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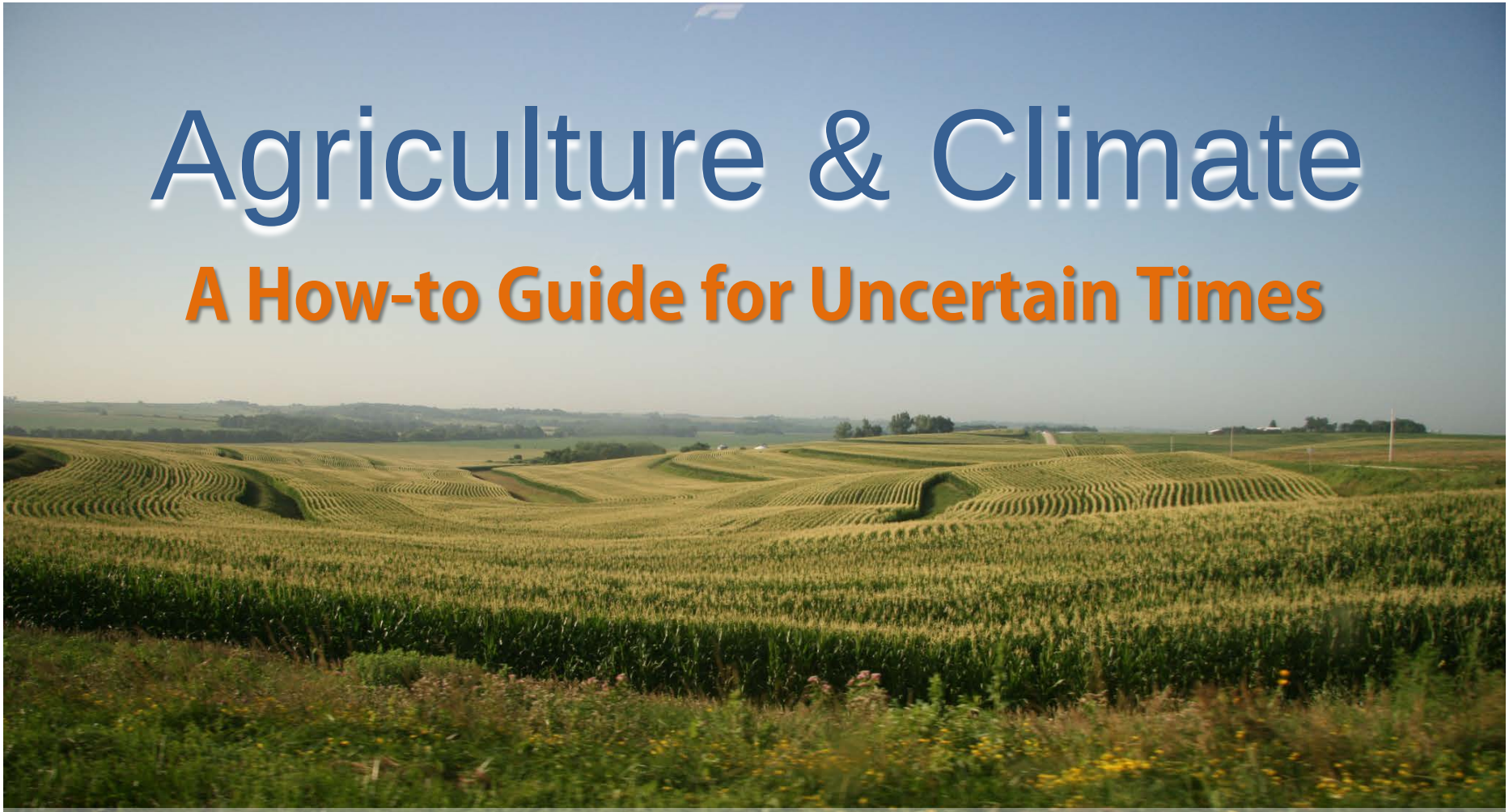
Agriculture & Climate

A How-to Guide for Uncertain Times



This research is part of a regional collaborative project supported by the USDA-NIFA Cropping Systems Coordinated Agricultural Project: Climate Change, Mitigation, and Adaptation in Corn-based Cropping Systems

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Cropping Systems Coordinated Agricultural Project

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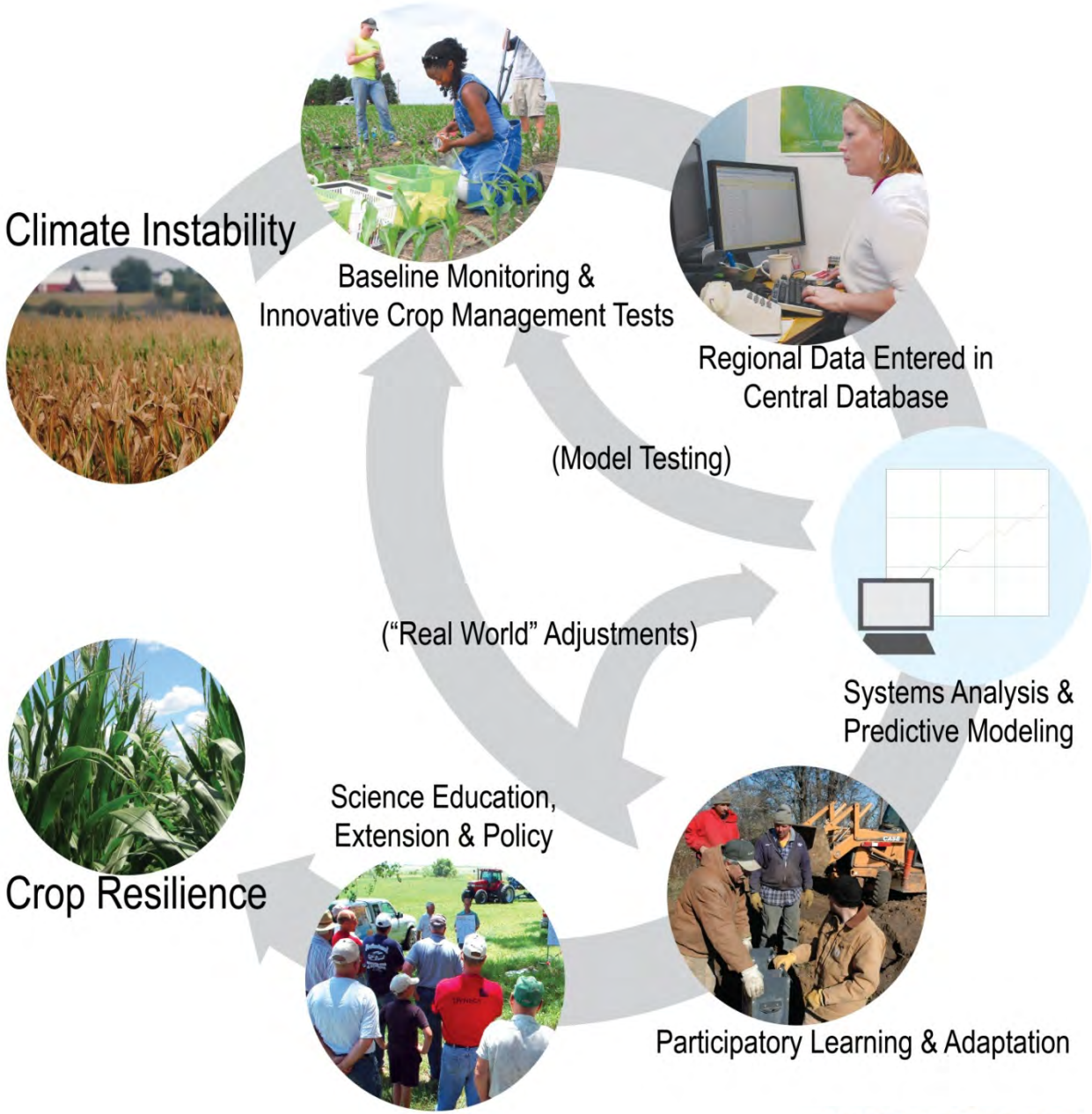

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Scientists and farmers working together to create a suite of practices for corn-based systems that:

- Are resilient in times of drought
- Reduce soil and nutrient losses under saturated soils and flood conditions
- Reduce farm field nitrogen losses
- Retain carbon in the soil
- Ensure crop and soil productivity

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- The New Normal
- The Good News
- The Bad News
- In-Field Solutions

Climate Change
The New Normal

Takle, Eugene S. (2011) Climate Change Science: A Basis for Agricultural Decision-Making. Presentation presented at the Heartland Climate Change Conference, 1-3 November 2011, Nebraska City, NE.

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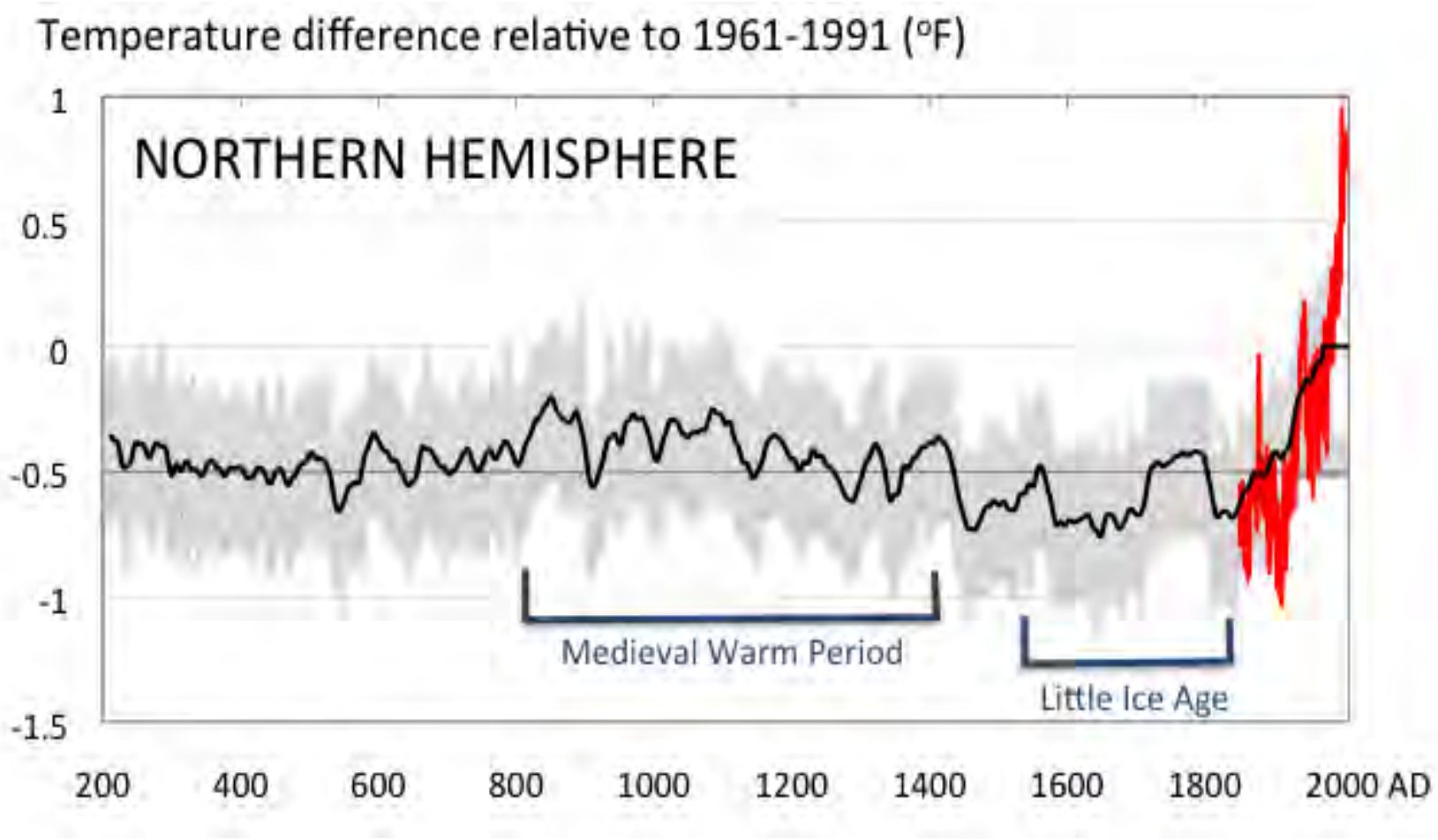

Conditions today are unusual in the context of the last 2000 years...

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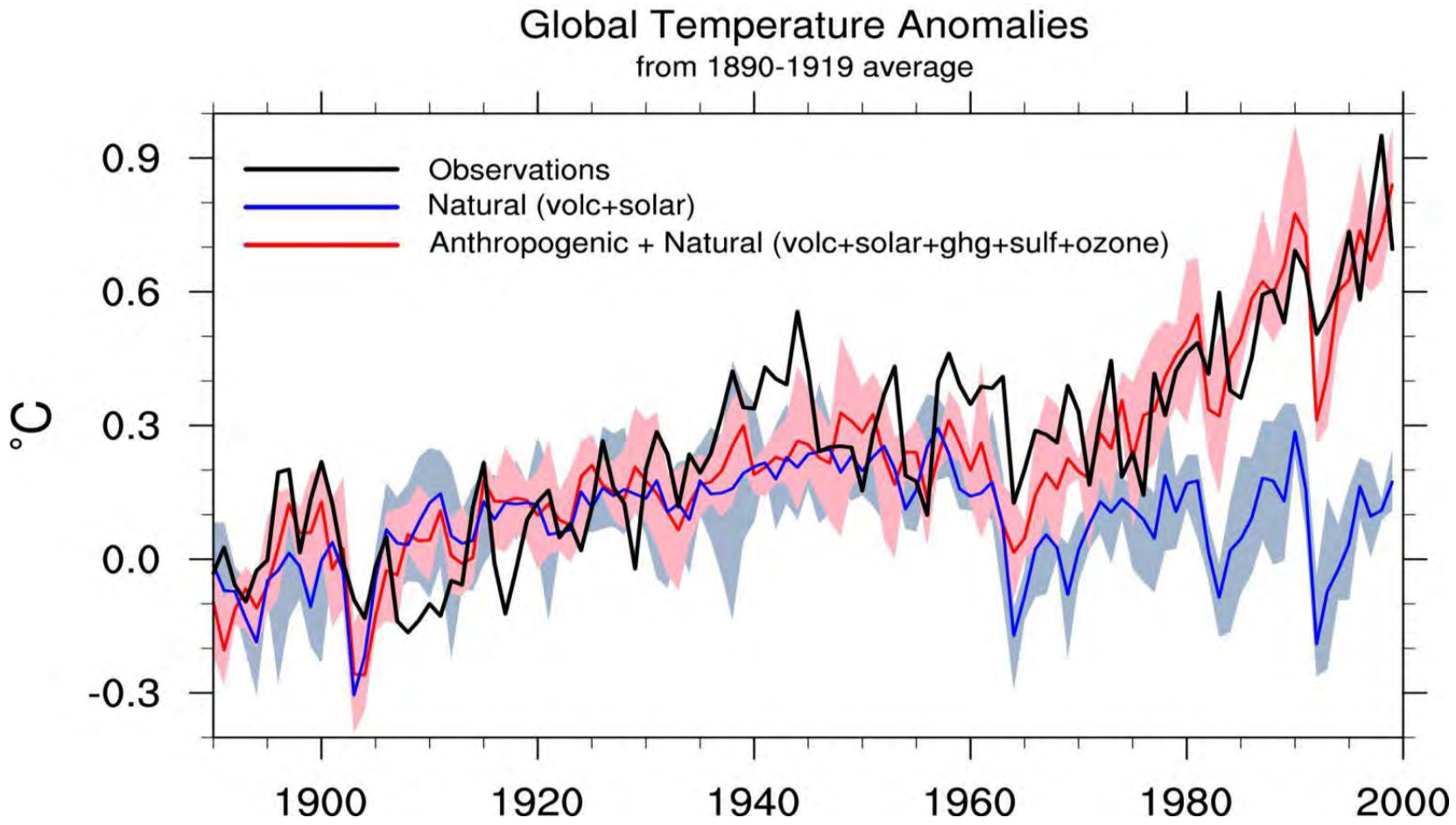

Natural & Man-made Processes

Takle, Eugene S. (2011) Climate Change Science: A Basis for Agricultural Decision-Making. Presentation presented at the Heartland Climate Change Conference, 1-3 November 2011, Nebraska City, NE.

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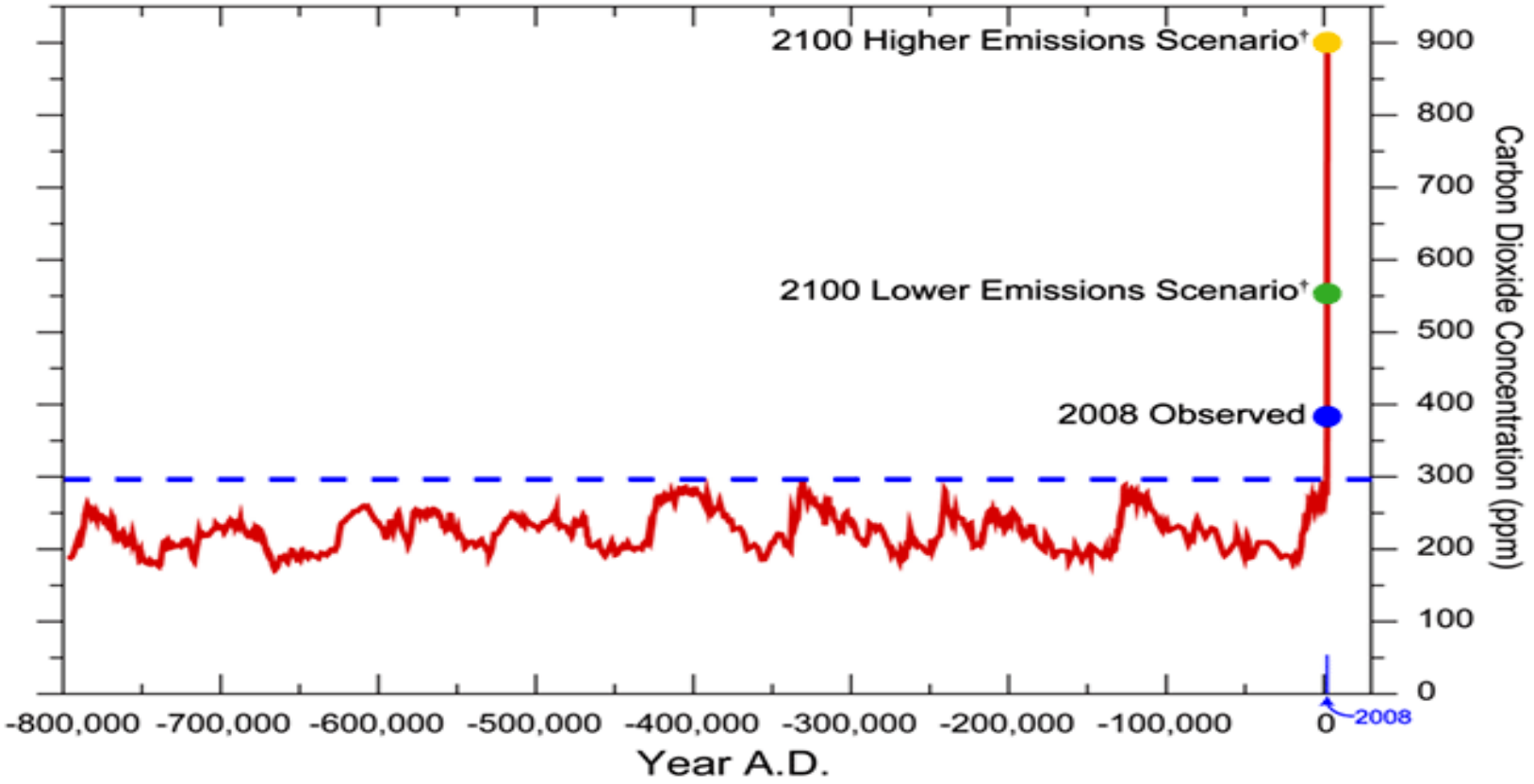
We have moved outside the range of historical variation



800,000 Year Record of Carbon Dioxide Concentration

Takle, Eugene S. (2011) Climate Change Science: A Basis for Agricultural Decision-Making. Presentation presented at the Heartland Climate Change Conference, 1-3 November 2011, Nebraska City, NE.

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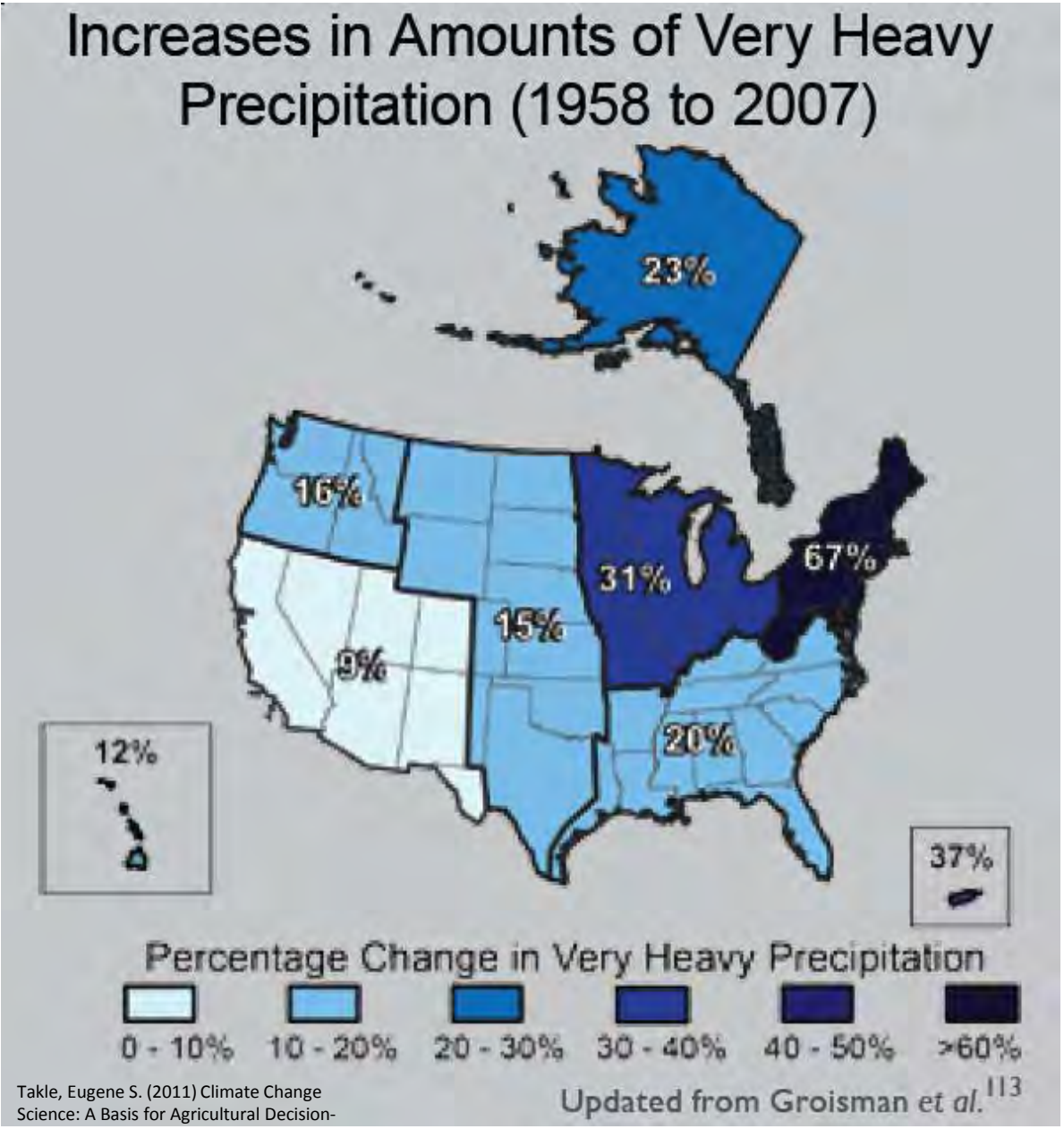

Takle, Eugene S. (2011) Climate Change Science: A Basis for Agricultural Decision-Making. Presentation presented at the Heartland Climate Change Conference, 1-3 November 2011, Nebraska City, NE.

And into the "new normal" of greater variability and unpredictability

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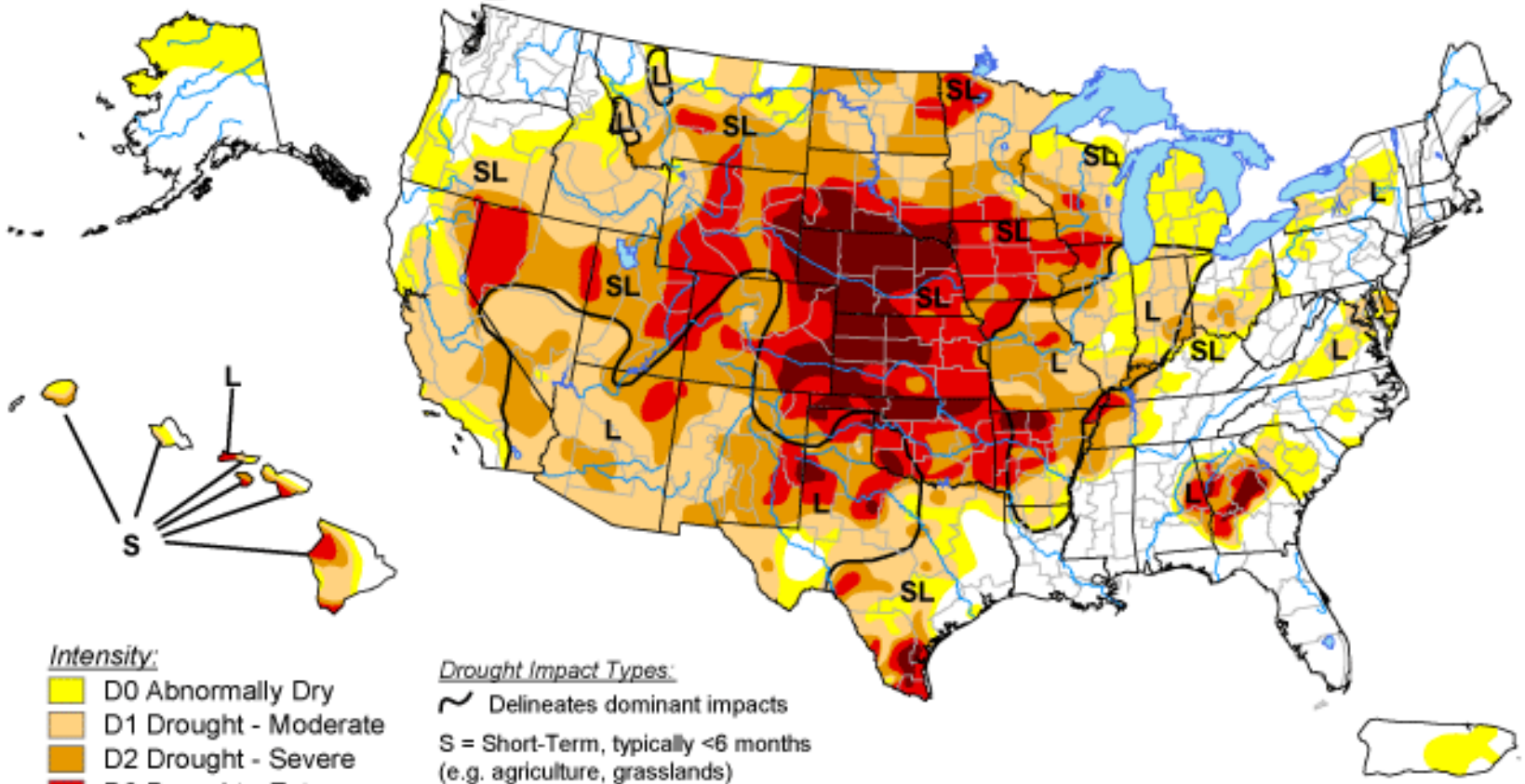
U.S. Drought Monitor

October 2, 2012
Valid 7 a.m. EDT



Intensity:
- D0 Abnormally Dry
- D1 Drought - Moderate
- D2 Drought - Severe
- D3 Drought - Extreme
- D4 Drought - Exceptional

Drought Impact Types:

Delineates dominant impacts

S = Short-Term, typically <6 months (e.g. agriculture, grasslands)

L = Long-Term, typically >6 months (e.g. hydrology, ecology)

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

http://droughtmonitor.unl.edu/

Released Thursday, October 4, 2012

Author: Anthony Artusa, NOAA/NWS/NCEP/CPC

Low statistical significance

Little significance for farmers and communities in the Midwest

Takle, Eugene S. (2011) Climate Change Science: A Basis for Agricultural Decision-Making. Presentation presented at the Heartland Climate Change Conference, 1-3 November 2011, Nebraska City, NE.

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The New Normal

- Volatility and irregularity of rainfall
- Greater temperature differentials season to season and year to year
- Decrease in overall regularity of weather patterns
- Increase in unpredictable conditions year to year

Takle, Eugene S. (2011) Climate Change Science: A Basis for Agricultural Decision-Making. Presentation presented at the Heartland Climate Change Conference, 1-3 November 2011, Nebraska City, NE.

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The Good News?

- Longer growing seasons
- More summer precipitation
- Fewer extreme heat events
- Higher humidity
- Drier autumns

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The Bad News

- Higher humidity
- Increase in CO_2 – a Greenhouse gas
- Waterlogged soils in spring
- Delayed fertilization application
- More soil erosion
- More weeds
- Decrease in water quality
- Increased risks for animal agriculture

Takle, Eugene S. (2011) Climate Change Science: A Basis for Agricultural Decision-Making. Presentation presented at the Heartland Climate Change Conference, 1-3 November 2011, Nebraska City, NE.

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Table of weather event trends and their effects

Weather Event	20th Century Trend?	21st Century Trend?	Is it beneficial?
Longer frost-free season	**Yes**	**Yes**	**Yes**
Higher winter temps	**Yes**	**Yes**	**Yes/No**
More freeze-thaw cycle	*Yes*	**Yes**	**Yes/No**
Warmer spring soil temps	**Yes**	**Yes**	**Yes**
Reduced risk of late spring freeze	*Yes*	**Yes**	**Yes**
Reduced risk of early fall freeze	*Yes*	**Yes**	**Yes**
More summer precipitation	**Yes**	*Yes/No*	**Yes/No**
More soil moisture	**Yes**	*Yes/No*	**Yes/No**
Higher CO_2	**Yes**	**Yes**	**Yes**
Higher water-use efficiency	*Yes*	**Yes**	**Yes**
Fewer extreme heat events	**Yes**	**No**	**Yes**
Drier autumns	**Yes**	**Yes**	**Yes**

Takle, Eugene S. (2011) Climate Change Science: A Basis for Agricultural Decision-Making. Presentation presented at the Heartland Climate Change Conference, 1-3 November 2011, Nebraska City, NE.

Bold=high confidence; *Italicized*=less confidence

Table of weather event trends and their effects, continued…

Weather Related Event	20th Century Trend?	21st Century Trend?	Is it beneficial?
More overwintering of pests	*Yes*	**Yes**	**No**
Wetter springs	**Yes**	**Yes**	**No**
Waterlogged soils in spring	**Yes**	**Yes**	**No**
Reduced water quality	**Yes**	**Yes**	**No**
More vigorous weed growth	*Yes*	**Yes**	**No**
Higher humidity	**Yes**	**Yes**	**No**
More intense rain events	**Yes**	**Yes**	**No**
Wetter summers	**Yes**	*Yes*	**No**
More droughts	**No**	*Yes*	**No**

Bold=high confidence; *Italicized*=less confidence

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Near-Term Challenges to Midwest Agriculture Due to Climate Change

Wetter spring and early summer:

- Continued challenges to early field work
- More soil compaction
- Delayed planting

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Near-Term Challenges to Midwest Agriculture Due to Climate Change

More frequent and higher-intensity extreme rain events:

- Water-logged soils
- Lack of oxygen to roots
- More ponding
- Flooding downstream urban areas
- Loss of nitrogen from the field

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Near-Term Challenges to Midwest Agriculture Due to Climate Change

Higher daily average temperatures (due to higher night-time temperatures):

- Pollination failure
- Reduced grain weight
- Loss of soil carbon

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Near-Term Challenges to Midwest Agriculture Due to Climate Change

Increased humidity:

- More pressure from pests and pathogens
- Multiple stressors

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Long-Term Challenges to Midwest Agriculture Due to Climate Change

Drought pattern from the west or south occasionally spills into the Midwest:

- Underlying warming pattern unmasked
- Difficult to maintain high yields
- Prairie fires
- Wind erosion of soils

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Long-Term Challenges to Midwest Agriculture Due to Climate Change

Overwintering of pests and pathogens

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Long-Term Challenges to Midwest Agriculture Due to Climate Change

Sustaining agricultural production will become increasingly difficult with more frequent and extreme weather events

Schnepf, Max and Craig Cox, eds. (2006) Environmental Benefits of Conservation on Cropland: The Status of Our Knowledge. Ankeny, IA: Soil and Water Conservation Society.

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Midwest Farming Solutions

We can adapt our in-field practices to help decrease the short- and long-term impacts of severe and unexpected weather events.

Knowledge, resources and the willingness to adapt can minimize vulnerability and risks.

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In-field practices can help manage cropping systems in changing conditions

- Too much water
- Not enough water
- Prevent nutrient loss
- Increase soil carbon
- Protect topsoil
- Manage pests and weeds

When there is too much water…

- Cover Crops & Crop Rotation
- Conservation Tillage
- Diversions and Water Control Basins
- Filter Strips
- Surface and Subsurface Drainage

Photograph courtesy of NRCS

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Cover crops increase water infiltration and overall storage capacity of the land

Crop rotations also increases water storage capacity of a field

Cover Crops and Crop Rotations

Schnepf, Max and Craig Cox, eds. (2006) Environmental Benefits of Conservation on Cropland: The Status of Our Knowledge. Ankeny, IA: Soil and Water Conservation Society.

Conservation tillage practices, such as no-till and ridge-till, increase in-field water infiltration over the medium term

No-till, in particular, increases soil drainage

Conservation Tillage

Schnepf, Max and Craig Cox, eds. (2006) Environmental Benefits of Conservation on Cropland: The Status of Our Knowledge. Ankeny, IA: Soil and Water Conservation Society.

Preserve the storage capacity of reservoirs, wetlands, ditches, canals, waterways and streams

Protect terraces

Reduce damages from upland runoff

Diversions and Water Control Basins

Schnepf, Max and Craig Cox, eds. (2006) Environmental Benefits of Conservation on Cropland: The Status of Our Knowledge. Ankeny, IA: Soil and Water Conservation Society.

- Direct the flow of water
- Control and reduce erosion
- Protect or improve water quality
- Maintain or enhance watershed functions

Grass Waterways & Filter Strips

Schnepf, Max and Craig Cox, eds. (2006) Environmental Benefits of Conservation on Cropland: The Status of Our Knowledge. Ankeny, IA: Soil and Water Conservation Society.

- Collect and/or convey drainage water
- Regulate water table and ground water flows
- Remove surface runoff

Surface and Subsurface Drainage

Schnepf, Max and Craig Cox, eds. (2006) Environmental Benefits of Conservation on Cropland: The Status of Our Knowledge. Ankeny, IA: Soil and Water Conservation Society.

When there is not enough water…

Cover Crops

Conservation Tillage

Photo by Charles Wittman, ISU Extension

Increase...

- Soil moisture
- Water infiltration
- Water storage capacity of a field
- Tolerance to intermittent drought

Cover Crops

Schnepf, Max and Craig Cox, eds. (2006) Environmental Benefits of Conservation on Cropland: The Status of Our Knowledge. Ankeny, IA: Soil and Water Conservation Society.

Increase...

- Water infiltration
- Water retention
- Water holding capacity in the soil profile over time

Conservation Tillage

Schnepf, Max and Craig Cox, eds. (2006) Environmental Benefits of Conservation on Cropland: The Status of Our Knowledge. Ankeny, IA: Soil and Water Conservation Society.

To prevent nutrient loss…

- Terraces
- Grassed waterways and filter strips
- Tile line drainage innovations
- Precision land forming
- Conservation tillage
- Crop rotation
- Precision nutrient management

Photo courtesy of NRCS

Significantly reduce N and P loss by intercepting runoff and promoting vegetative uptake

Terraces

Schnepf, Max and Craig Cox, eds. (2006) Environmental Benefits of Conservation on Cropland: The Status of Our Knowledge. Ankeny, IA: Soil and Water Conservation Society.

Reduce nutrient loss and improve or protect water quality

Grassed Waterways & Filter Strips

Schnepf, Max and Craig Cox, eds. (2006) Environmental Benefits of Conservation on Cropland: The Status of Our Knowledge. Ankeny, IA: Soil and Water Conservation Society.

Controlled Drainage Systems, Bioreactors, and other drainage technologies can minimize N loss

Tile Drainage Innovations

Schnepf, Max and Craig Cox, eds. (2006) Environmental Benefits of Conservation on Cropland: The Status of Our Knowledge. Ankeny, IA: Soil and Water Conservation Society.

Keeping residue on the field reduces loss of N and P by decreasing soil erosion and run-off

Conservation Tillage

Schnepf, Max and Craig Cox, eds. (2006) Environmental Benefits of Conservation on Cropland: The Status of Our Knowledge. Ankeny, IA: Soil and Water Conservation Society.

Increases nutrient use efficiency due to differing needs of each crop

When legumes are in the rotation, they fix nitrogen in the field

Photo courtesy of NRCS

Crop Rotations

Decreases excessive N use

Uses real-time N measurements to determine crop need and application rates

Precision Nutrient Management

Schnepf, Max and Craig Cox, eds. (2006) Environmental Benefits of Conservation on Cropland: The Status of Our Knowledge. Ankeny, IA: Soil and Water Conservation Society.

To increase soil carbon…

Photo courtesy of NRCS

- No-till
- Conservation Tillage
- Crop Rotation
- Cover Crops

Increases soil organic matter (carbon) in the soil

Improves soil structure and carbon cycling

Conservation Tillage and No-Till

Schnepf, Max and Craig Cox, eds. (2006) Environmental Benefits of Conservation on Cropland: The Status of Our Knowledge. Ankeny, IA: Soil and Water Conservation Society.

Increases carbon when high residue crops are included in the rotation

Crop Rotation

Schnepf, Max and Craig Cox, eds. (2006) Environmental Benefits of Conservation on Cropland: The Status of Our Knowledge. Ankeny, IA: Soil and Water Conservation Society.

Increase carbon and soil biological activity

Cover Crops

Schnepf, Max and Craig Cox, eds. (2006) Environmental Benefits of Conservation on Cropland: The Status of Our Knowledge. Ankeny, IA: Soil and Water Conservation Society.

To prevent soil loss…

Photo courtesy of NRCS

- No-till and Conservation Tillage
- Terraces
- Cover Crops
- Grassed Waterways

Decreases erosion and soil compaction

No-till resists soil dispersion

Conservation Tillage and No-Till

Schnepf, Max and Craig Cox, eds. (2006) Environmental Benefits of Conservation on Cropland: The Status of Our Knowledge. Ankeny, IA: Soil and Water Conservation Society.

Retain surface runoff

Enhance soil conservation

Terraces

Schnepf, Max and Craig Cox, eds. (2006) Environmental Benefits of Conservation on Cropland: The Status of Our Knowledge. Ankeny, IA: Soil and Water Conservation Society.

Photo courtesy of NRCS

Reduce runoff by holding sediment and soil in place

Cover Crops

Schnepf, Max and Craig Cox, eds. (2006) Environmental Benefits of Conservation on Cropland: The Status of Our Knowledge. Ankeny, IA: Soil and Water Conservation Society.

- Direct water flow
- Control erosion
- Convey runoff to designated areas
- Protect or improve water quality

Grassed Waterways

Schnepf, Max and Craig Cox, eds. (2006) Environmental Benefits of Conservation on Cropland: The Status of Our Knowledge. Ankeny, IA: Soil and Water Conservation Society.

To manage pests and weeds…

- Cover Crops
- Crop Rotation

Aid in weed suppression for current and subsequent crop plantings

Can break disease and pest cycles

Cover Crops

Schnepf, Max and Craig Cox, eds. (2006) Environmental Benefits of Conservation on Cropland: The Status of Our Knowledge. Ankeny, IA: Soil and Water Conservation Society.

Aids in weed suppression for current and subsequent crop plantings

Can break disease and pest cycles

Crop Rotation

Schnepf, Max and Craig Cox, eds. (2006) Environmental Benefits of Conservation on Cropland: The Status of Our Knowledge. Ankeny, IA: Soil and Water Conservation Society.

The Prognosis?

- ***Revisit your 3 or 4 main points, and note them on this slide***
- ***and make a closing statement***

References

- Slides 2-6; 8-20 modified from

Takle, Eugene S. (2011) Climate Change Science: A Basis for Agricultural Decision-Making. Presentation presented at the Heartland Climate Change Conference, 1-3 November 2011, Nebraska City, NE.

- Information from slides 24-29, 31, 32, 34-40, 42-44, 46-49, 51, 52 found in

Schnepf, Max and Craig Cox, eds. (2006) Environmental Benefits of Conservation on Cropland: The Status of Our Knowledge. Ankeny, IA: Soil and Water Conservation Society.

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Prepared by Jon Wolseth in cooperation with the USDA NIFA Heartland Regional Water Coordination Initiative

For more information:
www.sustainablecorn.org

Your contact information here:

This research is part of a regional collaborative project supported by the USDA-NIFA
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Climate Change, Mitigation, and Adaptation in Corn-based Cropping Systems