# Productivity, Tilth, and Health of Soils with Cover Crop Practices

- Long-term soil health and productivity goals can be achieved with the use of cover crops.
- Cover crops are grown to improve soil nutrient levels, residue cover, and organic matter.
- Soil structure that improves with cover crops, can lead to more efficient use of water and fertilizer.

Human-induced soil degradation has occurred on over 235 million acres in North America.[7] In some parts of the world, soil degradation is so severe, major engineering work and assistance beyond the ability of local farmers is required to restore soils. However, in more lightly degraded soils, the simple use of cover crops in the rotation between corn and soybeans can help restore soil productivity levels over time. Restoration of soil productivity is important for sustainable agriculture as yields are able to each their full potential when soils have good tilth and health. Tilth is a physical condition of soil and depends on aggregation—joining of individual soil particles into clusters. Increased aeration and water-holding capacity is demonstrated in soils that have good tilth, drain well, resist crusting, and quickly take in water. Soil health and productivity are long-term goals and benefits from the use of cover crops in rotations. When used long-term, cover crops provide a food source for soil organisms; in turn, soil organisms help with soil nutrient supply and plant uptake.

## Reduction of Runoff, Erosion, and Nutrient Loss

Physical characteristics of a soil help determine its ability to resist erosion. Aggregates can be bound by a water-insoluble protein called glomalin, a substance produced by mycorrhizal fungi. Cover crops, legumes in particular, increase populations of mycorrhizal species, and can promote their relationships with subsequent crops. Glomalin is thought to explain improved water infiltration and water storage on soils grown with cover crops even when increases to organic matter levels have not been detected.

**Runoff.** Thunderstorms that last a short time and are intense can cause noticeable soil movement. The impact of rain drops and shear force of water flow leads to inter-rill and rill erosion, respectively.[2] Soils are especially vulnerable to runoff and erosion during spring months when soils are often saturated, snow is melting, and vegetation is minimal. Runoff leads to nutrient loss, soil loss, and off-site contamination of surface waters. Additionally, soil water recharge is minimal when precipitation moves off-site.

Cover crop species can slow or stop runoff. The canopy of cover crops shield the soil and reduces the impact of rainfall energy. Shear force of water flow can be strong during periods between cash crops. Cover crops reduce the speed of flow over the surface and keep surface residue in place.

Runoff issues can be complicated by soil compaction. Subsoil compaction can be broken up or 'bio-drilled' by deep-rooted cover crops such as such as radishes or annual ryegrass. Soil structure is left intact when a cover crop, rather than tillage, is used to treat soil structure issues. Tillage quickly negates benefits of cover crops due to the breakdown of soil structure, and machinery used to relieve compaction may cause re-compaction of soils.

**Erosion.** Wind erosion is affected by soil particle size, roughness of soil surface, wind velocity, distance from shelter, and vegetation. Soil surface cover from no-till practices, has been estimated to cause wind erosion reductions of 60 percent compared to conventional tillage in Michigan.[3] Soils are especially prone to wind erosion in the Great Plains states, and growing vegetation helps stabilize the soil better than dead or incorporated residue.[6]

Some soil loss can occur without detectable yield loss; however, nutrients and water often need to be replaced at a cost to the grower. The USDA NRCS reported an average soil loss of 2.1 tons per acre per year from wind erosion in 2007.[4] Soil that is moved off-site is often topsoil that contains organic matter. While organic matter and nutrient levels vary, each ton of lost topsoil could contain 20 pounds of nitrogen (N), 12 pounds of phosphate, and 9 pounds of potash.[5]

**Nutrient Retention.** Nutrient loss from runoff, erosion, and leaching can be slowed or stopped with cover crop root and canopy growth. Nitrate-N is the nutrient frequently lost with water as runoff or leached through the soil profile. Cover crops take up or sequester excess N and reduce leaching into

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groundwater. Deep profile nutrient scavenging can bring nutrients to the surface and release them during cover crop degradation. Subsequent cash crops can use these released nutrients.

## Productivity

**Nitrogen Fixation.** A 2013 survey conducted by the Conservation Technology Information Center (CTIC) and the USDA found that 41 percent of the growers were planting cover crops to scavenge for N.[1] Legumes that fix N and can release N for a cash crop to recapture the nutrient in the spring help provide value to cover crops. Cover crop seed cost and ability to supply potential N should be compared to fertilizer costs. The Midwest Cover Crop Council (MCCC) website can help growers select cover crops and estimate how much N can be returned. The Cover Crop Decision Tool from MCCC can be found at **http://mcccdev.anr.msu.edu/VertIndex.php.**

**Residue Cover.** 'Soil erosion reduction' was a cover crop characteristic sought by 56 percent of respondents in the 2013 CTIC and USDA survey.[1] Along with decreased erosion and runoff, early spring growth of cover crops can help use excess moisture and stabilize the seed bed. This stability allows machinery to pass over cover-cropped fields sooner compared to tilled fields. Termination of spring cover crop growth should be timed early enough to preserve adequate water for the cash crop. A method other than tillage should be used to terminate cover crops. Maintaining cover crop roots such as in no-till fields, helps provide year-round habitat and food sources for microorganisms. Microorganisms are key to nutrient availability and pest suppression.

**Restoration.** Restoration of marginal acreage to production has also been accomplished with cover crops. Slight to complete crop loss can result from salinization - the accumulation of water-soluble salts in the root zone of crops. This type of soil degradation is caused by irrigation, or poor soil-water drainage where there are naturally-occurring soil and water salts. Salinization is complex; however, it can be corrected by removal of salts from the root zone. Salt-tolerant cover crops, such as barley or sugar beet, can be used to increase transpiration and reduce evaporation that leads to salt accumulation in the root zone.

**Prevented Plant Acreage.** Some planting seasons end with millions of acres left unplanted or enrolled as prevented plant acreage. Soil left fallow lacks root growth. Additionally, mycorrhizal fungi that promote phosphorus (P) uptake do not survive flooded soil conditions or without host roots. A corn crop planted the year after flooding may have plants with P deficiency symptoms, also known as 'fallow syndrome'. Mycorrhizal growth is important for supplying P to early corn growth and correction of' 'fallow-syndrome'. Cover crops can promote growth of mycorrhizal fungi and increase P levels within the plant comparable to if P was applied with the corn seed at a rate of 6.3 lbs/ac.[8]

Figure 1. Field planted with oilseed radish and annual ryegrass cover crop in the fall.

## Summary

There is increased public and private interest in cover crops. The NRCS recently started an awareness and education effort to share success stories and lessons learned by cover crop growers in numerous states. The CTIC is reporting an increase in cover crop use throughout the United States.[1] Growers are interested in long-term use of cover crops for several reasons: soil health, improved soil physical properties, better efficiency in the use of nutrients, and reduced loss of nutrients in surface and drainage water.


**Sources**

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