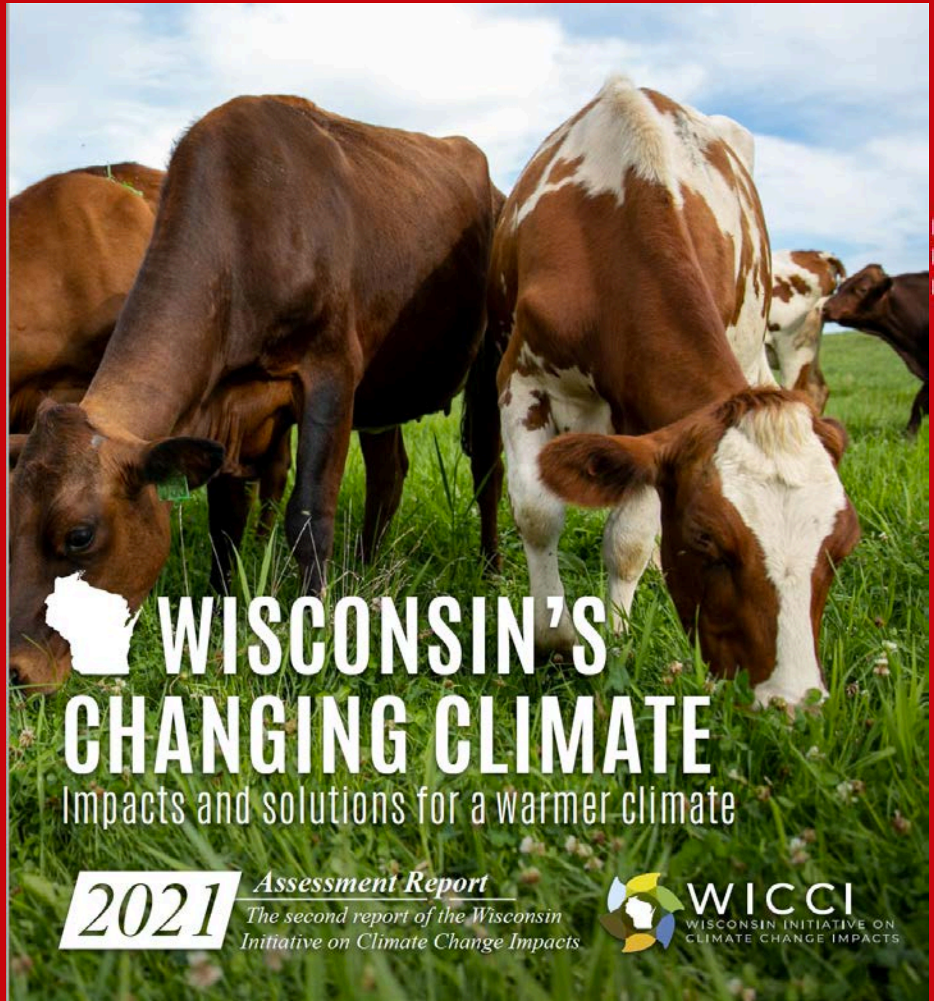
Wisconsin's Changing Climate:

Implications for Agriculture



Diane Mayerfeld

Extension

WICCI Agriculture Working Group Report

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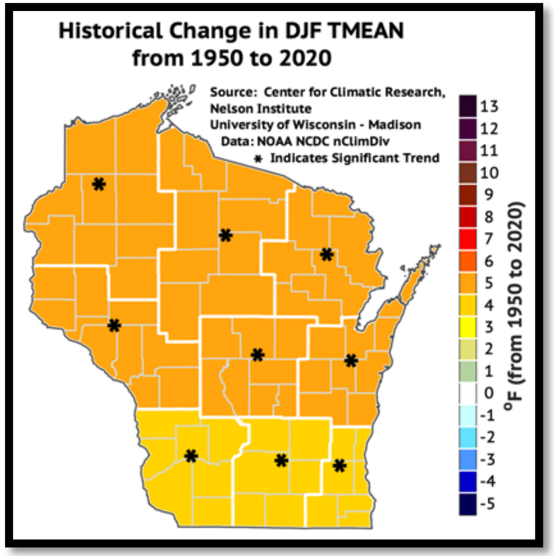
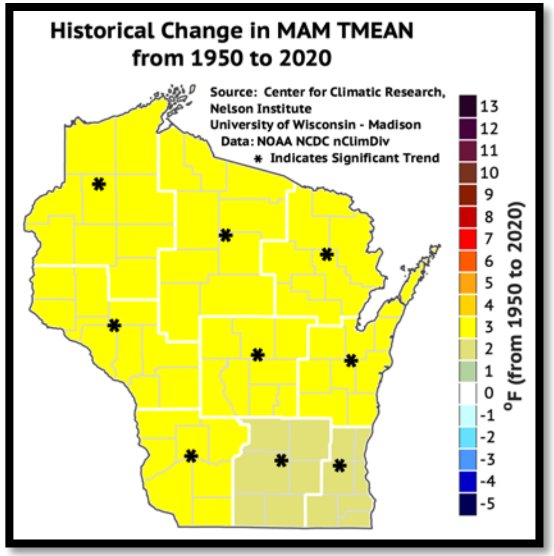
- What are the climate trends in Wisconsin?
- What are the climate projections for Wisconsin?
- What are the impacts on agriculture?
- What can farmers and communities do?

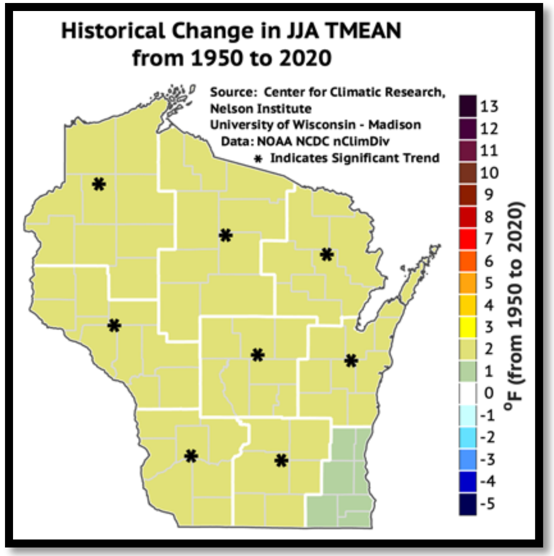
Temperature Seasonality and Trends (1950-2020)



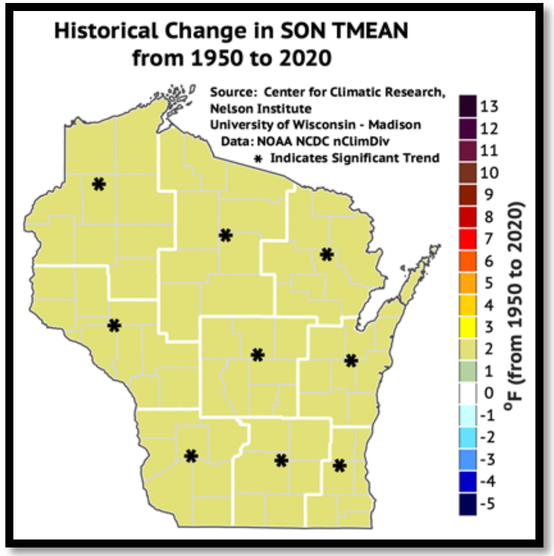
WINTER
+4-5ºF



SPRING
+2-3ºF



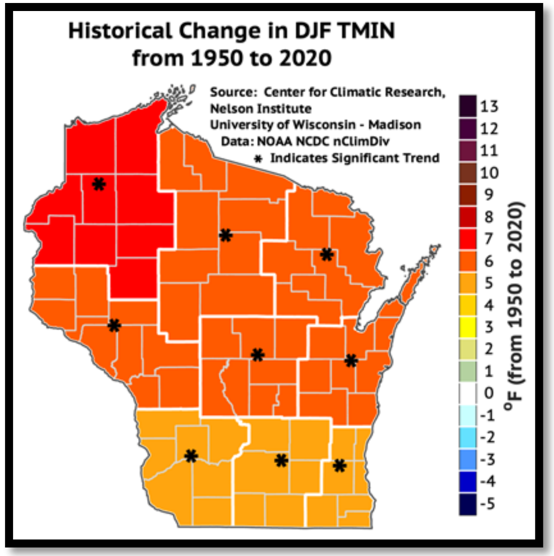
SUMMER
+1-2ºF



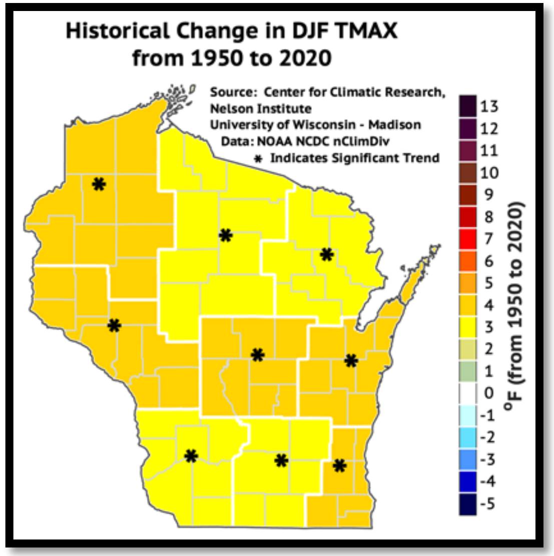
FALL
+2ºF

Winter has warmed most; Summer and Fall show least warming

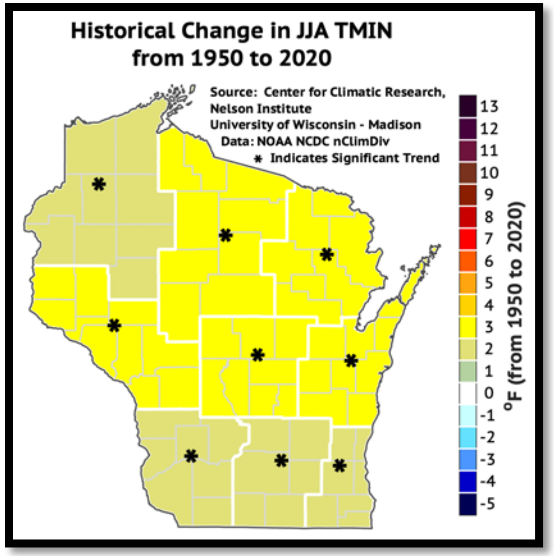
Temperature trends: Day vs. Night (1950-2020)



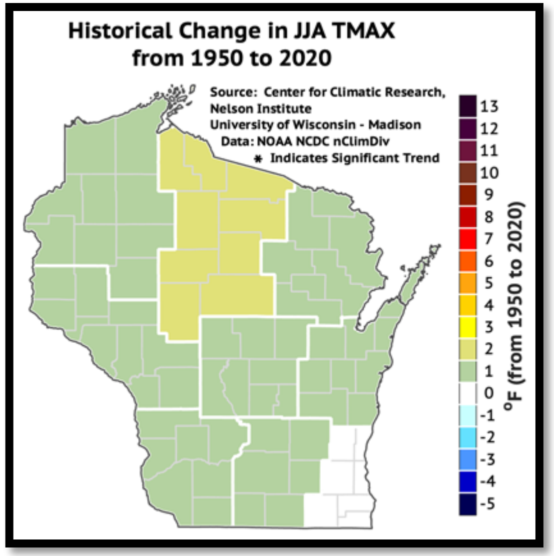
WINTER NIGHT
+5-7ºF



WINTER DAY
+3-4ºF



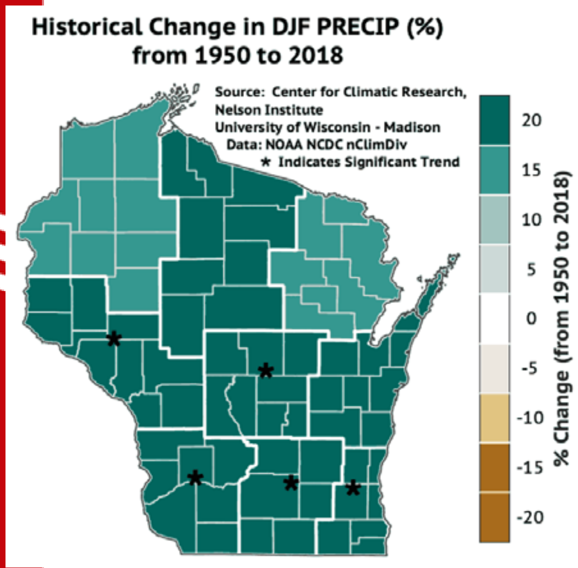
SUMMER NIGHT
+2-3ºF



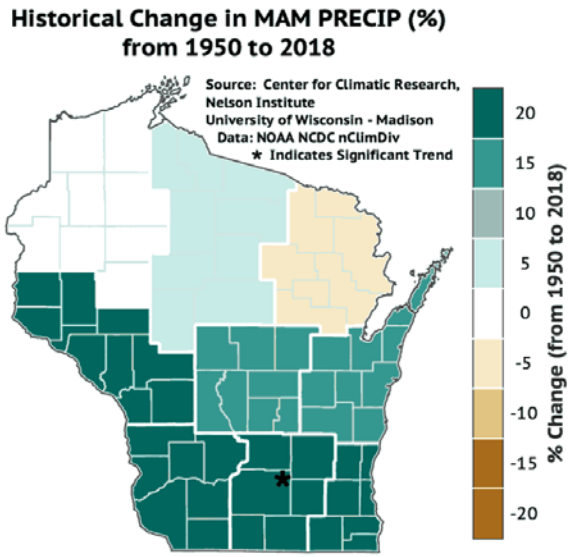
SUMMER DAY
+1-2ºF

Night has warmed more than day; most significant in winter

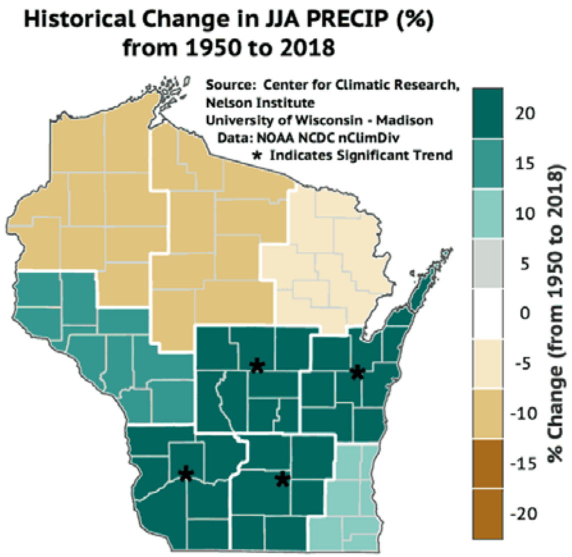
Seasonal Precipitation Trends (1950-2018)



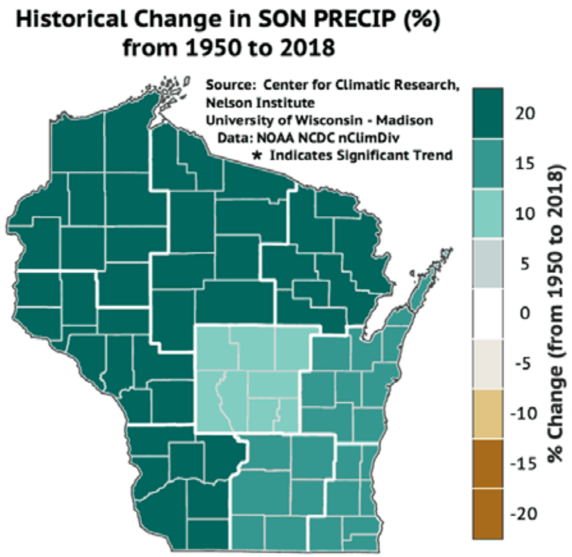
WINTER
+15-20%



SPRING
-5 to 20%



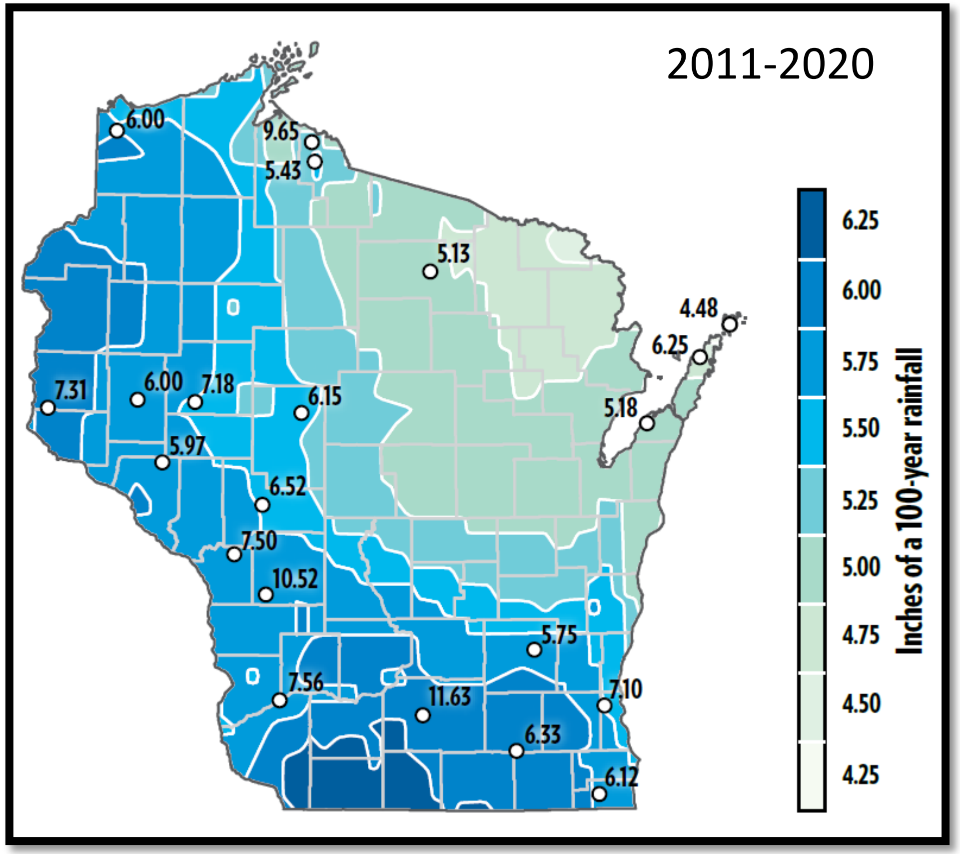
SUMMER
-10 to 20%



FALL
+10-20%

Significant increases during winter, spring, and summer in many agricultural regions of southern and central WI

Extreme Rainfall in last decade



Historical Rainfall:
Wisconsin has experienced at least **20** 100yr rainfall events (24hr) just in the decade between 2011-2020.

Occurring in areas that have highest concentration of agricultural land

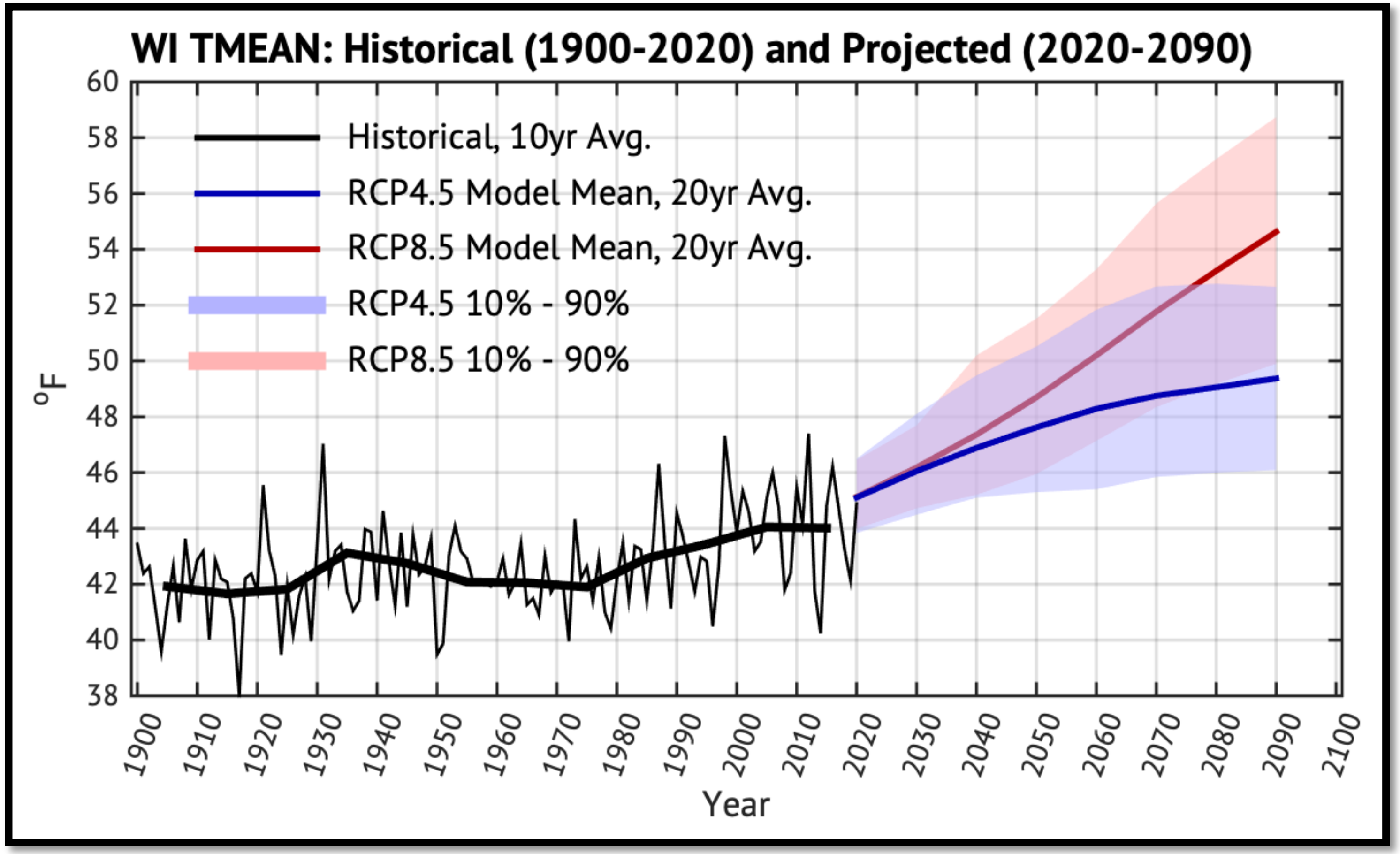
Source: Dan Vimont, UW-Madison AOS, Nelson Institute Center for Climatic Research, and WICCI

Future Wisconsin Temperature Projections

Wisconsin warms by:

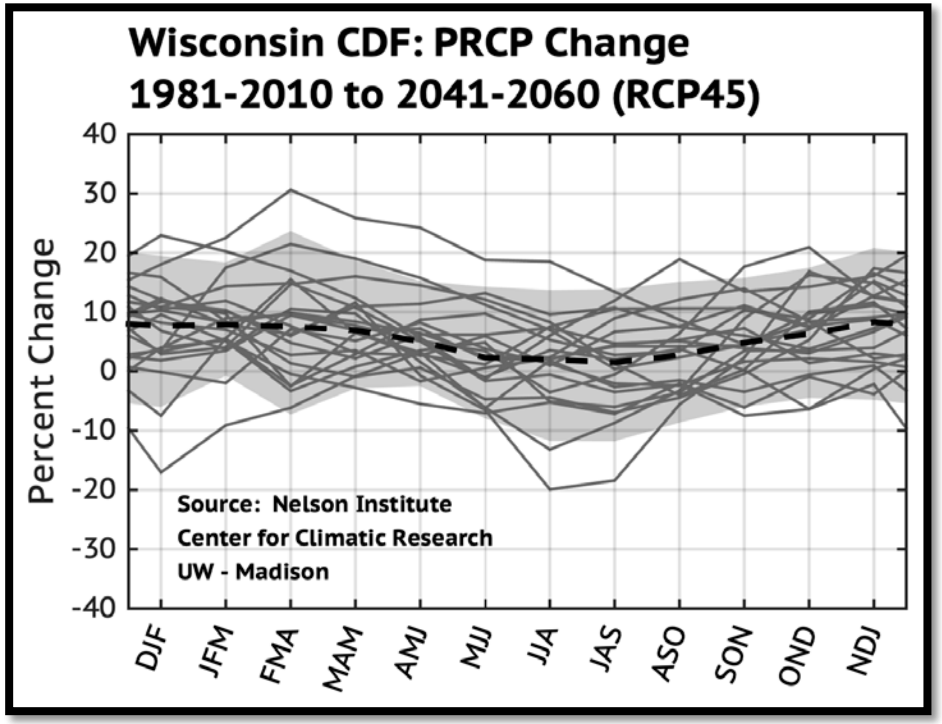
2050: 2-8°F (RCP4.5)
3-9°F (RCP8.5)

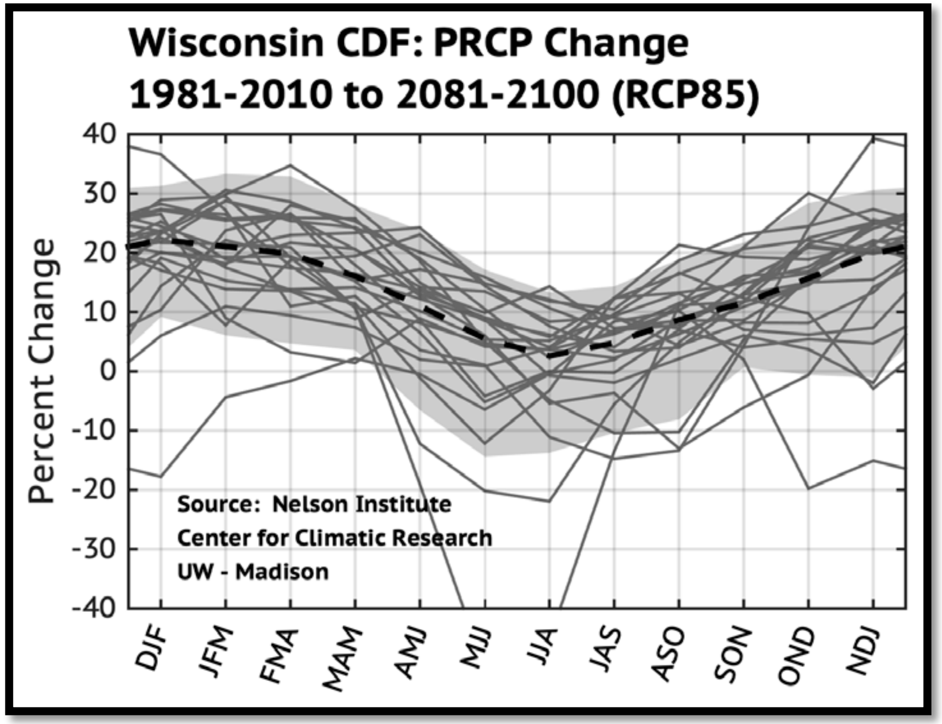
2090: 3-10°F (RCP4.5)
7-16°F (RCP8.5)



Source: Dan Vimont, UW-Madison AOS, Nelson Institute Center for Climatic Research, and WICCI

Future Rainfall Projections

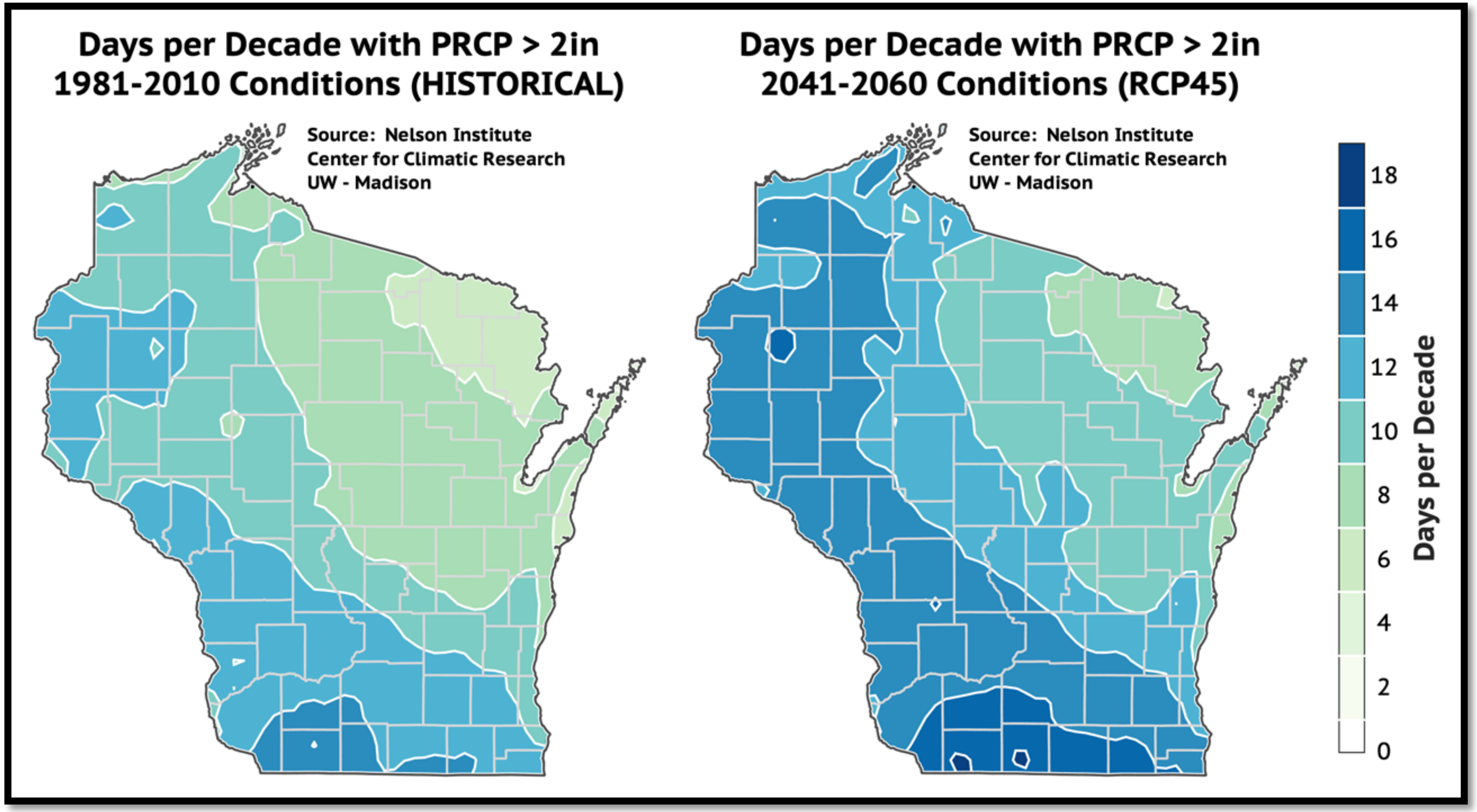


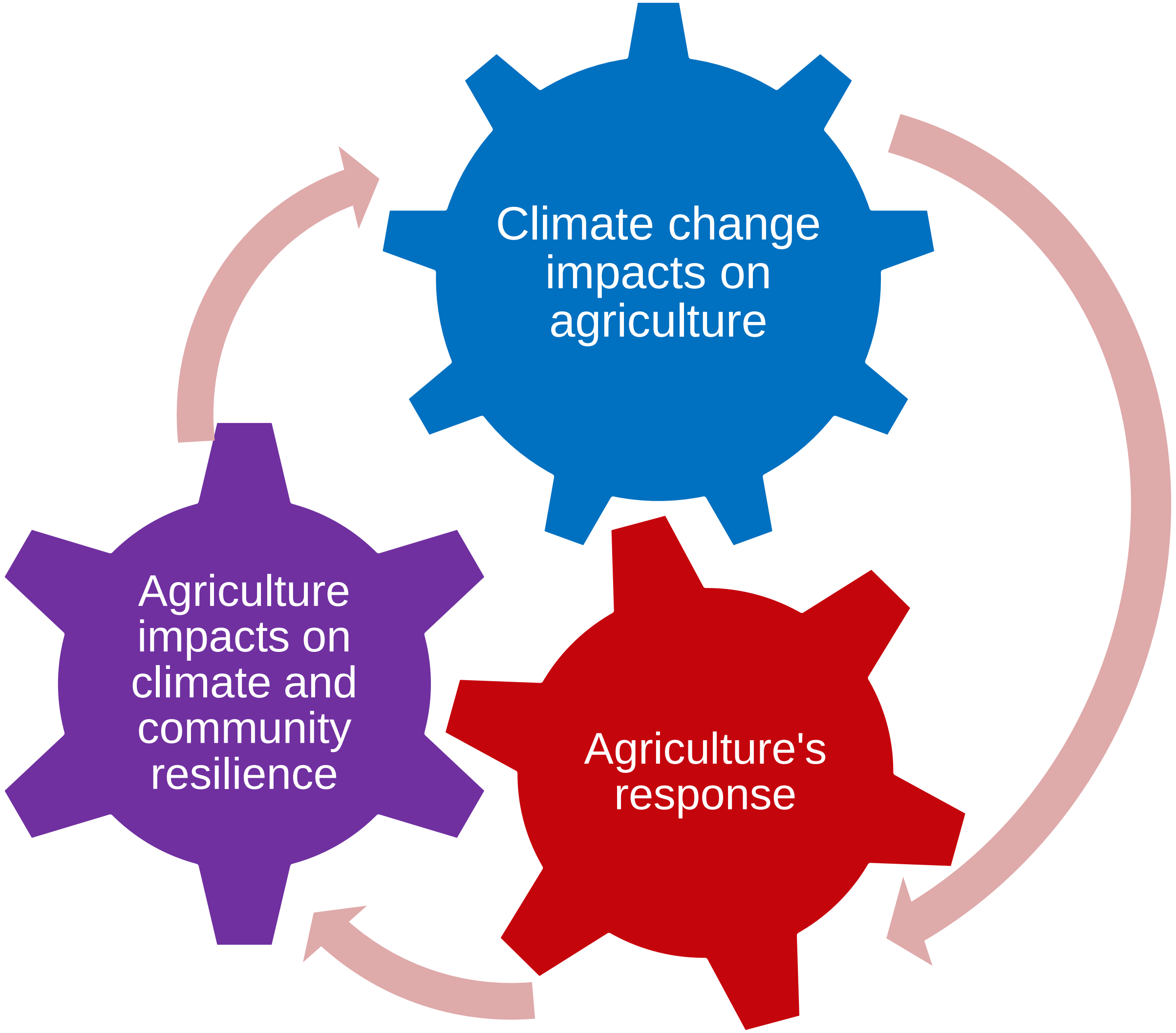


RCP4.5, 2050 Conditions
10% wetter in winter, spring, fall

RCP8.5, 2090 Conditions
15-20% Wetter – winter, spring, fall

Extreme Rainfall Projections




Climate change impacts on agriculture
Agriculture's response
Agriculture impacts on climate and community resilience

Climate change impacts on WI agriculture

Warmer temperatures:

Longer growing season →

- higher yield crop varieties
- more pest pressure

Photos: Russell Groves

Climate change impacts on WI agriculture

Warmer temperatures:

Winter thaws (reduced snow cover; ice sheeting; freeze-thaw cycles) →

- reduced alfalfa and winter wheat survival
- cranberries lack ice protection
- risk of fruit tree early bloom
- runoff risk

Climate change impacts on WI agriculture

Warmer temperatures:

Hotter summer nights and days →

- heat stress for livestock and workers
- water stress
- pollination

Climate change impacts on WI agriculture

More precipitation (spring & fall):

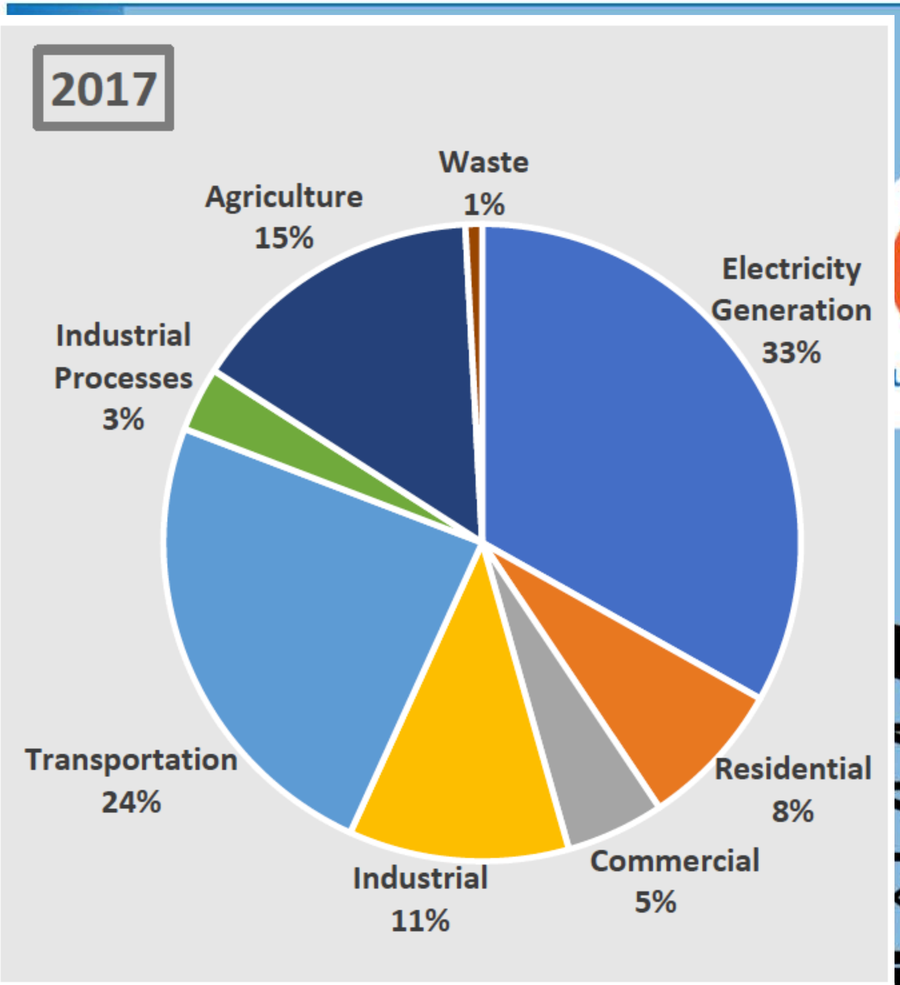
- less moisture stress
- delays in planting
- soil compaction
- increased risk of erosion & runoff
- delays in harvest
- increased risk of flooding

Climate change impacts on WI agriculture

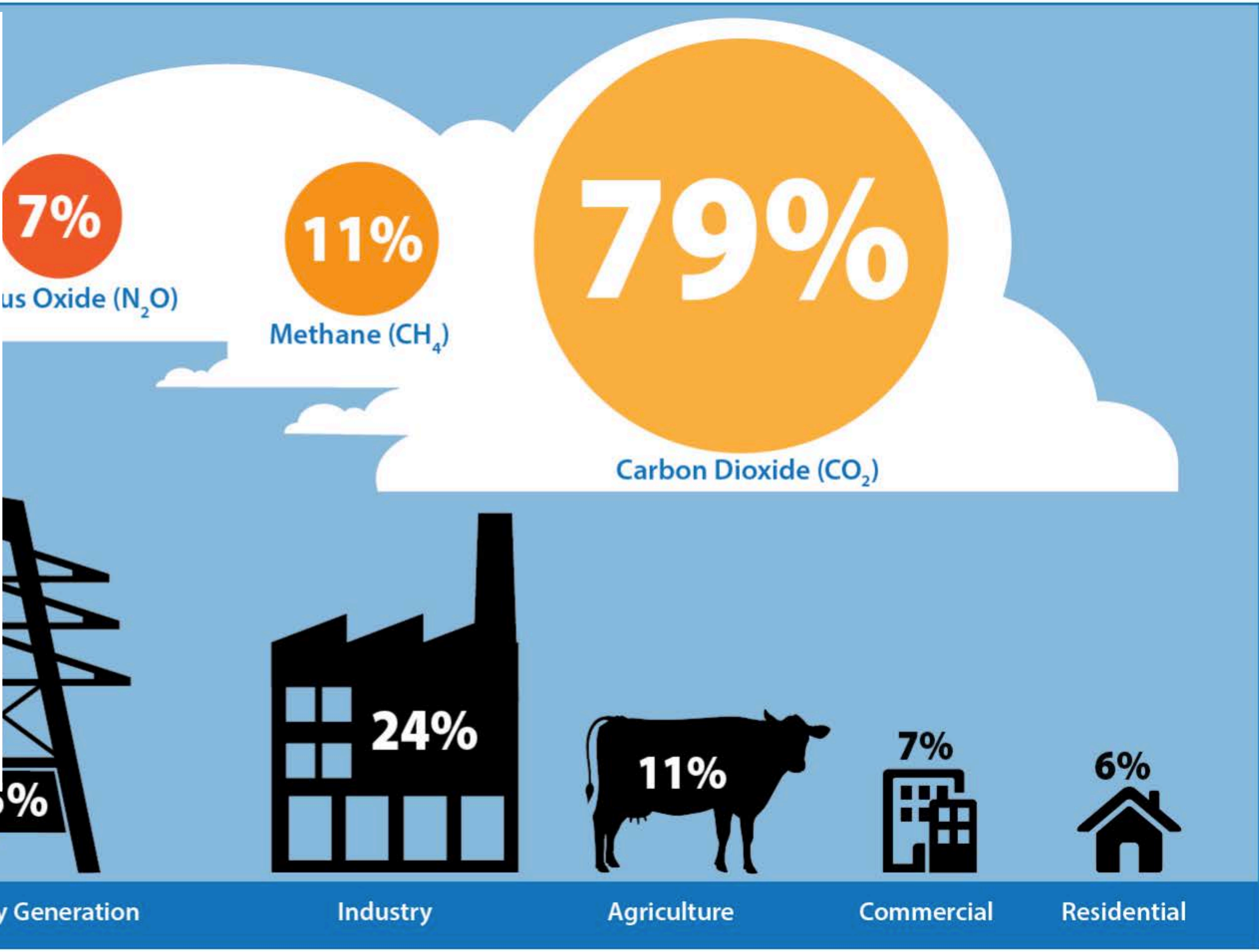
More precipitation:

- increased disease pressure

Photo: Damon Smith

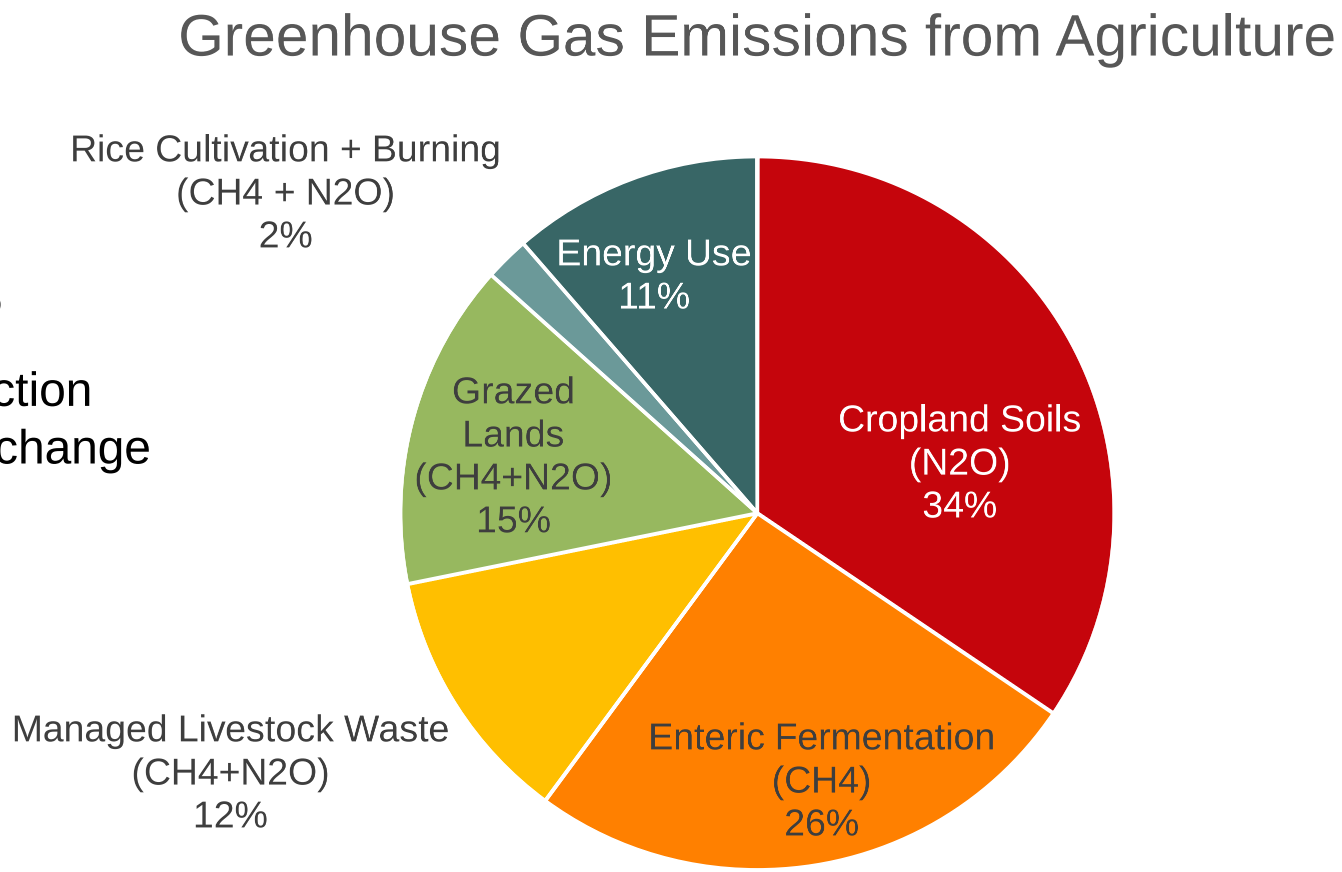


Wisconsin GHG emissions by sector, WI DNR



US EPA Greenhouse Gas Inventory Data Explorer https://cfpub.epa.gov/ghgdata/inventoryexplorer/index.html

What are agriculture's emission?

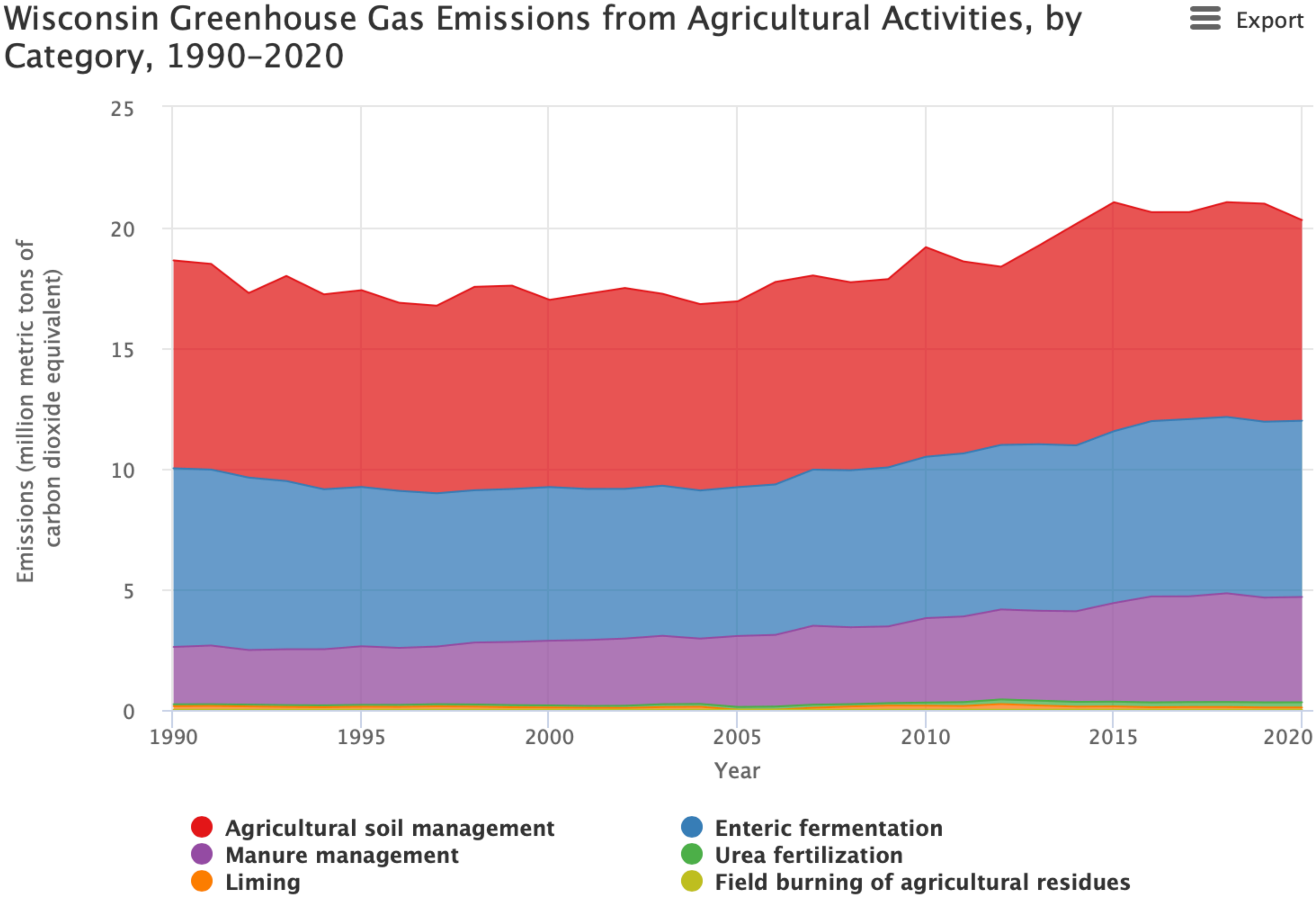


What's missing?

- GHG from input production
- Soil carbon / land use change

Source: U.S. Agriculture and Forestry Greenhouse Gas Inventory: 1990-2018, USDA Ag. Data Commons

Wisconsin Greenhouse Gas Emissions from Agricultural Activities, by Category, 1990–2020



Source: U.S. EPA's Inventory of U.S. Greenhouse Gas Emissions and Sinks by State: 1990–2020. https://www.epa.gov/ghgemissions/state-ghg-emissions-and-removals

Percent change:

1990–2020

Agricultural soil management:

▼ 3.5%

Enteric fermentation:

▼ 1.4%

Manure management:

▲ 83.6%

Urea fertilization:

▲ 169.4%

Liming:

▼ 37.3%

Field burning of agricultural residues:

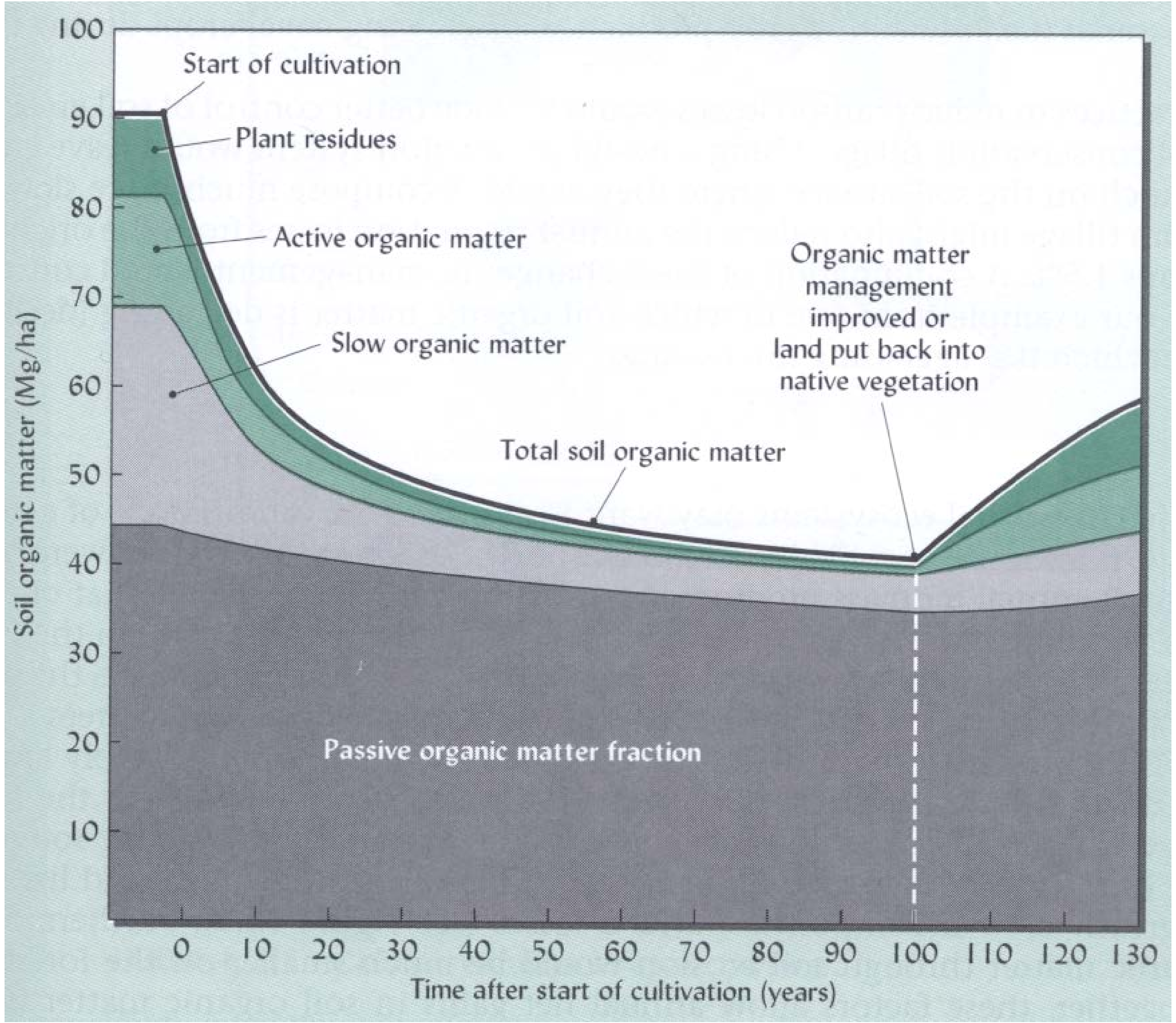
▲ 37.5%

Total: ▲ 9.0%

Soil carbon loss and storage

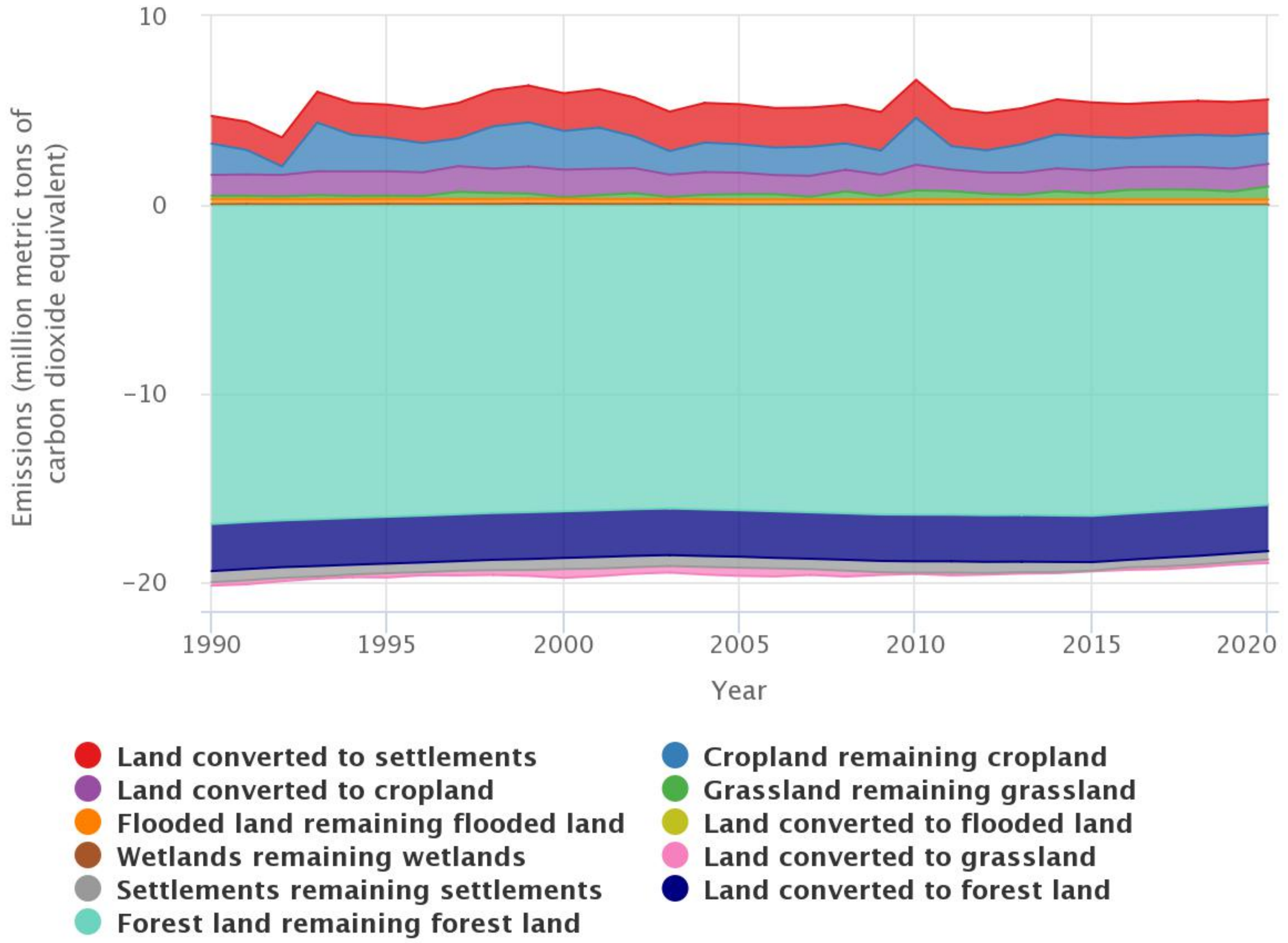
Soil health practices:

- Minimize disturbance
- Keep soil covered
- Maximize living roots
- Maximize biodiversity



(Brady and Weil, 1999)

Wisconsin Greenhouse Gas Emissions and Sinks from Land Use, Land-Use Change, and Forestry, by Category, 1990-2020



Source: U.S. EPA's Inventory of U.S. Greenhouse Gas Emissions and Sinks by State: 1990-2020. https://www.epa.gov/ghgemissions/state-ghg-emissions-and-removals

Percent change:

1990–2020

Land converted to settlements:
Emissions ▲ 22.8%

Cropland remaining cropland:
Emissions ▼ 2.9%

Land converted to cropland:
Emissions ▲ 8.6%

Grassland remaining grassland:
Emissions ▲ 291.4%

Flooded land remaining flooded land:
Emissions ▲ 1.5%

Land converted to flooded land:
Emissions ▼ 99.6%

Wetlands remaining wetlands:
Emissions ▼ 100.0%

Land converted to grassland:
Sink ▲ 3.0%

Settlements remaining settlements:
Sink ▼ 24.2%

Land converted to forest land:
Sink ▼ 1.6%

Forest land remaining forest land:
Sink ▼ 6.0%

Net total: Sink ▼ 13.3%

Adaptation strategies

Wet springs → increase tile drainage? Increase N fertilizer?
Or shift to more perennial pasture, improve soil health, and cover crop?

Increased pest pressure → increase pesticide use?
Or expand crop rotation and habitat for beneficials?

Increased heat stress → put livestock in buildings with fans and sprinklers?
Or establish silvopasture?

Mitigation strategies for WI agriculture

Reduce Emissions

- Manage manure
- Reduce nitrogen fertilizer applications
- Avoid converting pasture or natural habitat to cropland
- Improve energy efficiency

Co-benefits:
- Water quality
- Biodiversity

Increase Carbon Storage

- Build soil health
  - Reduce disturbance (tillage, pesticides & fertilizer)
  - Keep soil covered
  - Living roots in soil
  - Diversity
- Add trees
- Convert annual cropland to pasture, prairie or woodland

Surface water runoff is a destructive force during heavy rainfall.

When roads, bridges, and culverts washed out across the Midwest, short-term emergency repairs cost taxpayers $114 million in 2018-2019 alone.[1]

Bridge repair or replacement cost[2]
$68,000 - $184,000

Culvert replacement cost[4]
$5,200 - $32,200

Road maintenance cost[3] (resurface 1/2 mile)
$8,000 - $50,000

Investment in well-managed pasture and hay can slow water down and prevent costly damage.

Well-managed pasture and hay plants have well-developed root systems in the ground year-round.

These root systems soak up more water than annual roots. Less surface water runoff means less erosion, flooding and damage during heavy rainfall.

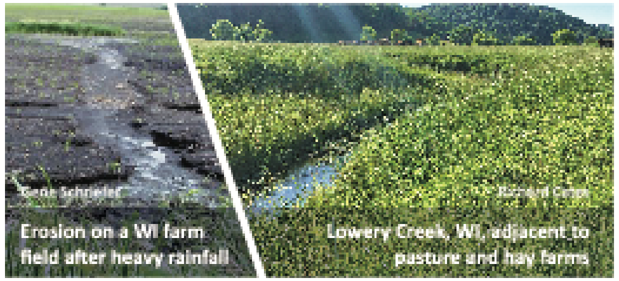
9 inches of rainfall absorbed by soil under well-managed pasture and hay crops.[5]

Annual plants have less dense, seasonal roots.

3 inches of rainfall absorbed by soil under corn and soybean crops[5]

Invest in Farmers

Farmers and landowners can create conditions that protect infrastructure.



Erosion on a WI farm field after heavy rainfall

Lowery Creek, WI, adjacent to pasture and hay farms

"As many small dairy farms have gone out of business, the land has lost well-managed forage land. Roads bordered by well-managed crop and pasture land seldom need ditching. Roads bordered by crop land that is poorly managed often need maintenance after every heavy rain event."

JACK HERRICKS
Jefferson Township Chairman, Monroe County, WI

Learn more about how productive, well-managed pasture and hay ground can protect infrastructure.

www.greenlandsbluewaters.org

Green Lands Blue Waters

Midwest Perennial Forage Working Group

1 FWHA emergency highway repair allocations, 2018-2019. https://www.fhwa.dot.gov/pressroom/fhwa1918.cfm
2 Averages for IL, IA, MN, MO, WI; non-National Highway System bridges; 2017. https://www.fhwa.dot.gov/bridge/nbi/sd2017.cfm
3 Average Annual Cost for Road Maintenance. USDA Forest Service. https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fseprd528063.pdf
4 2015 Maintenance Culvert Cost Data Analysis. MN DOT. http://www.dot.state.mn.us/bridge/hydraulics/culvertcost/2015%20Drainage%20Maintenance%20Data%20Summary%20-%20Final%20Version.pdf
5 Averages of measurements in June, August, and October/November. | L. Bharati, K.-H. Lee, T.M. Isenhart, and R.C. Schultz. 2002. Soil-water infiltration under crops, pasture, and established riparian buffer in Midwestern USA. Agroforestry Systems 56:249-257.

Challenges to sequestering carbon & building soil health

- Results vary depending on soil, climate, management details
- Time frames – C loss usually fast, while gains are slow
- Warming climate
- Reversable
- Food production
- Who pays? Especially for land use change
- May cause more GHG emissions (N_2O, CH_4, CO_2) to put that C in the soil than the total stored

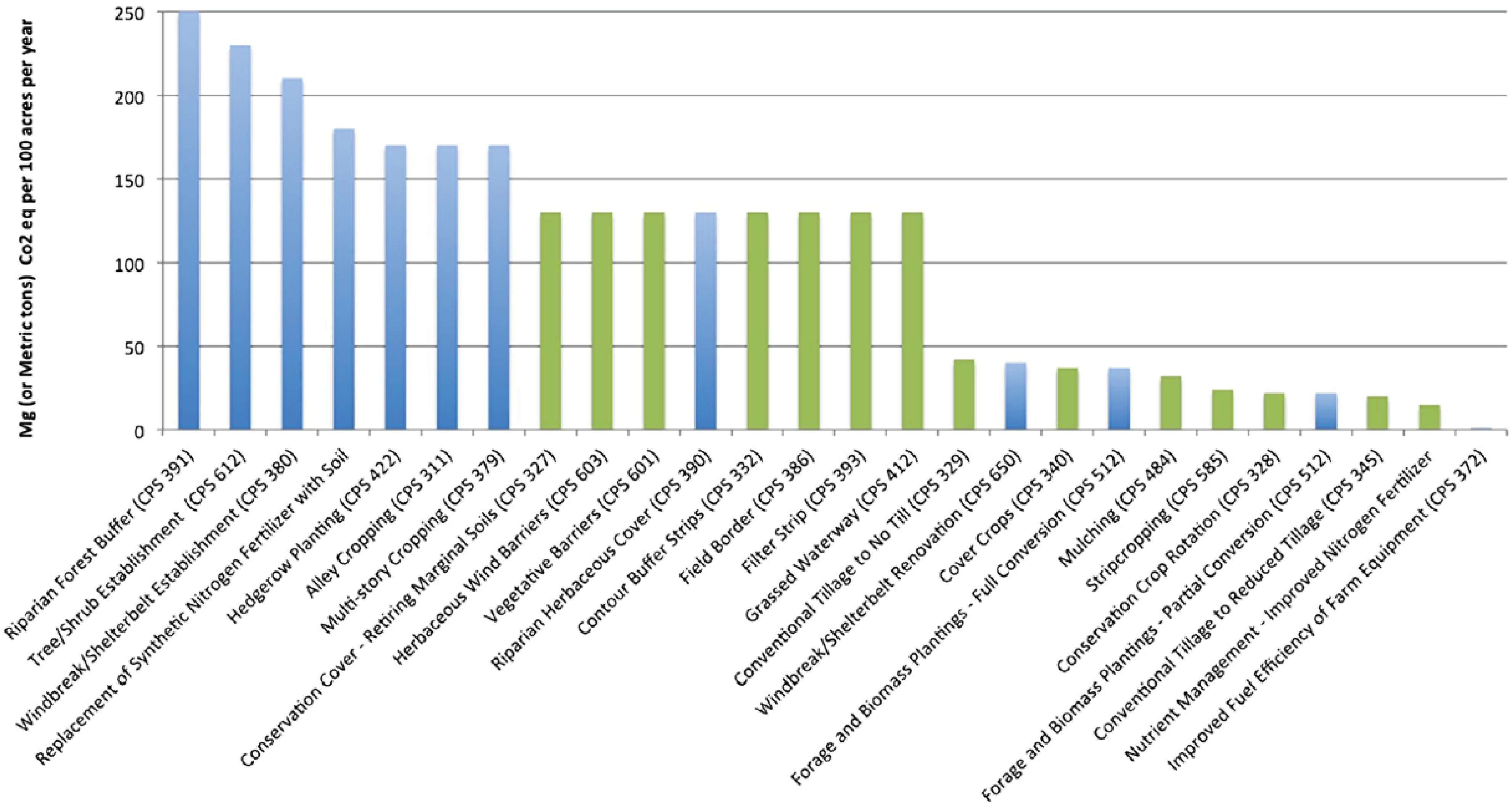
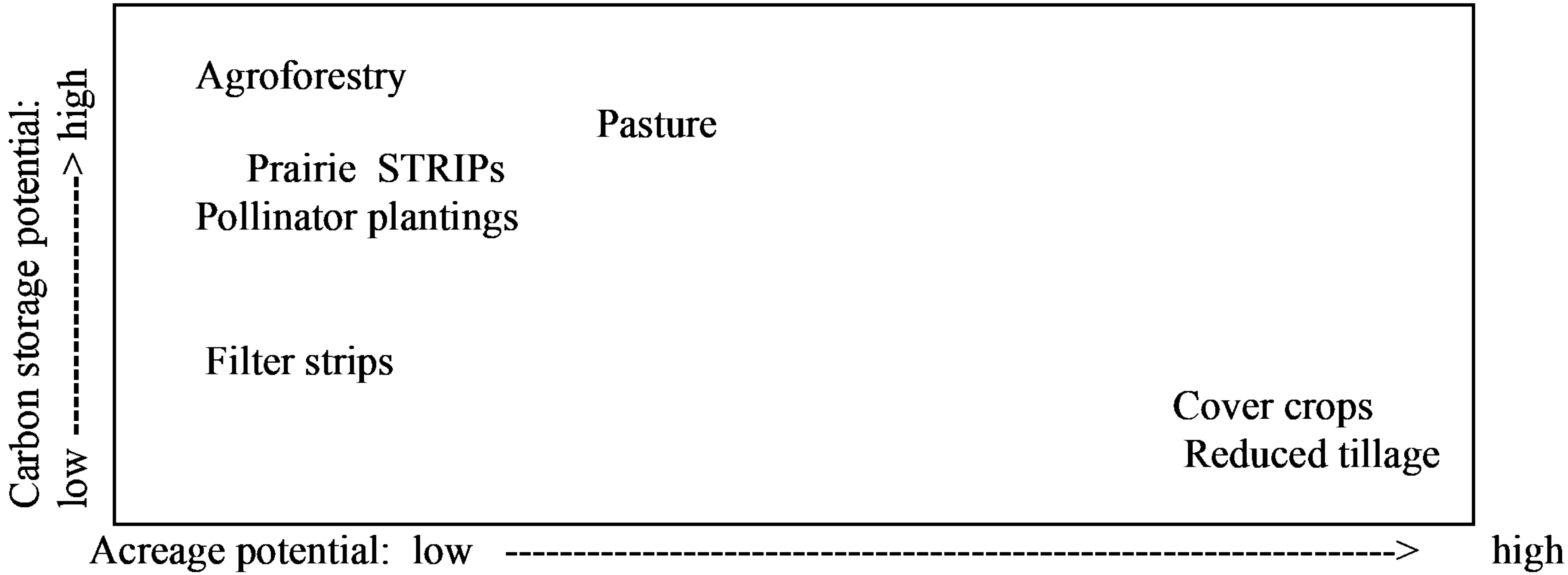
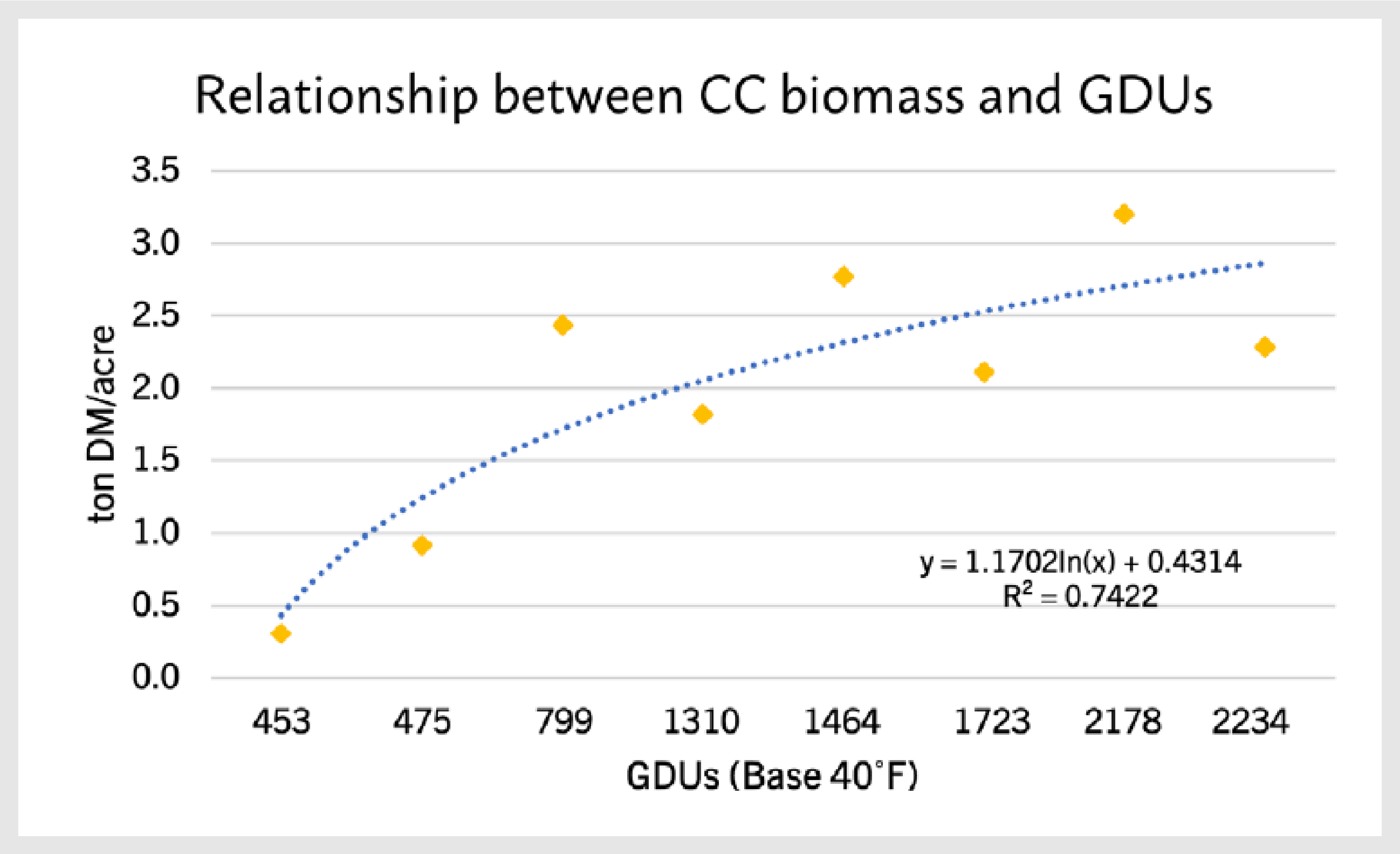


Figure 4. Soil Carbon Sequestration/Emissions Reduction Potential by Management Practice

Source: NRCS COMET-Planner (as excerpted from Biardeau et al., (2016).)


Carbon storage potential:
low ----------> high
Agroforestry
Pasture
Prairie STRIPs
Pollinator plantings
Filter strips
Cover crops
Reduced tillage
Acreage potential: low --> high

Benefits vary depending on management



Building Knowledge about Wisconsin's Cover Crops Farmer Research Project - 2020


Questions? Comments?

Limit disturbance

- No-till (usually relies on herbicides)
- Perennial crops

NRCS

Keep soil covered

- Crop residue
- mulch
- cover crops
- perennial crops

Mimi Broeske

Living Roots Year-round

- Cover crops
- (STRIPS, windbreaks)
- Perennial pasture, agroforestry

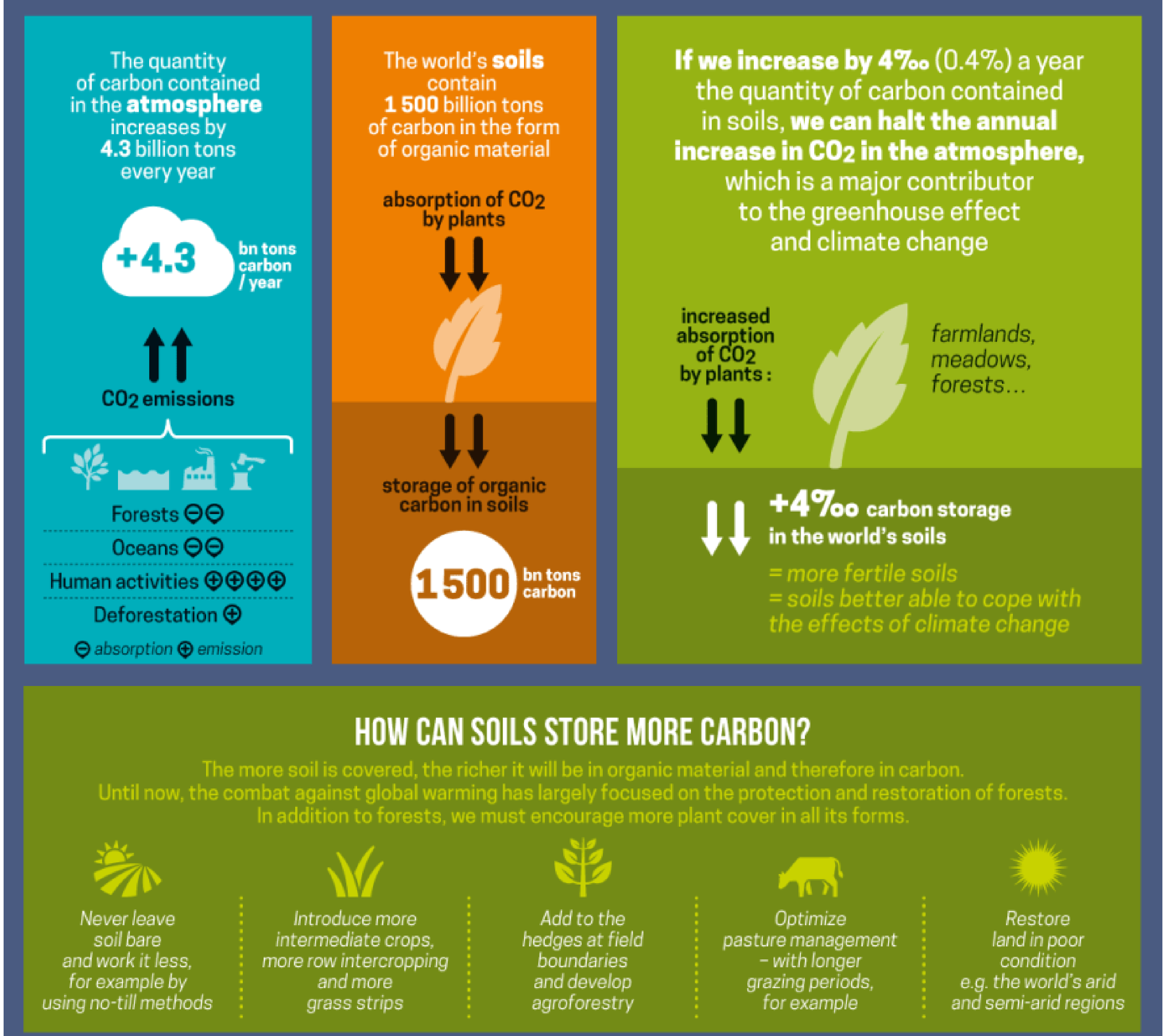
https://www.patagoniaprovisions.com/pages/why-beer

Diversity

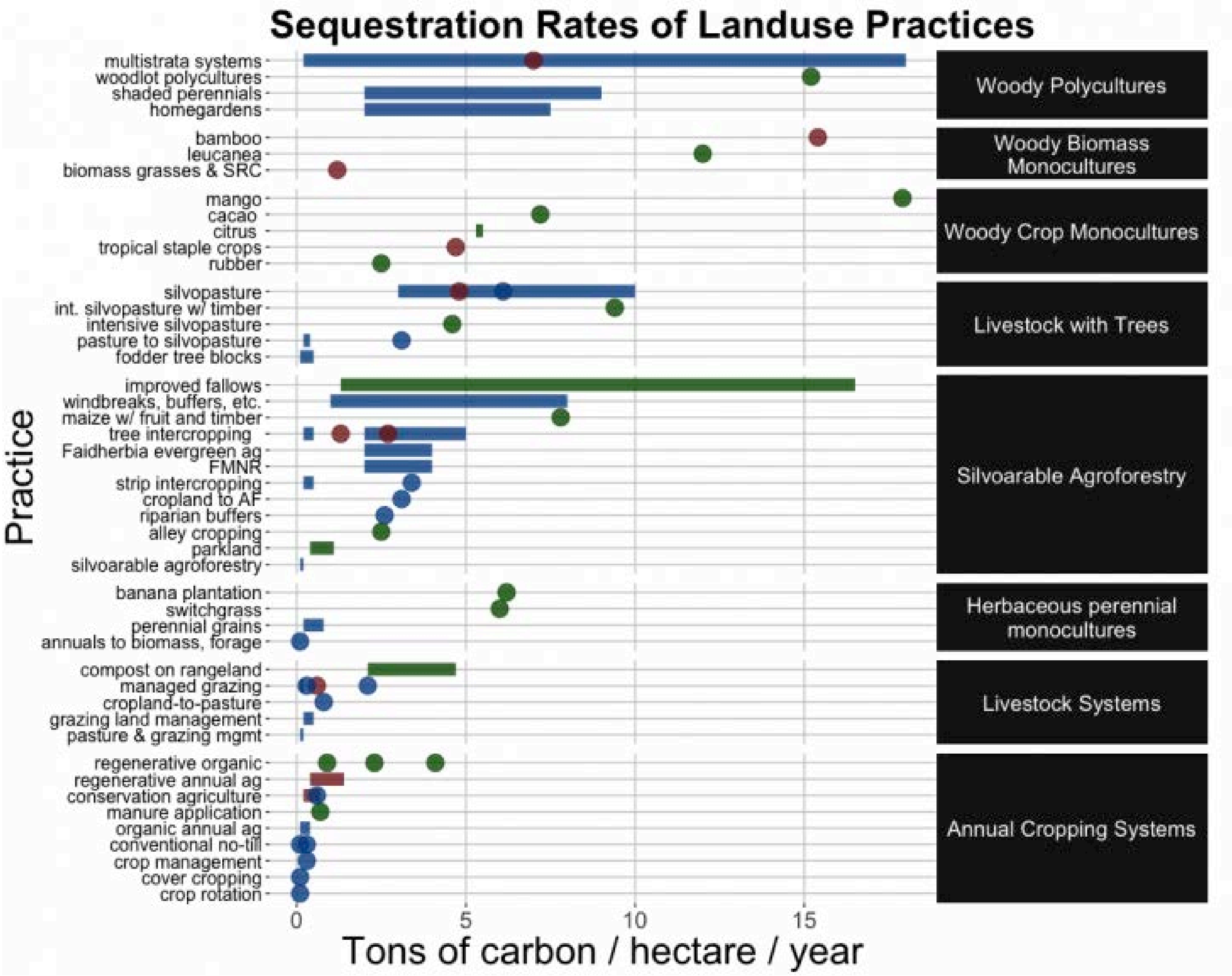
- Crop rotation
- Strip-cropping
- Cover crop cocktails
- STRIPS, buffers, etc.
- Diverse pastures
- Agroforestry

Integrate Animals

Ruth McNair

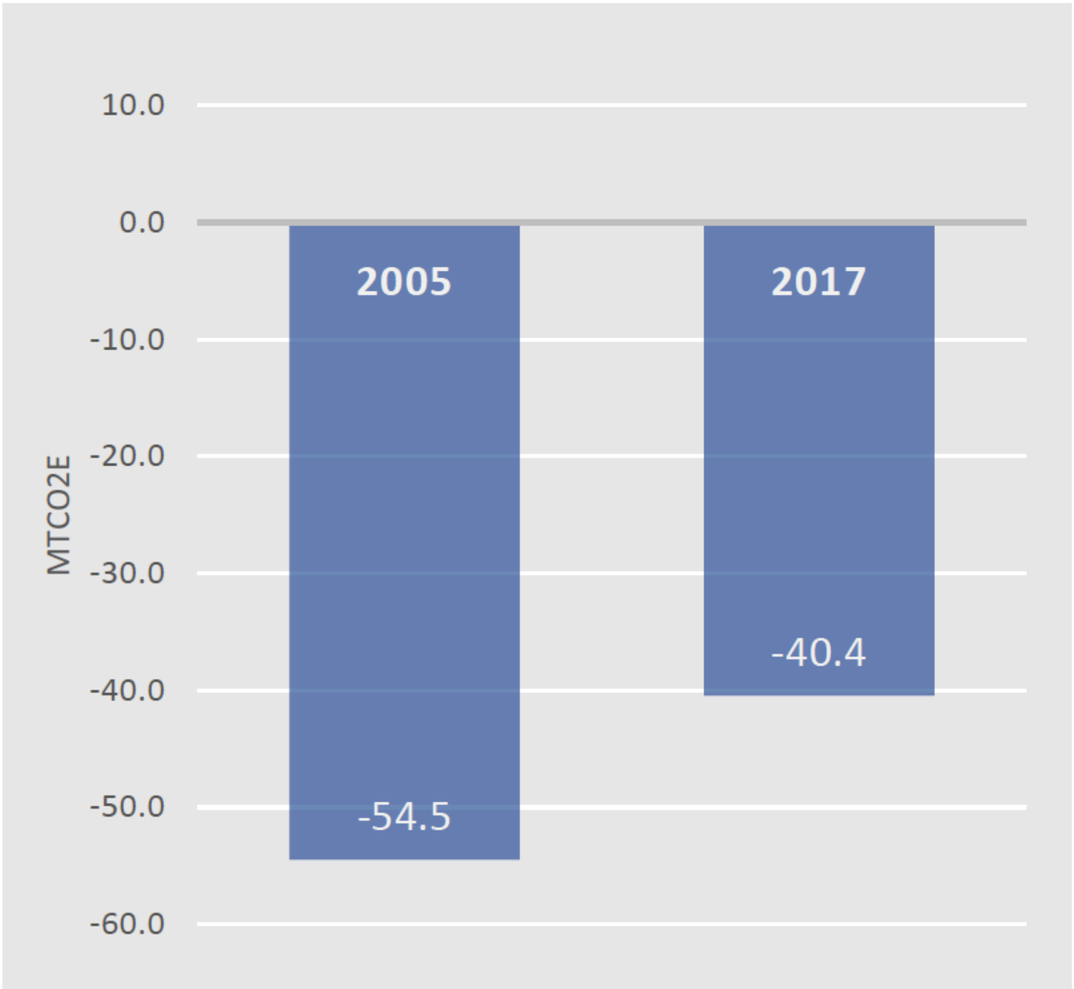


4 per 1000
Carbon sequestration in soils
for food security
and the climate

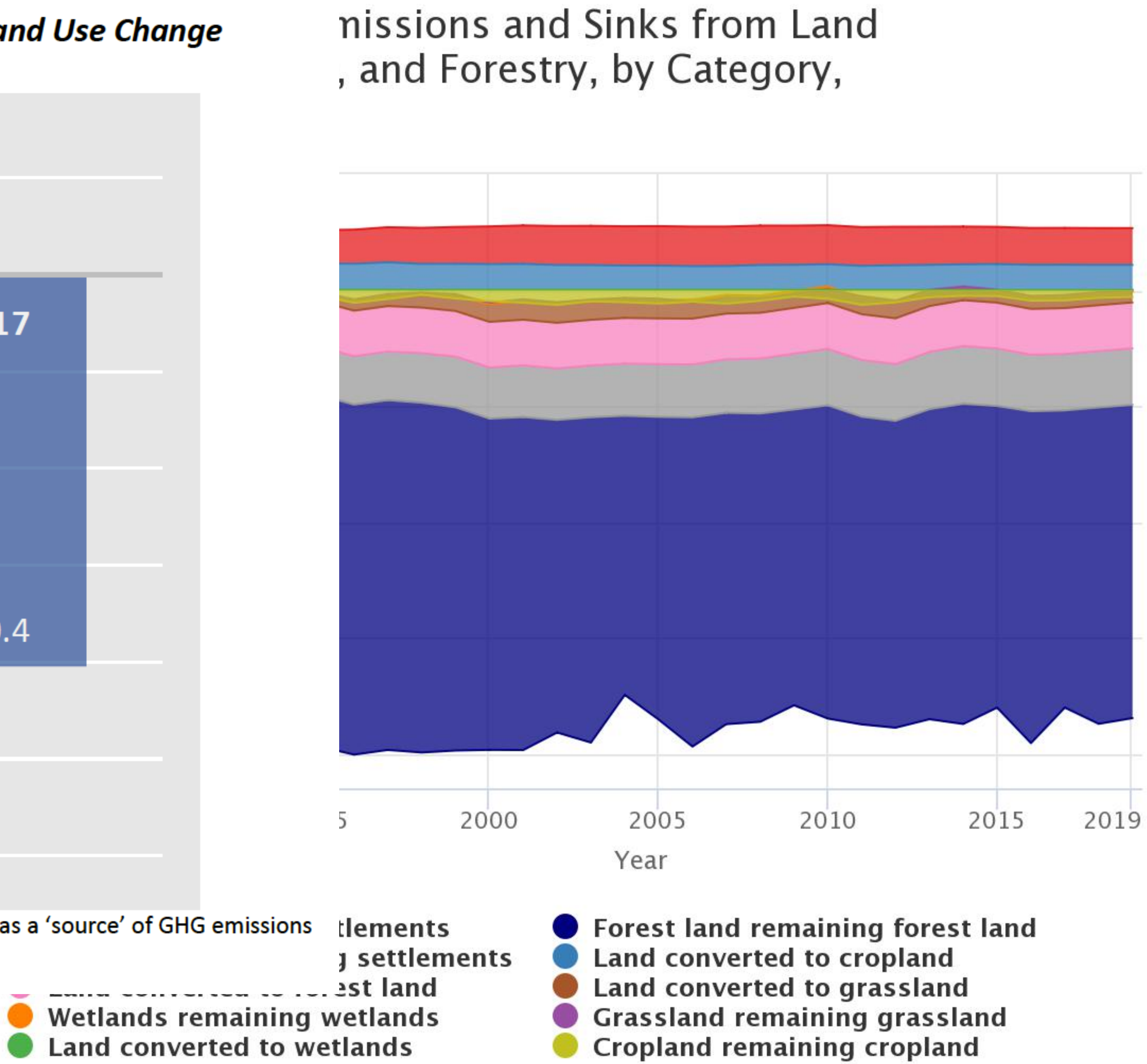


http://carbonfarmingsolution.com/carbon-sequestration-rates-and-stocks

Figure 4. Carbon Sequestration from Land-Use, Land Use Change and Forestry in Wisconsin

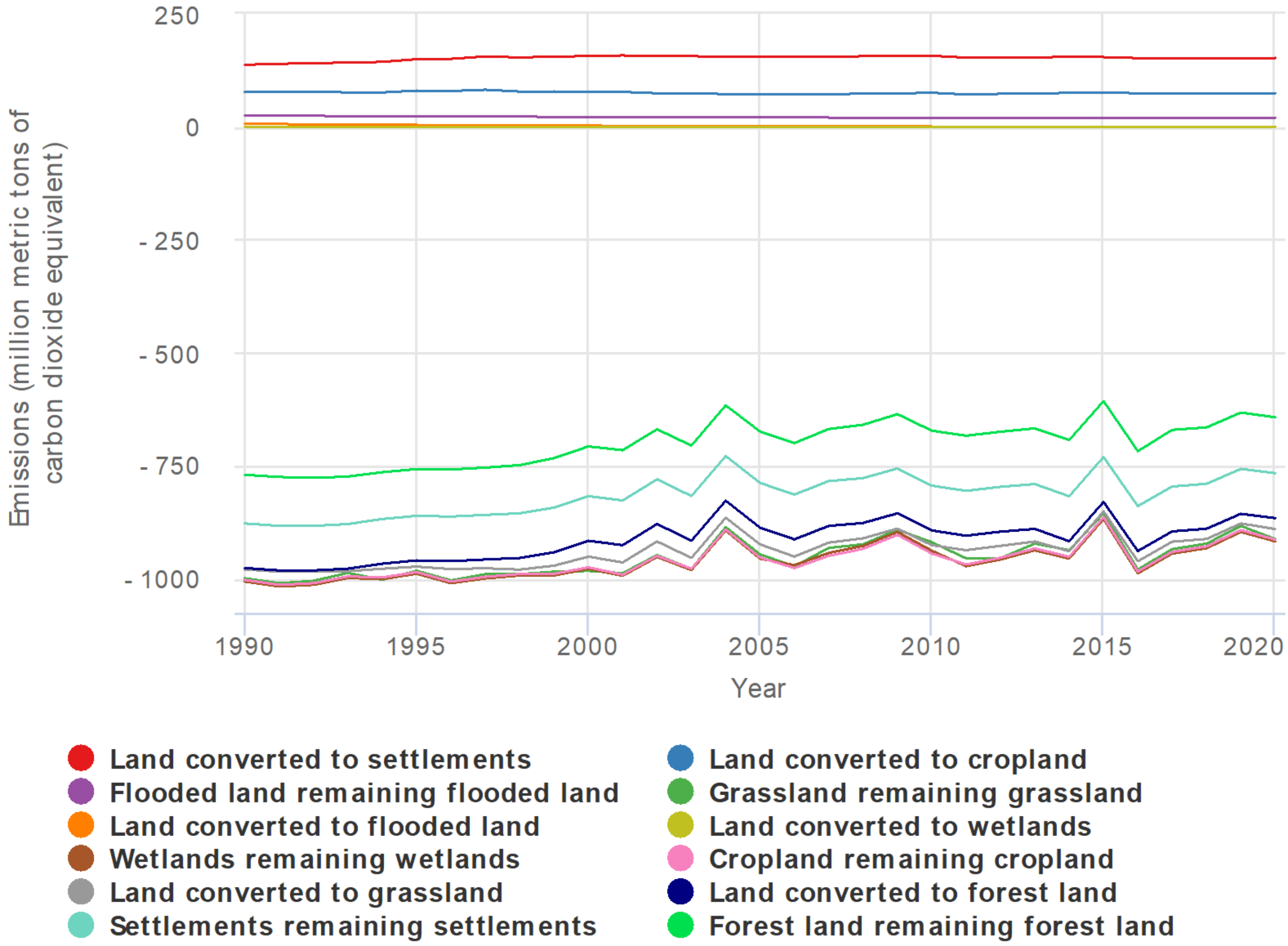


*Note: Values above zero on the chart above would indicate the sector was a 'source' of GHG emissions and negative values represent the sector is a 'sink' for GHG emissions.



Source: U.S. EPA's Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2019. https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks

U.S. Greenhouse Gas Emissions and Sinks from Land Use, Land-Use Change, and Forestry, by Category, 1990–2020



Source: U.S. EPA's Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2020. https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks

Percent change:

1990–2020

Land converted to settlements:
Emissions ▲ 28.1%

Land converted to cropland:
Emissions ▲ 5.0%

Flooded land remaining flooded land:
Emissions ▲ 9.3%

Grassland remaining grassland:
Emissions ▼ 27.9%

Land converted to flooded land:
Emissions ▼ 92.9%

Land converted to wetlands:
Emissions ▼ 77.0%

Wetlands remaining wetlands:
Sink ▲ 15.6%

Cropland remaining cropland:
Sink ▲ 0.7%

Land converted to grassland:
Sink ▲ 667.3%

Land converted to forest land:
Sink ▲ 0.9%

Settlements remaining settlements:
Sink ▲ 15.0%

Forest land remaining forest land:
Sink ▼ 16.6%

Net total: Sink ▼ 11.8%