SOIL QUALITY- AGRONOMY

Technical Note **No.1**

Cover and Green Manure Crop Benefits to Soil Quality

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This is the first note in a series of Soil Quality-Agronomy technical notes on the effects of land management on soil quality. This information is general and covers broad application.

Soil Quality and Resource Management

Soil is one of the five resources—soil, water, air, plants, and animals—that NRCS deals with in resource planning. Soil is intimately related to the other four resources, and its condition can either negatively or positively impact the other resources. For example, if the soil surface is functioning adequately, the soil will allow water to infiltrate, thus reducing the potential for erosion and increasing the amount of water stored for plant use. This function of soil affects water quality, plant growth, and the health of animals. In addition, protection of the surface layer resists wind erosion, thus protecting the air resource. Soil Quality is a critical factor in the management of natural resources, and the protection or enhancement of soil quality is the key component of all resource management assistance activities in the NRCS.

What is Soil Quality?

Soil quality is the capacity of a specific kind of soil to function within natural or managed ecosystem boundaries to:

* sustain plant and animal productivity
* maintain or enhance water and air quality
* support human health and habitation.

As defined, the terms soil quality, soil health, and soil condition are interchangeable.

Effects of Conservation Practices

One of the goals of conservation planning is to consider the effects of conservation practices and systems on soil quality. This is the first technical note in a series on how conservation practices affect soil quality. This technical note is designed to compliment local or regional information on the specific nature of cover crops.

Cover and Green Manure Crop Benefits to Soil Quality

1. EROSION - Cover crops increase vegetative and residue cover during periods when erosion energy is high, especially when main crops do not furnish adequate cover. Innovative planting methods such as aerial seeding, interseeding with cyclone seeder, or other equipment may be needed, when main crop harvest, delays conventional planting of cover crops during recommended planting dates.

2. DEPOSITION OF SEDIMENT - Increase of cover reduces upland erosion, which in turn reduces sediment from floodwaters and wind.

3. COMPACTION - Increased biomass, when decomposed, increases organic matter promoting increased microbial activity and aggregation of soil particles. This increases soil porosity and reduces bulk density. Caution: plant cover crops when soils are not wet, or use other methods such as aerial seeding.

4. SOIL AGGREGATION AT THE SURFACE - Aggregate stability will increase with the addition of and the decomposition of organic material by microorganisms.

5. INFILTRATION - Surface cover reduces erosion and run-off. Cover crop root channels and animal activities, such as earthworms, form macropores that increase aggregate stability and improve infiltration. Caution: Macropores can result in an increase in leaching of highly soluble pesticides if a heavy rain occurs immediately after application. However, if only sufficient rainfall occurs to move the pesticide into the surface soil after application, the risks for preferential flow are minimal. Cover crops, especially small grains, utilize excess nitrogen.

6. SOIL CRUSTING - Cover crops will provide cover prior to planting the main crop. If conservation tillage is used, benefits will continue after planting of main crop. Increases of organic matter, improved infiltration, and increased aggregate stability reduce soil crusting.

7. NUTRIENT LOSS OR IMBALANCE - Decomposition of increased biomass provides a slow release of nutrients to the root zone. Legume cover crops fix atmospheric nitrogen and provide nitrogen for the main crop. Legumes utilize a higher amount of phosphorus than grass or small grains. This is useful in animal waste utilization and management. Small grains are useful as catch crops to utilize excess nitrogen, which reduces the potential for nitrogen leaching. Caution: To prevent nutrient tie ups, cover crops should be killed 2-3 weeks prior to planting main crop. Tillage tools are used to kill and bury cover crops in conventional tillage systems. However, with conservation tillage systems, cover crops are killed with chemicals and left on or partially incorporated in the soil. Caution: Research has shown that incorporation of legume cover crops results in more rapid mineralization. However, due to delay in availability of nitrogen from legume cover crop in conservation tillage, a starter fertilizer should be applied at planting. (Reeves, 1994). An ARS study done in Morris, Minnesota reported dramatically higher carbon losses through $C0_2$ remissions under moldboard plow plots as compared to no-till. It was reported that carbon was lost as $C0_2$ in 19 days following moldboard plowing of wheat stubble that was equal to the total amount of carbon synthesized into crop residues and roots during the growing season. Long-term studies indicate that up to 2 percent of the residual organic matter in soils are oxidized per year by moldboard plowing" (Schertz and Kemper, 1994).

8. PESTICIDE CARRYOVER - Cover crops reduce run-off resulting in reduced nutrient and pesticide losses from surface runoff and erosion. Increased organic matter improves the environment for soil biological activity that will increase the breakdown of pesticides.

9. ORGANIC MATTER - Decomposition of increased biomass results in more organic matter. Research shows cover crops killed 2-3 weeks prior to planting main crop, results in adequate biomass and reduces the risk of crop losses from soil moisture depletion and tie up of nutrients.

10. BIOLOGICAL ACTIVITY - Cover and green manure crops increase the available food supply for microorganisms resulting in increased biological activity.

11.WEEDS AND PATHOGENS - Increased cover will reduce weeds. Caution: Research has shown reductions in yield are possible in conservation tillage cotton systems following winter cover crops. Reductions are attributed to interference from residue (poor seed/soil contact), cool soil temperatures at planting, increased soil borne pathogens, and increased insects and other pests. Harmful effects from the release of chemical compounds of one plant to another plant (allelopathic) are possible with crops like cotton, but losses can be reduced by killing the cover crop 2-3 weeks prior to planting main crop, and achieving good seed/soil contact with proper seed placement. Cover crops have shown some allelopathic effects on weeds reducing weed populations in conservation tillage (Reeves, 1994).

12. EXCESSIVE WETNESS - Cover and green manure crops may remove excess moisture from wet soils, resulting in reduction of "waterlogging" in poorly drained soils. Caution: transpiration of water can be a detriment in dry climates. Planners should adjust the kill date of cover crops to manage soil water.

Summary

Cover and Green Manure Crops as a conservation practice can improve soil health. Soil quality benefits such as increased organic matter, biological activity, aggregate stability, infiltration, and nutrient cycling accrue much faster under no-till than other tillage practices that partially incorporate the residue. One example comes from the Jim Kinsella farming operation near Lexington, Illinois. He reports that organic matter levels have increased from 1.9 percent 6.2 percent after 19 years of continuous no-till (Schertz and Kemper, 1994). Future technical notes will deal with other conservation practice effects on soil quality. The goal of the Soil Quality Institute is to provide this information to field offices to enable them to assist landusers in making wise decisions when managing their natural resources.

References:

Reeves, D.W. 1994. Cover Crops and rotations. p. 125-158 *In* J.L. Hatfield, and B.A. Stewart (eds.) Crops Residue Management, Adv. Soil Science.

Schertz, D.L. and W. D. Kemper. (1994) Crop residue management systems and their role in achieving a sustainable, productive agriculture. ISCO94 Conference. New Delhi.