CONSERVATION PRACTICE IMPACT ON CARBON SEQUESTRATION

A REPORT BY KAYLA BERGMAN,
CENTER FOR RURAL AFFAIRS

CENTER *for* RURAL AFFAIRS

CONSERVATION PRACTICE IMPACT ON CARBON SEQUESTRATION

KAYLA BERGMAN

Senior Policy Associate,
Center for Rural Affairs

March 2022

Conservation Practice Impact on Carbon Sequestration

By:
Kayla Bergman, senior policy associate.

Center for Rural Affairs
145 Main Street
PO Box 136
Lyons, NE 68038
402.687.2100
info@cfra.org
cfra.org

Cover photo by Kalee Olson.

Report editing by:
Teresa Hoffman, senior communications associate;
Rhea Landholm, communications manager;
Catharine Huddle, communications consultant;
and Liz Daehnke, communications consultant.

Design by:
Kylie Kai, communications consultant.

CONTENTS

FIGURES AND TABLES

I. INTRODUCTION

Due to recent glaciation, the midwestern U.S. has some of the most productive soils in the world. These rich soils contain a layer of organic matter, called the O horizon, atop a layer of topsoil, called the A horizon. Both of these soil layers contain nutrients necessary for plant growth.

Agricultural land use is a significant driver of soil organic carbon levels. Over the past 150 years, agriculture has grown to be one of the leading industries for the midwestern region. Consequently, the A horizon has been completely removed from approximately one third of the Midwest.[1]

Fertile soils in the region are susceptible to soil organic carbon loss due to land management practices, however a variety of management and structural practices allow farmers to produce crops while maintaining healthy soils and sequestering carbon.

Conservation on working lands provides many ecosystem services talked about frequently. Those include water quality and soil health improvement, wildlife habitat, and reduced operation cost. Not covered as often is the carbon sequestration and greenhouse gas emission reductions these practices provide.[2] This report takes a closer look at this lesser-advertised benefit of many conservation practices used today.

II. SOIL ORGANIC CARBON

Soil organic matter is an important indicator of soil health and affects the soil's physical, chemical, and biological properties. It makes up 1% to 6% of the total soil mass, depending on soil-forming conditions.[3]

Healthy soil with high levels of organic matter provide many benefits including water-holding capacity, aggregate stability, and nutrient availability. | Photo by Kate Hansen

Within soil organic matter, soil organic carbon (SOC) makes up 50% to 58%.[4] SOC is carbon present in the organic fraction of the soil.

III. SOIL ORGANIC MATTER IN THE UPPER MIDWEST

The soils in the upper Midwest are relatively young, with the last glaciers receding just 11,000 years ago.[5] Compared to others in the U.S., these soils have had less time to be depleted.

In addition, most of this region was covered by prairies until about 150 years ago. The deep roots of the perennial vegetation contributed large amounts of organic matter in the soil.

The short growing season and frigid winters prevent decomposition of organic matter for part of the year. Soil organisms aren't active during those long periods of freezing conditions, which allows the organic matter in soils to accumulate and remain at high levels.[6]

1 Thaler, Evan A., et al. "The extent of soil loss across the U.S. Corn Belt." Proceedings of the National Academy of Sciences of the United States of America, Feb. 23, 2021, pnas.org/content/118/8/e1922375118. Accessed January 2022.

2 "GHG Carbon Sequestration Ranking Tool." U.S. Department of Agriculture, Natural Resources Conservation Service, nrcs.usda.gov/wps/portal/nrcs/detailfull/national/air/quality/?cid=stelprdb1044982. Accessed January 2022.

3 Al-Kaisi, Mahdi, and David Kwaw-Mensah. "Iowa Soil Health Management Manual." Iowa State University Extension and Outreach, August 2017, store.extension.iastate.edu/Product/14682.pdf. Accessed January 2022.

4 Gobin, A., et al. "Soil organic matter management across the EU–best practices, constraints, and trade-offs." VITO (Vision on Technology), European Commission's DG Environment, October 2011, ec.europa.eu/environment/soil/pdf/som/Chapter1-3.pdf. Accessed January 2022.

5 "Soil organic matter in cropping systems." University of Minnesota Extension, 2019, extension.umn.edu/soil-management-and-health/soil-organic-matter-cropping-systems#climate-1388112. Accessed January 2022.

6 Gasch, Caley, and Jodi DeJong-Hughes. "Soil Organic Matter Does Matter." North Dakota State University, November 2019, ag.ndsu.edu/publications/crops/soil-organic-matter-does-matter. Accessed January 2022.

Conservation practices, like this grassed waterway, can be incorporated into existing row-crop farming operations. | Photo by Kalee Olson

IV. Benefits of healthy soil

Healthy soil with high levels of organic matter and SOC provide many benefits to those using the land for productivity.[7] They include:

Water-holding capacity

Organic matter in the soil creates large pore spaces and channels that allow water to infiltrate and drain. It also creates small pore spaces that hold onto water to be released when the plant needs it.

Aggregate stability

Soil structure benefits from plant exudates and microbiological organism secretions, holding soil particles together to form stable aggregates. This leads to better aeration, tilth, water infiltration and drainage, and less surface crusting. In addition, it creates an environment for soil microorganisms to thrive, which will in turn create more secretions to aid in aggregate stability.

Nutrient availability

Soil organisms break down and decompose soil organic matter, causing nutrients to be consumed and released into the soil solution. There, it is free for uptake by plants or other organisms.

7 "Soil organic matter in cropping systems." University of Minnesota Extension, 2019, extension.umn.edu/soil-management-and-health/soil-organic-matter-cropping-systems#climate-1388112. Accessed January 2022.

V. How to increase soil organic carbon while still using the soil for agricultural production

Several conservation practices—often called climate-smart agricultural practices—can be incorporated into existing row-crop farming operations to help build soil organic carbon. These vary in management intensity, cost, and ability to sequester carbon. Some in-field practices alter annual land management activities, however there are structural or edge-of-field practices that cause minimal change to annual land management systems.

A. Reduced tillage

Limiting soil-disturbing activities improves soil carbon retention and minimizes carbon emissions from soils. While no tillage is the best method for carbon sequestration, strip-tillage also reduces emissions when compared to conventional methods.

Converting cropland from intense tillage to reduced tillage has the potential to sequester up to 0.13 metric tons of carbon dioxide per acre per year, and up to 0.22 metric tons of carbon dioxide equivalent per acre per year.[8,9]

8 Swan, Amy, et al. "COMET-Planner: Carbon and Greenhouse Gas Evaluation for NRCS Conservation Practice Planning." U.S. Department of Agriculture, Natural Resources Conservation Service and Colorado State University, marincarbonproject.org/document.doc?id=114. Accessed January 2022.

9 Via, Sara. "Increasing Soil Health and Sequestering Carbon in Agricultural Soil: A Natural Climate Solution." Izaak Walton League of America and National Wildlife Federation, 2021, iwla.org/soil_report. Accessed January 2022.

B. NO TILLAGE

In a no-tillage system (commonly referred to as no-till), most of the crop residue is maintained on the soil surface throughout the year. This practice involves an in-row soil disturbance operation only during planting and a seed row/furrow closing device. No full-width soil disturbance is performed from the time immediately following harvest or termination of one cash crop through harvest or termination of the next cash crop in the rotation.[10]

Converting cropland from intense tillage to no-till has the potential to sequester up to 0.42 metric tons of carbon dioxide per acre per year, and up to 0.73 metric tons of carbon dioxide equivalent per acre per year.[11,12]

C. COVER CROPS

Cover crops are planted between cash crop seasons to keep a living cover on the soil. Common cover crops species include cereal rye, wheat, oats, turnips, and tillage radishes. The amount of carbon sequestration from cover crops is dependent on the species, as well as the timing of application and termination.

Implementing cover crops has the potential to sequester up to 0.32 metric tons of carbon dioxide per acre per year, and up to 0.49 metric tons of carbon dioxide equivalent per acre per year.[13,14]

D. CONSERVATION CROP ROTATION

Conservation crop rotation, also called extended crop rotation, extends beyond a corn/soybean rotation to include additional crops for several more growing seasons. Typical crops added in a conservation crop rotation include grasses, legumes, or small grains.[15]

Increasing the crops in rotation has the potential to sequester up to 0.26 metric tons of carbon dioxide per acre per year, and up to 0.57 metric tons of carbon dioxide equivalent per acre per year.[16,17]

E. CONTOUR BUFFER STRIPS

Contour buffer strips are strips of grass or a mixture of grasses and legumes that run along the contour of a farmed field.[18] They alternate down the slope of a field with wider cropped strips.

10 "Natural Resources Conservation Service, Conservation Practice Standard, Residue and Tillage Management, No Till (Code 329)." U.S. Department of Agriculture, September 2016, nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1249901.pdf. Accessed January 2022.

11 Swan, Amy, et al. "COMET-Planner: Carbon and Greenhouse Gas Evaluation for NRCS Conservation Practice Planning." U.S. Department of Agriculture, Natural Resources Conservation Service and Colorado State University, marincarbonproject.org/document.doc?id=114. Accessed January 2022.

12 Via, Sara. "Increasing Soil Health and Sequestering Carbon in Agricultural Soil: A Natural Climate Solution." Izaak Walton League of America and National Wildlife Federation, 2021, iwla.org/soil_report. Accessed January 2022.

13 Swan, Amy, et al. "COMET-Planner: Carbon and Greenhouse Gas Evaluation for NRCS Conservation Practice Planning." U.S. Department of Agriculture, Natural Resources Conservation Service and Colorado State University, marincarbonproject.org/document.doc?id=114. Accessed January 2022.

14 Via, Sara. "Increasing Soil Health and Sequestering Carbon in Agricultural Soil: A Natural Climate Solution." Izaak Walton League of America and National Wildlife Federation, 2021, iwla.org/soil_report. Accessed January 2022.

15 "Conservation Choices: Crop Rotation." U.S. Department of Agriculture, Natural Resources Conservation Service, nrcs.usda.gov/wps/portal/nrcs/detail/null/?cid=nrcseprd414440. Accessed January 2022.

16 Swan, Amy, et al. "COMET-Planner: Carbon and Greenhouse Gas Evaluation for NRCS Conservation Practice Planning." U.S. Department of Agriculture, Natural Resources Conservation Service and Colorado State University, marincarbonproject.org/document.doc?id=114. Accessed January 2022.

17 Ciborowski, Peter, and Leslie Hunter-Larson. "Greenhouse gas reduction potential of agricultural best management practices." Minnesota Pollution Control Agency, October 2019, pca.state.mn.us/sites/default/files/p-gen4-19.pdf. Accessed January 2022.

18 "Conservation Choices: Contour Buffer Strip." U.S. Department of Agriculture, Natural Resources Conservation Service, nrcs.usda.gov/wps/portal/nrcs/detail/null/?cid=nrcseprd413956. Accessed January 2022.

TABLE 1. CONSERVATION PRACTICE IMPACT ON CARBON SEQUESTRATION (IN METRIC TONS PER ACRE PER YEAR)

	NRCS/CSU (By climate zone)*		MPCA**		IWL/NWF***
	NRCS/CSU (Dry/semi-arid)	NRCS/CSU (Moist/humid)	In-state and out-of-state	In-state only	Illinois
Reduced tillage	.10/.17	.13/.20	- /.15	- /.14	- /.22
No-till	.22/.35	.42/.31	- /.14	- /.13	- /.73
Cover crops	.21/.26	.32/.37	- /.20	- /.19	- /.49
Conservation crop rotation	.26/.26	.21/.22	- /.40	- /.57	- /.22
Contour buffer strips	1.05/1.13	.98/1.26	- /1.61	- /1.41	- /.97
Filter strips	1.05/1.13	.98/1.26	-	-	- /.97
Grassed waterway	1.05/1.13	.98/1.26	-	-	- /.97

* U.S. Department of Agriculture Natural Resource Conservation Service Colorado State University
**Minnesota Pollution Control Agency
***Izaak Walton League of American/National Wildlife Federation

CO_2/Total CO_2 equivalents
Estimates are presented as emission reductions relative to baseline management, thus positive values denote a decrease in GHG emissions.

Implementing contour buffer strips into a row-crop field has the potential to sequester up to 1.05 metric tons of carbon dioxide per acre per year, and up to 1.61 metric tons of carbon dioxide equivalent per acre per year.[19,20]

F. FILTER STRIPS

A filter strip is a strip or area of herbaceous vegetation such as grass, trees, or shrubs that removes contaminants from overland flow. Filter strips are established on sites where existing vegetation does not adequately protect environmentally sensitive areas that need protection from sediment, other suspended solids, and dissolved contaminants in runoff. Sensitive areas include streams, lakes, wetlands, drainage ditches, and other surface sources.[21]

19 Swan, Amy, et al. "COMET-Planner: Carbon and Greenhouse Gas Evaluation for NRCS Conservation Practice Planning." U.S. Department of Agriculture, Natural Resources Conservation Service and Colorado State University, marincarbonproject.org/document.doc?id=114. Accessed January 2022.

20 Ciborowski, Peter, and Leslie Hunter-Larson. "Greenhouse gas reduction potential of agricultural best management practices." Minnesota Pollution Control Agency, October 2019, pca.state.mn.us/sites/default/files/p-gen4-19.pdf. Accessed January 2022.

21 "Filter Strips: Conservation Practice Job Sheet." U.S. Department of Agriculture, Natural Resources Conservation Service, April 1997, nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs144p2_013892.pdf. Accessed January 2022.

Establishing a filter strip into a row-crop field has the potential to sequester up to 1.05 metric tons of carbon dioxide per acre per year, and up to 1.26 metric tons of carbon dioxide equivalent per acre per year. [22,23]

G. GRASSED WATERWAYS

Grassed waterways are constructed graded channels planted into perennial vegetation to guide water flow at a non-erosive pace to a stable outlet.

Seeding a waterway has the potential to sequester up to 1.05 metric tons per acre per year, and up to 1.26 metric tons of carbon dioxide equivalent per acre per year.[24,25]

22 Swan, Amy, et al. "COMET-Planner: Carbon and Greenhouse Gas Evaluation for NRCS Conservation Practice Planning." U.S. Department of Agriculture, Natural Resources Conservation Service and Colorado State University, marincarbonproject.org/document.doc?id=114. Accessed January 2022.

23 Ibid.

24 Ibid.

25 Ibid.

VI. EVALUATING CARBON SEQUESTRATION

A variety of practices and tools are available for evaluating carbon sequestration in agricultural soils. See Table 1 on page 4.[26,27,28] At this time, there is no consensus on the timing, spacing, or depth of soil samples to measure carbon sequestration. One tool of note is the COMET-FARM planning tool.

A. COMET-FARM PLANNING TOOL

COMET-FARM planner, an evaluation tool developed by the U.S. Department of Agriculture-Natural Resources Conservation Service (USDA-NRCS), provides generalized estimates of the greenhouse gas impact of conservation practices based on land management scenarios. The tool is used for initial planning purposes with NRCS. Since carbon sequestration is site-specific, more detailed assessments of carbon sequestration require on-farm data collection.[29]

26 Swan, Amy, et al. "COMET-Planner: Carbon and Greenhouse Gas Evaluation for NRCS Conservation Practice Planning." U.S. Department of Agriculture, Natural Resources Conservation Service and Colorado State University, marincarbonproject.org/document.doc?id=114. Accessed January 2022.

27 Soil organic matter in cropping systems." University of Minnesota Extension, 2019, extension.umn.edu/soil-management-and-health/soil-organic-matter-cropping-systems#climate-1388112. Accessed January 2022.

28 Via, Sara. "Increasing Soil Health and Sequestering Carbon in Agricultural Soil: A Natural Climate Solution." Izaak Walton League of America and National Wildlife Federation, 2021, iwla.org/soil_report. Accessed January 2022.

29 "New Online Tool Helps Producers Estimate Carbon Stowed in Soil." U.S. Department of Agriculture, Natural Resources Conservation Service California, nrcs.usda.gov/wps/portal/nrcs/detail/ca/home/?cid=STELPRDB1119532. Accessed January 2022.

VII. FUNDING THE CONSERVATION PRACTICES

To offset the upfront investment of conservation practice implementation, USDA-NRCS has working lands conservation programs. The Conservation Stewardship Program (CSP) and Environmental Quality Incentives Program (EQIP) allow farmers and ranchers to continue using land for agricultural productivity while incorporating voluntary conservation practices into their operations. Both CSP and EQIP are multi-year commitments with annual payments.

VIII. CONCLUSION

While the structural/edge-of-field practices sequester more carbon dioxide and carbon dioxide equivalent per acre, the management practices are important tools that can be incorporated on working lands.

For our agricultural soils in the midwestern U.S. to continue to be productive, the abovementioned conservation practices must be widely implemented. Not only do they provide a carbon sequestration service, they also provide soil health, water quality, wildlife habitat, and economic benefits to the farm and our ecosystem.

About the Center for Rural Affairs

Established in 1973, the Center for Rural Affairs is a private, nonprofit organization with a mission to establish strong rural communities, social and economic justice, environmental stewardship, and genuine opportunity for all while engaging people in decisions that affect the quality of their lives and the future of their communities.