Cropping Systems Coordinated Agricultural Project: Extended Rotations

Joe Lauer, Emerson Nafziger, Maciej Kazula, Maria Villamil, Gevan Behnke, and Thierno Diallo

University of Wisconsin and University of Illinois

Iowa State University, Ames, IA

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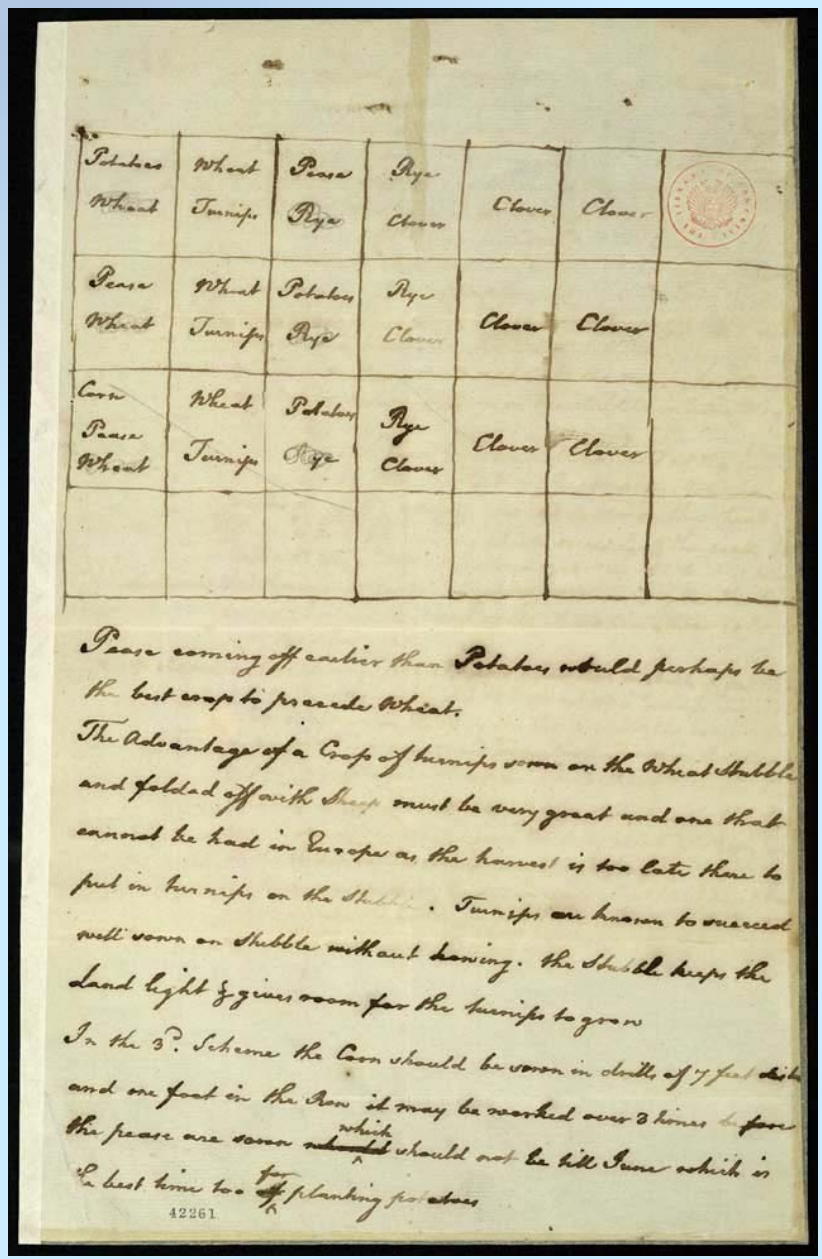
http://corn.agronomy.wisc.edu

UW Extension
University of Wisconsin-Extension

Crop rotation plan for Monticello



- Thomas Jefferson used a scientific approach to farming
  - ✓ Carefully considered a workable method of crop rotation for Monticello
  - ✓ An innovative practice at the time
- The corn-soybean system of the U.S. Corn Belt is a relatively young cropping system.
  - ✓ Currently challenged by many abiotic and biotic factors
  - ✓ Is it sustainable?

The Wisconsin and Illinois Rotation Trials

Corn-Soybean-Oat-Alfalfa-Wheat
Lancaster since 1966
CC
CSCOA
CCCOA
CCOAA
COAAA:*1966-1976*
CCAA:*1977-1986*
AA:*1977-2004*
CS:*1987-*
CA:*1987-2004*
CSW:*2005-*

Corn N rate
1966-76: 0, 75, 150, 300
1977- : 0, 50, 100, 200

Systems Trials
Soils *1958-*
Weeds *1987-*
WICST *1990-*
GLBRC *2009-*

Corn-Soybean
since 1983
CC
SS
CS
CCCCCSSSSS

Tillage=2
N rate
Cultivar
Population
Row spacing
Seed insecticide
N timing
N source

Corn-Alfalfa
ARL and MAR since 2010
CC
CCAAA
CCAA
CCAA biomass

Tillage
since 2001
CC
CS

Tillage=6
Starter
Planting date

BioChar
since 2009
CC
CS

Tillage=2
BioChar

Corn-Soybean-Wheat
MON and PER since 1996
CC
SS
CS
CSW
CWS

Tillage=2

Corn-Soybean-Wheat
1984 to 2000
CC
SS
CS
CSW:*1984-1994*
CCS:*1995-2000*
CCCS:*1995-2000*

Corn-Soybean-Wheat
ARL & MAR since 2002
CC
SS
WW
CS
CSW
CWS
CWS biomass

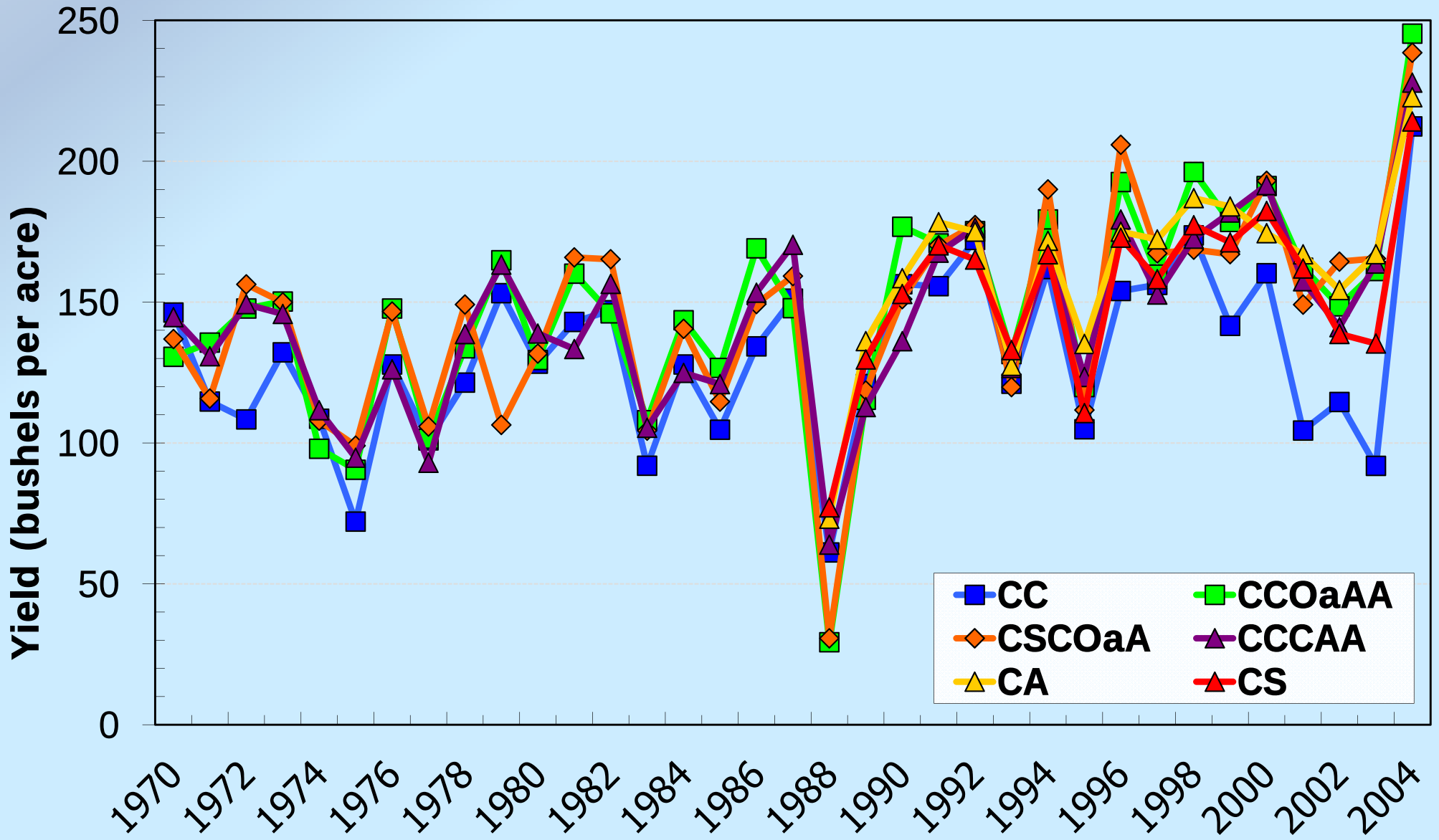
Seed fungicide
Foliar fungicide
Fusarium management

Photo by Justin Hopf

Overview

- Objective: To compare GHG emissions of extended crop rotations.
- What are we looking for?
  - ✓ What is the experimental unit?
  - ✓ How can we tell if change is occurring?
- Crop Rotation
  - ✓ The control (Corn-Soybean)
  - ✓ Options (CC, CCS, etc.)
  - ✓ Extended – Adding a third crop (CSW)
- GHG Emissions
- Soil changes

Corn Yields in the Lancaster Rotation Experiment (Analysis over time: 1970-2004)



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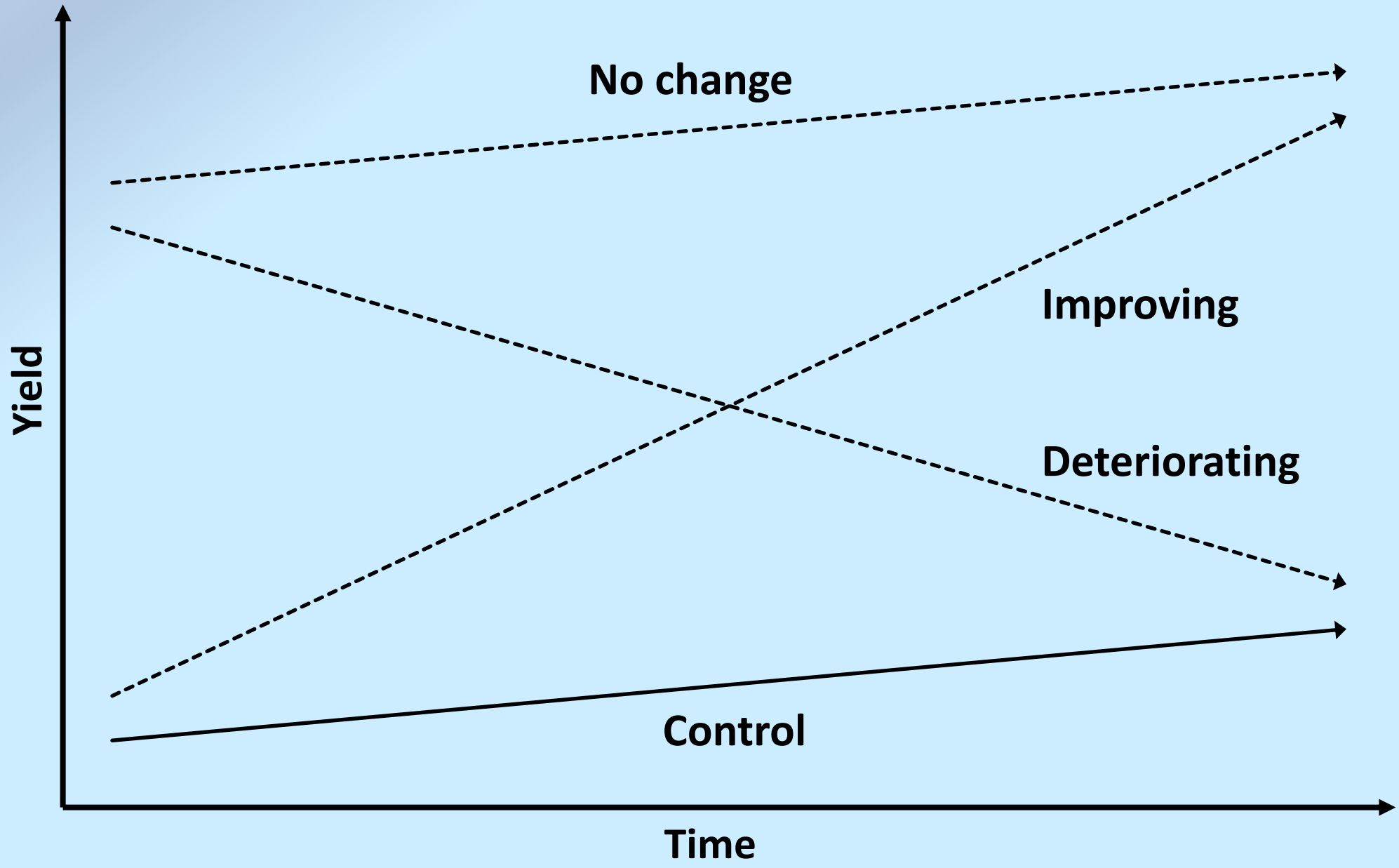
Stanger and Lauer, 2008

What is the experimental unit?
Analysis over Time and Space (1-yr, 2-yr and 3-yr Cycles)

Year	Cycle	CC	Cycle	CS		Cycle	CSW		
2011	1	C	1	C	S	1	C	S	W
2012	2	C	1	S	C	1	W	C	S
2013	3	C	2	C	S	1	S	W	C
2014	4	C	2	S	C	2	C	S	W
2015	5	C	3	C	S	2	W	C	S
2016	6	C	3	S	C	2	S	W	C

How can you tell if a cropping system is changing?



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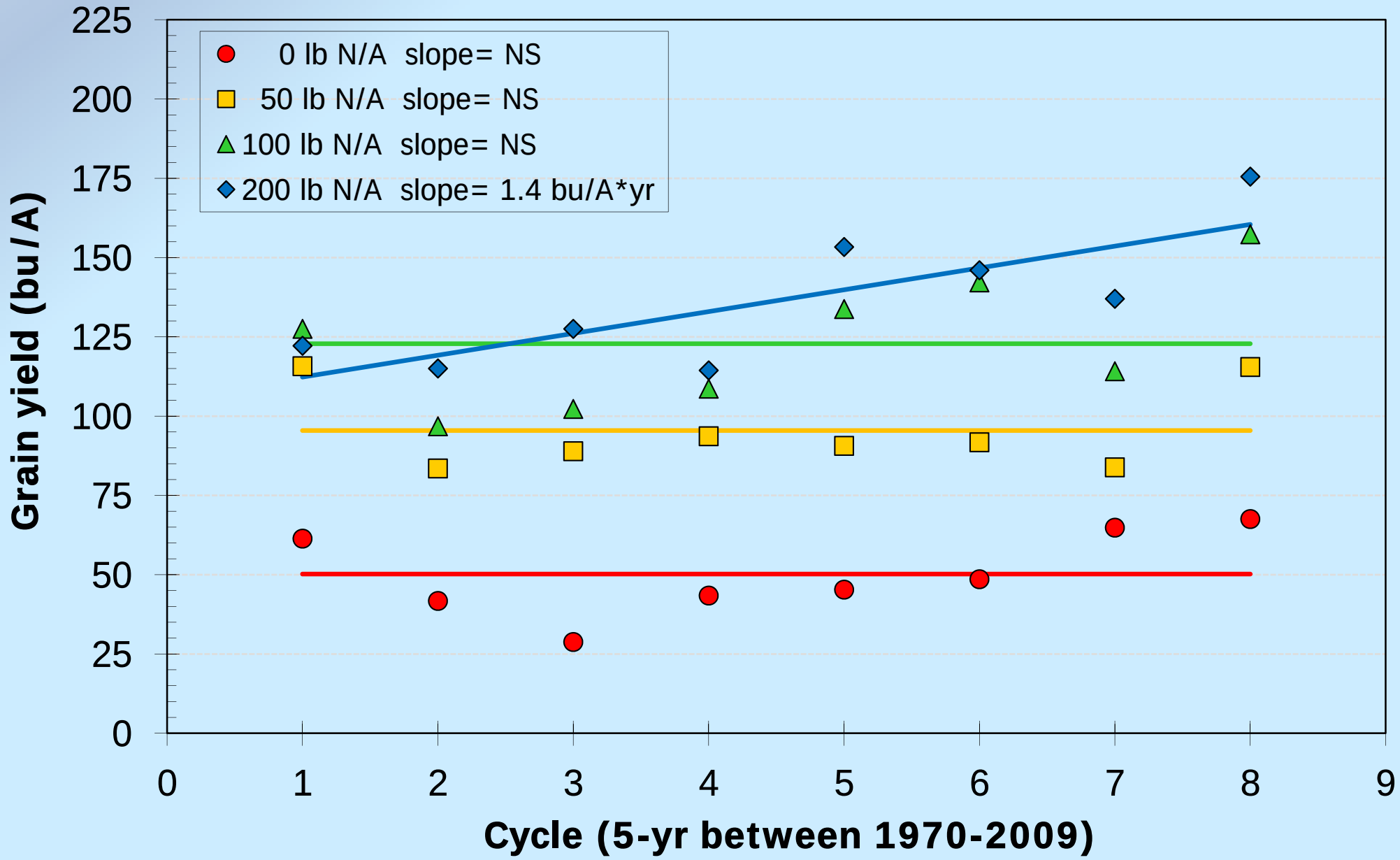
Continuous corn grain yield response to N rate (over time and space) at Lancaster, WI.



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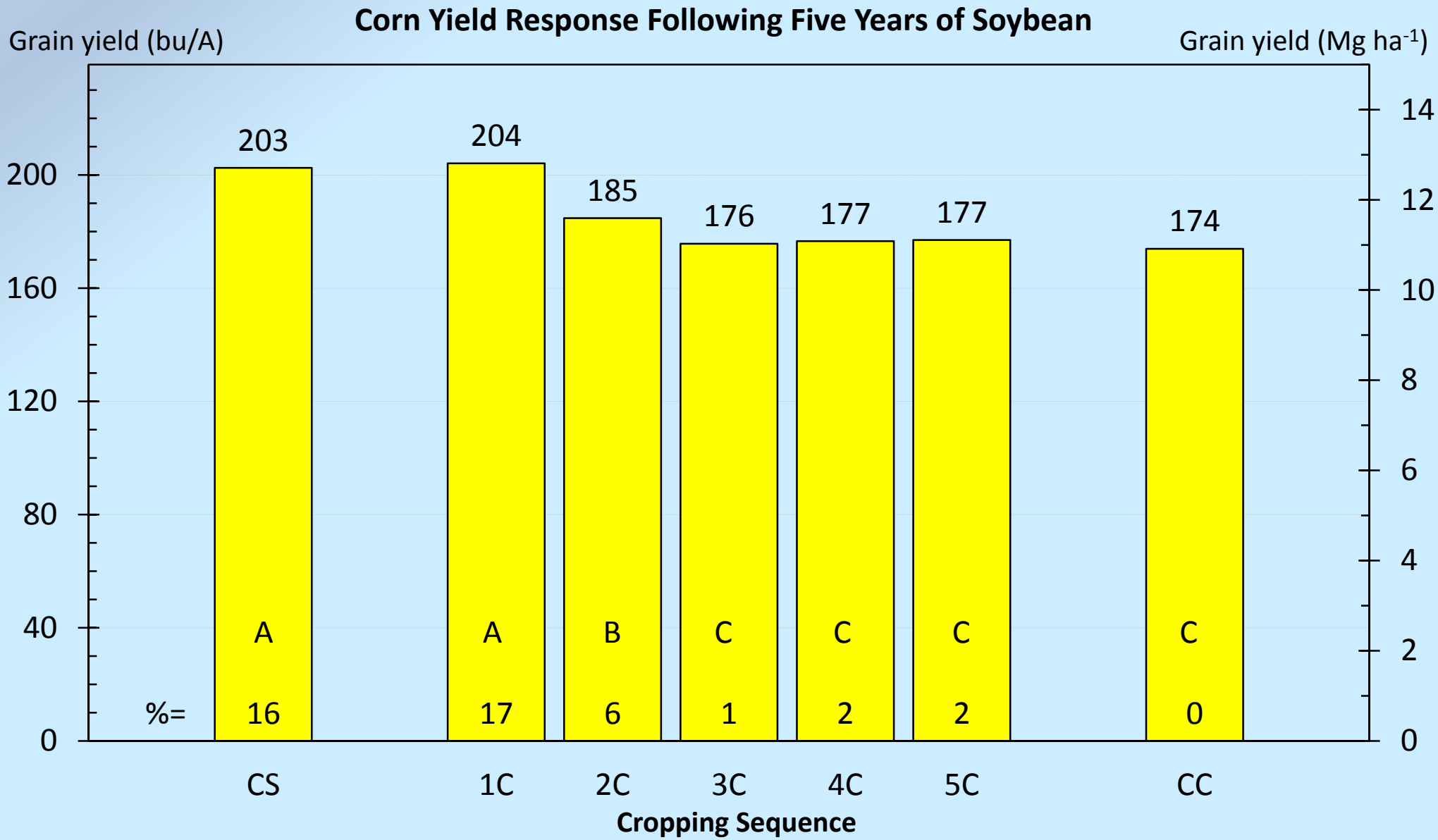
Crop Sequence for 2-Crop Rotation Experiment at Arlington, WI (C= Corn, S= Soybean)

Rotation Sequence	Year									
	1	2	3	4	5	6	7	8	9	10
1	C	C	C	C	C	C	C	C	C	C
2	S	S	S	S	S	S	S	S	S	S
3	C	S	C	S	C	S	C	S	C	S
4	S	C	S	C	S	C	S	C	S	C
5	C	C	C	C	C	S	S	S	S	S
6	C	C	C	C	S	S	S	S	S	C
7	C	C	C	S	S	S	S	S	C	C
8	C	C	S	S	S	S	S	C	C	C
9	C	S	S	S	S	S	C	C	C	C
10	S	S	S	S	S	C	C	C	C	C
11	S	S	S	S	C	C	C	C	C	S
12	S	S	S	C	C	C	C	C	S	S
13	S	S	C	C	C	C	C	S	S	S
14	S	C	C	C	C	C	S	S	S	S

The rotation effect lasts two years increasing corn grain yield 16 to 17% for CS/1C and 6% for 2C …



C= Corn, S= Soybean, 1C= First year corn, 2C= Second year corn … CC= Continuous corn

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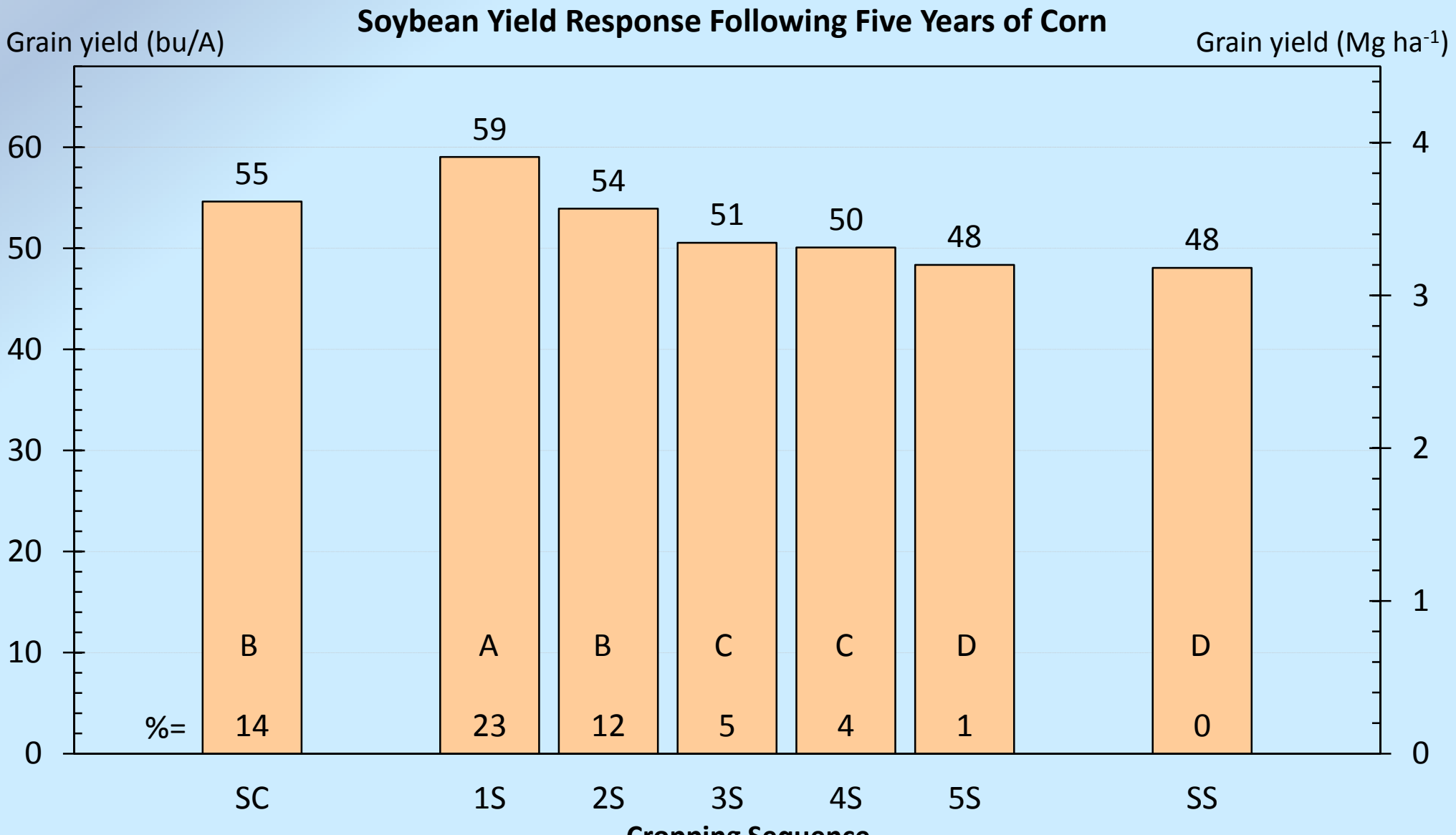
Lauer, 1993-2012 (Arlington, Control treatments)

The rotation effect is greater for 1S than SC. Yield decreases in 2S and still further in 3S …



C= Corn, S= Soybean, 1S= First year soybean, 2S= Second year soybean … SS= Continuous soybean

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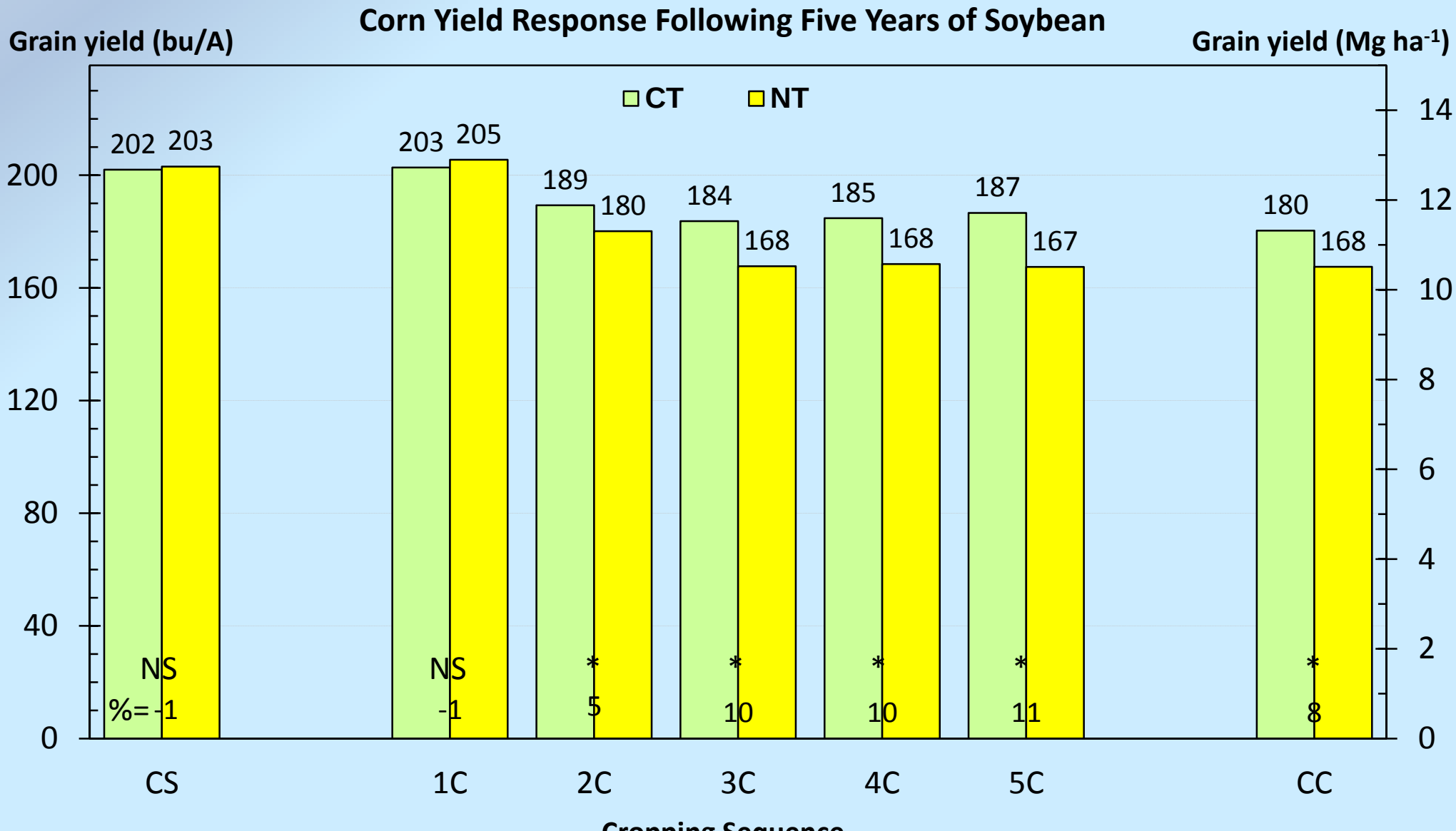
Lauer, 1993-2012 (Arlington, Control treatments)

Tillage does not affect corn yield in CS/1C, but improves yield 5% in 2C, and 10% in 3C …



C= Corn, S= Soybean, 1C= First year corn, 2C= Second year corn … CC= Continuous corn

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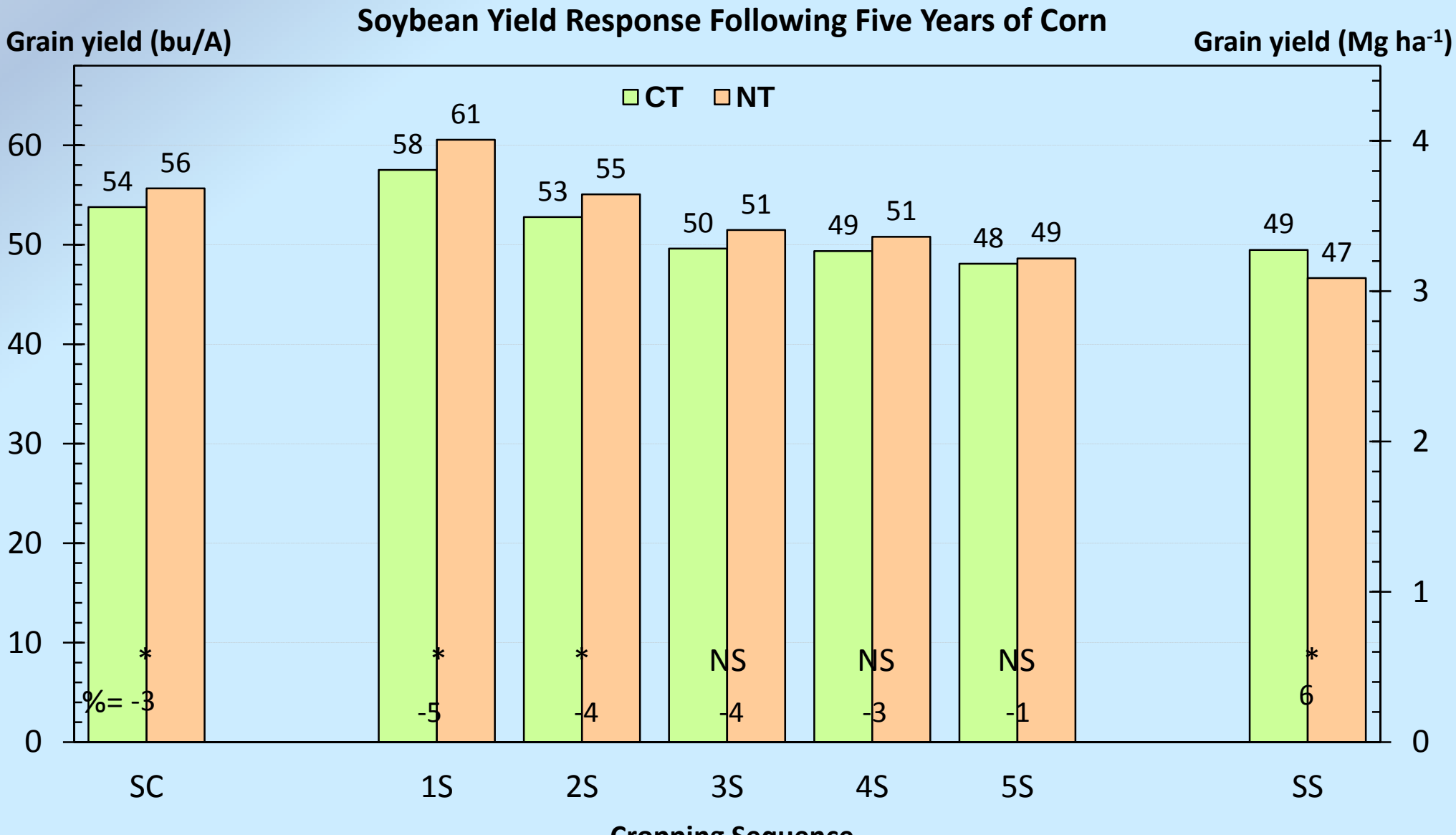
Lauer, 1993-2012 (Arlington, Control treatments)

No-till increases soybean yield in CS, 1C and 2C. Tillage increases yield in continuous soybean.



C= Corn, S= Soybean, 1S= First year soybean, 2S= Second year soybean … SS= Continuous soybean

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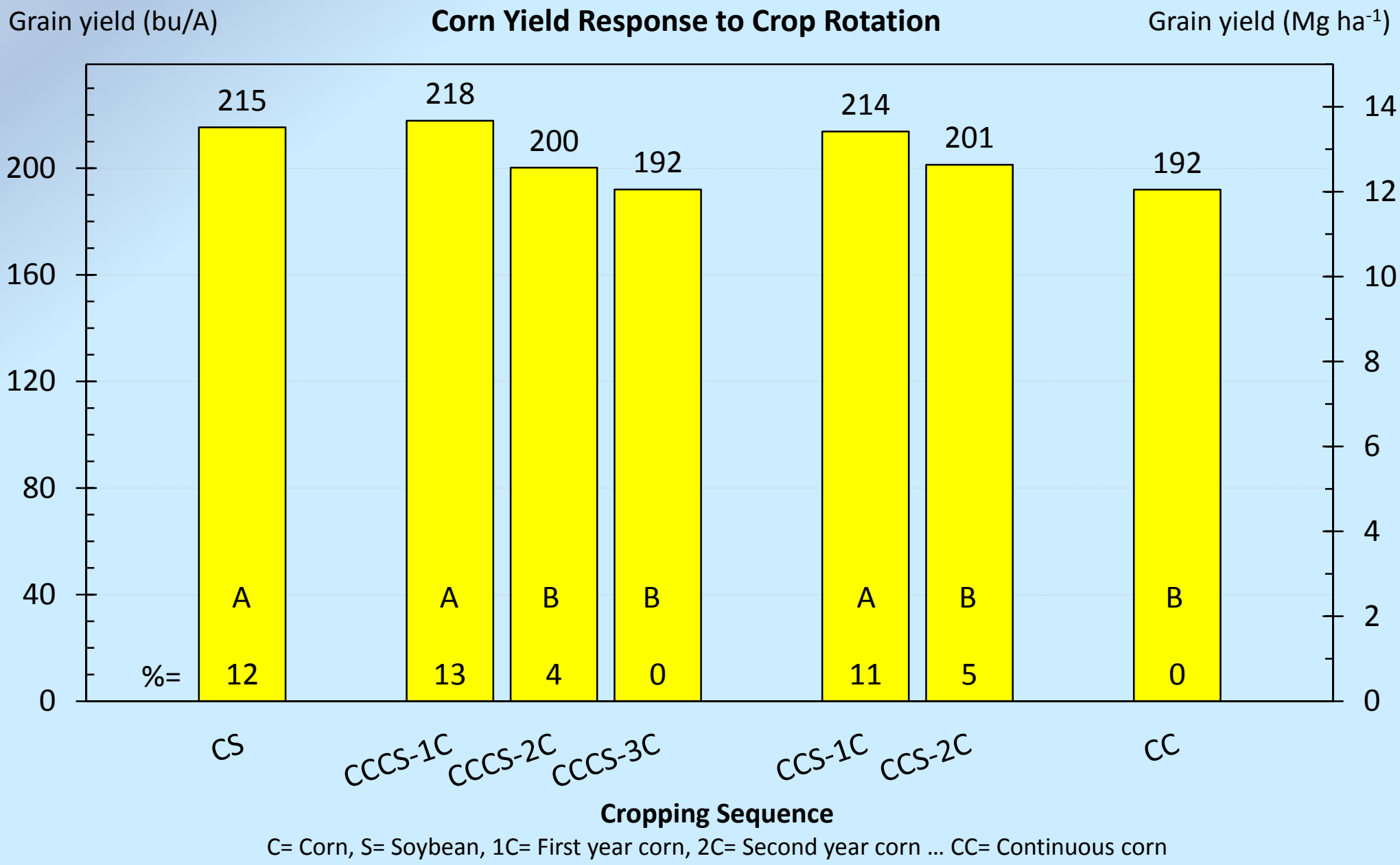
Lauer, 1993-2012 (Arlington, Control treatments)

If there is only a one year break in the rotation, then the second corn phase is equivalent to continuous corn …



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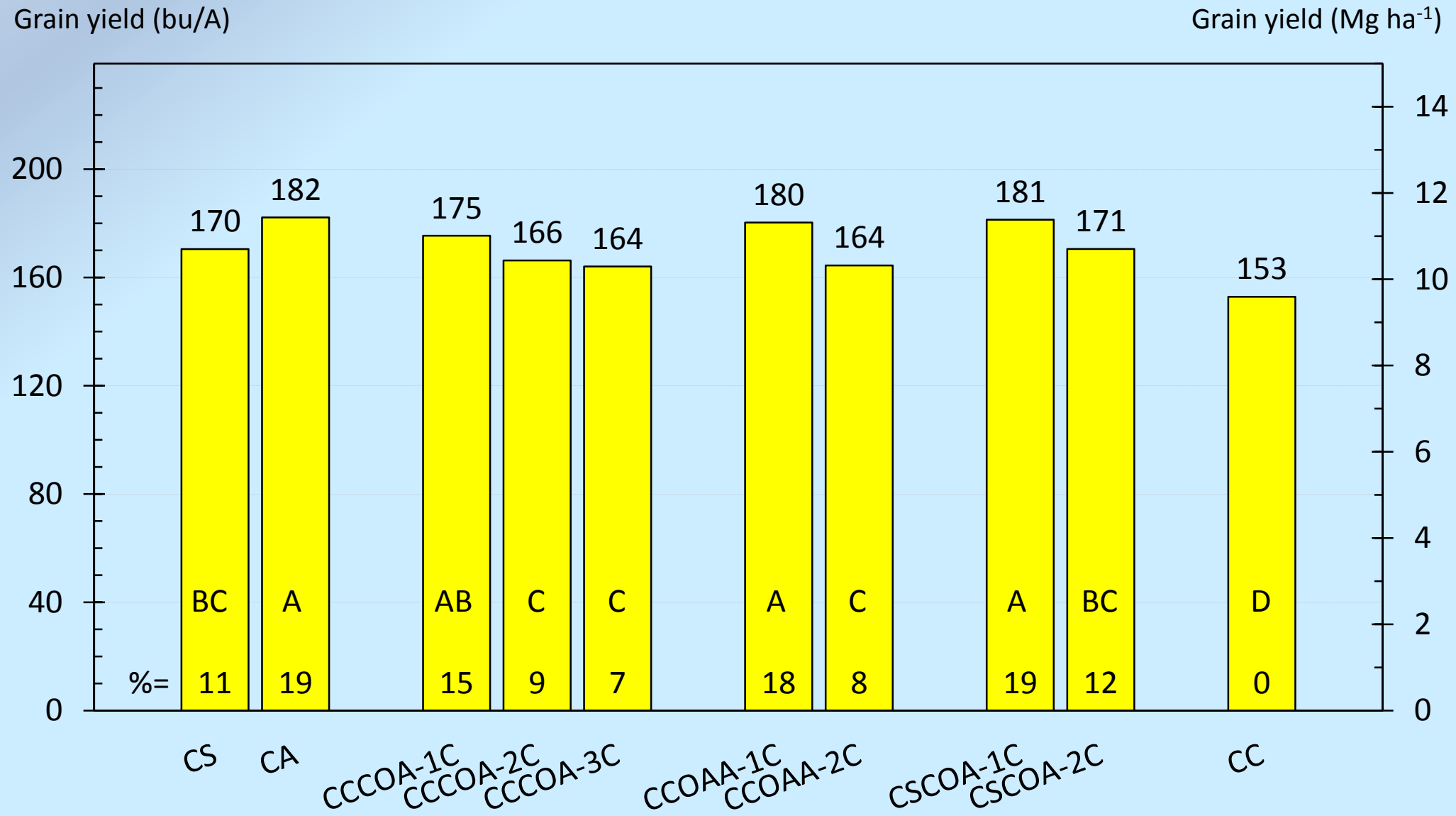
Lauer, 1998-2000 Control treatments

What about extending the rotation by adding a third crop?

Photo by Justin Hopf

At least two break years are needed to measure a response in the second corn phase (compared to CC) …



A= Alfalfa, C= Corn, O= Oat, S= Soybean, 1C= First year corn, 2C= Second year corn … CC= Continuous corn

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Lauer, 1990-2009 (Lancaster, Control treatments)

Crop Sequence for 3-Crop Rotation Experiment at Arlington, WI (C= Corn, S= Soybean, W= Wheat)

Rotation Sequence	Year		
	1	2	3
1	C	C	C
2	S	S	S
3	W	W	W
4	C	S	C
5	S	C	S
6	C	S	W
7	W	C	S
8	S	W	C
9	C	W	S
10	S	C	W
11	W	S	C
12 (Biomass)	C	W	S
13 (Biomass)	S	C	W
14 (Biomass)	W	S	C

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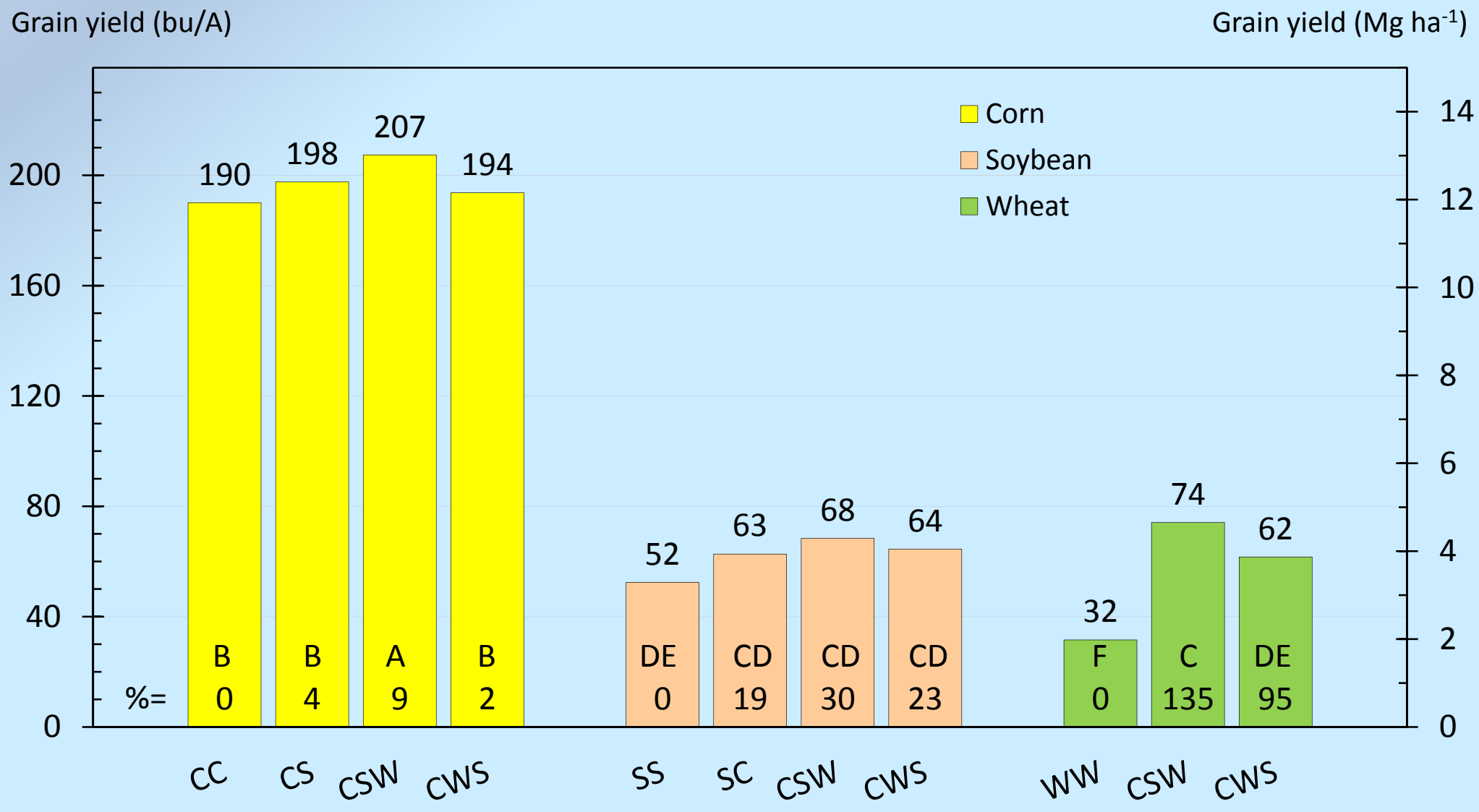
Extending crop rotation improves grain yield of all crops



Cropping Sequence

C= Corn, S= Soybean, Wheat= W, CC, SS, or WW= Continuous corn, soybean or wheat

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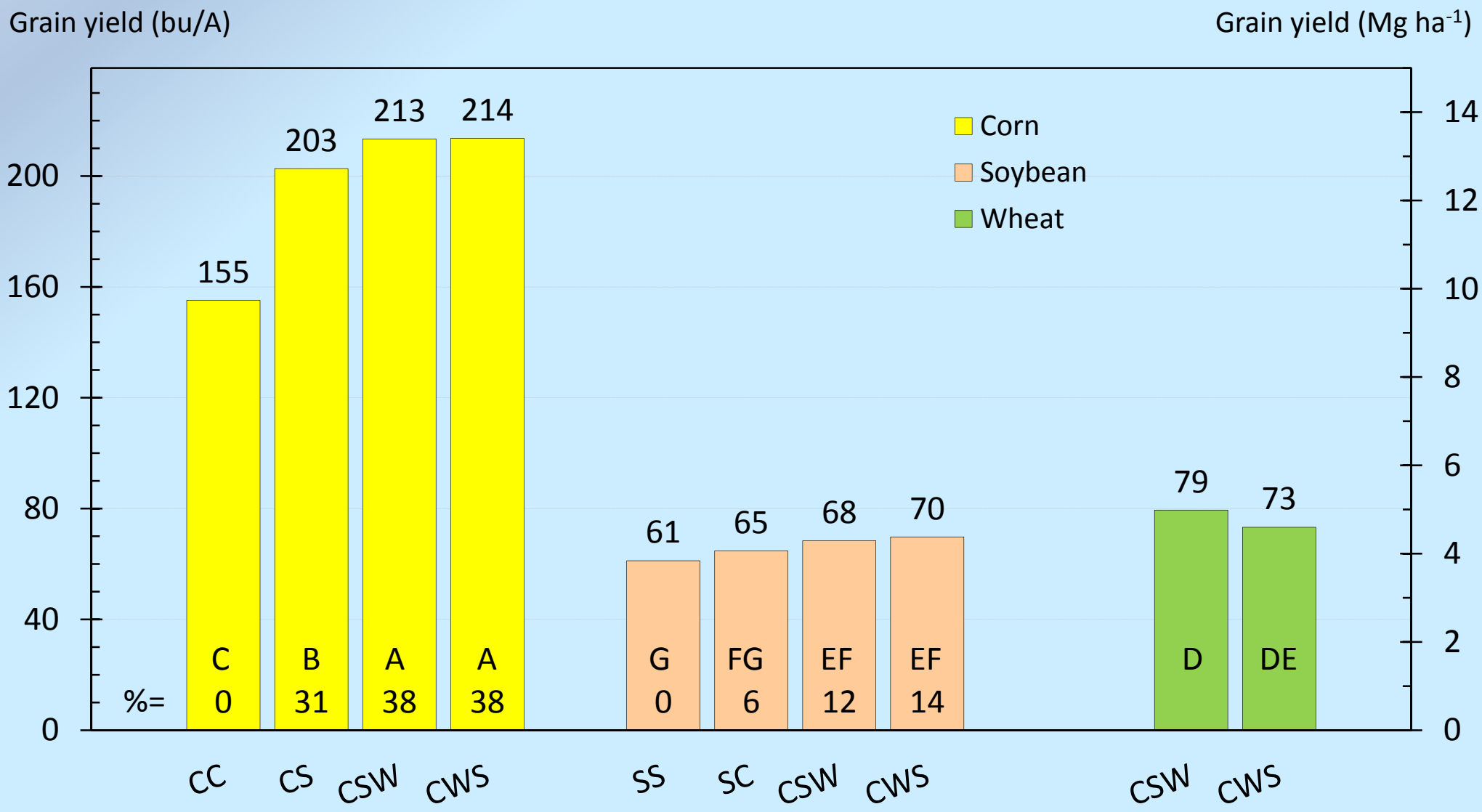
Lauer, 2004-2012(Arlington, Control treatments)

Extending crop rotation improves grain yield of all crops



Cropping Sequence

C= Corn, S= Soybean, Wheat= W, CC, SS, or WW= Continuous corn, soybean or wheat

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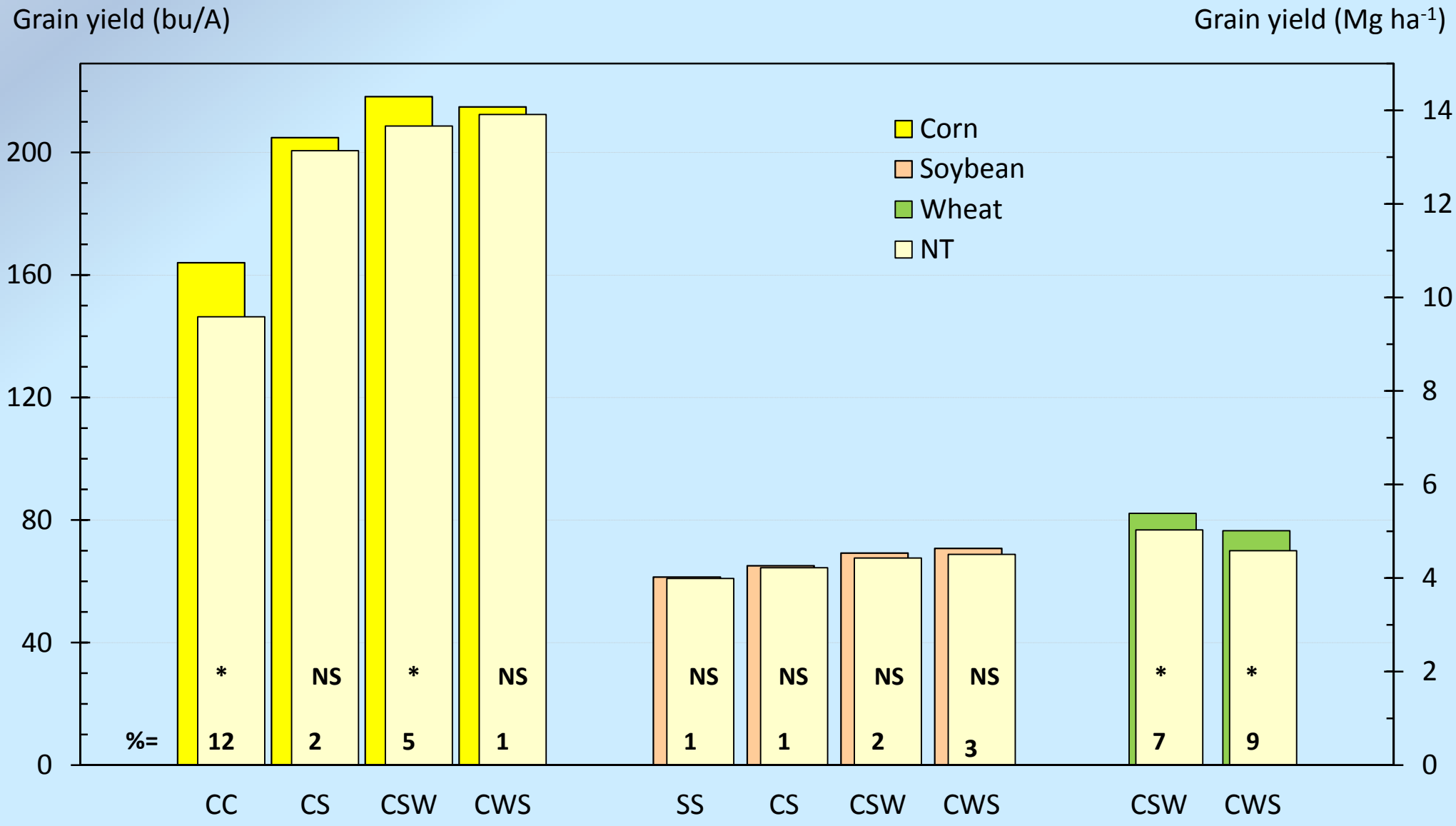
Nafziger, 2002-2013 (Monmouth, IL)

Tillage increases grain yield … except when corn is rotated with soybean



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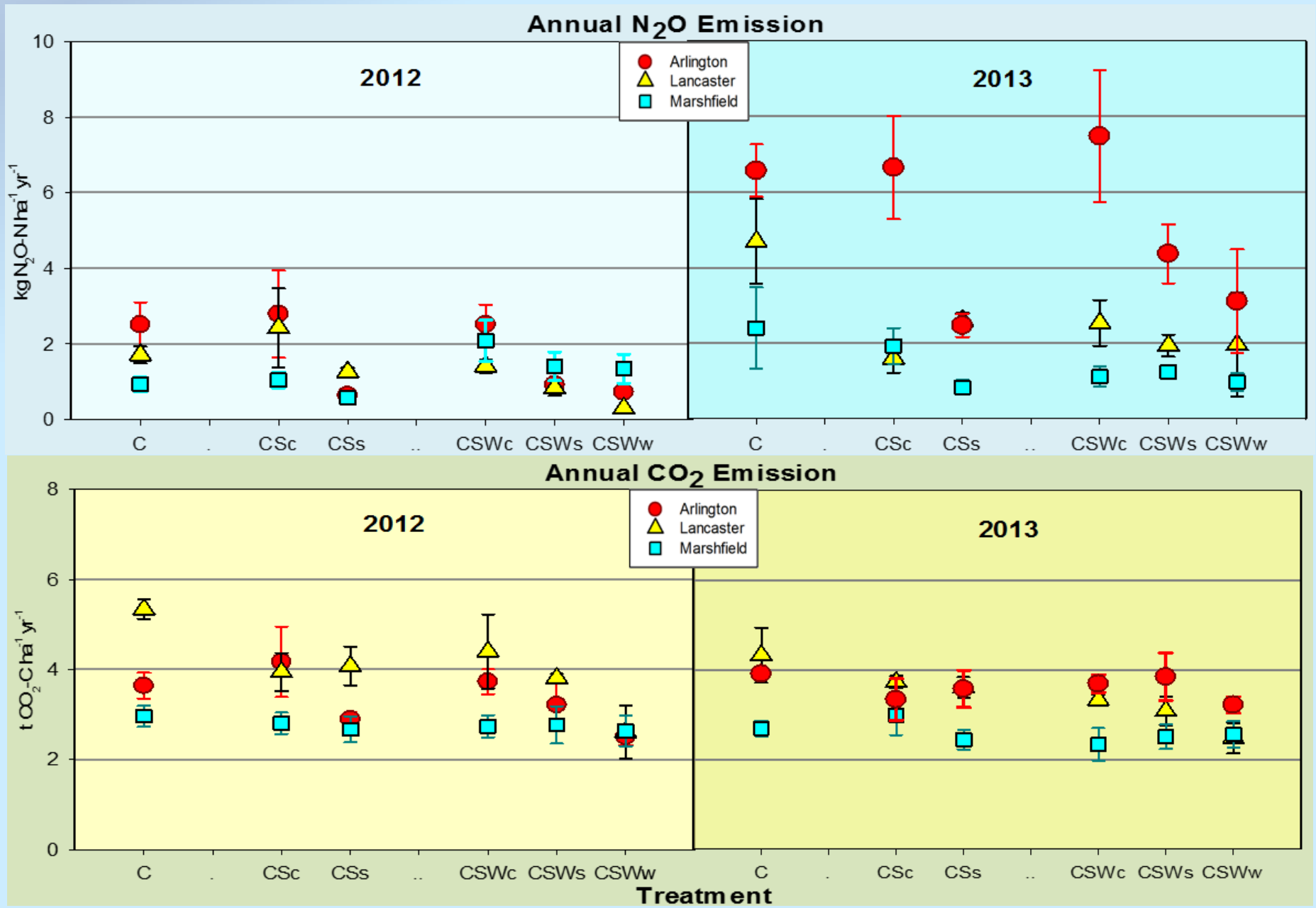
Nafziger, 2002-2013 (Monmouth, IL)

Cumulative N_2O and CO_2 emissions at three locations in Wisconsin



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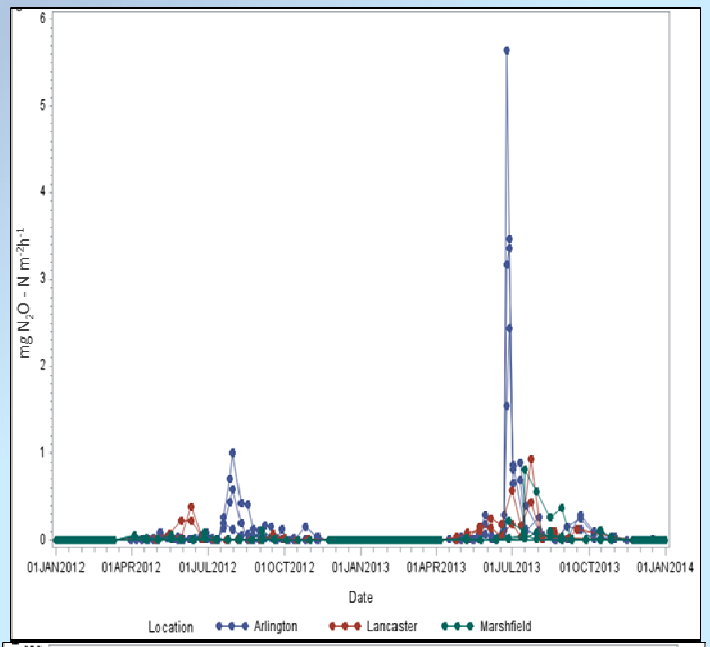
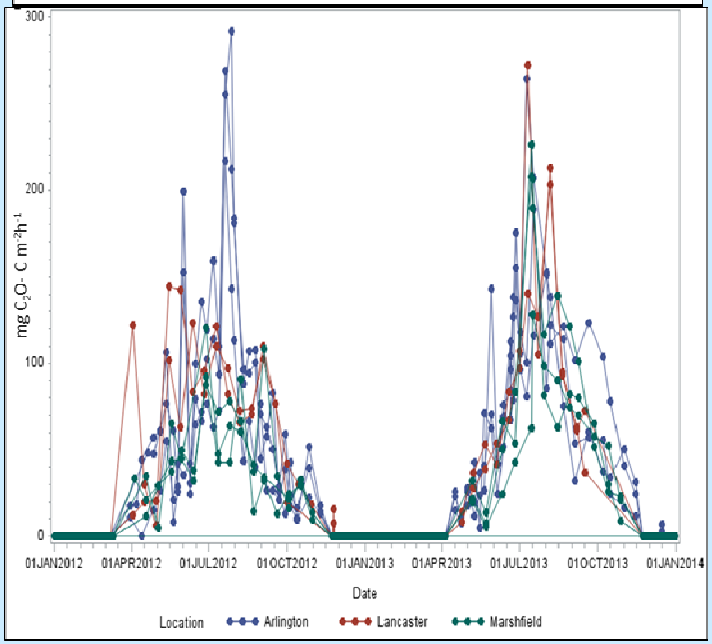
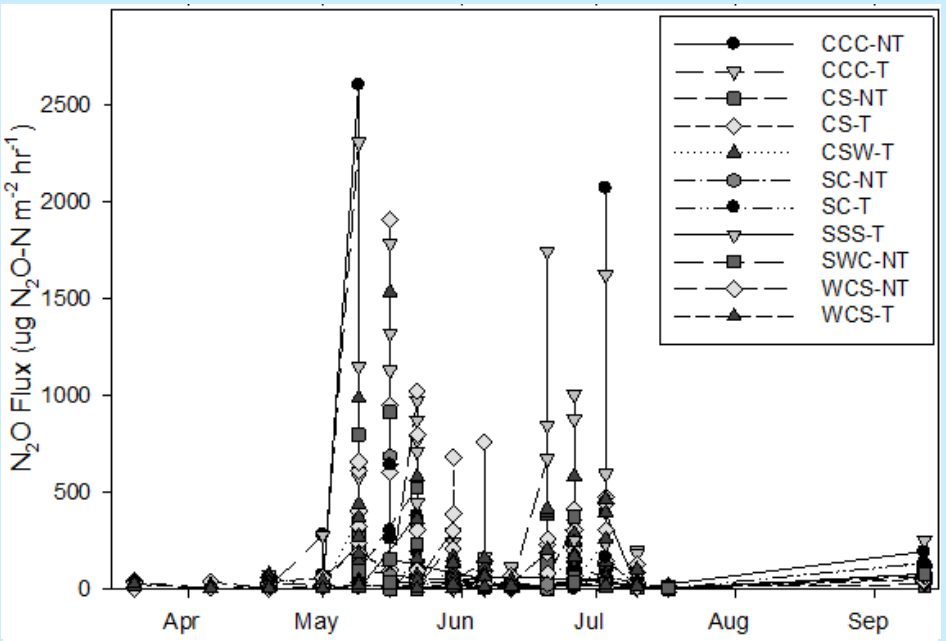
Kazula, 2012-2013

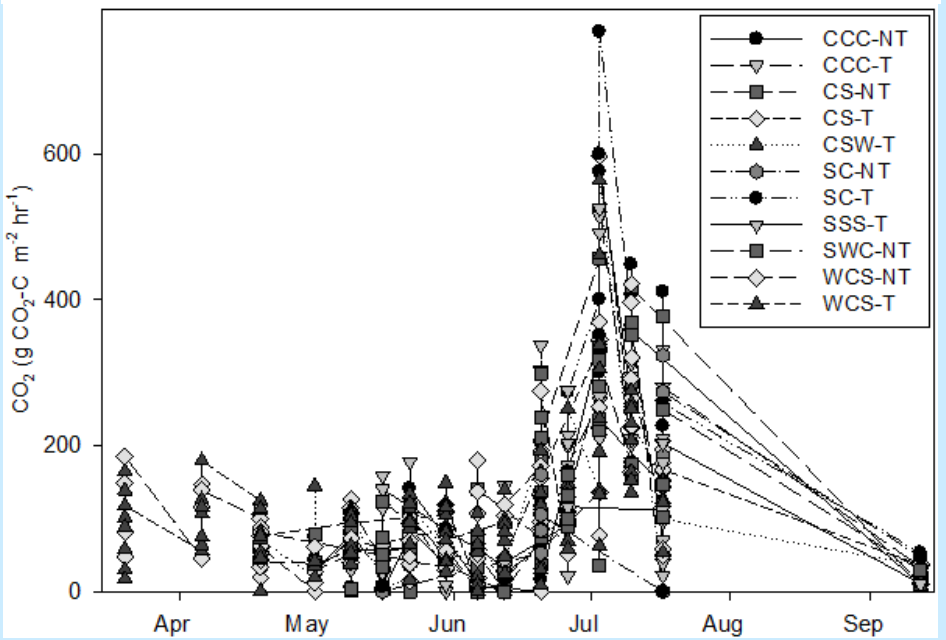
Seasonal Distribution N_2O and CO_2 emissions at Monmouth, IL and three locations in WI





Kazula, 2012-2013





Nafziger, 2012 (Monmouth, IL)

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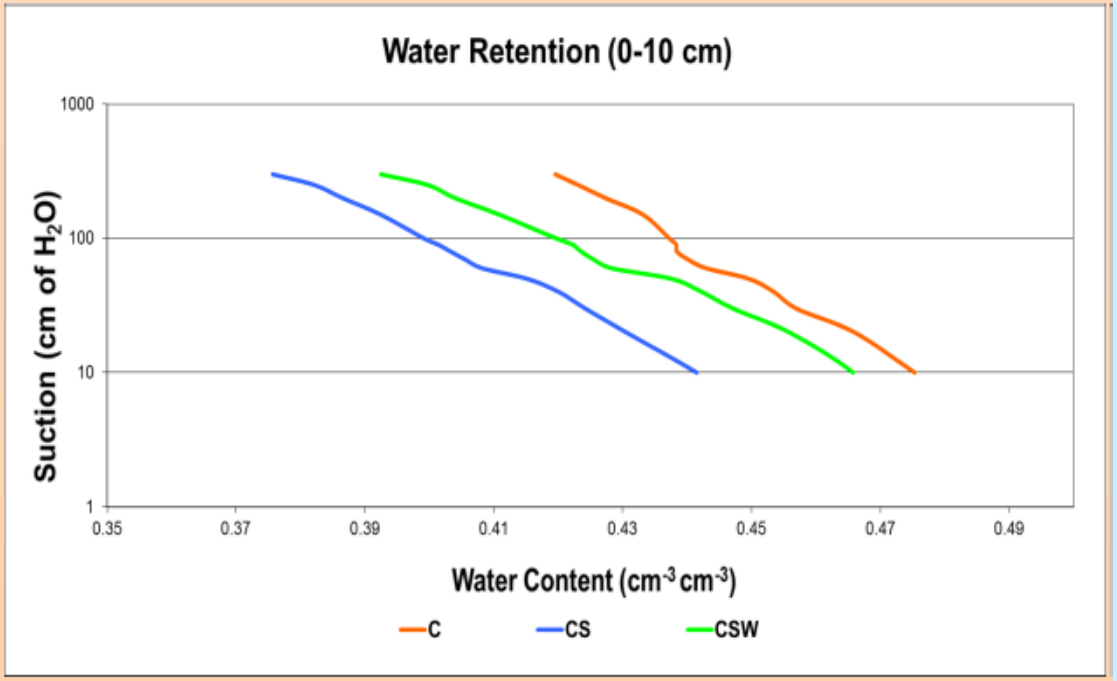
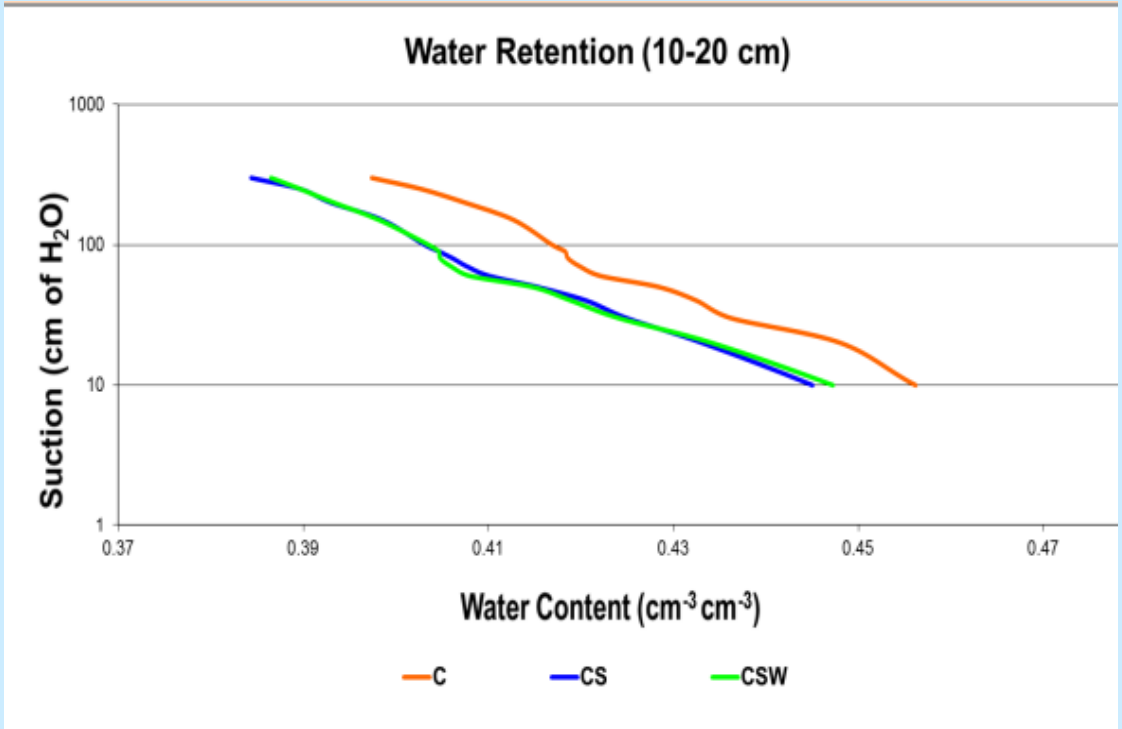
Water retention curves at Arlington.





Summary

- Modern corn hybrids and management practices have the same rotation response as older hybrids and practices.
- The rotation effect lasts at most two years increasing grain yield 10 to 19% for 1C and 0 to 7% for 2C.
- At least two break years are needed to measure a response in the second continuous cropping year.
  - ✓ A one year break using soybean reduces the rotation effect in the second continuous year.
- Tillage does not affect corn yield the first year following soybean, but improves yield 5% in the second year, and 9% in the third year.
- The addition of other crops to the rotation can improve grain yield of all crops.
  - ✓ Prudent thing to do
- Greenhouse gas emissions can be mitigated by extended crop rotations.
- The “rotation effect” is probably unique from field to field.
- Long-term rotation experiments are giving us a preview of crop rotation responses in the future.
  - ✓ Allows faster development and formulation of producer recommendations

The End For Now – Questions?
Thanks for your attention!

Photo by Justin Hopf