Climate change and agriculture in the midwest

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What do we know about climate change?
How does it make you feel?  
About your research?  
About your farm?  
About anything?
Climate trends in the Midwest: \(-1.5 \, ^\circ F\) warmer

Temperatures are Rising in the Midwest

Pryor et al. 2014 NCA
Climate trends in the Midwest

Estimated warming by mid-century (2040-2070)
Climate trends in the Midwest

- Statewide Average Daily Winter Low Temperature
- 10 Warmest
- 9-Year Moving Average (Winter Lows)
- Average Rate of Change: +0.49 Degrees F per Decade
Climate trends in the Midwest

Trends in Flood Magnitude

Change per Decade (%)

Positive Trends

Negative Trends
Climate trends in the Midwest

Total Precipitation Percentiles
January–October 2019
Ranking Period: 1895–2019

National Centers for Environmental Information

Created: Mon Nov 04 2019
Data Source: 5km Gridded Dataset (nClimGrid)
Who is responsible?

Sources of Greenhouse Gas Emissions
by major sector

- electricity: 25%
- food, land use: 24%
- transportation: 21%
- industry: 6%
- buildings: 10%
- other energy: 14%
Who is responsible?

Greenhouse Gas Emissions by major gas

- CO₂ fossil fuels: 62%
- CH₄: 16%
- CO₂ chemicals: 3%
- N₂O: 6%
- CO₂ land use: 11%
- F-gases: 2%

(non-CO₂ gases converted with their equivalent "global warming potential")

DATA FROM EPA
IMAGE BY J. FOLEY, PROJECT DRAWDOWN
Emissions from Agriculture:

Greenhouse Gas Emissions
by major gas
(non-CO2 gases converted with their equivalent "global warming potential")

- CO2 fossil fuels: 62%
- CH4: 16%
- CO2 chemicals: 3%
- CO2 land use: 11%
- F-gases, N2O: 2%
Who is responsible?

- Fluorinated Gases: 3%
- Nitrous Oxide (N₂O): 6%
- Methane (CH₄): 10%
- Carbon Dioxide (CO₂): 82%

**Total U.S. Greenhouse Gas Emissions by Economic Sector in 2017**

- Transportation: 29%
- Electricity Generation: 28%
- Industry: 22%
- Agriculture: 9%
- Commercial: 6%
- Residential: 5%
How are these changes impacting agriculture?
Impacts: corn yield loss under warming

Low emissions model

High emissions model

2025

2075

2025

2075

RCP 4.5
Year: 2025

RCP 8.5
Year: 2025

More yield loss

Less yield loss
Impacts: sensitivity of yield loss

Williams et al. 2016
Winter warming leads to more pests

Corn rootworm optimal conditions

Last century vs. This century

Corn rootworm

Soybean aphid

Sets of 24 years
Flooding and crop loss
$33 Million damages May-April 2019 in MN
Oslo, MN, April 12 2019. credit: CBS News
Flooding and crop loss
$15-34 Million damages specifically to corn/soy in the Midwest
This map denotes the approximate location for each of the 14 separate billion-dollar weather and climate disasters that impacted the United States during 2019.
Impacts: sensitivity of yield loss

Williams et al. 2016
Impacts: sensitivity of yield loss
What is so great about Minnesota?

Williams et al. 2016
Impacts: sensitivity of yield loss

Why are Minnesota corn yields more stable?

Williams et al. 2016
Impacts: sensitivity of yield loss

Why are Minnesota corn yields more stable?

We have beautiful soils! Our soil has high water holding capacity to protect against drought.

Williams et al. 2016
SOILS STORE AND FILTER WATER

Soils improve food security and our resilience to floods and droughts
What is soil moisture?

Soil moisture content is the amount of water in the soil (by weight).

The maximum amount of water that a soil can retain depends on:

- the soil’s texture and structure
- organic matter content
- rooting depth

Soil organic matter can retain about 20 times its weight in water.

Healthy soils with a high organic matter content can store large amounts of water. This is crucial for maintaining food production while also improving resilience to floods and droughts.
Improving soil moisture

Many sustainable agricultural and land management practices can improve soil moisture retention:

soil moisture retention = buffer against drought = flood mitigation

Conservation tillage

Conservation agriculture Perennialization

Zero-tillage

Knowledge-based precision irrigation

Residue covers, cover crops and mulching
Improving soil moisture
Many sustainable agricultural and land management practices can improve soil moisture retention:

soil moisture retention = buffer against drought = flood mitigation

Also: VOTE,
Contact your elected officials to reduce emissions
Perennial agriculture as a climate solution: Meet Kernza®

Jerry Glover of The Land Institute: Photo by Jim Richardson
Even after 2 years, infiltration is higher in Kernza systems.

![Soil water dynamics graph](image)

- Alfalfa
- Kernza + Alfalfa
- Kernza + Manure
- Kernza + Urea
- Soy_corn_soy
- RC_Soy_Wheat

Photo credit: Carmen Fernholtz
Thanks!

If you want to hear more about Kernza®:
Saturday, 8:30 am “Perennial Future: Kernza”, room B

Photo credit: Carmen Fernholtz