

Impact: Climate-Smart Agricultural Practices

Penn State AgScience Research



PennState
College of Agricultural Sciences

A solution-oriented approach to growing and sustaining food and resources that will **ensure a reliable food supply** for current and future generations.

Where We Are:

Scientists in the College of Agricultural Sciences at Penn State are developing and testing balanced, efficient, climate-smart solutions to preserve our resources while increasing productivity and profitability for producers and land managers.

For nearly three decades, faculty in the College of Agricultural Sciences have been researching the benefits of climate-smart agricultural practices, such as cover crops and no-till agriculture. Penn State scientists have shown how various versions of these practices can sequester carbon, reduce erosion and runoff of excess nutrients into waterways, control undesirable weeds, add carbon and nitrogen to soil, support beneficial organisms, and increase yields. Their research has helped to underpin the [growing adoption of these practices](#) nationwide and in Pennsylvania.

Their research has contributed essential scientific evidence that can be used by federal agencies, such as the USDA Natural Resources Conservation Service and the USDA Agricultural Research Service, as well as locally by Penn State Extension to provide producers with:

- » Data from long-running cover crop experiments such as the [dairy cropping systems](#) project at the Russell E. Larson Agricultural Research Center at Rock Springs
- » [Cutting-edge technologies](#) such as the patented Interseeder, which helps farmers with shorter growing seasons to introduce cover crops into their rotations
- » Demonstrations of strategies for reducing environmental impacts without compromising productivity or profit, such as the award-winning [Virtual Farm](#)
- » Innovative methods that can lead to [more resilient crops](#) that [produce higher yields](#)

Where We're Going:

The decades of research behind our understanding of climate-smart practices positions our scientists to lead this next phase of climate-smart solutions.

Penn State researchers are now turning their attention to how we can [more accurately measure the benefits gained](#) from these practices and go beyond soil conservation and carbon sequestration to not only passively draw down carbon from the atmosphere but also to slow and even prevent other greenhouse gases such as nitrous oxide and methane from escaping in the first place. They are building a system to reliably measure, monitor, verify, and report these reductions to establish a value for those improvements that can be trusted along the supply chain, from producers to buyers of a commodity. Penn State's transdisciplinary approach brings together plant, animal, soil, and climate scientists, economists, sociologists, producers, and commodity-based organizations to position farmers and land managers to capitalize on new markets for emerging, climate-smart commodities.



How Can We Grow More Food with Less?

Problem:

- » National and global food security faces multiple challenges, including climate instability, a growing global population, increasing competition for resources, and shrinking acreage of land available for production agriculture.
- » Producers are especially impacted by these challenges, with rising costs and unpredictable weather patterns making it difficult to break even.

Findings:

Researchers are determining efficient, sustainable ways to increase productivity and profitability by using cutting-edge technologies and innovative methods to increase adaptability and resiliency of crops and forests and helping farmers become critical players in decreasing emissions and lessening the burden on our earth's resources.

- » Penn State has been at the forefront of research that has helped establish climate-smart practices, including cover cropping and no-till agriculture to sequester carbon and conserve soil health.
- » Penn State agricultural scientists continue to lead the way in exploring how we can more accurately measure the benefits gained from these practices and test new methods, such as feed additives or management of manure and nutrients that will reduce or even prevent other agricultural emissions, including methane and nitrous oxide.

Impact:

Decades of research at Penn State underpin the growing adoption of these practices nationwide and provide essential scientific evidence that federal agencies and Penn State Extension can use in helping producers to both implement and benefit from these practices.

- » Cover crop acreage across the United States increased by 50% from 2012 to 2017. In Pennsylvania, the number of acres planted in cover crops increased by 33% during that time and marked a 70% increase in acreage since 2002.
- » Climate-smart research has provided producers with strategies that can be immediately applied to practices that increase productivity, reduce input costs, and improve the quality of their yields.
- » Continued discovery will help to accurately and reliably measure environmental benefits that can be gained from climate-smart practices, opening new market opportunities for producers and land managers in emerging, climate-smart value chains.



HEATHER KARSTEN

2022

Penn State was awarded a \$25 million grant from the USDA Natural Resources Conservation Service as a part of the historic \$3.1 billion investment by the federal government into establishing Partnerships for Climate-Smart Commodities. The five-year project establishes a collaborative framework among scientists, dairy producers, industry organizations, and government agencies that will provide technical and financial assistance for producers in implementing a customizable suite of climate-smart practices that will be measured, monitored, and verified to establish quantifiable benefits of those practices and bring economic value to producers along the supply chain.

- » [USDA Partnership for Climate-Smart Commodities](#)
- » [Penn State awarded grant to help dairy farmers develop climate-smart commodities](#) (Penn State News, 9/19/2022)

2017

Pennsylvania reported a 70% increase in acreage of cover crops for the state since 2002.

- » [USDA National Agricultural Statistics Service](#)
- » [USDA Census of Agricultural Historical Archive](#)

2014

The Penn State team was awarded \$2.2 million from the U.S. Environmental Protection Agency to fund a new “Center for Nutrient Solutions,” one of four new National Centers for Innovative and Sustainable Water Research, to study the right practices that can be implemented in the right places in a cost-effective manner.

- » [New center to explore solutions for nutrient pollution](#) (Penn State News, 1/31/2014)

2013

The Penn State team licensed patented agricultural machinery for the Interseeder, which was developed to address the difficulties farmers faced in adopting cover crop practices into crop rotations in a profitable and reliable way.

- » [Farm equipment developed at Penn State example of ag sciences entrepreneurship](#) (Penn State News, 12/16/2014)

2011

The USDA Natural Resources Conservation Service reported that the increase of cover crop acreage to 52% planted at least once every four years and 18% of acres planted in cover crops every year led to major improvements: average 78% reduction in sediment loss, 35% less nitrogen surface loss, 40% cut in nitrogen subsurface loss, and 30% decrease in total phosphorus loss.

- » [USDA Impacts of Conservation Adoption on Cultivated Acres of Cropland in the Chesapeake Bay Region, 2003-06 to 2011](#)

2009

A Penn State team, in collaboration with the USDA Agricultural Research Service’s Pasture Systems and Watershed Management Research Unit at University Park, was awarded a U.S. Department of Agriculture Sustainable Agriculture Research and Education (SARE) grant to evaluate cropping system strategies that can produce the forage, feed, and fuel for an average-sized dairy farm in Pennsylvania. They established a continuously running, 12-acre experiment that has been a part of numerous affiliated research projects through to the present.

- » [Penn State Department of Plant Science Sustainable Dairy Cropping Systems](#)
- » [Climate-smart ag strategies may cut nitrous oxide emissions from corn production](#) (Penn State News, 4/21/2021)



STEVE WILLIAMS, PENN STATE

2006

The USDA Natural Resources Conservation Service reported that 5% of cropped acres in the Chesapeake Bay region had cover crops planted every year, and 88% of acres never had any cover crops planted.

- » [USDA Impacts of Conservation Adoption on Cultivated Acres of Cropland in the Chesapeake Bay Region, 2003-06 to 2011](#)

2002

2002 Ag Census includes acreage of cover crops for first time. Pennsylvania is recorded as having 348,524 acres of cover crops planted.

- » [USDA Census of Agricultural Historical Archive](#)

Mid-1990s

Early research on benefits gained from cover crops:

- » [Winter wheat cover cropping, VA mycorrhizal fungi and maize growth and yield](#) (1998)
- » [Assessment of weed and crop fitness in cover crop residues for integrated weed management](#) (1998)
- » [Fall-planted cover crops support good yields of muskmelons](#) (1996)
- » [The influence of a hairy vetch \(*Vicia villosa*\) cover crop on weed control and corn \(*Zea mays*\) growth and yield](#) (1994)

2014–2022 Coverage of Climate-Smart Research in Penn State News

- » [Mixed cover crops capture carbon in soil, could help mitigate climate change](#) (9/21/2022)
- » [No-till management may reduce nitrous oxide gas releases, fight climate change](#) (9/14/2022)
- » [Cover crops more effective than insecticides for managing pests, study suggests](#) (3/31/2022)
- » [Soil tillage reduces availability of 'longevity vitamin' ergothioneine in crops](#) (2/7/2022)
- » [Dairy farmers can adapt to climate change](#) (1/5/2022)
- » [No-till production farmers can cut herbicide use, control weeds, protect profits](#) (8/23/2021)
- » [Nitrous oxide emissions, coming from legume cover crops, manure, can be reduced](#) (8/2/2021)
- » [Climate-smart ag strategies may cut nitrous oxide emissions from corn production](#) (4/21/2021)
- » [More precise nitrogen recommendations for corn to help farmers, cut pollution](#) (10/15/2020)
- » [Cover crop mixtures must be 'farm-tuned' to provide maximum ecosystem services](#) (8/17/2020)
- » [Cover crop roots are key to understanding ecosystem services](#) (8/12/2020)
- » [Organic soybean producers can be competitive using little or no tillage](#) (3/30/2020)
- » ['Sustainable intensification' of cropping systems good for farmers, environment](#) (3/12/2020)
- » [Choosing most cost-effective practices for sites could save in bay cleanup](#) (11/4/2019)
- » ['Planting green' cover-crop strategy may help farmers deal with wet springs](#) (7/1/2019)
- » ['Right' cover-crop mix good for both Chesapeake and bottom lines](#) (4/29/2019)
- » [Manure injection offers hope, challenge for restoring Chesapeake water quality](#) (2/6/2019)
- » [Manure application changes with winter crop can cut nitrogen loss, boost profits](#) (2/2/2019)
- » [Conservation dairy farming could help Pa. meet Chesapeake target](#) (9/13/2018)
- » [Reducing reliance on herbicides the objective of research at Penn State](#) (8/7/2017)
- » [Cover crops may be used to mitigate and adapt to climate change](#) (4/14/2017)
- » [First-of-kind study suggests cover crop mixtures increase agroecosystem services](#) (9/7/2016)
- » [Recoupling crops and livestock offers energy savings to Northeast dairy farmers](#) (3/2/2016)
- » [Tillage timing influences nitrogen availability and loss on organic farms](#) (10/1/2015)
- » [Research reveals true value of cover crops to farmers, environment](#) (3/18/2014)



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