Placement of Continuous Living Cover

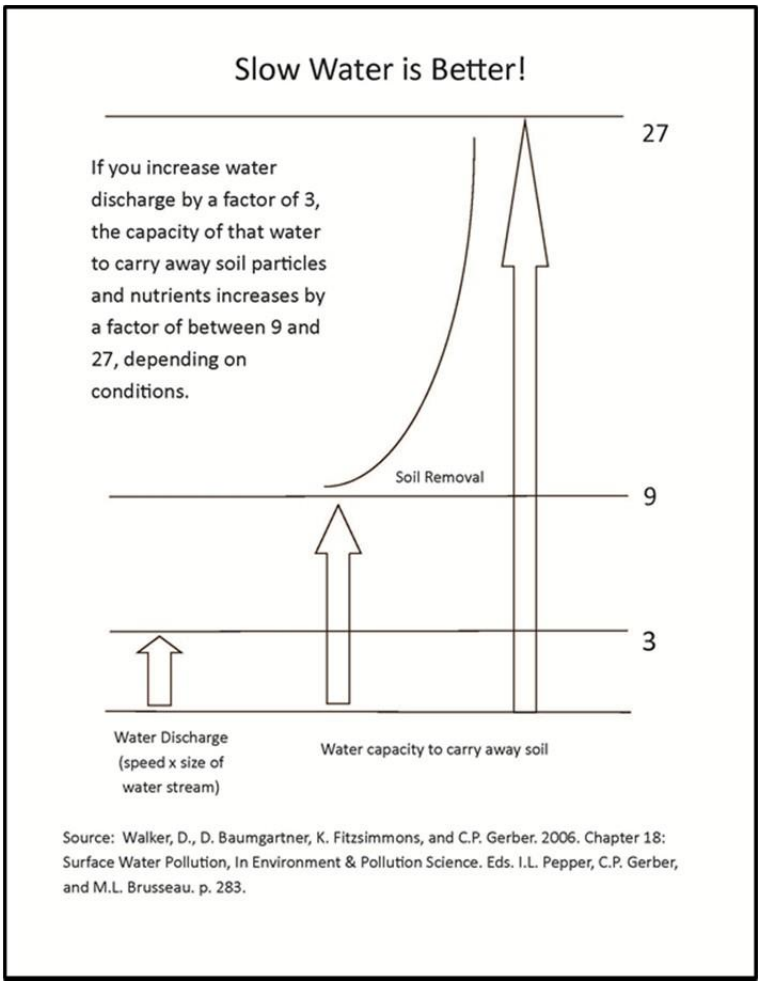
Photo: Elm Creek Watershed, Linda Meschke, Rural Advantage

Almost all of the research and recommendations around placement of Continuous Living Cover (CLC) practices has one or both of these objectives:

1. Slow down water
2. Slow down wind

The goal of these objectives is to reduce soil and nutrient loss from agricultural fields. Continuous Living Cover practices that slow down water and wind:

- Prairie strips within fields
- Windbreaks
- Grassed waterways
- Riparian buffers
- Perennial forage
- Cover crops



Fast Water = Soil Erosion

Fast water carries soil away, and the amount of soil carried is in a squared-to-cubed ratio to the speed of

the water and the size of the channel. If even a small channel or gully gets started in bare soil in a heavy rain, it can quickly expand and be responsible for significant soil losses.

Continuous Living Cover practices, strategically placed, slow water down and give it a chance to infiltrate the soil. CLC practices also improve the water infiltration rate of soil - the capacity of the soil to rapidly take in water into the soil profile. Rapid water infiltration into soil is desirable both for retention of soil-borne nutrients in the soil, and for ensuring adequate soil moisture for crop growth.

60-minute water infiltration rate (inches) under six different plant species types; average of measurements in June, August, and October/November.					
Silver maple	Switchgrass	Cool-season grass mixture	Corn	Soybean	Continuously grazed pasture
15	10	9	2	4	< 2

Source: Soil-water infiltration under crops, pasture, and established riparian buffer in Midwestern USA. 2002. L. Bharati, K.-H. Lee, T.M. Isenhart, and R.C. Schultz. Agroforestry Systems 56: 249–257.

Fast Wind = Soil Erosion

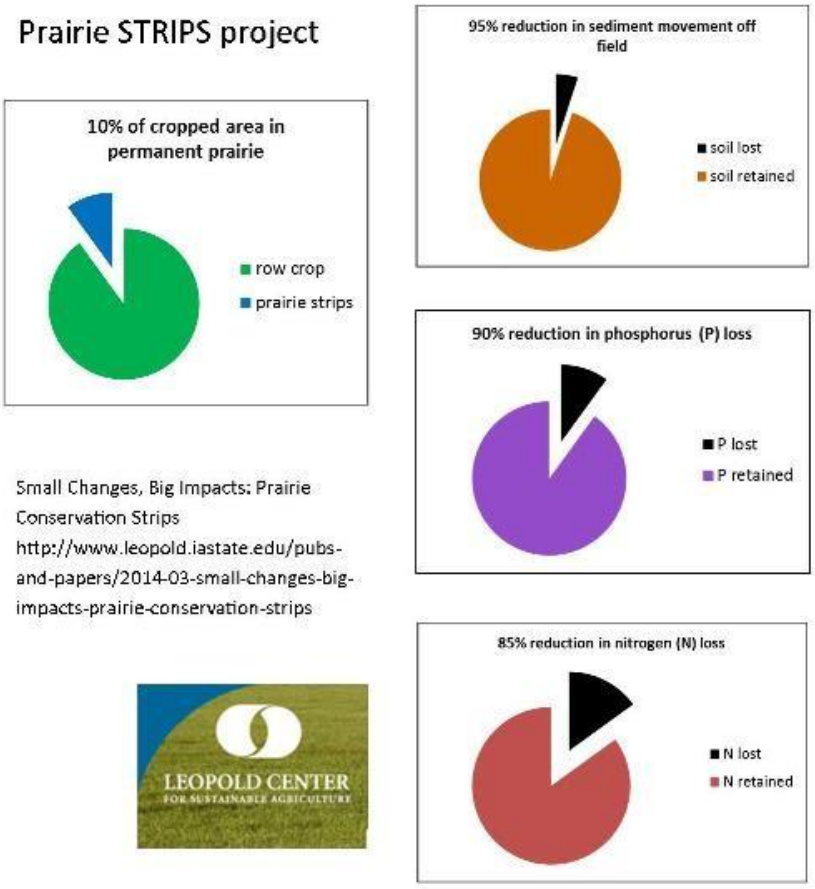
Wind speed, similar to water speed, has a non-linear relationship with amount of soil lost. Simulation studies showed a four-fold increase in soil erosion for a 20% increase in wind speed. Conversely, there was a 10-fold reduction in soil erosion with a 20% decrease in wind speed.

Source: Sensitivity of the US corn belt to climate change and elevated CO2: II. Soil erosion and organic carbon. 1996. Jeffrey J. Lee, Donald L. Phillips, Rusty F. Dodson. Agricultural Systems Volume 52, Issue 4, December 1996, Pages 503–521.

Perennial prairie plants + strategic placement on 10% of cropped land = large reductions in loss of soil, P, and N.

Prairie Strips to Reduce Soil and Nutrient Loss

The Prairie STRIPS Project (Science-based Trials of Rowcrops Integrated with Prairie Strips) is based at Iowa State University and involves a number of researchers. The

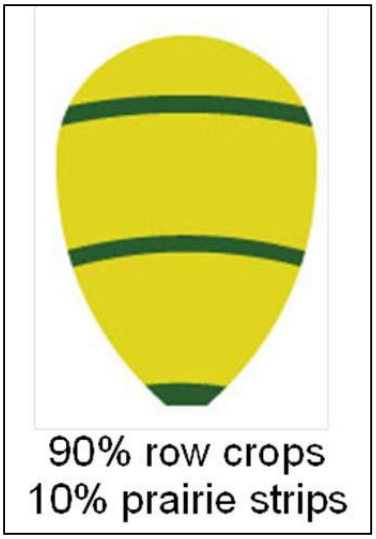


project overall has been finding greater-than-expected benefits from the establishment of relatively small, permanent strips of perennial plants strategically located within crop fields.

In fields with 6% to 10% slopes, narrow strips of prairie along field contours and a strip at the foot slope reduced soil loss by 95%, P loss by 90% and N loss by 85% when compared to fields in corn with no prairie strips.

Besides the reduction in soil and nutrient losses, researchers found more positive benefits to the strips:

- Four-fold increase in number of plant species that support pollinators and other beneficial insects
- Double the number of bird species, triple the abundance of birds



Cost of implementing prairie strips in a field: $24 to $35 per acre per year, which includes the opportunity cost of the lost crop acres.

Source: *Small Changes, Big Impacts: Prairie Conservation Strips*. http://www.leopold.iastate.edu/sites/default/files/pubs-and-papers/2014-03-small-changes-big-impacts-prairie-conservation-strips.pdf

Resource:

Photo courtesy of Matt Helmers, Iowa State University

STRIPS Research Team. http://www.leopold.iastate.edu/strips- research-team

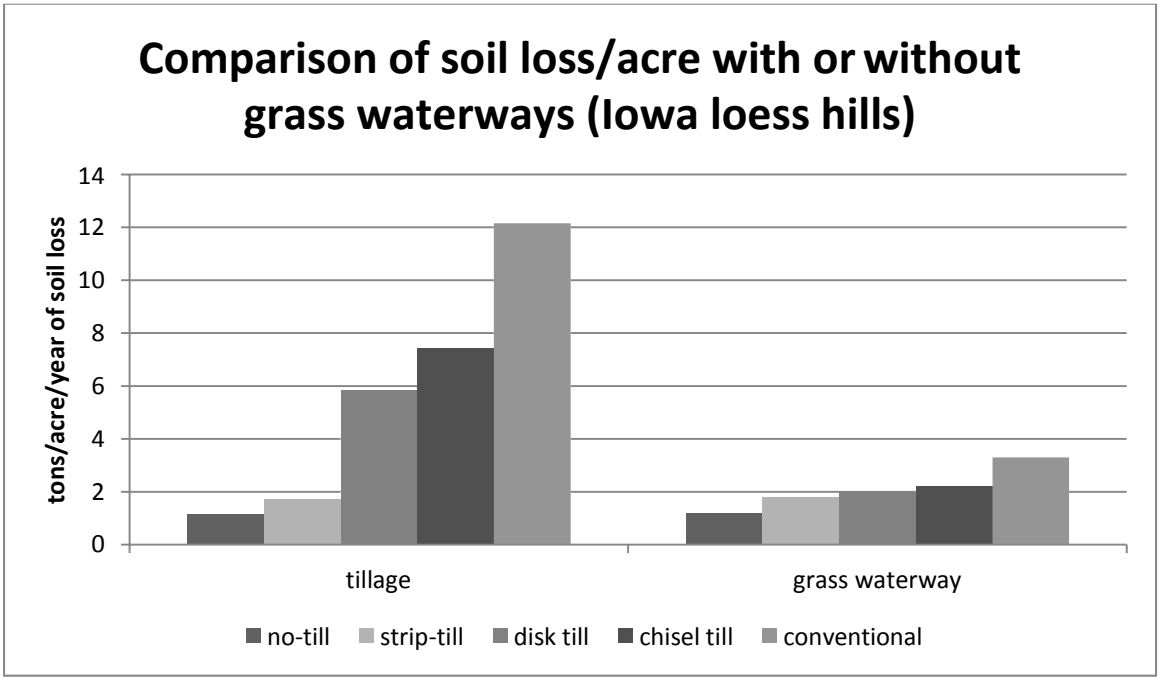
Grassed Waterways

Similar to prairie strips on contours within crop fields, grassed waterways can dramatically reduce the amount of soil lost from fields. Rainwater running through grassed waterways is slowed down by the presence of the grass and is less able to carry away soil into streams and rivers. On conventional-tilled fields in western Iowa's loess hills, the presence of grassed waterways reduced soil loss from 12 tons/acre/year (more than twice the tolerable rate, T), down to about 2.5 tons/acre/year (half the tolerable rate).

Fred Abels, farmer near Holland, IA:

When I started with beef cattle, I had NRCS funding to establish grazing paddocks but I didn't have any hay ground. A friend was custom-farming big acreage and didn't want to take care of the grassed waterways, so I hayed them. There were about 25 to 30 acres of grassed waterways, and I mowed it twice and got all my winter feed.

Federal and state funds are available to support construction of grassed waterways, and there are detailed agency standards for their construction (see resources below). Grassed waterways can also be a resource for livestock production. Hay made from them can provide a significant portion of the winter feed for a farm's cattle herd. Periodic grazing is also permitted to maintain the grass stand.



Source: Impact of Conservation Practices on Soil Erosion in Iowa's Loess Hills https://www.extension.iastate.edu/NR/rdonlyres/26DC3619-5E13-4992-9F38-C104F60E6DBE/135600/Conservation_Practices_on_Soil_Erosion_Loess_Hills.pdf

Resources:

Grassed Waterways. Conservation Practices: Minnesota Conservation Funding Guide. http://www.mda.state.mn.us/protecting/conservation/practices/waterway.aspx

Grassed Waterway: Iowa Fact Sheet. Natural Resources Conservation Service, USDA. http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_007306.pdf

Design of Grassed Waterways: Illinois Drainage Guide. University of Illinois, Urbana-Champaign. http://www.wq.uiuc.edu/dg/grass.htm

Windbreaks for Wind Speed Reduction

Planted windbreaks (or shelterbelts; the terms are interchangeable) are highly effective at slowing down wind and reducing soil erosion – surprisingly, on both the upwind and downwind sides of the windbreak.

The percentage reduction in wind speed on the downwind side is related to the density of the windbreak planting. At 5H, a multi-row conifer planting can reduce wind speed by 75%. A more open deciduous tree planting can reduce wind speed by 50%.

Detailed information on windbreak height, width, length, and density for maximum effectiveness can be found in the Chapter 6: Windbreaks reference shown in the box to the right.

Wind Speed Reduction from Windbreaks, Shelterbelts

H = height of the tallest trees in the windbreak

Area of wind speed reduction on upwind side = 2H to 5H out from windbreak

Area of wind speed reduction on downwind side = up to 30H out from windbreak

Source: Chapter 6: Windbreaks. In Training Manual for Applied Agroforestry Practices - 2015 Edition. Center for Agroforestry, University of Missouri. http://www.centerforagroforestry.org/pubs/training/

Riparian Buffers and Riparian Corridors

Riparian buffers slow water down before it gets to a river or stream, and trap and hold nutrients that may have escaped from cropped fields or pastures in runoff water. They are a critically important last line of defense against N, P, and soil loading into surface waters.

Riparian buffers can also be a way to connect individual farms to each other and to the larger landscape. Establishment of riparian buffers on multiple properties along an entire waterway produces a riparian corridor, which can be an important refuge for wildlife as well as protecting the entire waterway.

Many farmers who are committed to conservation practices lament the fact that a neighbor's poor practices can negate their efforts to protect surface and groundwater. On a larger landscape scale, promoting riparian corridors are a way for landowners to begin to work together to address water protection issues – and riparian buffers are a very fundable conservation practice.

From the Bear Creek Riparian Buffer Project, supported by the Leopold Center for Sustainable Agriculture, Iowa State University
http://www.leopold.iastate.edu/sites/default/files/pubs-and-papers/2013-06-funding-impact-brief-bear-creek-riparian-buffer-project.pdf

What did we learn?

Riparian buffers:

1. Cut sediment in surface runoff as much as 90 percent
2. Cut nitrogen and phosphorus in runoff by 80 percent
3. Entice and support 5 times as many bird species as row cropped or heavily grazed land
4. Allow water to infiltrate 5 times faster than row cropped or heavily grazed land
5. Remove up to 90 percent of groundwater nitrate
6. Cut stream bank erosion by as much as 80 percent from row cropped or heavily grazed land
7. Reach maximum efficiency for sediment removal in as little as 5 years
8. Reach maximum nutrient removal efficiency in 10-15 years
9. Increase soil organic carbon up to 66 percent
10. Are most effective at upper reaches of a watershed

Resources:

Connecting landscape fragments through riparian zones. 2012. Bentrup, G., M. Dosskey, G. Wells, and M. Schoeneberger**.** p. 93–109. In *Forest Landscape Restoration*. Springer. link.springer.com/chapter/10.1007/978-94-007-5326-6_5

Riparian Management System. Iowa State University. http://www.buffer.forestry.iastate.edu/HTML/buffer.html

Agroforesty Practices: Riparian Forest Buffers. The Center for Agroforestry, University of Missouri. http://www.centerforagroforestry.org/practices/rb.php

Perennial Forage

Research in Iowa has shown that matching length of the crop rotation and the location of permanent perennial cover to the slope of the ground is successful at reducing erosion below the "tolerable rate," T (5 tons/acre/year of soil loss).

% Slope	Crop Selection for Soil Loss < T
< 5%	2-year corn/soybean
5% - 14%	6-year corn-soybean-corn-oat+forage-forage-forage
>14%	Permanent perennial forage

At a slope less than 5%, a two-year corn-soybean rotation would keep soil losses from water erosion below T; although soil losses approached T at slopes approaching 5%. An extended rotation with perennial forage would drop average soil losses well below T on even modest slopes.

At slopes of 5% to 14%, the very low soil loss during years in perennial forage would balance the higher soil loss in the corn-soybean years.

At slopes higher than 14%, the low soil loss during years in perennial forage was not enough to balance the extreme soil losses seen in the corn-soybean years. These slopes should be in permanent perennials.

This study did not look at wind erosion. On flat ground where water erosion may be less of a concern, there could still be wind erosion that would make an extended rotation or use of cover crops, or both, desirable to hold soil in place.

Source: 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.

Cover Crops

Cover crops to keep roots in the ground at all times of the year can help reduce both water and wind erosion on the low slopes or flat ground where a two-year corn-soybean rotation may be practiced. Cover crops on higher % slopes, combined with an extended rotation, can help reduce soil loss to below T.

On low slopes or flat ground where a two-year corn-soybean system may be used, cover crops can scavenge N and reduce N leakage from the cropped fields; reducing NO3 levels in drainage water by as much as 61% in one study.

Reduction in nitrate concentration in drainage water from corn/soybean systems with cover crops: 3 studies		
Study description	N03 reduction with cover crop:	Citation
Spring-applied UAN vs. Spring-applied UAN+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 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. Agricultural Water Management 110 (2012) 25–33. http://naldc.nal.usda.gov/naldc/download.xhtml?id=54466&content=PDF
Winter rye cover crop + no-till over 4 years	61%	Rye cover crop and gamagrass strip effects on NO3 concentrations and load in tile drainage. 2007. T.C. Kaspar, D.B. Jaynes, T.B. Parkin, T.B. Moorman. *Journal of Environmental Quality*. 36(5):1503-11