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Managing Soil Health: Concepts and Practices

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INTRODUCTION

Healthy soil is the foundation for profitable, productive, and environmentally sound agricultural systems. By understanding how the soil processes that support plant growth and regulate environmental quality are affected by management practices, it is possible to design a crop and soil management system that improves and maintains soil health over time. This article is for farmers and gardeners who want to understand the physical, chemical, and biological components of healthy soil and how to manage them.

Soil is a critical resource - the way in which it is managed can improve or degrade the quality of that resource. Soil is a complex ecosystem where living microorganisms and plant roots bind mineral particles and organic matter together into a dynamic structure that regulates water, air, and nutrients. In an agricultural context, soil health most often refers to the ability of the soil to sustain agricultural productivity and protect environmental resources. A healthy soil provides many functions that support plant growth, including nutrient cycling, biological control of plant pests, and regulation of water and air supply. These functions are influenced by the interrelated physical, chemical, and biological properties of soil, many of which are sensitive to soil management practices.

Management Practices to Improve Soil Health:

1. Reduce Inversion Tillage and Soil Traffic

Excessive tillage is harmful to soil health in a number of ways. Tillage increases oxygen in the soil, stimulating microbial biological activity, and results in the decomposition of organic matter. Tillage also disrupts soil aggregates, exposing particles of organic matter that had been physically protected within aggregates to microbial consumption. If additions of organic matter are not sufficient to counteract the losses from decomposition, organic matter levels will decline over time, reducing soil health. Inversion tillage also reduces the soil coverage provided by crop residues, leaving soil more exposed to erosion. Tillage can also disrupt the hyphal network of mycorrhizal fungi, which can lead to their decline over time. When not managed carefully, most inversion and non-inversion tillage methods compact the subsoil, creating a hard pan, which restricts root growth and access to water and nutrients in the subsoil.

Excessive wheel and foot traffic can compact the surface soil, reducing macroporosity and impeding root growth. Physical disturbances such as inversion tillage can also have profound effects on the biological properties of soil. Compaction and removal of surface residue may contribute to reduction in soil moisture and living space for soil-dwelling organisms. Diversity and abundance of arthropod predators associated with the soil surface can be greater under conservation tillage management in comparison to conventional inversion tillage, and natural control of pest insects in soil may be enhanced in conservation tillage systems. Beneficial insects associated with the soil are more likely to survive in fields where noninversion (e.g., chisel plowed) tillage is used. In comparison with inversion tillage practices (e.g., mouldboard plow), non-inversion tillage causes less soil disturbance and thus less direct mortality of beneficial soil organisms.

2. Increase Organic Matter Inputs

To maintain or increase soil organic matter levels, inputs of organic matter must meet or exceed the losses of organic matter due to decomposition. Healthy crops can be a valuable source of organic matter, and crop residues should be returned to the soil to the extent possible. Incorporation of cover crops or perennial crops and judicious additions of animal and green manure and compost can also be used to increase or maintain soil organic matter. Soil organic matter content can be monitored over time if you request an organic matter analysis when submitting soil fertility samples to your soil testing laboratory. Be sure that your organic matter comparisons over time are based on data from the same lab or from labs that use the same procedure for organic matter analysis, as results can differ significantly between analysis methods.

3. Use Cover Crops

Cover crops contribute numerous benefits to soil health. They keep the soil covered during the winter and other periods of time when crops are not growing, reducing the risk of erosion. The biomass produced by cover crops is usually returned to the soil, enhancing organic matter levels. Cover crops with taproots can create macropores and alleviate compaction. Fibrous-rooted cover crops can promote aggregation and stabilize the soil. Species of cover crops that host mycorrhizal fungi can sustain and increase the population of these beneficial fungi. Legume cover crops can add nitrogen to the soil through nitrogen fixation. Cover crops can retain nitrate and other nutrients that are susceptible to leaching losses.

4. Reduce Pesticide Use and Provide Habitat for Beneficial Organisms

Beneficial insects that contribute to biological control or pest organisms can be harmed by the application of broad spectrum insecticides. Farm scaping is a whole-farm, ecological approach to increase and manage biodiversity with the goal of increasing the presence of beneficial organisms. Farm scaping methods include the use of insectary plants, hedgerows, cover crops, and water reservoirs to attract and support populations of beneficial organisms such as insects, spiders, amphibians, reptiles, bats, and birds that parasitize or prey on insect pests. Farmscapes placed in contours between fields, steep ditches, or places that are easily eroded give stability to the soil. Farmscaping can also be used as a filter strip to prevent water runoff and soil erosion. Plants used in farmscapes contribute to healthy soil by adding organic matter, the base of the soil food web.

5. Rotate Crops

Diverse crop rotations will help break up soil borne pest and disease life cycles, improving crop health. Rotations can also assist in managing weeds. By growing diverse crops in time and space, pests that thrive within a certain crop are not given a chance to build their populations over time. Rotating crops can also help to maintain soil fertility.

6. Manage Nutrients

Carefully planning of source, timing, application method, and quantity of manure, compost, and other fertilizers will allow you to meet crop nutrient demands and minimize nutrient excesses. Healthy, vigorous plants that grow quickly are better able to withstand pest damage. However, overfertilizing crops can increase pest problems. Increasing soluble nitrogen levels in plants can decrease their resistance to pests, resulting in higher pest density and crop damage. Maintaining a soil pH appropriate for the crop to be grown will improve nutrient availability and reduce toxicity. Maintaining adequate calcium levels will help earthworms thrive and improve soil aggregation.

7. Integrated nutrient management:

INM by combined application of chemical fertilizer, organic manure and biofertilizer which enhanced balance nutrient based on soil test, improved physical properties of soils and increase in nutrient use efficiency through use of biofertilizers and ultimately soil biota.

8. Increase in soil resilience:

It describes the level of resistance to driving soil degradation and provide insight into mechanism that endow soils with favourable properties from physical, chemical and biological perspectives. Hence, it prime important to reclaim degraded soils by application of organic, chemical amendment, provision of drainage, soil and water conservation practices, growing of salt tolerant crops etc.

CONCLUSION

Soil health can be improved by adopting the suitable crops and cropping pattern that sequester more carbon.Improve nutrient management practices for better soil health through integrated nutrient management.

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