

# COVER CROP FACTS

## Cover Crops at Work: Keeping Nutrients Out of Waterways

*An overview of cover crop impacts on nitrogen and phosphorus losses from agricultural systems<sup>1</sup>*



Photo Credit: Edwin Remsburg

### ABOUT COVER CROPS

Cover crops are tools to keep the soil in place, bolster soil health, improve water quality and reduce pollution from agricultural activities.

- They include cereals, brassicas, legumes and other broadleaf species, and can be annual or perennial plants. Cover crops can be adapted to fit almost any production system.
- Popular cover crops include cereal rye, crimson clover and oilseed radish. Familiar small grain crops, like winter wheat and barley, can also be adapted for use as cover crops.

Learn more at  
[www.sare.org/cover-crops](http://www.sare.org/cover-crops)



<sup>1</sup> Unless otherwise cited, all data comes from a bibliography that will soon be available online.

This publication was developed by Sami Tellatin and Rob Myers of NCR-SARE and the University of Missouri under Cooperative Agreement No.83695601 awarded by the U.S. Environmental Protection Agency. EPA made comments and suggestions on the document intended to improve the scientific analysis and technical accuracy of the document. However, the views expressed in this document are those of the author. The EPA, the USDA and SARE do not endorse any products or commercial services mentioned in this publication. The SARE program is supported by the National Institute of Food and Agriculture, U.S. Department of Agriculture, under award number 2014-38640-22173.

### Cover Crops Reduce Nitrogen Losses to the Environment

Nitrogen can be lost from agricultural fields in runoff water and groundwater. This displaced nitrogen may then travel into waterways and cause imbalances in the nutrient levels of these sensitive ecosystems. Farmers want nitrogen to remain on the land to fertilize their crops and support productive growing systems, and society as a whole doesn't want excess levels of nitrogen in the water.

- So how can cover crops help? They scavenge soil nitrogen and prevent it from being leached, and they can provide natural sources of nitrogen to cash crops and thus reduce the amount of fertilizer needed for production.
- Cover crops reduced the amount of nitrogen leaving a field by 1% to 89%, with a median value of 48% (across 10 studies and 16 observed reductions).

### What About Phosphorous?

Compared to the impact of cover crops on erosion or losses of nitrogen, the impact of cover crops on phosphorus in the field is less studied and the research inconclusive.

- Phosphorus can be transported to waterways by above- or below-ground water flows.
- Some studies report finding no significant effect of cover crops on total phosphorus losses, sometimes because the cover crops may have reduced total phosphorus losses but increased soluble phosphorus losses (often in below-ground, leachate water).
- However, reductions have been observed, showing that cover crops reduced total phosphorus loads in water samples by 15% to 92%.
- The main mechanism by which cover crops may inhibit phosphorus losses is through preventing soil loss by covering the ground and rooting to secure the soil in place.

### A Systems Approach to Enhanced Water Quality and Smart Nutrient Management

When faced with problems such as eutrophication and hypoxia in our waterways, we can turn to cover crops and other conservation practices as tools to mitigate this pollution.

- With cover crops, smart fertilizer- and manure-management decisions will also decrease nutrient-loss risks.
- Continuous ground cover paired with no-till management, will successfully prevent erosion and will therefore reduce above-ground nutrient losses to the environment.



# COVER CROP FACTS

## Cover Crops at Work: Increasing Infiltration

*An overview of cover crop impacts on water infiltration to the soil<sup>1</sup>*



Photo Credit: Edwin Remsberg

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### Cover Crops and Infiltration

Cover crops can successfully increase the infiltration of water into the soil layer. They do this by covering the ground with their biomass and by improving soil structure with their roots. Some specific mechanisms include:

- Preventing soil surface sealing (where the soil becomes impermeable after rainfall)
- Improving soil structure with increased soil aggregate stability, soil porosity and water storage capacity

Different types of cover crops may have different effects on infiltration because of their unique biomass growth and composition, and results vary based on how long the cover crop is grown.

- Non-legume cover crops, including brome grass and rye, increased infiltration by 8% to 462%, based on a range of studies.
- Legume cover crops, including crimson clover, hairy vetch and strawberry clover, increased infiltration by 39% to 528%.
- Soil surface cover by residue alone increased infiltration by up to 180% in field trials.

### Management Decisions Matter

Management that encourages continuous ground coverage by residues and cover crops will be best suited to positively impact the infiltration of water to the soil surface. Tillage practices are another important management decision for water infiltration.

- No-till management has been found to increase rainfall infiltration.
- One study reported that runoff from no-till fields was two to four times less than from conventional-till plots.

### A Far-Reaching Solution

When water is able to enter the soil profile, rather than running off the soil surface, there is less risk of displacing soil particles through erosion. Increased infiltration also signals possible benefits to the water conditions within the soil profile. By keeping the soil in place and improving soil conditions, cover crops are mitigating pollution risk while also boosting the productive capacity of the soil.



# COVER CROP FACTS

## Cover Crops at Work: Covering the Soil to Prevent Erosion

*An overview of cover crop impacts on soil losses  
from agricultural production systems<sup>1</sup>*



Photo Credit: Edwin Remsburg

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### Cover Crops and Erosion

Cover crops can successfully decrease, or almost completely eliminate, soil loss from various production systems. They do this by:

- Providing coverage of the soil surface and protecting it from rain and wind
- Rooting into the soil profile and improving soil structure
- Encouraging water infiltration to the soil profile

#### Studies have shown decreases in soil loss from fields planted into different types of cover crops.

- Non-legume cover crops, including rye, ryegrass, triticale, barley, and wheat, reduced soil loss by 31% to 100% as compared to fields in which no cover crops were grown.
- Legume cover crops, including red clover, crimson clover, lentil and pea, reduced soil loss by 38% to 69% as compared to no cover crops.
- Mustard, a brassica, reduced soil loss by up to 82% as compared to no cover crop.
- On average, cover crops reduced sediment losses from erosion by 20.8 tons per acre on conventional-till fields, 6.5 tons per acre on reduced-till fields and 1.2 tons per acre on no-till fields.

### Management Decisions Matter

- The best management practices for preventing soil loss are those that maximize ground coverage year-round, and these include no-till management in combination with cover crop growth.
- Conservation tillage practices were responsible for an 89% reduction in soil loss as compared to conventional tillage.

### Cover Crops Can Steward Water Quality and Soil Health

- Erosion is a costly depletion of resources, a displacement of soil from where it is needed to where it becomes a pollutant in waterways. Displaced soil can carry nutrients, like nitrogen and phosphorus, which further pollute waterways.
- We can invest in reduced rates of soil loss from agricultural fields, whether in vineyard rows or corn fields, by planting cover crops, maintaining constant ground cover and utilizing no-till management.

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# COVER CROP FACTS

## Cover Crops Improve Soil Conditions and Prevent Pollution

*An overview of cover crop impacts on erosion, infiltration, nutrient losses and soil organic matter on U.S. cropland<sup>1</sup>*



Photo Credit: Edwin Remsburg

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**In 2012, the USDA reported 10.3 million acres of U.S. cropland planted to cover crops.<sup>2</sup>**

- Recent surveys by the SARE Program and the Conservation Technology Information Center (CTIC) suggest that cover crop acreage is increasing and illustrate that U.S. agricultural producers are intrigued by this conservation practice.
- With about 267 million acres of row crop agriculture in the U.S., the potential for cover crop adoption is quite higher than what has actually been achieved to date.<sup>3</sup>

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### Why Plant Cover Crops?

The scientific literature is ripe with data about the benefits of planting cover crops. Cover crops have been shown to decrease, or almost completely eliminate, erosion from agricultural fields, increase rainfall infiltration to the soil layer, keep nutrients like nitrogen and phosphorus in place and prevent the loss of these nutrients to vulnerable waterways, and increase soil organic matter (a measure of soil fertility).

### Reductions in Soil Loss and Sediment Pollution of Waterways

- On average, cover crops reduced sediment losses from erosion by 20.8 tons per acre on conventional-till fields, 6.5 tons per acre on reduced-till fields and 1.2 tons per acre on no-till fields.
- Sediment is a costly pollutant in U.S. waterways, with estimated average sediment losses of 2.7 tons per acre per year across the U.S.<sup>4</sup>

### Increases in Rainfall and Water Infiltration to the Soil

- Cover crops increased infiltration to the soil layer by more than six-fold in some systems.
- Improvements in rainfall infiltration to the soil surface signal two important benefits to cropping systems: decreased runoff and thus less erosion risk, and improved soil water and soil structural conditions that can benefit crop production.

### Scavenging of Nitrogen and Prevention of Nutrient Losses to Waterways

Nitrogen can be lost from agricultural fields in runoff water and groundwater. This displaced nitrogen may then travel into waterways, and cause imbalances in the nutrient levels of these sensitive ecosystems.

- Cover crops have been shown to reduce these nitrogen losses by an average of 48% (concentration measurements, median of 10 studies), and as much as 89% in one study.
- Cover crops are able to successfully reduce nitrogen losses to waterways because they cover the ground and prevent runoff and erosion, and they scavenge soil nitrogen and keep it in place. Additionally, some cover crops can provide natural sources of nitrogen to other crops and thus can reduce the amount of fertilizer needed for production.
- Several sources also illustrated the ability of cover crops to reduce average total phosphorus loads to waterways by 15% to 92%, though more research on this is needed.





Photo Credit: Edwin Remsberg

## Improved Soil Organic Matter Levels Signal Increased Soil Fertility and Soil Health

Soil organic matter is decomposed organic material (leaves, roots, microorganisms) that exists in the soil and acts as a reservoir of water and nutrients.

- Cover crops are able to increase soil organic matter by protecting the soil surface from erosion, adding biomass to the soil (especially below the soil surface), and creating a habitat for microorganisms like fungi that contribute to the soil biology and provide more pathways for nutrient management in the soil ecosystem.
- Legume cover crops were found to increase levels of soil organic matter by 8% to 114%.
- Non-legume cover crops, including grasses and brassicas, were found to increase soil organic matter levels by 4% to 62%.

## Combining Management for Farm and Ecosystem Health

Cover crop management can be combined with no-till management and intentional manure management to create healthy conditions on the farm and in surrounding ecosystems.

- Like cover crop management, no-till management is also associated with reducing erosion and nutrient-loss risks in agricultural systems, especially when paired with cover crops and residue maintenance. One source showed that conservation tillage practices were responsible for an 89% reduction in soil loss as compared to conventional tillage.
- Manure application rates can be managed to mitigate losses of nitrogen and phosphorus to the soil, especially when cover crops are planted to offset any nutrient-loss risks posed by manure application.

## A Proven Approach to Improving Our Ecosystems, Waterways and Soil Systems

The scientific consensus is in: cover crops reduce erosion, improve soil conditions and protect waterways from harmful nutrient loads. And, farmers and ranchers are curious about cover crops and are increasingly incorporating them into their systems. Though cover crop acreage has been rising each year, we still have enormous potential to increase the adoption of this beneficial practice and to improve our land and water quality for future generations.

<sup>1</sup> Unless otherwise cited, all data comes from a bibliography that will soon be available online.

<sup>2</sup> Myers, R. and C. Watts. 2015. Progress and perspectives with cover crops: interpreting three years of farmer surveys on cover crops. *Journal of Soil and Water Conservation*. 70(6):125A:129A.

<sup>3</sup> National Agricultural Statistics Service. 2016a. Acreage. [www.usda.gov/nass/PUBS/TODAYRPT/acrg0616.pdf](http://www.usda.gov/nass/PUBS/TODAYRPT/acrg0616.pdf).

<sup>4</sup> Natural Resources Conservation Service. 2007 National Resources Inventory. National soil erosion results tables. [www.nrcs.usda.gov/wps/portal/nrcs/detail/national/home/?cid=stelprdb1041678](http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/home/?cid=stelprdb1041678).



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