



## Cover Crop Benefits to Productivity and Soil and Environmental Health

The use of cover crops, a crop planted outside of the normal cash cropping sequence, is becoming a more common agronomic practice with over 15 million acres in the U.S. in 2017. This is a 50% increase in five years. Cover crops help provide soil nitrogen (N), reduce soil erosion, increase soil quality, and suppress weeds. In higher precipitation areas where a cash crop is grown every year, a cover crop is grown outside of the normal cash crop sequence. In areas with less precipitation, cash crops may be grown every other year, and cover crops may be used during the summer fallow period of the rotation. There are many benefits to including a cover crop, including:

- Increasing long-term soil health and productivity goals
- Reducing soil and nutrient loss from erosion and runoff
- Adding N to the soil, mining nutrients from deep in the soil, supporting populations of beneficial soil organisms which help improve nutrient availability and uptake, and improving soil stability
- Reducing soil compaction and improving soil structure
- Increasing soil carbon levels and utilizing an important tool for soil carbon sequestration.

### *The Importance of Soil Physical Structure<sup>1</sup>*

Introducing cover crops into the rotation between cash crop cycles can help improve soil tilth, health, and productivity. Tilth is the physical condition of a soil and involves aggregation (the joining of individual soil particles into clusters), moisture and air content, and the rate of water infiltration and drainage. Soils with good tilth have increased aeration and water-holding capacity, drain well, resist crusting, and quickly take in water. Soils with stable aggregates can better resist water and wind erosion. Aggregates can be bound by clay particles, organic matter, fungal hyphae, and

a protein called glomalin, a water-insoluble substance produced by mycorrhizal fungi.

### *Reduction of Erosion, Runoff, and Nutrient Loss*

Wind and water erosion can lift and carry loose soil particles off site. The sheer force of wind and water flow can be exceptionally strong during periods between cash crops when the soil is fully exposed to these forces. The impact of raindrops can break apart weak soil aggregates resulting in smaller soil particles that are more easily carried away by wind and runoff. Runoff can also lead to off-site contamination to surface waters. Soil water recharge is also reduced when precipitation moves off site. Soil that is moved off site is often topsoil that contains organic matter and nutrients. While the organic matter and nutrient levels of soils vary, each ton of lost topsoil could contain 20 pounds of N, 12 pounds of phosphorous (P), and 9 pounds of potassium (K).<sup>2</sup> When soil loss occurs, nutrients and water often need to be replaced at an expense to the grower. Cover crops and crop residue can slow or stop runoff and erosion. The canopy of cover crops helps shield the soil and reduce the impact of rainfall. Cover crop roots help anchor soil particles and cover crop residue can increase the amount of organic matter near the soil surface, which helps to further stabilize soil aggregates, making them less likely to break apart. Cover crops also reduce the speed of water flow over the soil surface.

### *Nutrient Retention*

Nutrient loss from runoff, erosion, and leaching can be slowed or stopped with cover crop root and canopy growth. Nitrate-N is easily lost with water as runoff or leached through the soil profile. Cover crops take up or sequester excess N and reduce leaching into groundwater. Some deep-rooted cover crops can also pull nutrients from deeper in the soil profile and release them back into the soil closer to the soil

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surface, making them more available to subsequent cash crops.

## Nitrogen Release and Fixation

Legume cover crops can fix and release N for a cash crop to recapture in the spring. The seed cost for a cover crop and the ability to supply N should be compared to fertilizer costs. Research in Ontario suggests that different cover crop species release N at different times. Oilseed radish is an excellent nitrogen scavenger but tissues start to break down before the spring crop is in place therefore, some N loss can occur. Annual ryegrass and clovers do not release N until early to mid-summer.<sup>3</sup>

The Midwest Cover Crop Council (MCCC) website can help with selecting cover crops and estimating how much N is returned. The Cover Crop Decision Tool from MCCC can be found at <https://mccc.msu.edu/covercroptool/>.

## Impact on Soil Stability and Structure

Along with decreased erosion and runoff, early spring growth of cover crops can help utilize excess soil moisture and stabilize the seed bed. This improved stability can allow machinery to pass over cover-cropped fields earlier compared to tilled fields. Termination of spring cover crop growth should be timed early enough to preserve adequate water for the subsequent crop. Herbicides, mowing, or another method besides tillage should be used to terminate cover crops.

## Mitigation of Compaction

Subsoil compaction can be broken up or 'bio-drilled' by deep-rooted cover crops such as oilseed radish or annual ryegrass, particularly under no-till cropping systems.<sup>4</sup> Soil structure is left intact when a cover crop, rather than tillage, is used to improve compaction issues. Tillage quickly negates the benefits of cover crops as the use of tillage machinery breaks down the soil structure. Additionally, soils may be re-compacted by machinery, sometimes worse than before deep tillage.

## Restoration

Cover crops can be used to stabilize and, in some cases, remediate lightly degraded soils. Salinization is the accumulation of water-soluble salts in the root zone of crops. This type of soil degradation is caused by poor quality irrigation water, or poor drainage in areas where there are naturally-occurring salts in the soil and water supply. As soil water evaporates, it pulls the salts from deeper in the soil profile up to the surface. The use of salt-tolerant cover crops, such as barley or annual ryegrass, helps reduce soil water evaporation between the cash crops, thereby helping to stabilize salinity.

## Improved Nutrient Availability

When used long term, cover crops provide a food source for beneficial soil organisms, and in turn, soil organisms help with soil nutrient supply and plant uptake. Soils left fallow lack root growth, and mycorrhizal fungi that promote P uptake do not survive without host roots. Some cover crop species that are deep rooted can mine P from deeper in the soil profile making it available to the subsequent crop.<sup>4</sup>

The cover crop survey report from the Sustainable Agriculture Research and Extension (SARE) program, Conservation Technology Information Center (CTIC), and American Seed Trade Association (ASTA) contains valuable statistics about the adoption and value of cover crops across the U.S. To access the latest version of this report, visit [https://www.ctic.org/data/Cover\\_Crops\\_Research\\_and\\_Demonstration\\_Cover\\_Crop\\_Survey](https://www.ctic.org/data/Cover_Crops_Research_and_Demonstration_Cover_Crop_Survey).

## Sources

<sup>1</sup> Kaspar, T.C. and Singer, J.W. 2011. The use of cover crops to manage soil. Soil Management Practices. American Society of Agronomy and Soil Science Society of America. Chapter 21.

<sup>2</sup> Sullivan, P. 1999. Sustainable soil management, soil system guide. Appropriate Technology Transfer for Rural Areas. [www.soilandhealth.org/](http://www.soilandhealth.org/).

<sup>3</sup> Cover Crops: Adaptation and Use of Cover Crops. 2021. Ontario Ministry of Agriculture, Food, and Rural Affairs. [http://www.omafra.gov.on.ca/english/crops/facts/cover\\_crops01/cover.htm#cover%20crop%20functions](http://www.omafra.gov.on.ca/english/crops/facts/cover_crops01/cover.htm#cover%20crop%20functions)

<sup>4</sup> Williams, S. and Weil, R. 2004. Crop cover root channels may alleviate soil compaction effects on soybean crop. Soil Science Society of America Journal. <https://www.researchgate.net/>.

## Legal Statements

Performance may vary, from location to location and from year to year, as local growing, soil and weather conditions may vary. Growers should evaluate data from multiple locations and years whenever possible and should consider the impacts of these conditions on the grower's fields.

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