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Disclaimer: The research and data in this report is part of an *on-going* research project which will be completed in Fall 2025.

This presentation is for internal reflection only.

This is NOT to be shared, referenced, or cited.

We'll make sure the final report is shared when ready :)

Thanks,

-RE-AMP

Reducing Greenhouse Gas Emissions from Agriculture

REAMP Ag-Hub

April 16, 2024

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Natural Climate Solutions Manager

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About Clean Wisconsin

- **Our mission:** To combat climate change and pollution in our air, water, and land, and ensure a healthy future for every Wisconsin community.
- **How we work:** science, legal strategies, government relations, and communications
- **Issues we work on:** Water pollution (PFAS, nitrates, etc.), agriculture, Natural Climate Solutions, Air pollution, Green infrastructure, Renewable energy and energy efficiency, Clean transportation, Environmental justice, and lots more!

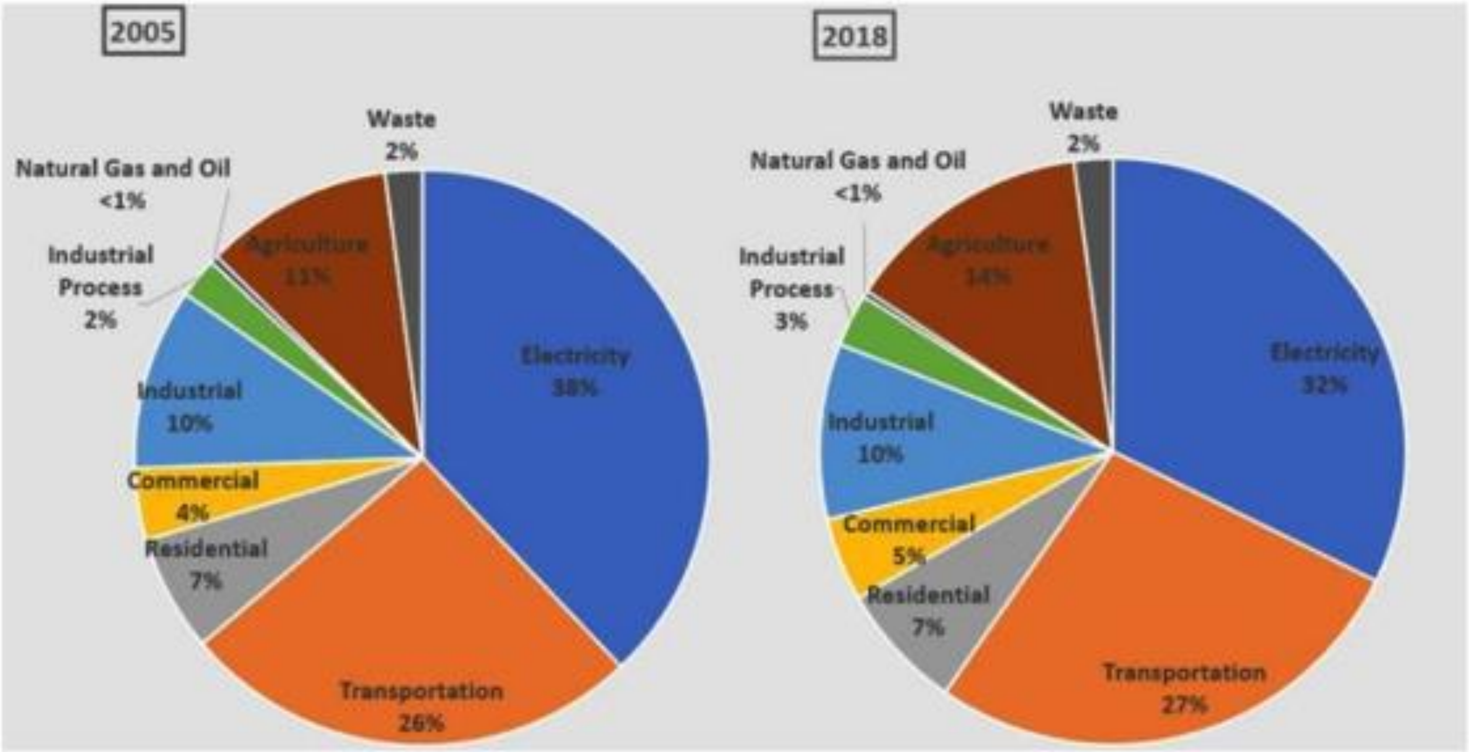
About Kata

- Socio-agroecologist
  - Master of Forest Science, Yale University
  - B.S. Agriculture & Rural Development, Cornell University
    - *Integrated landscape management:*
      - Agroecology, Soil Ecology, Economic Botany (ethnobotany)
      - Climate Adaptation/Mitigation
      - Development Sociology, Agroeconomics, Policy
- 19 yrs. working with rural and urban communities at varying scales and points of intervention
  - 14 countries
    - Farmers and Farmer Organizations
    - Indigenous and/or marginalized communities
    - Women and youth
    - NGOs (WWF, CARE International, Climate Focus, EcoAgriculture Partners, etc.)
    - Multi-lateral institutions (UN-FAO, World Bank, etc.)
    - In partnership with Government Agencies (USAID, Ministries of Agriculture- Mozambique, Bangladesh, Honduras, etc.)
    - Policymakers (Bangladesh, Mozambique, Brasil, etc.)

The Issue:
WI Ag is a significant and growing source of greenhouse gas emissions

- Since 2005, GHG emissions from buildings, transportation, electricity has *decreased*
- Since 2005, **emissions from agriculture *increased* 21.3%** (3.5 $MtCO_2e$)

Figure 5. 2005 and 2018 Wisconsin GHG Emissions by Sector (Percent)



From: Wisconsin DNR, 2021. Wisconsin Greenhouse Gas Emissions Inventory Report.

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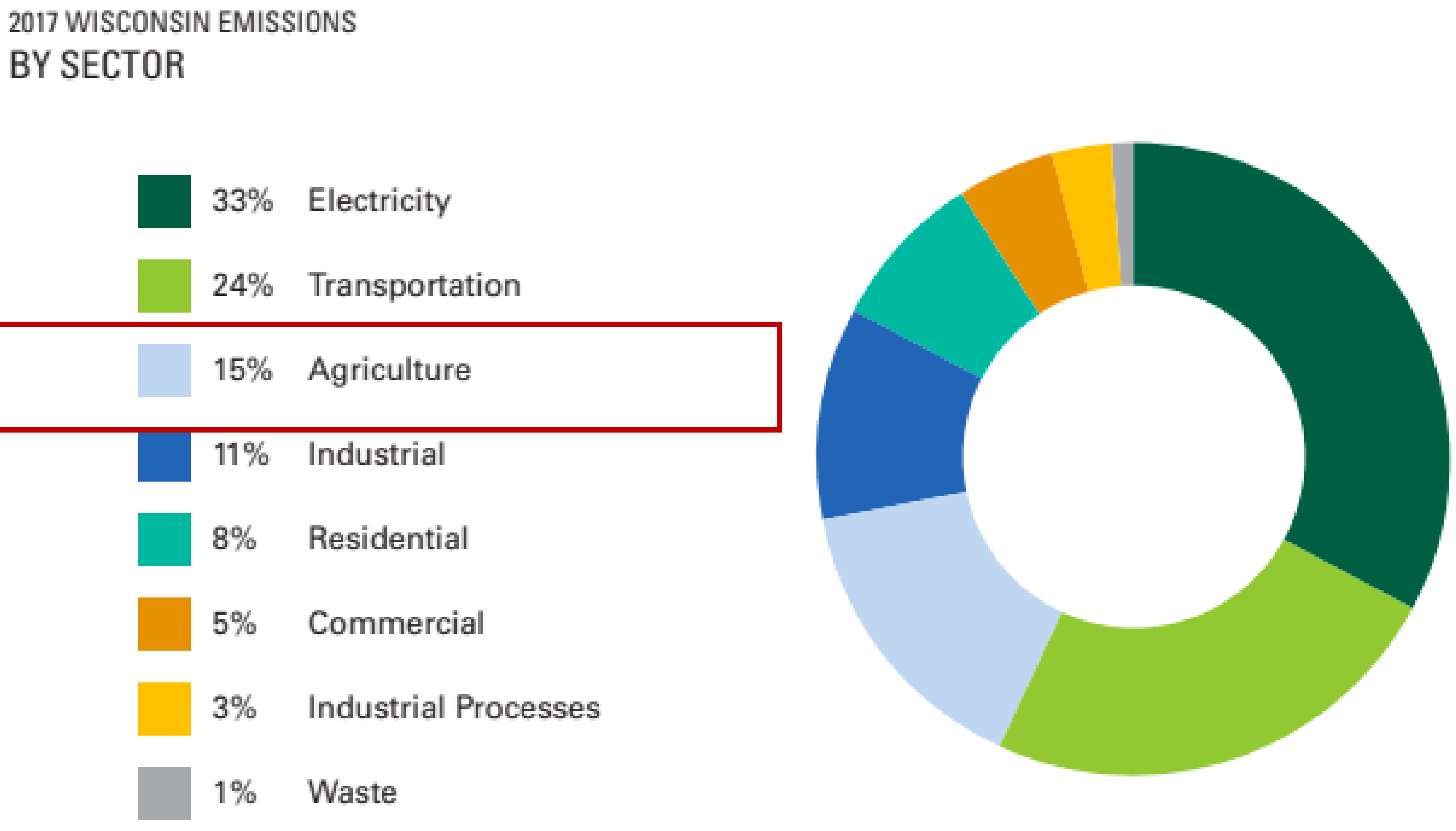
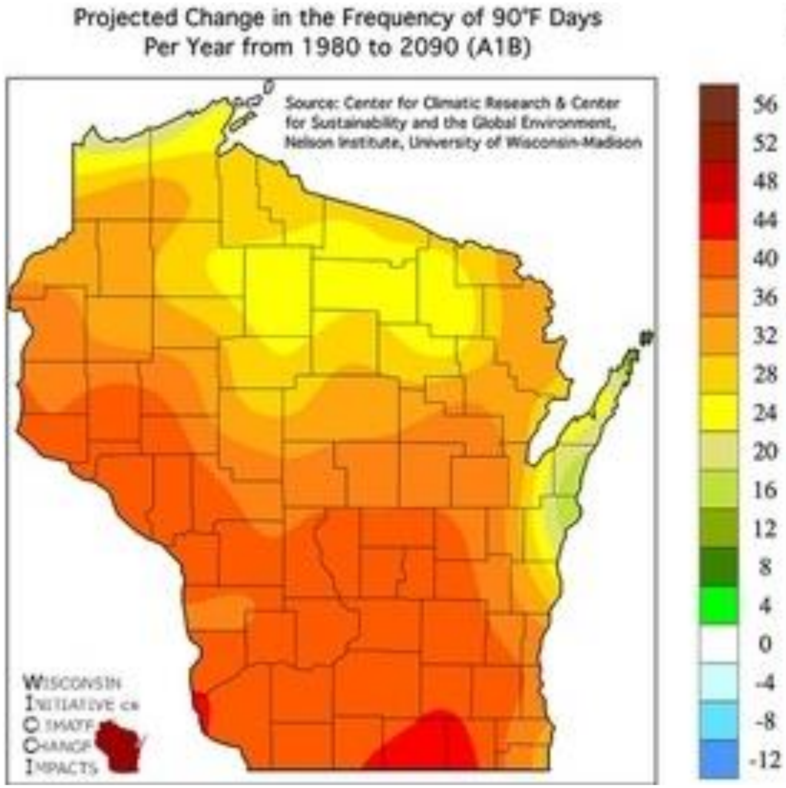
WI Ag is a significant and growing source of greenhouse gas emissions

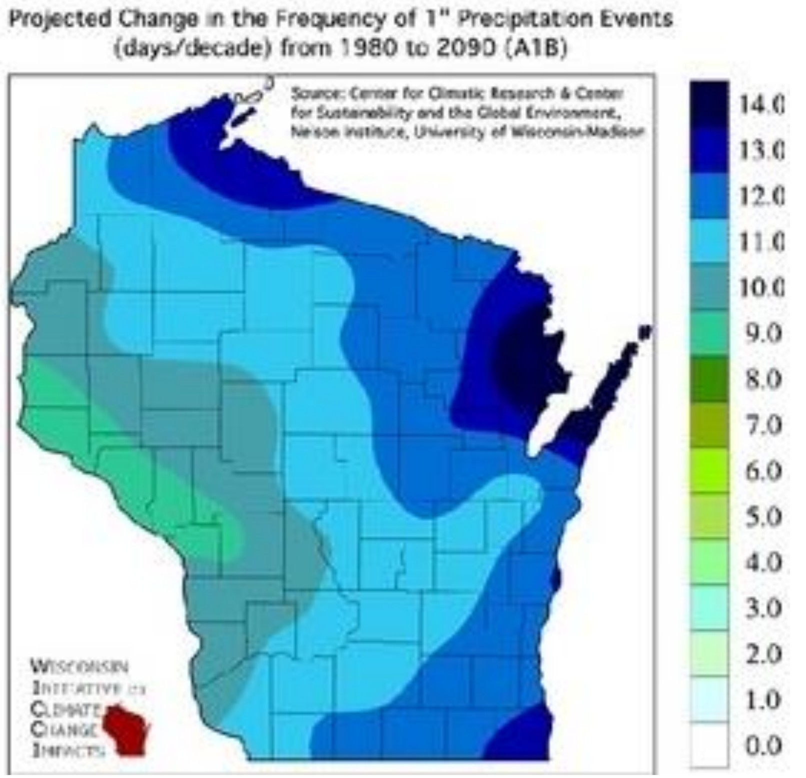


Source: Governor's Taskforce on Climate Change

In turn, climate change is impacting Wisconsin farms:

- ✓ Warmer winters, wetter springs, increased extreme rainfall events
- ✓ Waterlogged soils delay planting & harvest
- ✓ More nutrient runoff and soil erosion, harming water quality
- ✓ Extreme heat decreases milk production, increases water usage





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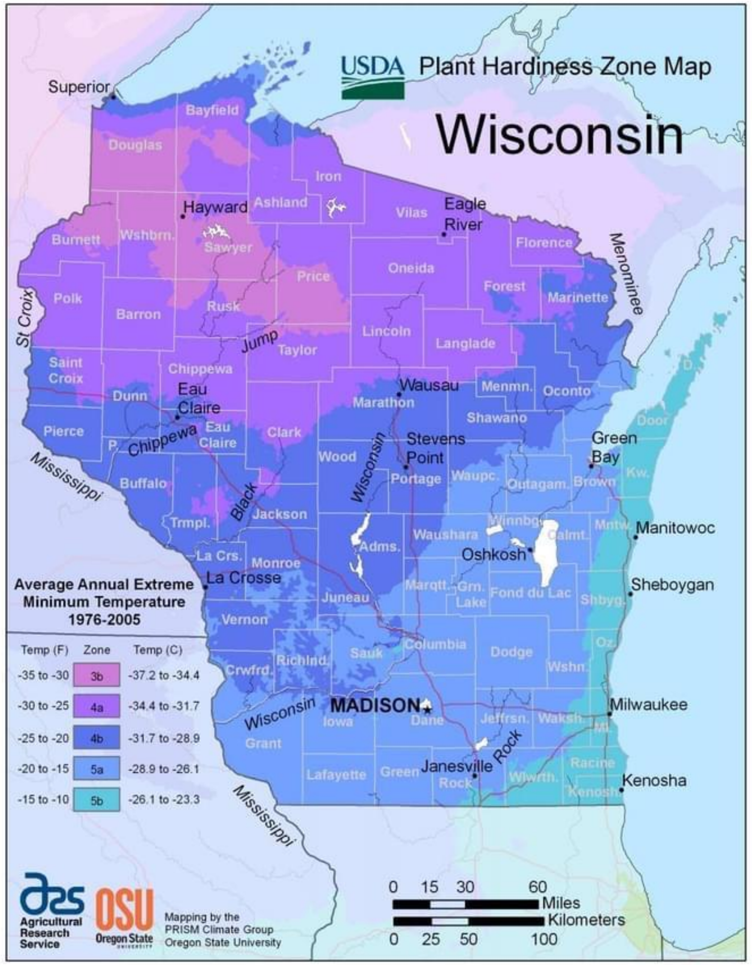
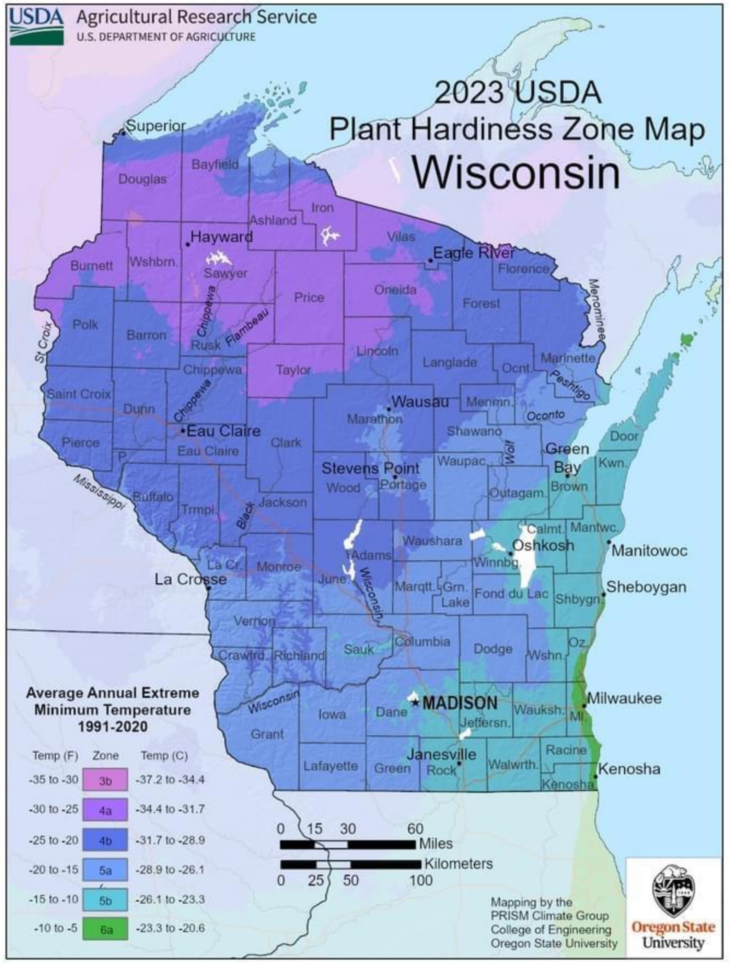
Shifting *what* we can grow, *where* we can grow it

2012



2023



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What are "Natural Climate Solutions"?

Natural Climate Solutions refer to **land management**, restoration, and protection **practices that measurably sequester carbon in the environment and reduce/minimize emissions of greenhouse gases**.

"Nature-based solutions"

"Conservation agriculture" ?

"Natural carbon storage"

"Regenerative agriculture"

"Natural carbon sequestration"

"Climate-smart agriculture" ?

"Agro-ecological intensification"

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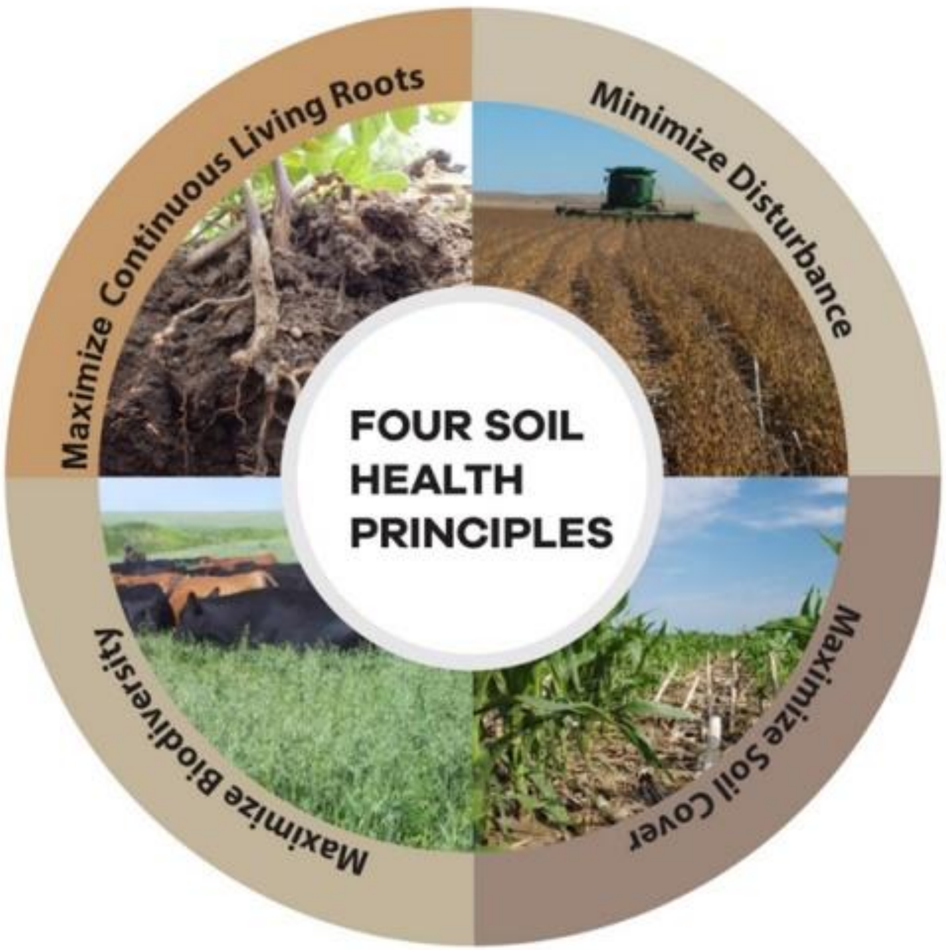
What are "Natural Climate Solutions"?



Climate mitigation is a main benefit of NCS, but these same solutions can also improve:

- **Water quality**:
  - Improved quality of surrounding bodies of water
- **Soil health**:
  - Better water retention, increased biological diversity, runoff and erosion prevention
- **Biodiversity:**
  - Increased soil microbes, pollinators, wildlife
- **Resilience:**
  - Increased resiliency of farmed land to the effects of climate change
- **Economics:**
  - Some practices lower overhead costs, but farmers need access to markets/incentives for ROI

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- With ever-increasing funding for climate action and solutions and growing carbon markets, public and private sectors are putting more $ toward supporting specific land management practices to reduce GHG emissions from ag

- Growing evidence that the climate mitigation impact of the most common conservation ag practices is *overstated*
  - These practices have lots of great benefits (water, soil, erosion)!

- We need better understanding of what practices are meaningfully reducing GHG emissions from agriculture
  - In terms of GHG emissions, we need to stop throwing good money after bad carbon.

What are the most effective natural climate solutions for cool, humid temperate climates like Wisconsin?

SCIENCE ADVANCES | RESEARCH ARTICLE

APPLIED ECOLOGY

Natural climate solutions for Canada

C. Ronnie Drever[1*†], Susan C. Cook-Patton[2,3†], Fardausi Akhter[4], Pascal H. Badiou
Scott J. Davidson[7], Raymond L. Desjardins[8], Andrew Dyk[9], Joseph E. Fargione[1

SCIENCE ADVANCES | RESEARCH ARTICLE

ENVIRONMENTAL STUDIES

Natural climate solutions for the United States

Joseph E. Fargione[1*], Steven Bassett[2], Timothy Boucher[3], Scott D. Bridgham[4], Richard T. Conant[5],
Susan C. Cook-Patton[3,6], Peter W. Ellis[3], Alessandra Falcucci[7], James W. Fourqurean[8],
Trisha Gopalakrishna[3], Huan Gu[9], Benjamin Henderson[10], Matthew D. Hurteau[11],

Natural climate solutions

Bronson W. Griscom[a,b,1], Justin Adams[a], Peter W. Ellis[a], Richard A. Houghton[c], Guy Lomax[a], Daniela A. Miteva[d],
H. Schlesinger[e,1], David Shoch[f], Juha V. Siikamäki[g], Pete Smith[h], Peter Woodbury[i], Chris Zganjar[a],
ackman[g], João Campari[j], Richard T. Conant[k], Christopher Delgado[l], Patricia Elias[a], Trisha Gopalakrishna[a],
. Hamsik[a], Mario Herrero[m], Joseph Kiesecker[a], Emily Landis[a], Lars Laestadius[l,n], Sara M. Leavitt[a],
innemeyer[l], Stephen Polasky[o], Peter Potapov[p], Francis E. Putz[q], Jonathan Sanderman[c], Marcel Silvius[r],
lenberg[s], and Joseph Fargione[a]

e Conservancy, Arlington, VA 22203; [b]Department of Biology, James Madison University, Harrisonburg, VA 22807; [c]Woods Hole Research Cen
MA 02540; [d]Department of Agricultural, Environmental, and Development Economics, The Ohio State University, Columbus, OH 43210; [e]C
Ecosystem Studies, Millbrook, NY 12545; [f]TerraCarbon LLC, Charlottesville, VA 22903; [g]Resources for the Future, Washington, DC 20036;

Mitigation potential = *sequestration rate (per acre) x (acres the practice is implemented on)*

<u>Field carbon sequestration</u>

- Cover crops
- No-till
- Perennial crops
- Pasture
- Agroforestry

<u>Other GHG emissions reduction</u>

- Nitrogen management
- Enteric emissions *(in progress)*
- Manure management *(in progress)*
- Biochar *(in progress)*

- Gathered sequestration rates from published meta-analyses and literature reviews
- C sequestration rates are highly variable and strongly site-specific
- Very limited data exists from Wisconsin

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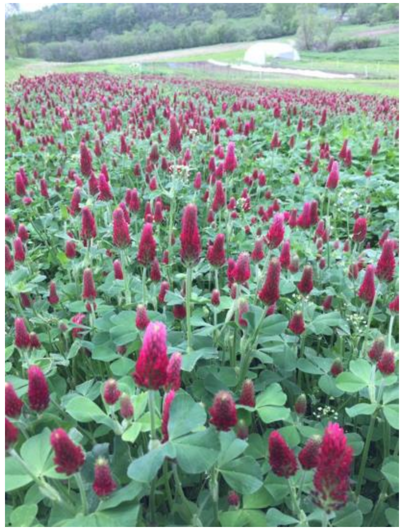
Modeled Scenarios

- 100% cover crop adoption

Cover crops = crops planted to cover the soil, not for the purpose of being harvested



Modeled Scenarios

- 100% cover crop adoption
- 100% no-till adoption

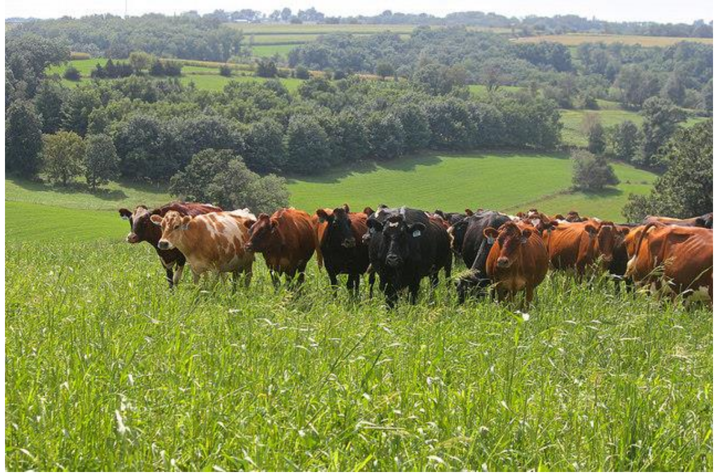
No-till = growing crops without disturbing the soil through tillage (digging/ stirring/ turning the soil over)

https://fyi.extension.wisc.edu/foxdemofarms/conservation-agriculture/minimal-soil-disturbance-conservation-tillage/

Modeled Scenarios

- 100% cover crop adoption
- 100% no-till adoption
- 20% crop → pasture conversion

Pasture = land covered in plants like grass grown for grazing animals



https://news.wisc.edu/pasture-partnership-supports-organic-dairy-farmers-across-wisconsin/

Modeled Scenarios

- 100% **cover crop** adoption
- 100% **no-till** adoption
- 20% crop → **pasture** conversion
- 20% annual crop → **perennial** crop conversion

Perennial crops = crops that, unlike annual crops, grow back after harvest & don't have to be replanted each year.

https://landinstitute.org/scientific-pub/wild-plants-rescue/

Modeled Scenarios

- 100% cover crop adoption
- 100% no-till adoption
- 20% crop → pasture conversion
- 20% annual crop → perennial crop conversion
- 5% pastureland → silvopasture conversion

Silvopasture = integrating trees into pasture

Modeled Scenarios

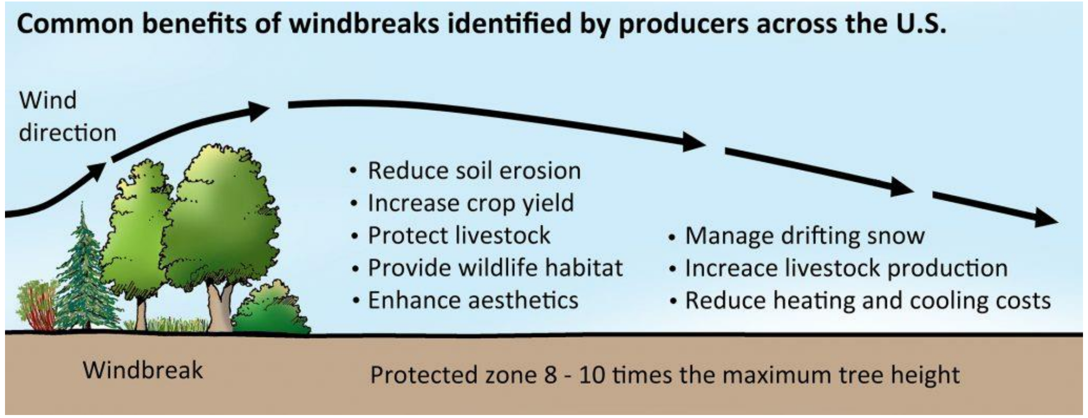
- 100% cover crop adoption
- 100% no-till adoption
- 20% crop → pasture conversion
- 20% annual crop → perennial crop conversion
- 5% pastureland → silvopasture conversion
- 10% cropland → alley crop conversion

Alley cropping = planting crops between rows of trees

Modeled Scenarios

- 100% cover crop adoption
- 100% no-till adoption
- 20% crop → pasture conversion
- 20% annual crop → perennial crop conversion
- 5% pastureland → silvopasture conversion
- 10% cropland → alley crop conversion
- 2% cropland → windbreak conversion

Windbreaks = planting a strip of trees at the edge of fields



https://woodlandinfo.org/windbreaks/

Modeled Scenarios

- 100% cover crop adoption
- 100% no-till adoption
- 20% crop → pasture conversion
- 20% annual crop → perennial crop conversion
- 5% pastureland → silvopasture conversion
- 10% cropland → alley crop conversion
- 2% cropland → windbreak conversion
- 5% cropland → riparian buffer implementation

All considered "agroforestry" (the last four scenarios)

Riparian buffer = planting trees, shrubs, and other perennials next to a river or stream

https://woodlandinfo.org/riparianbuffers/

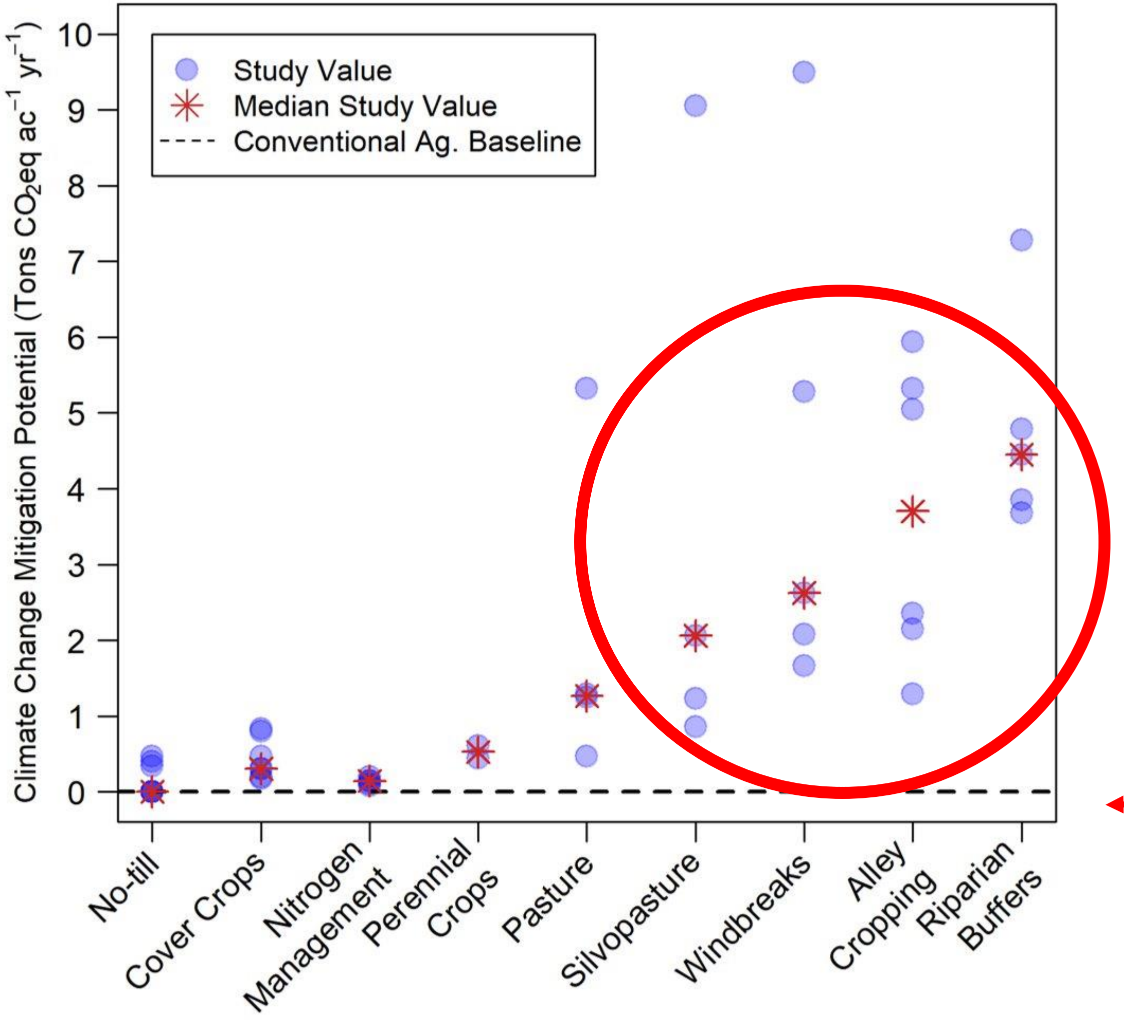
Modeled Scenarios

- 100% cover crop adoption
- 100% no-till adoption
- 20% crop → pasture conversion
- 20% annual crop → perennial crop conversion
- 5% pastureland → silvopasture conversion
- 10% cropland → alley crop conversion
- 2% cropland → windbreak conversion
- 5% cropland → riparian buffer implementation
- 20% reduction in nitrogen applications

Reduced nitrogen applications = reduced use of nitrogen-based fertilizer onto fields

https://modernfarmer.com/2023/02/its-possible-to-reduce-fertilizer-emissions-by-80-percent-before-2050/

Scenario RESULTS: PER-ACRE Mitigation Potential (for Wisconsin)



High GHG impact

- ✓ Integration of **TREES** (agroforestry)
- ✓ Rotational grazing strategies
- ✓ Perennial soil cover
- ✓ Conversion to perennial crops

Low GHG impact

- ✓No-till, cover crops, N management

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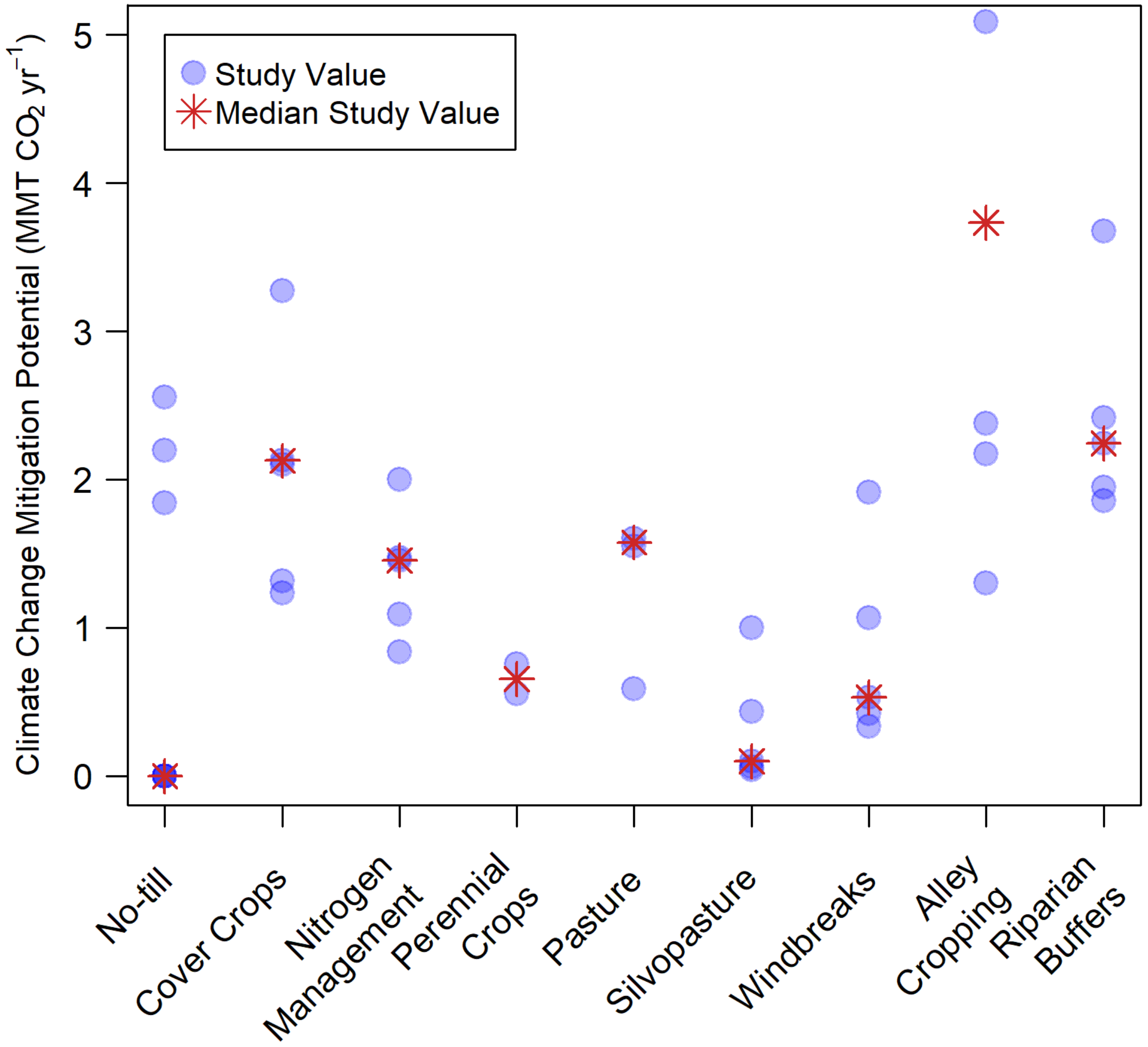
Scenario RESULTS: TOTAL Mitigation Potential (for Wisconsin)



Highest state-wide GHG impact

- ✓ Alley-cropping (agroforestry)
- ✓ Riparian Buffers (agroforestry)
- ✓ Cover Crops
- ✓ Pasture (managed grazing)
- ✓ Nitrogen management

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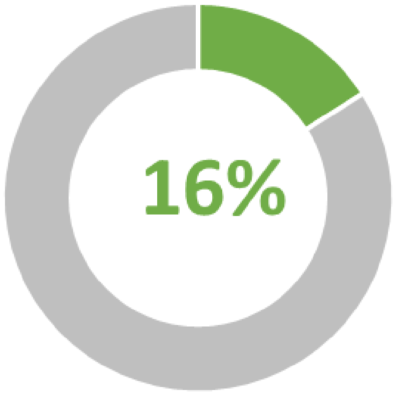
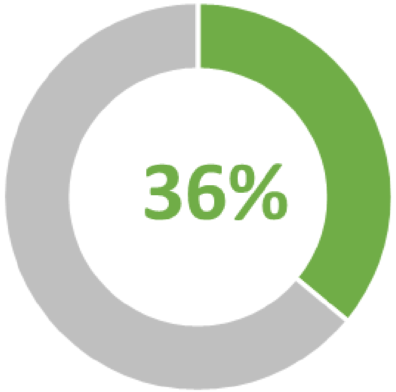
How much of our soil agricultural emissions can these practices offset?

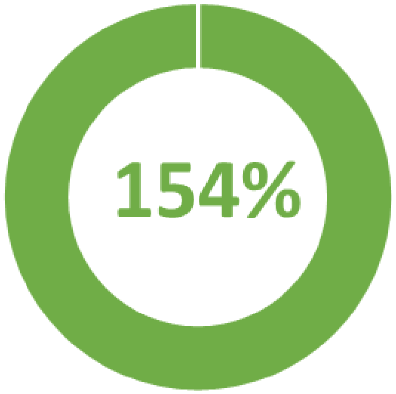
Conservation Agriculture



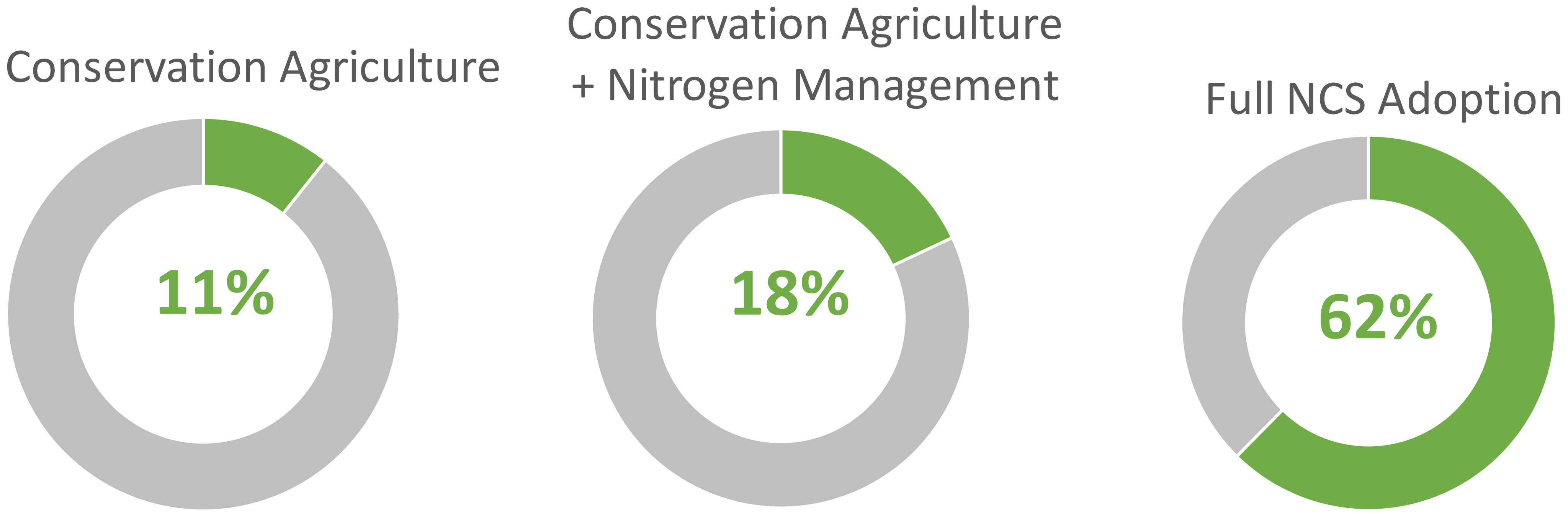
Conservation Agriculture
+ Nitrogen Management



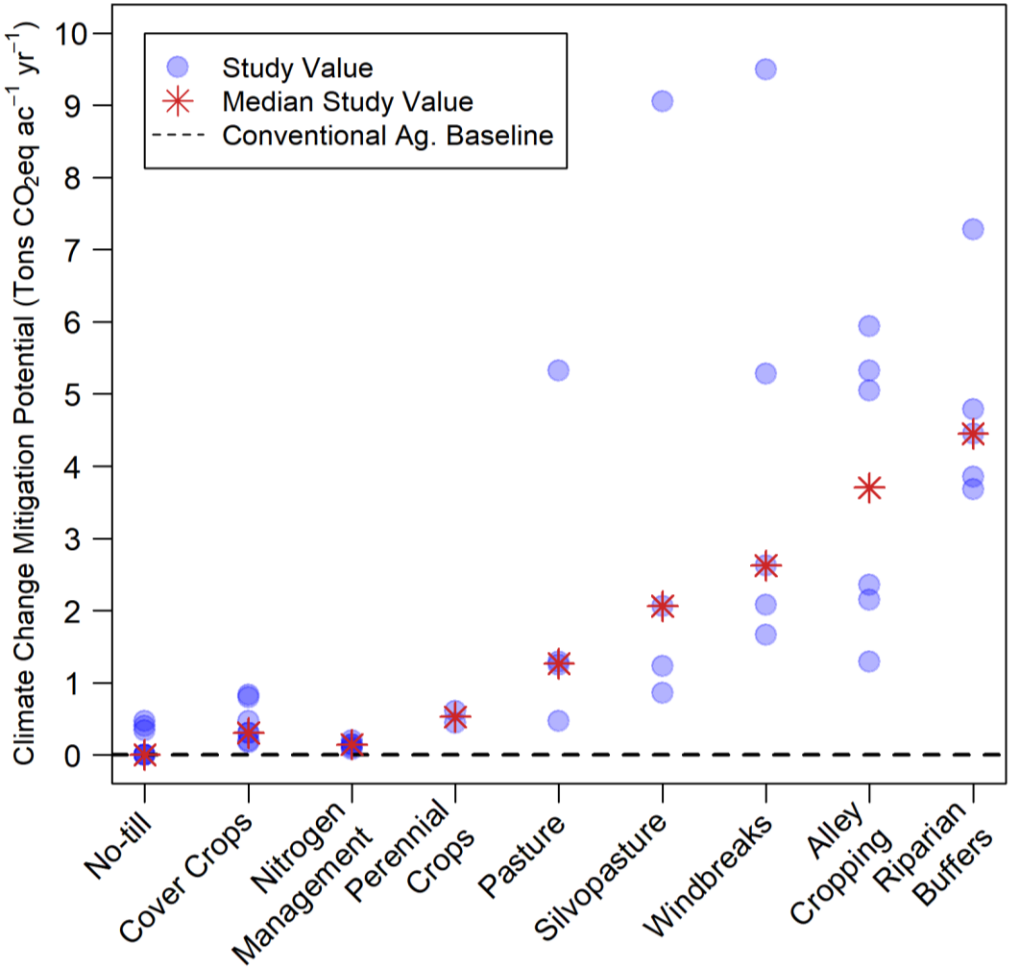
Full NCS Adoption



How much of our total agricultural emissions can these practices offset?



What land management practices do we need in WI to achieve net-zero emissions in agricultural sector by 2050?



To reduce GHGs from ag, we need:

1. **More trees!**
2. **More perennials!**
3. **Less fertilizer!**
4. **More diversity!**

And we need to tackle emissions from livestock

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Key Take-Aways

Perennialization has the most potential to sequester C

- Incorporating more trees & perennial grasses into ag landscape
- Shifting from annual to perennial crops
- Shifting from grain-fed to pasture-fed livestock
- Avoiding conversion from non-cultivated to cultivated land

+ Nitrogen management has the biggest *immediate* impact

+ Cover crops & no-till are good for water quality & soil health/erosion.

- But have a small impact on GHG emissions, so we need additional solutions to reduce ag's climate contributions.

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A Natural Climate Solutions Roadmap to Net-Zero by 2050 for WI Agriculture

- **Policy, programs and supply-chain development analyses:**
  - What are the barriers to NCS adoption? What enabling conditions are needed to incentivize and economically support the scaling of these solutions?
- **Modeling existing and likely adoption scenarios** for land use practices for the whole state, not just a field
  - Scenarios will be informed by existing and recommended policy & supply-chain development interventions
- **NCS crop suitability mapping:** Current (historical) and future projected (2030, 2040, 2050) climate conditions under RCP 4.5 and RCP 8.5
  - County-level, state-wide
  - Monthly projections to inform risks to current commodities and thresholds of tolerance for perennial crops
    - <u>Example:</u> climate change impacts to flowering, fruiting, harvesting

3 pilot projects to ground-truth NCS recommendations and lay foundation for systemic change:

- **WI-grown Kernza Supply Chain Hub** (Michael Fields Agricultural Institute, Clean WI, UW-Madison Picasso Lab, UW-Extension's Emerging Crops Program)
- **Tree crop suitability mapping and value-chain analyses** (Savanna Institute, Clean WI, Wisconsin Initiative on Climate Change Impacts, UW-Madison's Dept. Of Atmospheric & Oceanic Studies)
- **NE WI Managed Grazing Learning Hub** (UW-Madison's Grassland 2.0)

Daybreak Fund — cleanwisconsin — MICHAEL FIELDS AGRICULTURAL INSTITUTE — SAVANNA INSTITUTE — grassLAND 2.0 — Platform for Agriculture + Climate Transformation

Questions?

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