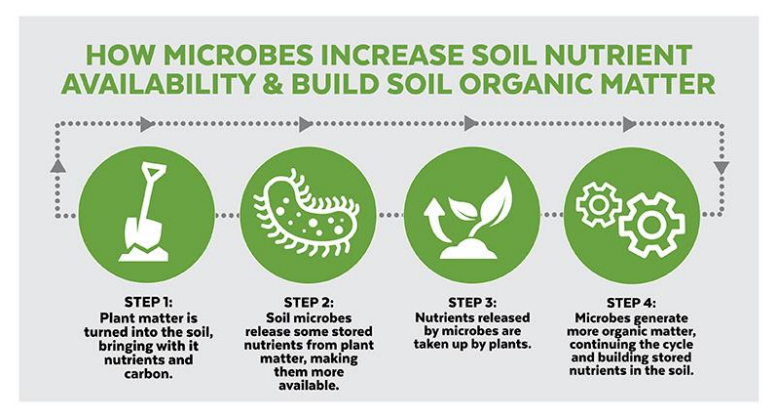
Table 2: Value of Soil Organic Matter

Assumptions: 2,000,000 pounds soil in top 6 inches	
Nutrients	1% organic matter = 20,000# 50% Carbon, C:N ratio = 10:1
Nitrogen:	1000# * $0.50/#N = $500
Phosphorus:	100# * $.70/#P = $70
Potassium:	100# * $0.40/#K = $40
Sulfur:	100# * $0.50/#S = $50
Carbon:	10,000# or 5 ton * $4/Ton = $20
Value of 1% SOM Nutrients/Acre	= $680
Relative Ratio of Nutrients:	100 Carbon/10 Nitrogen/ 1 Phosphorus/1 Potassium/1 Sulfur

from the result of SOM breakdown. In a hundred pounds of SOM, 60-80% breaks down into carbon dioxide, 3-8% living organisms, 3-8% non-humic compounds, and 10-30% humus (Hoorman). SOM contains primarily carbon and oxygen but contains hydrogen, nitrogen, phosphorous, and sulfur. Understanding the carbon and nitrogen cycles will help with improving microbial population. How can microbes improve efficiency of an operation financially? According to Ohio State Extension, the nutrients in the soil have a current value of $680 for each 1 percent SOM or $68 per ton of SOM based on economic values for commercial fertilizer (Hoorman).

Figure 3

Soils that are biologically active and have more carbon recycle release more nutrients than inactive soils that contain less organic matter. In a no-till situation nutrients are released slowly and efficiently for plant use whereas in a conventional tillage situation, nutrients are released in large quantities quickly damaging the overall nutrient capacity and availability. SOM is a slow building process that takes years and years. Microbes need carbon in the soil to survive, and tilling the soil allows the carbon to be oxidized into carbon dioxide and released to the atmosphere (Miransari). The breakdown of SOM is affected by temperature, moisture, and pH. SOM breaks down quicker in warm climates compared colder climates that have freezing. Soil that goes through wetting and drying increases the rate of decomposition. Neutral or



just slightly basic soils have a higher rate of decomposition of organic matter than acidic soils. SOM is an important way that farmers can improve their efficiency of production of crops.

Conclusion

Industrial style farming dominates the agricultural world of the United States, and it is effective at producing enormous amounts crops. The efficiency of operations could be greatly improved by incorporating a touch of organic farming techniques. These techniques include no-tillage or conservation tillage, cover cropping, and soil microbial population improvements. Farmers should utilize the some of the effective organic practices and incorporate them into their conventional farming operations.

Figure 4

References

Hoorman, J. J., & Islam, R. (2010, September 07). Ohioline. Retrieved from https://ohioline.osu.edu/factsheet/SAG-16

Miransari, M. (2011). Soil microbes and plant fertilization. *Applied Microbiology and Biotechnology, 92*(5), 875-85. doi:http://dx.doi.org/10.1007/s00253-011-3521-y

University of Nebraska-Lincoln, P. J. (2018, December 10). Tillage: Advantages and Disadvantages. Retrieved from https://cropwatch.unl.edu/tillage/advdisadv

Wittwer, R. A., Dorn, B., Jossi, W., & Van Der Heijden, M.,G.A. (2017). Cover crops support ecological intensification of arable cropping systems. *Scientific Reports (Nature Publisher Group), 7*, 41911. doi:http://dx.doi.org/10.1038/srep41911

Pictures

Figure 1: https://corn.agronomy.wisc.edu/Management/L007.aspx

Figure 2: https://www.alltech.com/articles/incorporate-cover-crops-plant-and-soil-health

Figure 3: https://ohioline.osu.edu/factsheet/SAG-16

Figure 4: https://www.midwesternbioag.com/leveraging-soil-microbes-build-som-crop-yields/

Title Page: https://dairydoo.com/wp-content/uploads/2018/03/row-crops.jpg