



Cover Crops



Summer 2015
Continuous Living Cover Series

Placing Cover Crops

- Use cover crops with corn-soybean rotations on slopes <5% to scavenge N and reduce N leakage
- Use cover crops on slopes <5% to reduce wind erosion
- Use cover crops with corn-soybean production on 5% to 14% slopes to reduce sheet, rill, and gully erosion

Adapted from: Impacts of integrated crop-livestock systems on nitrogen dynamics and soil erosion in western Iowa watersheds. 2005. Burkart, M., D. James, M. Liebman, and C. Herndl. *J. Geophys. Res.*, 110, G01009, doi:10.1029/2004JG000008.

photo from Mark Zumwinkle, Minnesota Department of Agriculture

Cover crops keep soil covered and keep living roots in the ground at times of the year when a corn, soybean, or small grain crop is not present and growing.

Late fall after harvest, winter, and early spring before planting are very high-risk times for soil loss and nutrient loss from fields. Heavy fall or spring rains, spring snowmelt, and winter winds can erode soil from fields that have little protection, causing large losses of nutrients and soil. Covering the soil year round keeps our Midwestern soil, our “black gold,” in place and producing high yielding crops for the future. Reduced tillage helps reduce soil losses, but anchoring soil with the roots of a cover crop helps even more.

Know your goals for a cover crop before getting started. Determine if you want to use cover crops to reduce nitrogen loss, protect from wind erosion or provide nutrients for a cash crop. Set your cover crops up for success by determining your goals before you start, and then select

species that help accomplish your goals.

Roots in the Ground

Cover crops improve the soil and reduce nutrient loading to surface waters by keeping roots in the ground year-round. Living roots are key. Don't be disappointed

if you only see short cover crop plants aboveground. The aboveground appearance may not show much growth, but the roots can be surprisingly well-developed below ground. Because of deep roots, the cover crop can do its jobs of capturing nitrogen before it leaches out of the soil profile; and of slowing overland flow of water, allowing water to better infiltrate into the soil.

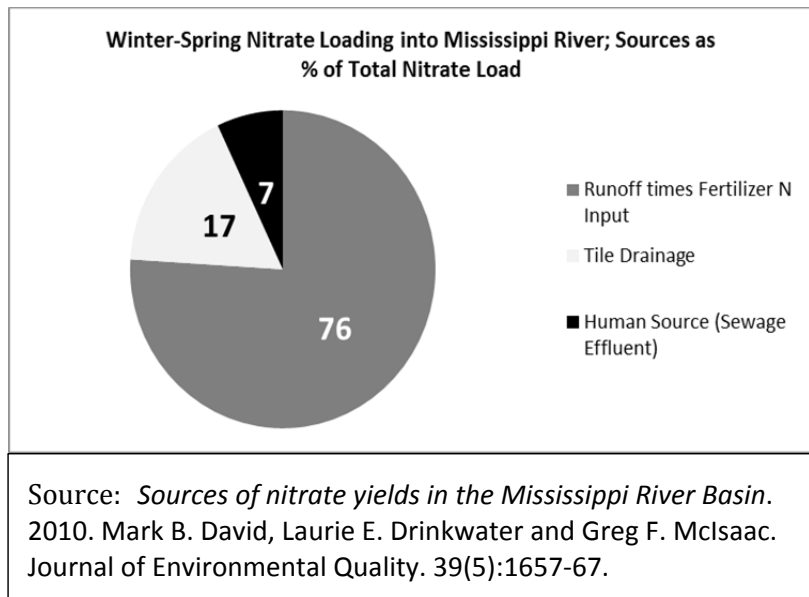
Dave Robison, an agronomist working on cover crops in the Midwest, has found 21" roots under 4" high annual ryegrass tops. (<http://plantcovercrops.com/short-cover-crops-put-down-deep-roots/>)

"Always take a shovel with you.
You will likely be surprised!"

Dave Robison, plantcovercrops.com

Cover Crop Prevention of N Leakage: Scavenging

Winter cereal rye, with its fibrous roots, is a good scavenger of nitrogen. The tile drainage studies listed in the table on the next page showed a 26% to 61% reduction in nitrates in drainage water when a winter cereal rye cover crop was used. Tile drainage water accounts for 17% of the nitrate flowing into the Gulf of Mexico, as shown in the chart below; so reducing nitrates from tile drainage water has potential to make a difference in surface water quality.

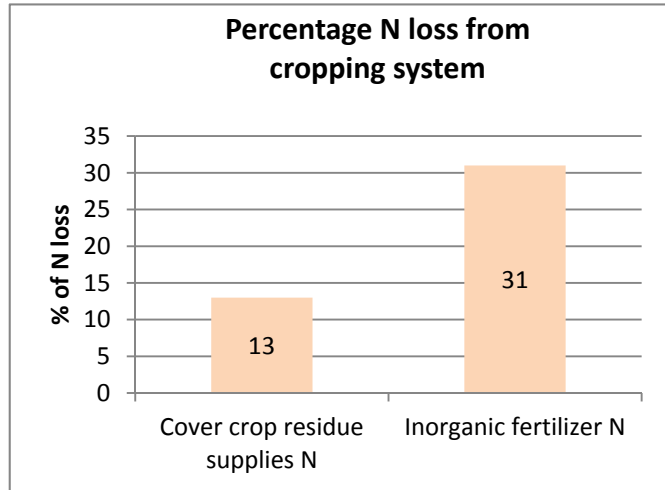


Reduction in nitrate concentration in drainage water from corn/soybean systems with cover crops: three studies		
Study description	NO ₃ reduction with cover crop:	Citation
Spring-applied UAN vs. Spring-applied UAN+winter cereal rye cover crop	26%	Drainage water quality impacts of current and future agricultural management practices. Leopold Center for Sustainable Agriculture Competitive Grant Report XP2011-14. http://www.leopold.iastate.edu/sites/default/files/grants/XP2011-04.pdf
Winter cereal rye cover crop Fall oat cover crop Cover crops used on both corn and soybean crops	48% 26%	Effectiveness of oat and winter cereal rye cover crops in reducing nitrate losses in drainage water. 2012. T.C. Kaspar, D.B. Jaynes, T.B. Parkin, T.B. Moorman, J.W. Singer. <i>Agricultural Water Management</i> 110 (2012) 25–33. http://naldc.nal.usda.gov/naldc/download.xhtml?id=54466&content=PDF
Winter cereal rye cover crop + no-till over 4 years	61%	Winter cereal rye cover crop and gamagrass strip effects on NO ₃ concentrations and load in tile drainage. 2007. T.C. Kaspar, D.B. Jaynes, T.B. Parkin, T.B. Moorman. <i>Journal of Environmental Quality</i> . 36(5):1503-11 http://naldc.nal.usda.gov/download/14937/PDF

Cover Crop Prevention of N Leakage: Green Manure for Slow Release of N

Legume cover crops or mixtures of legumes with small grains and/or broadleaf plants that are plowed down as a green manure can release significant N back to a subsequent corn crop.

Use of cover crops as green manure can also reduce N leakage from the cropping system because the slow release of N from decomposing cover crops results in greater percentage uptake of released N by the subsequent crop. Use of cover crops as a green manure may require different management practices than use of cover crops for soil protection, however. Green manures require a longer growth period to build up biomass, and then timing of cover crop termination so that the green manure crop residue is breaking down and releasing N at the same time that the subsequent crop is growing and taking up N. This slow release of N from the decomposing green manure crop, synchronized with the cash crop's uptake of N, results in very little loss of N from the system. As the chart shows, using green manures as the N source for subsequent crops results in an average loss of 13% of the N from the cropping system, compared to an average loss of 31% of the N if synthetic fertilizers are the source of N.



Source: *Using Cover Crops and Cropping Systems for Nitrogen Management*. Chapter 9 in *Advances in Nitrogen Management for Water Quality*. Edited by Jorge A. Delgado and Ronald F. Follett. 2010, 424 pages, hardcover. Soil and Water Conservation Society. ISBN 978-0-9769432-0-4.

http://www.swcs.org/documents/filelibrary/advances_in_nitrogen_management_for_water_quality/ANM9_A41356AAD3B6A.pdf

Estimate the N contribution from a green manure cover crop:				
	Baseline, 2000 lbs. biomass/acre	Inches over baseline * lbs./in.	% cover	% N in above- ground biomass
Legume - preflower	100% cover, 6"	(in * 150 lbs./ac)	estimate	3.5 – 4
Legume – flower	100% cover, 6"	(in * 150 lbs./ac)	estimate	3.0 – 3.5
Grasses (small grain)	100% cover, 6"	(in * 300 lbs./ac)	estimate	2.0 – 3.0
Cereal Winter cereal rye	100% cover, 8"	(in * 150 lbs./ac)	estimate	2.0 – 3.0
Brassicac & others	100% cover, 6"	(in * 300 lbs./ac)	estimate	1.5 – 2.5

Formula: $[2000 \text{ lbs./acre} + (\text{inches over baseline} * \text{lbs./in.})] * (\% \text{ cover}/100) * (\% \text{ N}/100)$
 = Lbs./acre of N supplied by the cover crop

Source: Building Soil Fertility. In: *Managing Cover Crops Profitably*. 2007. Marianne Santiano. Sustainable Agriculture Research and Education (SARE), USDA.
<http://www.sare.org/Learning-Center/Books/Managing-Cover-Crops-Profitably-3rd-Edition/Text-Version/Building-Soil-Fertility>

Cover Crop Plant Categories

Single-species cover crop plantings are often used in corn and soybean production. Winter cereal rye, particularly, is popular with corn and soybean producers because it can germinate and grow even if planted quite late in the season, so it allows farmers more flexibility to plant the cover crop and get stand establishment after crop harvest. The experience of Fred Abels with winter cereal rye (sidebar) is a good example of the use of winter cereal rye with corn. Multi-species mixes also have a place, and many farmers are finding that diversity of plant species confers benefits. These mixes are easier to establish and have more time to grow following shorter season crops like oats, winter wheat, vegetable crops, or corn silage.

Check with local cover crop experts, or do your own on-farm testing, to ensure that the cover crop resource you choose is appropriate for your climate, cropping system, and goals. Cropping system differences, rainfall and growing degree days can differ even from farm to farm in the same area. When looking at research results, check where the research occurred before implementing a cover crop plan for your area.

Fred Abels, farmer near Holland, IA:

In fall of 2013 we put in winter cereal rye on silage acres after the crop had been taken off. We had had no rain and this was prior hay ground with very hard-packed soil. The seeder didn't get the winter rye into the ground very well and we had a weak stand.

Spring of 2014, I was side-dressing 50 pounds of nitrogen fertilizer on four-inch corn. There was some very hard soil; I took a whole bag of shear bolts with me because they were breaking often. When I got to the field that had had the cover crops, I didn't break a single shear bolt on that field. Then we sent in some soil samples as part of hosting a field day, and could clearly see the benefit of the winter rye cover crop in the soil test report.

My cousin's husband in northern Iowa had winter rye flown on 100 acres in the fall two years ago. Last year he said the soil was so mellow in the fall, he could move one mile per hour faster through the field at harvest.

This fall, we're putting a winter rye cover crop on 100% of our corn and bean acres.

There are many ways to group cover crops into categories with different characteristics to choose from. Here's one example of a list of types:

- *Cool-season summer annual grasses
- * Warm-season summer annual grasses
- * Winter annual grasses
- * Winter annual broadleaves
- * Annual Legumes
- * Biennial Legumes
- * Perennial Legumes
- * Tap-rooted Brassicas
- * Fibrous-rooted Brassicas
- * Other broadleaves

Summer annual grasses sprout from seed in the spring, produce a seed crop during the summer, and die in the fall. Warm-season grasses like corn, sorghum, and sudangrass produce a greater volume of biomass than cool-season

Kent Solberg, farmer and Cover Crop Champion with the National Wildlife Federation:

"You need to understand the characteristics of the plant options that are available – the basic principles of what the crops do for you. Some are doing a 'shotgun' approach of planting whatever seed is handy, and being disappointed. We're doing better with carefully selected, complex mixtures of cover crops."

grasses like oats and annual ryegrass.

Winter annuals are planted and sprout from seed in the fall, grow until going dormant for the winter, then start growth again in the spring and produce a seed crop in the late spring or early summer if allowed to mature. Winter annual grasses include winter cereal rye, winter barley, and winter wheat. Winter annual broadleaves include pennycress.

Legumes are plants that form root nodules containing *Rhizobium* species of bacteria, which collect atmospheric nitrogen and convert it into an organic form of nitrogen within those root nodules. Annuals sprout from seed and mature and produce seed in one year.

Biennials are vegetative-only for their first year of growth, and mature and produce seed in the second year. Perennials live for multiple years. Some may not produce seed in the first year.

Brassicas are plants related to mustard and turnips. Winter canola is a winter annual brassica, but most are summer annuals. They are distinguished primarily by rooting behavior: tap-rooted brassicas like oilseed radish produce a long and fleshy root, while fibrous-rooted brassicas like canola produce a dense mat of roots.

Other broadleaves include plants like chicory, buckwheat, sunflower, and sunn hemp that vary greatly in their growth habits.

Resources for Cover Crop Selection

Midwest Cover Crop Council Crop Descriptions
<http://www.mccc.msu.edu/CCinfo/cropbycrop.html>

Midwest Cover Crop Council's Cover Crop Selector Tool
<http://mcccdev.anr.msu.edu/VertIndex.php>

Cover Crop Chart. USDA-ARS Northern Great Plains Research Laboratory, Mandan, ND.
<http://www.ars.usda.gov/main/docs.htm?docid=20323>

SmartMix Calculator from Green Cover Seed
<https://greencoverseed.com/>

Managing Cover Crops Profitably, 3rd Edition. <http://www.sare.org/Learning-Center/Books/Managing-Cover-Crops-Profitably-3rd-Edition>

Cover Crop Establishment and Cost

A 2015 publication on use of cover crops in soybean production suggests three main windows of opportunity to plant cover crops that are intended to provide cover following the fall harvest of a cash crop:

- Early-season interseeding
- Before harvest of the cash crop
- After harvest of the cash crop

Early-season interseeding is identified as an experimental practice in that publication.

Source: *Integrating Cover Crops in Soybean Rotations: Challenges and Recommendations for the North Central Region*. 2015. Midwest Cover Crops Council.

www.mccc.msu.edu/documents/2015Integrating_CoverCrops_Soybeans.pdf

Before harvest of the cash crop:

In northern climates, cover crops often need to be seeded into a standing crop of corn or soybean (overseeding) in order to have enough time to establish and grow before winter. Successful cover crop establishment with this method depends on proper timing of the seeding, based on a combination of rainfall, competition with the main crop, and calendar date. Overseeding either too early or too late can result in poor establishment.

Typical overseeding methods:

- Aerial seeding into the standing crop with a plane or helicopter; many have dry boxes that can be used for cover crop seed with no modifications.
- Seeding with high-clearance equipment into the standing crop.



Equipment options for seeding cover crops are evolving rapidly. A very few years ago, “overseeding” always meant broadcasting of seed. Now, high-clearance equipment that can do some incorporation of the seed is under development.

Prototype seeding equipment under development.

*Photo credit: M. Scott Wells,
University of Minnesota*

After harvest of the cash crop:

Good cover crop establishment typically results from good to soil-to-seed contact. Planting cover crop seed with a drill or inter-planter after the cash crop is harvested is a reliable way to achieve that. If labor is available, then drilling can be an inexpensive option.

Soybean harvest is often early enough to allow an opportunity for post-harvest planting of a cover crop. Corn silage, seed corn, small grains, and other early maturing crops also provide opportunities.

Seeding cover crops after cash-crop harvest does not always result in a better stand than overseeding into the standing cash crop. A Practical Farmers of Iowa study showed that aerial seeding into the standing crop resulted in a better fall stand and better spring stand of the cover crop than drill seeding after soybean harvest. The aerial-seeded cover crop did better because it had a longer time to establish. A key point, though, is that rainfall was adequate following the aerial seeding. Lack of rainfall can be the biggest limitation to an overseeded cover crop.

Comparison of aerial seeding vs. post-harvest drilling for establishment of a hairy vetch, cover crop radish, and rapeseed mixture		
	Aerial-seeded	Drilled post-harvest
Fall biomass (lbs./acre)	43	29
Spring biomass (lbs./acre)	527	348
Subsequent corn yield (control with no cover crop = 175 bu/ac)	179	179
Source: Aerial seeding versus drill seeding cover crops: Updated with corn yield observations. Sarah Carlson, Stephan Gailans, and McGrew Brothers' Farm. http://practicalfarmers.org/farmer-knowledge/research-reports/2013/aerial-seeding-versus-drill-seeding-cover-crops-updated-corn-yield-observations/		

Early planting of the cover crop is desirable if the goals include scavenging N. The longer time a cover crop like winter cereal rye has available to grow, the more soil N it can take up and prevent from leaching.

Cost of planting cover crops varies depending on the species selected for the cover crop mix, local rates for seed, and local rates for seeding. An example of costs from Allamakee County, Iowa in 2012:

- \$20 to \$35 per acre for cover crop seed blend
- \$15 per acre for aerial seeding into standing corn or soybean crop
- Total: \$35 to \$50 per acre to establish a cover crop

Source: Aerial Seeding Cover Crops. 2012. Allamakee Soil & Water Conservation District.
<http://allamakeeswcd.org/aerial-seeding-cover-crops/>

Cover Crop Termination and Cost

Cover crop termination may produce more farmer anxiety than cover crop establishment. Terminate too early, and you risk bare soil during spring rains as well as loss of some of the N that is held in the cover crop. Terminate too late, and you risk delayed planting of the cash crop, as well as too much N tie-up in the cover crop residue; although the early-season N tie-up can be mitigated by the addition of a starter N fertilizer when planting. Farmers terminating a cover crop too late need to make sure their planter settings are prepared for increased residue. Increased down pressure may be needed to have good soil to seed contact.

Many farmers associate their cost of termination with regular spring weed management and seed bed preparations. If there is a desire to separate the cover crop costs, the cost of termination will vary with local rates, but has been estimated at:

- \$16/ac for termination by tillage
- \$7/ac for ground spraying
- \$10/ac for aerial spraying

Source: 2013 Iowa Farm Custom Rate Survey. March 2013. William Edwards, Ann Johanns, and Andy Chamra. In *Ag Decision Maker*, Iowa State University Extension and Outreach.
www.extension.iastate.edu/agdm/crops/pdf/a3-10.pdf

Of course, cover crops that winter-kill do not need to be terminated in the spring. Many cover crops like spring cereals or brassicas do not overwinter in the upper Midwest.

Follow USDA agency guidelines on cover crop termination in order to remain eligible for crop insurance and stay in compliance with conservation programs:

Cover Crops – Iowa, Minnesota, and Wisconsin. January 2014. Risk Management Agency Fact Sheet.

http://www.rma.usda.gov/fields/mn_rso/2014/covercrops.pdf

Crop Insurance, Cover Crops and NRCS Cover Crop Termination Guidelines FAQs

<http://www.rma.usda.gov/help/faq/covercrops2015.html>

Cover Crops, Yield, and Drought Resiliency

Three years of survey results from farmers who use cover crops have documented consistent reports of a yield increase in the corn and soybean crops following a cover crop. In the most recent survey year, 2014, there was a statistically significant increase of 3.7 bu/ac corn yield (2.1% increase), and 2.2 bu/ac soybean yield (4.2% increase), for these crops planted after cover crops.

Source: *2014-2015 Annual Report: Cover Crop Survey*. 2015. Steve Werblow. Conservation Technology Information Center, Sustainable Agriculture Research and Education Program, and American Seed Trade Association.

<http://www.sare.org/Learning-Center/From-the-Field/North-Central-SARE-From-the-Field/2015-Cover-Crop-Survey-Analysis>

Survey results in the Corn Belt in late 2012, a year of widespread drought, showed that fields that had cover crops in the previous season had even higher percentage yield increases than fields without cover crops. This report is suggestive of the potential of cover crops to mitigate the effects of drought on crop yields, although replicated research trials in that year did not show a similar result.

Survey results from 234 farmers reporting corn yields and 196 farmers reporting soybean yields from the 2012 crop year.		
	Corn	Soybean
	Bu/ac	Bu/ac
With cover crops	126.2	47.1
Without cover crops	115.1	42.2

Source: *2012-2013 Cover Crop Survey*. June 2013. Steve Werblow and Chad Watts. Conservation Technology Information Center (CTIC) and North Central Region SARE. www.ctic.org/media/pdf/Cover%20Crops/SARE-CTIC%20Cover%20Crop%20Survey%202013.pdf

Cover Crops and the Forage Chain

Cover crops seeded into corn (especially corn silage), soybean, or small grain fields can be a source of livestock feed in the late fall or early spring. Depending on the crop and the season, cover crops can supplement or replace stored forage at those times of year; or allow pastures to recover.

Cover crop mixtures seeded in the spring as a transition from row cropping to a perennial forage stand can be grazed in mid-summer when other forages may be growing more slowly

due to heat and dry soil. This can be useful for giving pastures a break during the “summer slump” in forage production.

Practical Farmers of Iowa has a series of reports available describing options for using cover crops as livestock feed:

Grazing Cover Crops. 2013. Margaret Dunn, Practical Farmers of Iowa.

<http://practicalfarmers.org/farmer-knowledge/research-reports/2013/grazing-cover-crops/>

Grazing Cover Crops on Corn Ground. 2014. Margaret Dunn, Practical Farmers of Iowa.

<http://practicalfarmers.org/farmer-knowledge/research-reports/2014/grazing-cover-crops-corn-ground/>

Grazing Cover Crops for Winter Feed. 2014. Margaret Dunn, Practical Farmers of Iowa.

<http://practicalfarmers.org/farmer-knowledge/research-reports/2014/grazing-cover-crops-winter-feed/>

Lease Considerations for Grazing Cover Crops on Non-Owned Land. 2013. Margaret Dunn, Practical Farmers of Iowa.

<http://practicalfarmers.org/farmer-knowledge/research-reports/2013/lease-considerations-for-grazing-cover-crops-on-non-owned-land/>

Support for Cover Cropping

There’s an awful lot of information available about cover crops. There are also experts available to help sort through the information; and a handy pocket-sized field guide to cover crops for times when it’s hard to access a website. Directories of cover crop service providers are also available.

Cover Crop Business Directory. 2015. Practical Farmers of Iowa.

<http://practicalfarmers.org/wp-content/uploads/2015/05/PFI-Cover-Crop-Business-Directory-2015.pdf>

Cover Crop Field Guide, pocket-sized printed booklet. 2012. The Midwest Cover Crop Council and Purdue University; available for \$5 per copy:

<https://ag.purdue.edu/agry/dtc/Pages/CCFG.aspx>

Continuous Living Cover Series, Summer 2015

A project of Green Lands Blue Waters, funded by NCR-SARE

Kent Solberg (Verndale, MN) plans his cover crop mixes so that he can graze the cover crops and also use them to establish a perennial forage crop.

Warm-season grasses like corn, millet and sorghum provide high productivity of forage for grazing during the mid-summer. Cool-season small grains are good nurse crops for establishing a perennial forage. Brassicas like turnip provide late-season forage. Legumes supply nitrogen to the soil. His current cover crop mix for pasture renovation includes 12 species.

Cover Crops Resource Websites, Publications and Contact People. Green Lands Blue Waters.

<http://greenlandsbluwaters.net/strategies/cover-crops>

Illinois Cover Crops: Directory of Businesses. 2014. Illinois Stewardship Alliance.

<http://www.agr.state.il.us/covercrops/businessdirectory.pdf>

Minnesota Cover Crop Business Directory. 2014. University of Minnesota Extension.

<http://www.mccc.msu.edu/states/Minnesota/2015.MN.Cover.Crop.Business.Directory.pdf>