Historical view of corn and soybean production – What about the future?

Joe Lauer and Emerson Nafziger
University of Wisconsin and University of Illinois

2024 Advanced Crop Advisers Workshop
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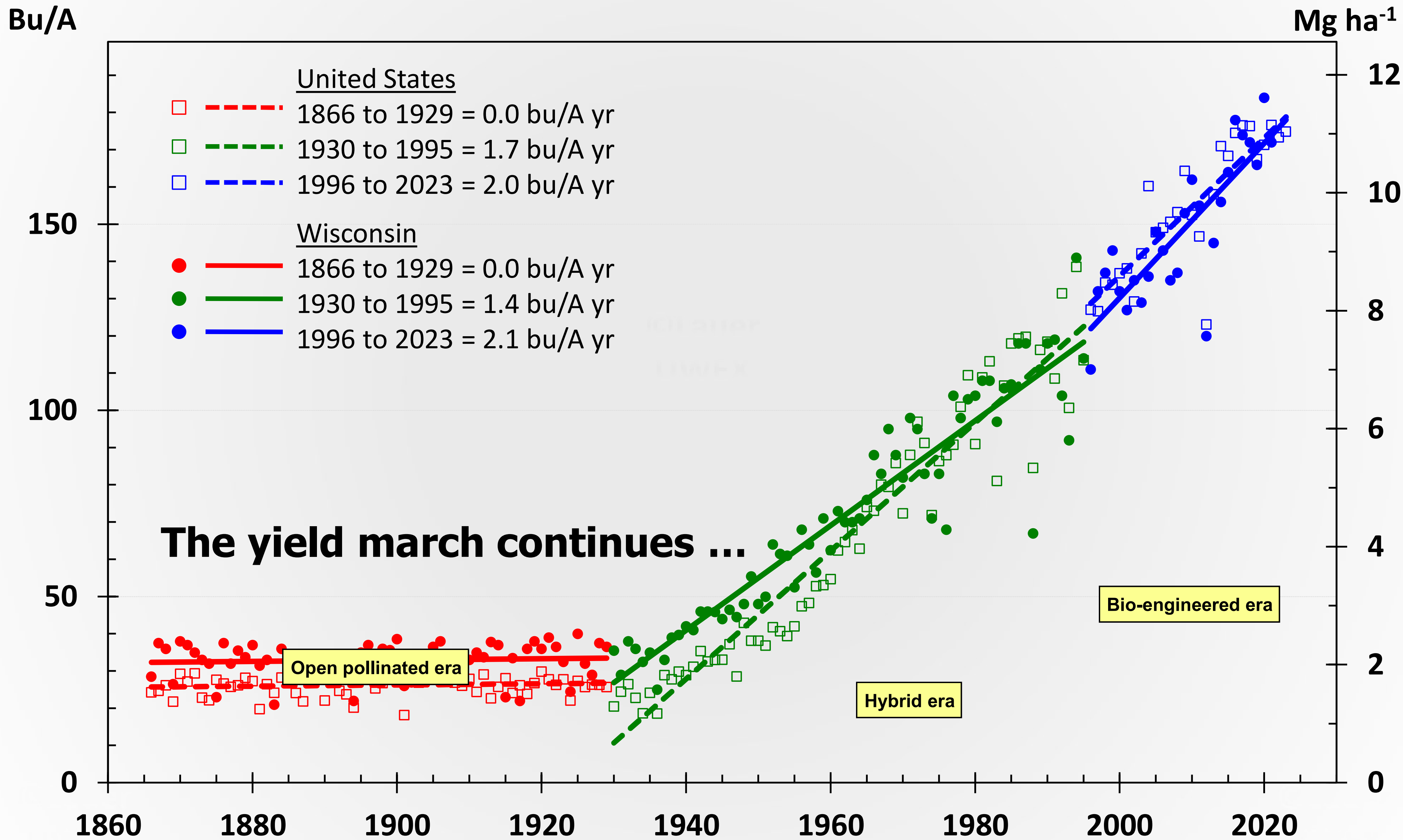
Corn grain yield in Wisconsin and the U.S. since 1866



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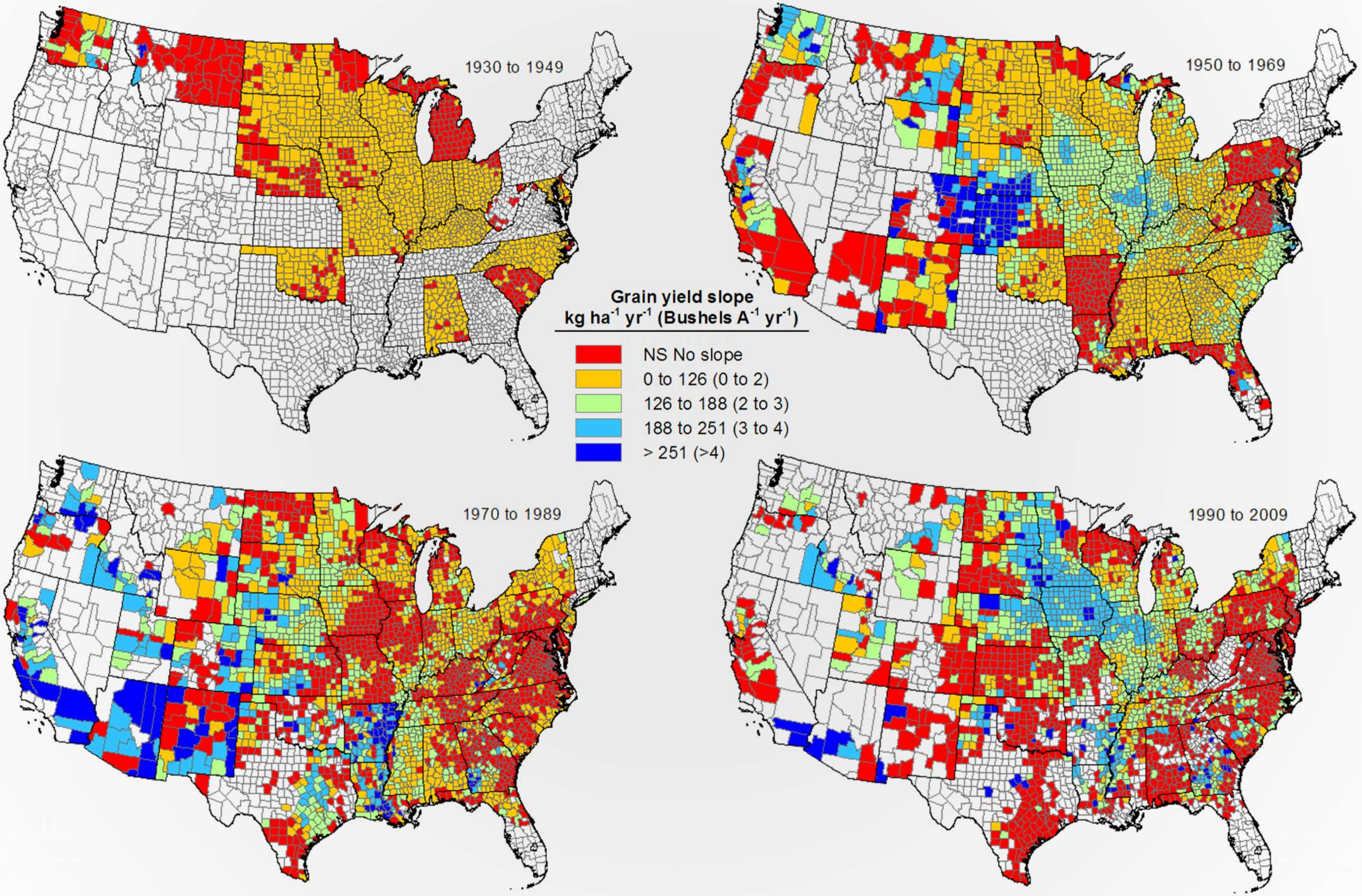
USDA-NASS
UW Hybrid Trials

Corn grain yield rate of change over time for U.S. counties.



Lauer, 2016 (Data source: USDA-NASS)

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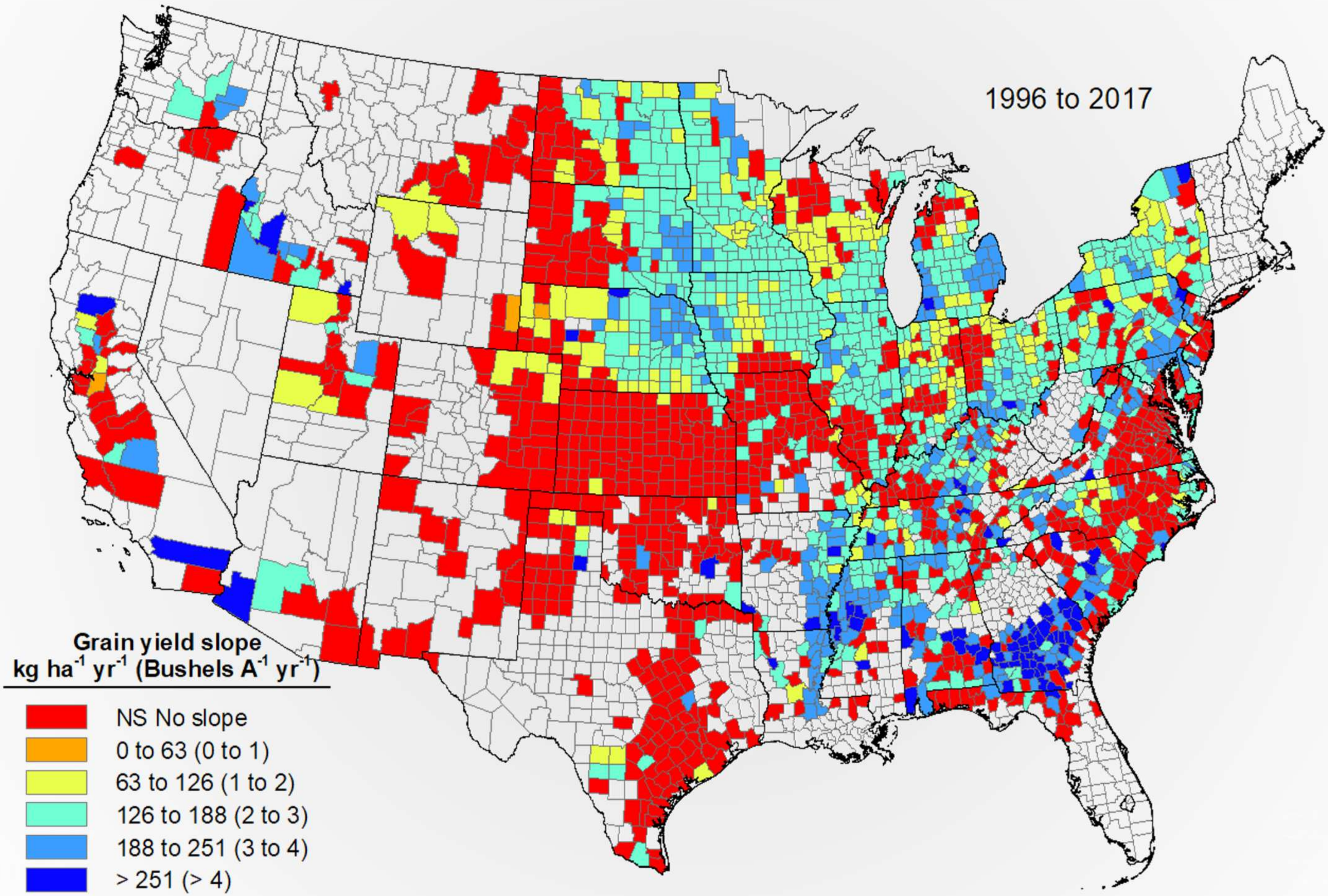
Corn grain yield rate of change over time for U.S. counties



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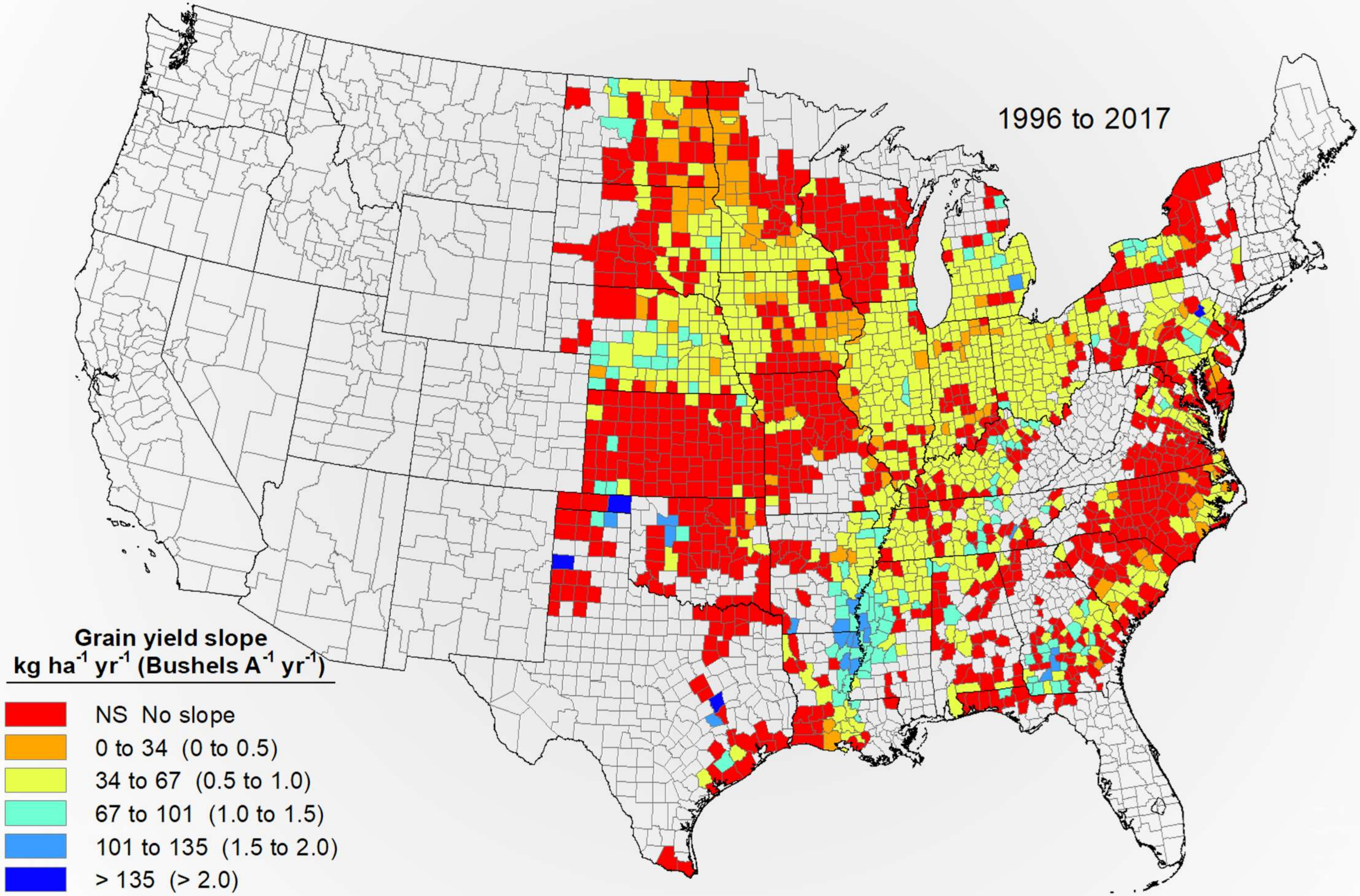
Lauer, 2019 (Data source: USDA-NASS)

Soybean grain yield rate of change over time for U.S. counties



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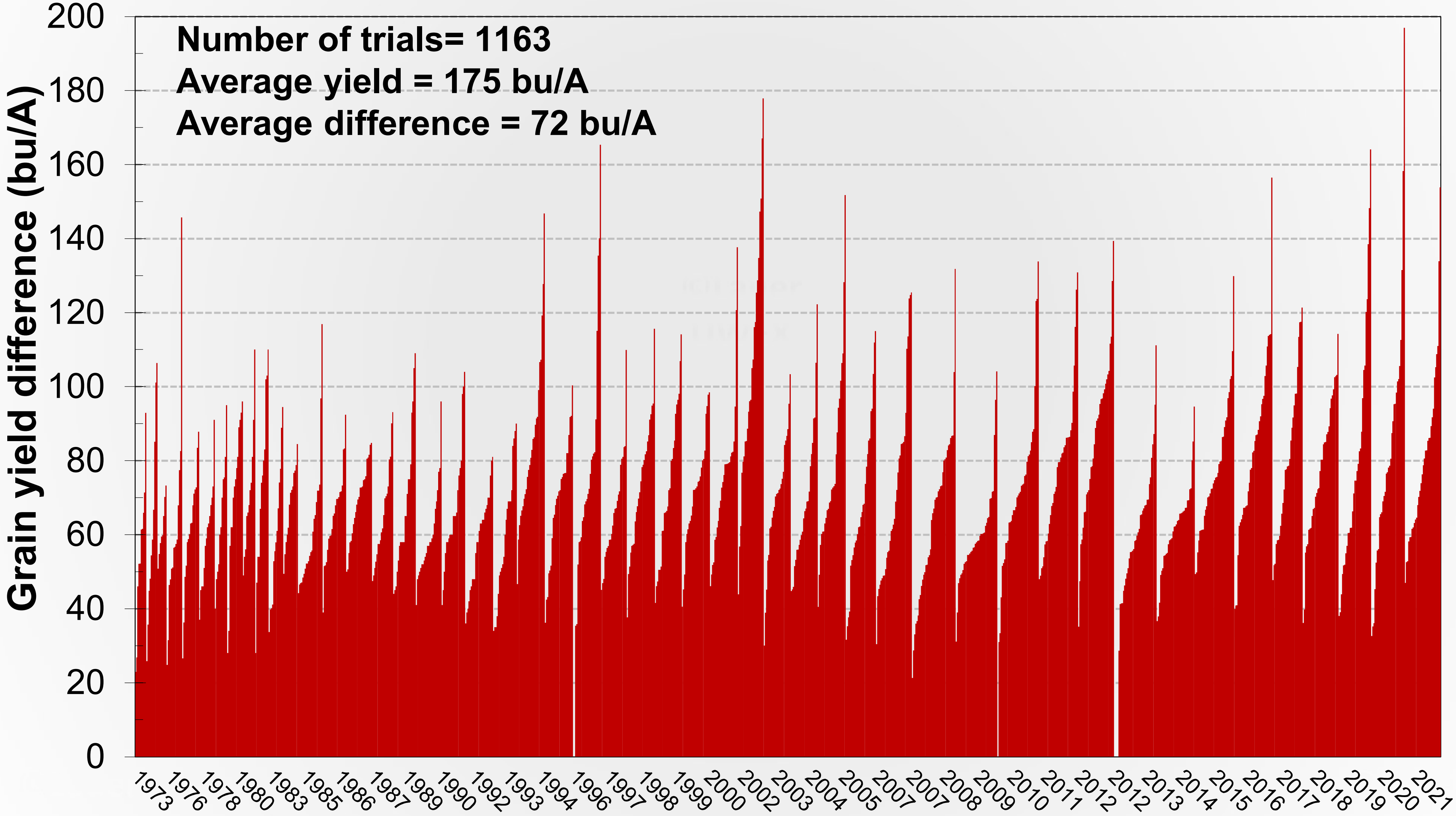
Lauer, 2019 (Data source: USDA-NASS)

Agronomic Yield and Profit/Loss Potential of Corn Production Decisions

(*= added Moisture deductions)

Factor	Maximum yield	Economic optimum	Decision	Range Silage T DM/A	Range Grain bu/A	Grain Economics $/A @ 5.00/bu
Hybrid yield	Top	Seed price	Top vs Bottom	3.5	70	$350
Fertilizer	Over apply	UWEX recs	0 vs UWEX vs Over	1.1-2.8	40-100	$200-500
Pest control (Weeds > Insects > Diseases)	+	+	+ or -	0.0-2.8	0-100	$0-500
Planting date	May 1-10	April 20 - May 1	May 1 vs June 1	1.2	60 *	$300 *
Rotation	CS or CSW	Market driven	CC vs CS vs CSW	1.1	40	$200
Plant population	38K	34K	38K vs 20K	1.1	40	$200
Harvest moisture	30-33%	20-25%	Early v. Late	0.6	20 *	$80 *
Tillage	CP	NT	CP vs NT	0.4	14	$70
Hybrid RM	Full	Shorter	Full vs Shorter	0	0 *	$90 *
Hybrid traits	NS (+)	> $50-75 bag difference	Yes or No	0	0	$0
Seed treatment	Fungicide +	Fungicide	Fungicide vs None	0	8	$32
Row spacing	Narrower	Narrower	30-in. vs Narrower	0.4	6	$30
Fungicides	NS (+)	None	+ or -	0	4	$20
Biologicals, PGRs, etc.	NS	None	+ or -	0	0	$0

Grain yield difference between top- and bottom-performing corn hybrid in each UW trial since 1973



Lauer, UW Hybrid Trials (1973-2021)

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Hybrid maturity recommendations …

- To ensure genetic diversity on your farm, select corn hybrids differing for relative maturity.
- Desire to accept risk
  - ✓ Longer season hybrids offer the highest yield potentials, but may also increase drying costs and/or delay harvest.
- Potential use
  - ✓ Dry grain versus high moisture corn versus silage,
- Field conditions
  - ✓ Shorter season hybrids should be selected when field conditions include heavy crop residue, reduced tillage, and heavy soil textures (Others?).
- Hybrid dry down and grain quality characteristics
- Hybrid mix
  - ✓ Traditional: (50% full-, 25% mid-, 25% short-season)
  - ✓ "Crystal ball": predicting next year
  - ✓ Recommendation: Base upon intended use & drying method

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Plant population	38K	34K	38K vs 20K	1.1	40	$200
Harvest moisture	30-33%	20-25%	Early v. Late	0.6	20 *	$180 *
Tillage	CP	NT	CP vs NT	0.4	14	$70
Hybrid RM	Full	Shorter	Full vs Shorter	0	0 *	$90 *
Hybrid traits	NS (+)	> $50-75 bag difference	Yes or No	0	0	$0
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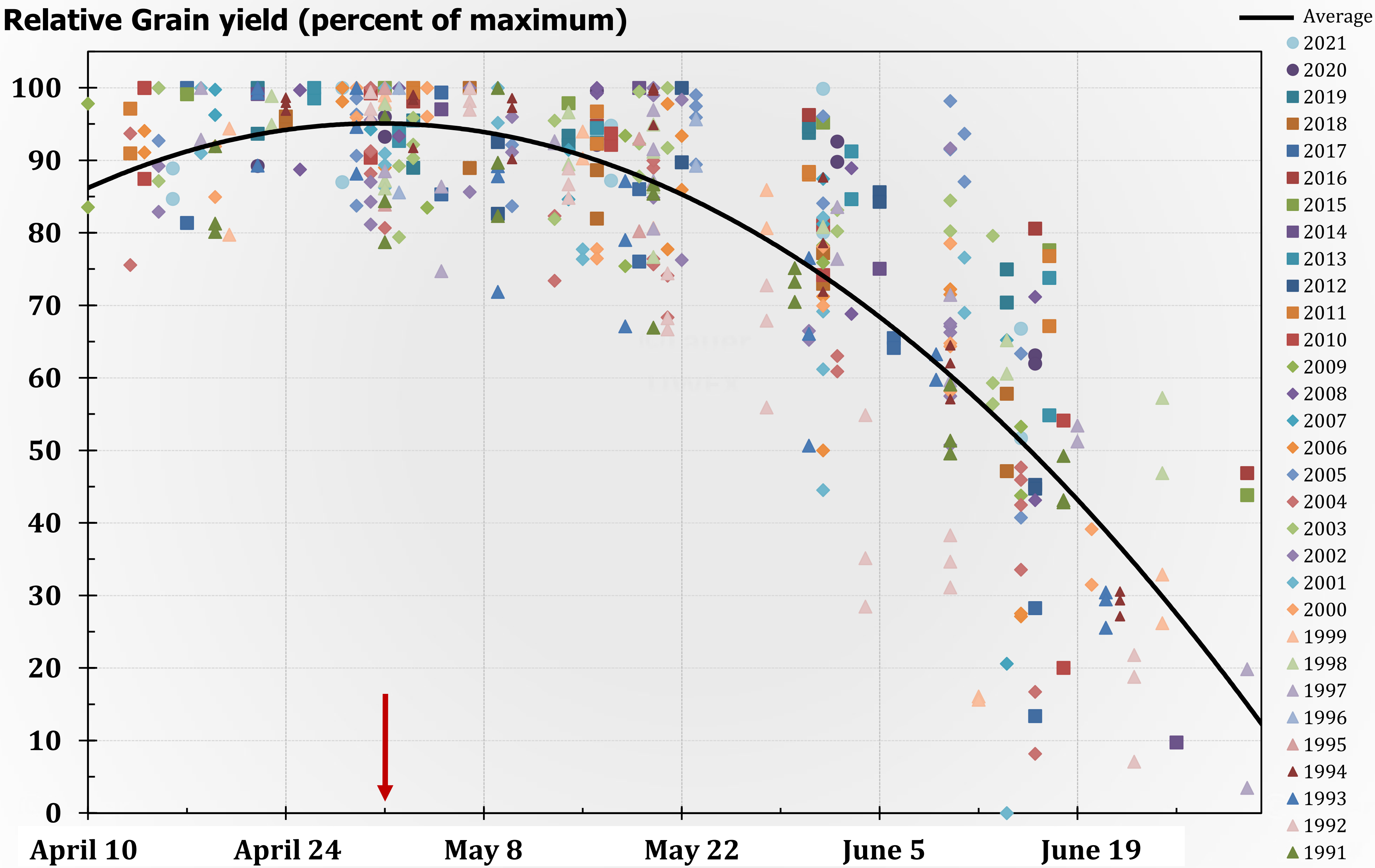
Planting date

- Priceless!
  - ✓ "Sets up the season"
  - ✓ "Double-whammy": late planting = low yield AND higher moisture
- Focus on seedbed conditions and calendar date rather than soil temperature.
- Follow local extension recommendations
  - ✓ Crop insurance requirements
- Disadvantages of early planting
  - ✓ Seedling diseases
  - ✓ Crusting
  - ✓ Late spring frost
  - ✓ European corn borer

Maximum grain yield planting date is May 1.

Grain yield decreases 0.5 bu/A per day on May 15 and accelerates to 2.5 bu/A per day on June 1.



Lauer (All hybrids at Arlington, WI)

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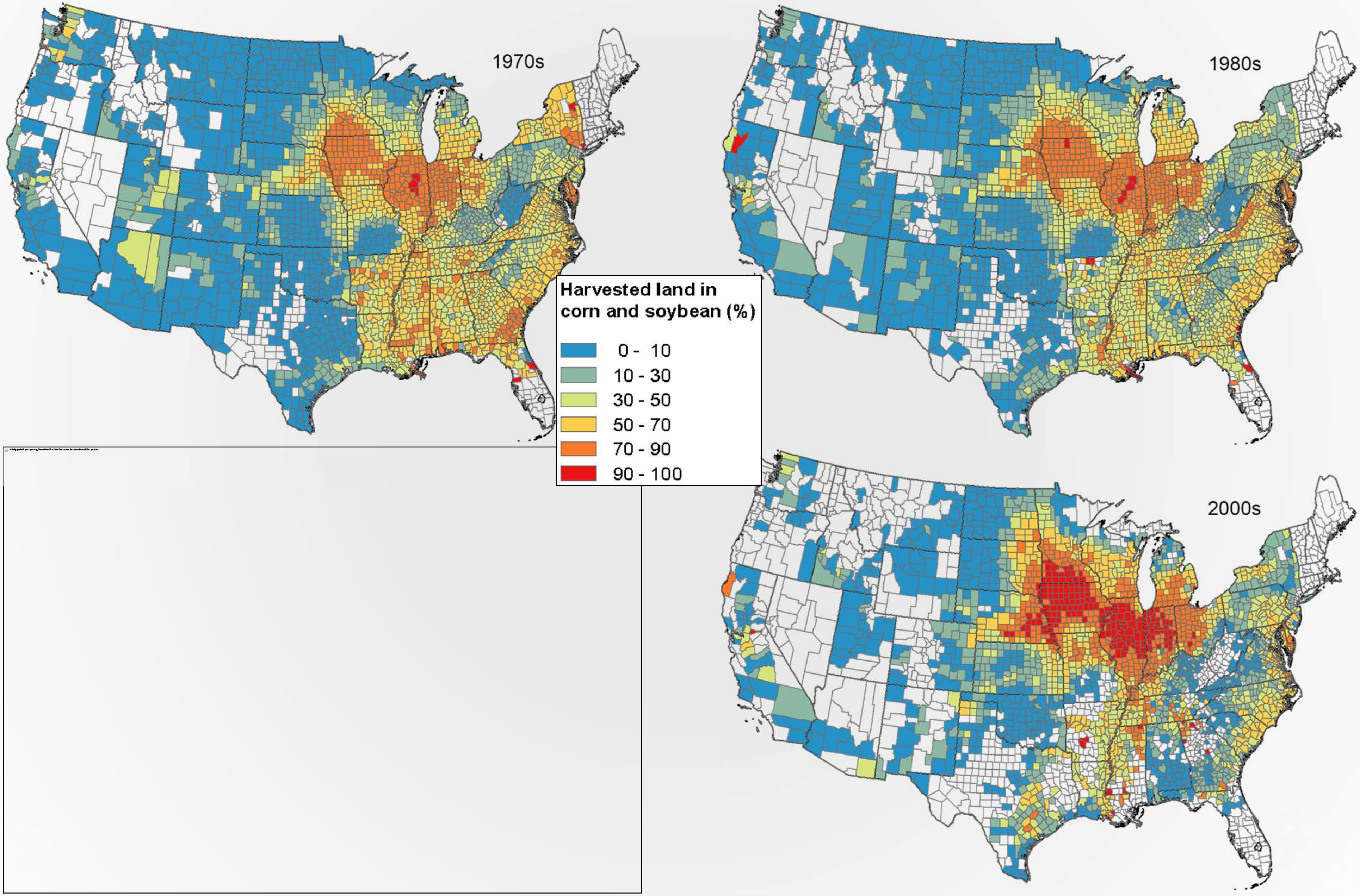
Crop Rotation

- "Easiest yield you can get."
- "The gift that keeps on giving."
- Corn yield increases 8-19% when rotated with soybean.
- The rotation effect lasts at most two years.
  - ✓ Depends upon the length of the break
    - ➢ 2 or more break years → Yield of 2nd year corn > continuous corn.
    - ➢ 1 year break → Yield of 2nd year corn = continuous corn.
  - ✓ Yield of 3rd year corn is similar to continuous corn.
- The rotation effect is even more dramatic in stressful years.

Percent of Harvested Field Crop and Vegetable Land in Corn and Soybean



Lauer, 2019 (Data source: USDA-NASS)

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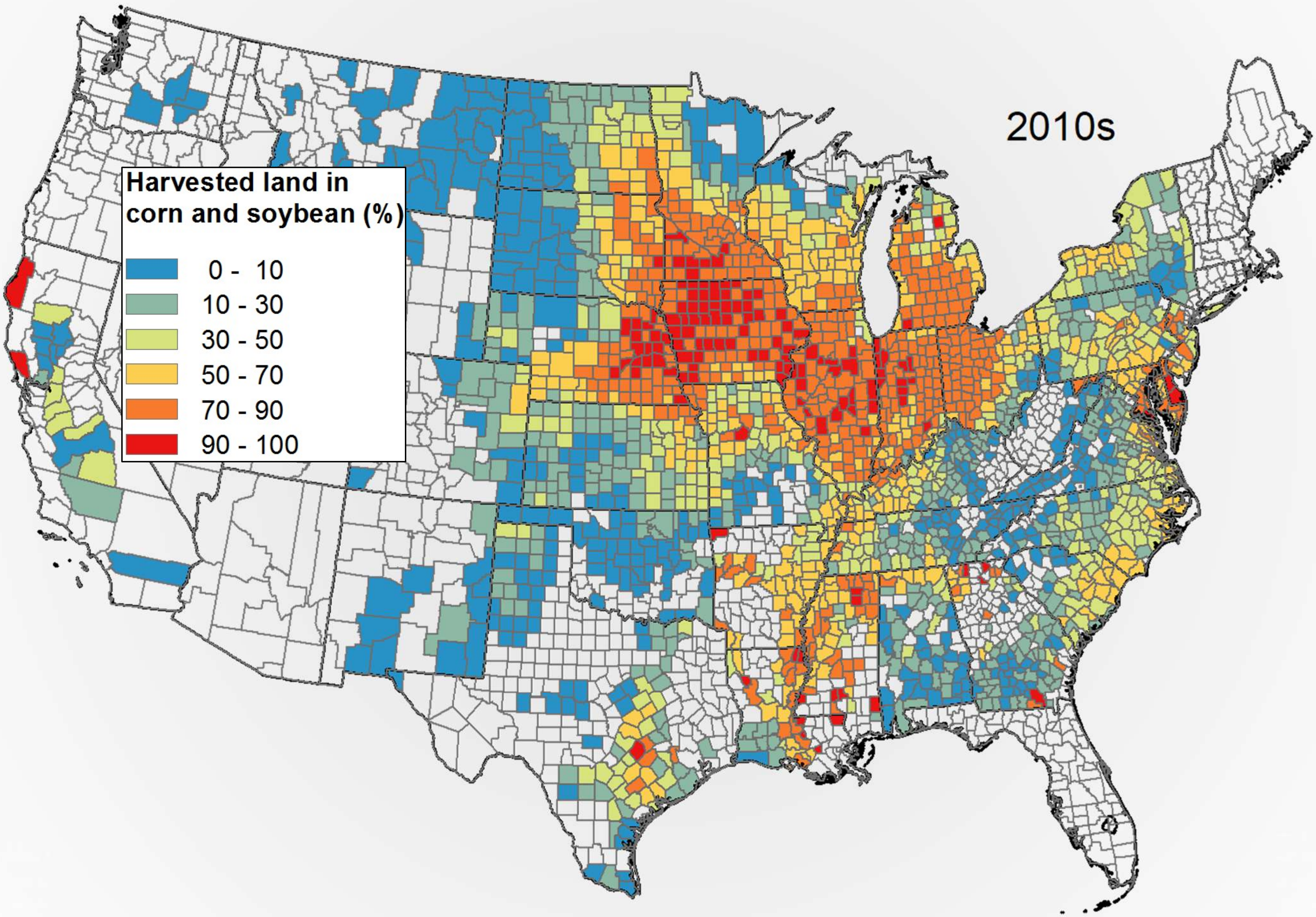
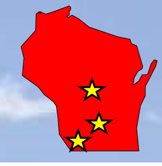


Lauer, 2019 (Data source: USDA-NASS 2010-2017)

The Wisconsin 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
Seed fungicides

Tillage
since 2001
CC
CS

Tillage=6
Starter
Planting date

BioChar
since 2009
CC
CS

Tillage=2
BioChar

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

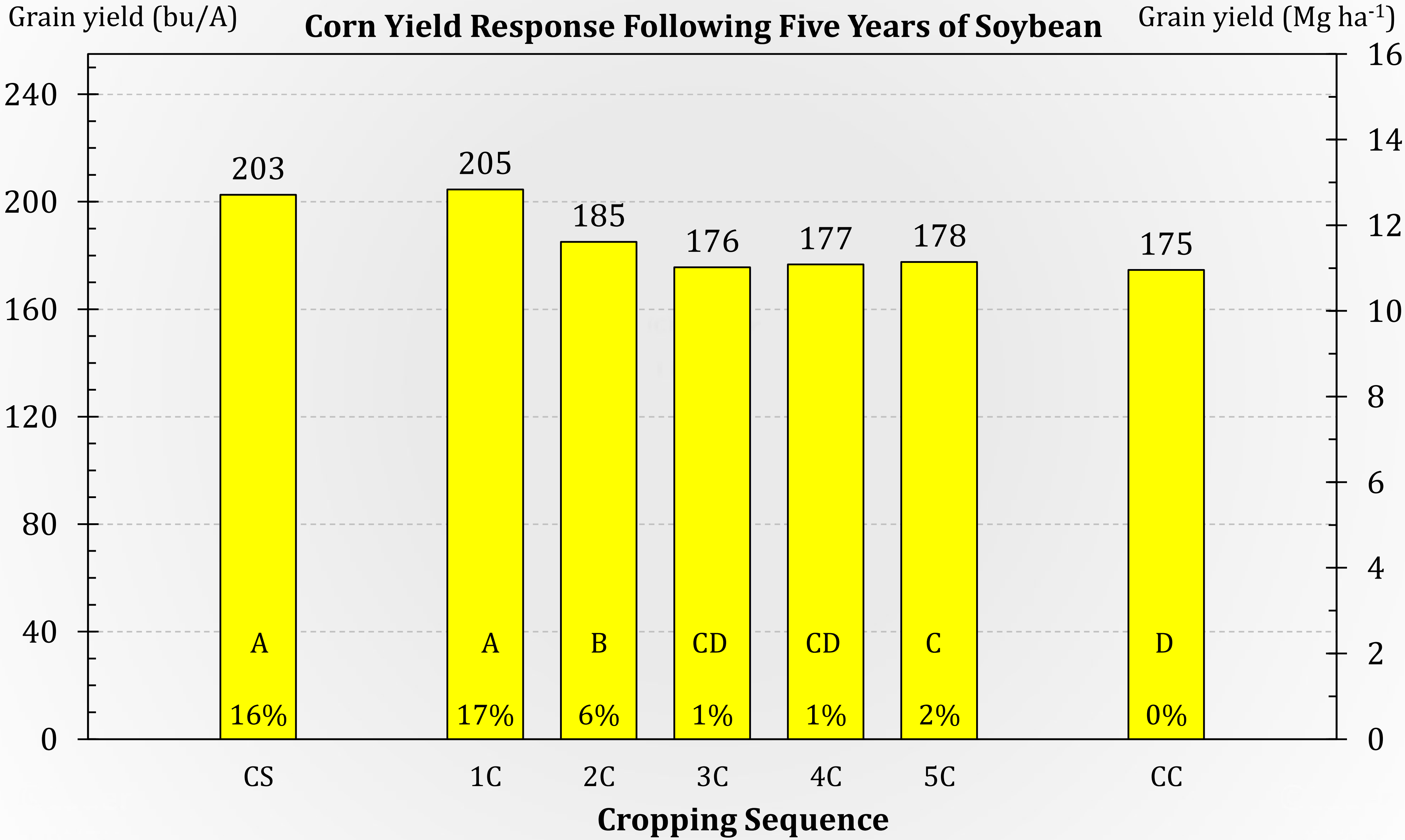
Corn-Soybean-Wheat
1984 to 2000
CC
SS
CS
CSW:*1984-1994*
CCS:*1995-2000*
CCCS:*1995-2000*

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

Seed fungicide
Foliar fungicide
Fusarium management
Cover Crops

Photo by Justin Hopf

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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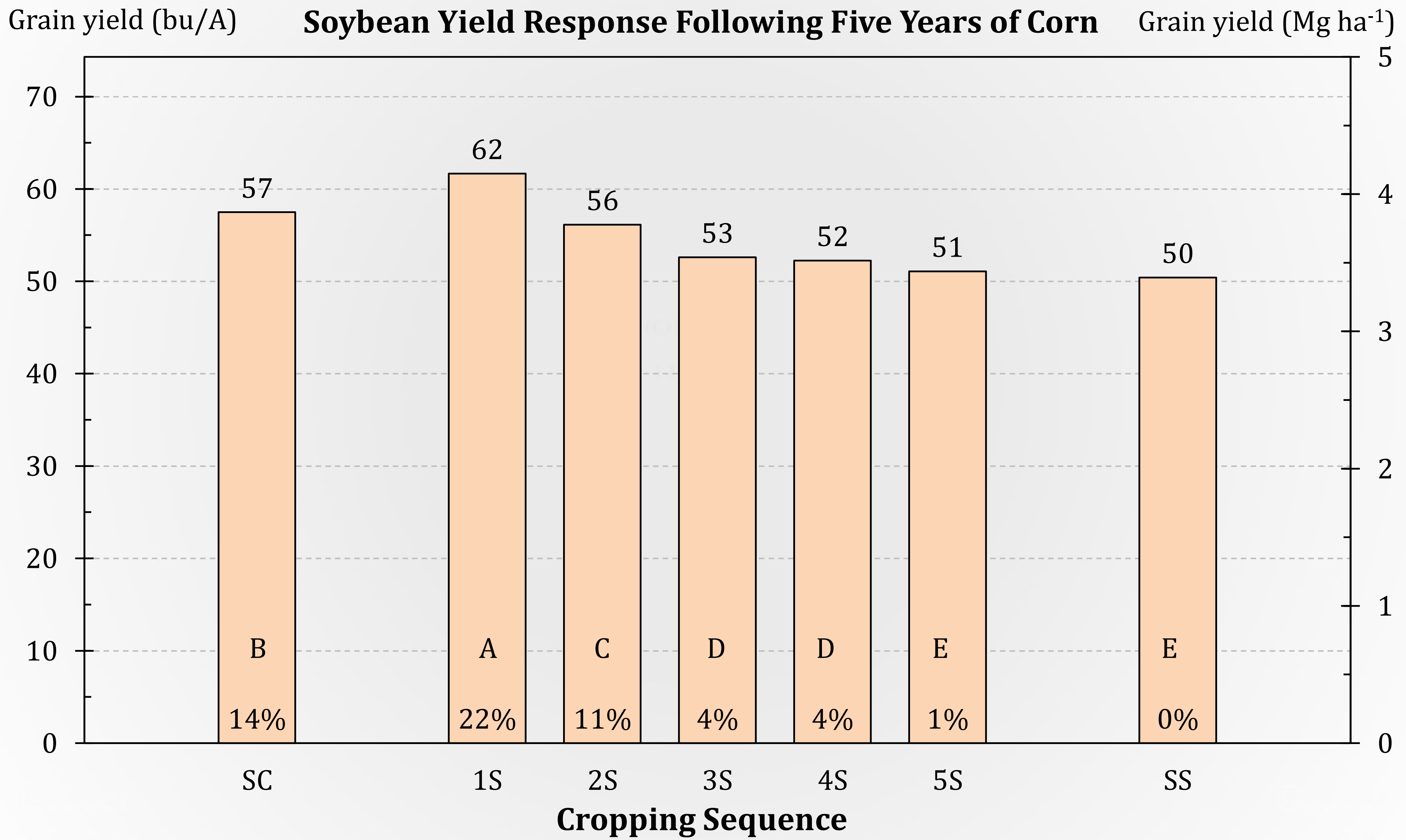
Lauer, 1987-2021 N= 2568
Arlington, Control treatments

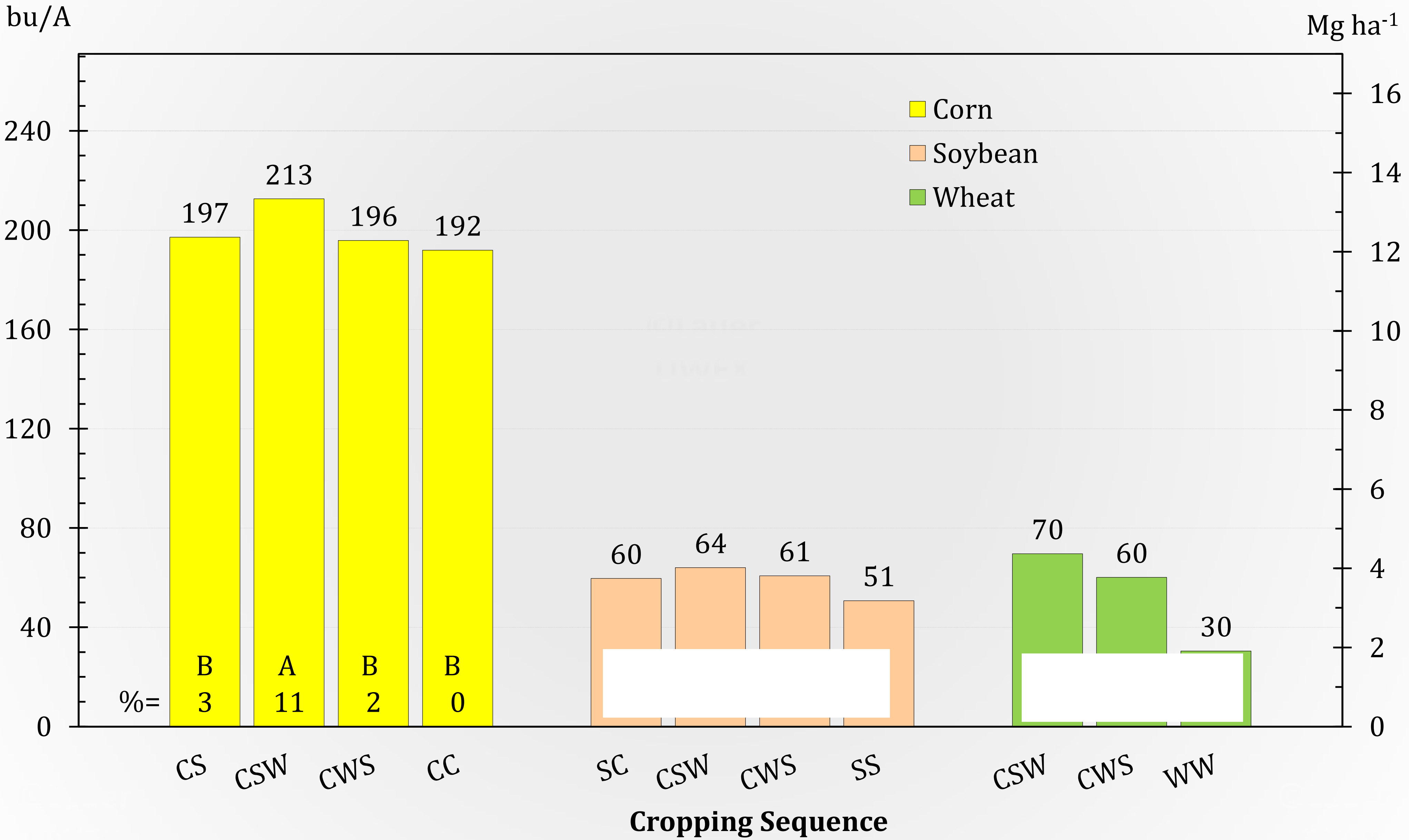
The story for soybean is different. The rotation effect is greater for 1S than SC. Yield decreases in 2S and still further in 3S …



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

Lauer, 1987-2021 N= 2738
Arlington, Control treatments

Extending crop rotation improves grain yield of all crops, however, sequence seems important.



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

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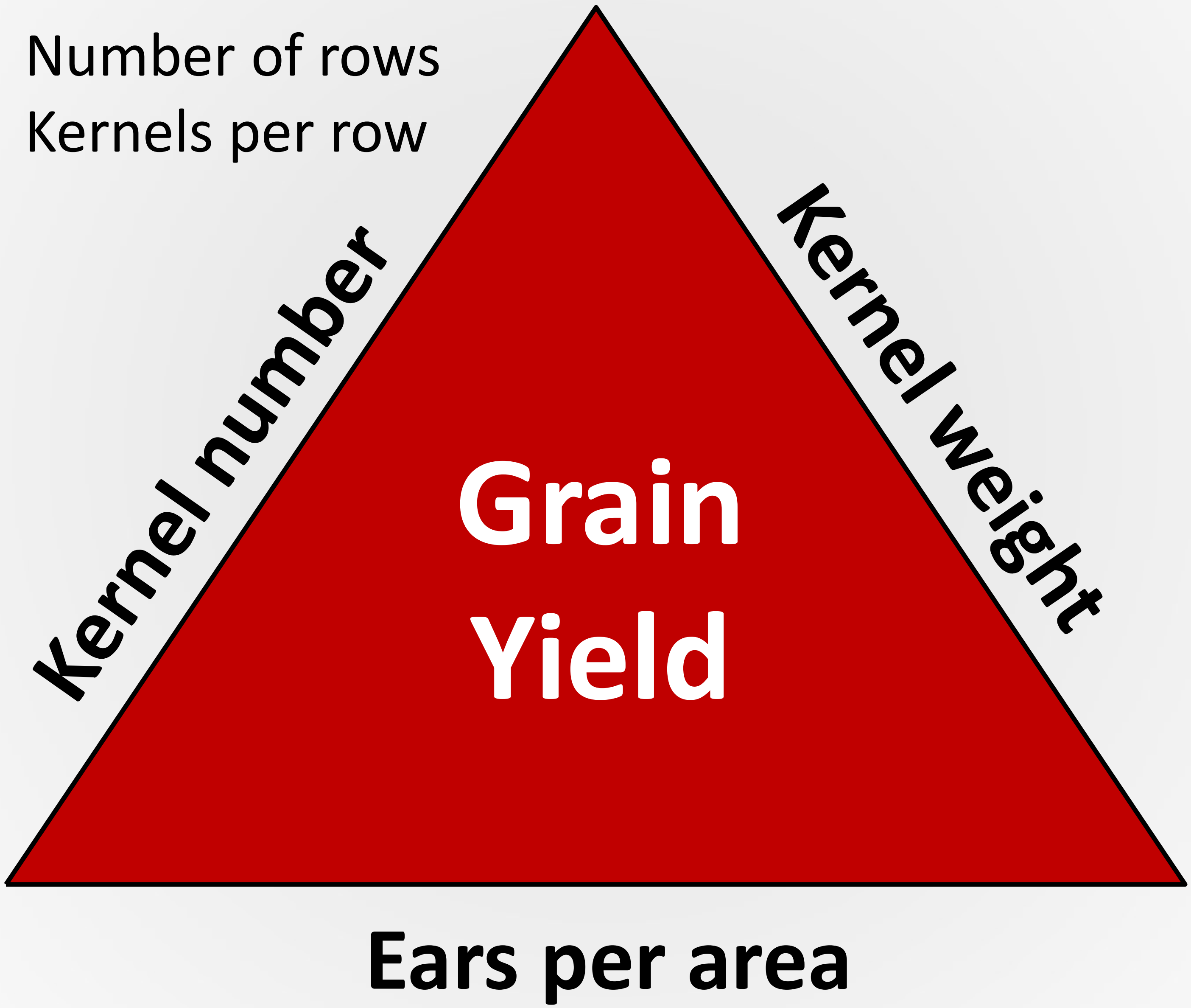
Lauer, 2005-2016 (Arlington, Control treatments)

Plant Distribution – Plant density and Row spacing

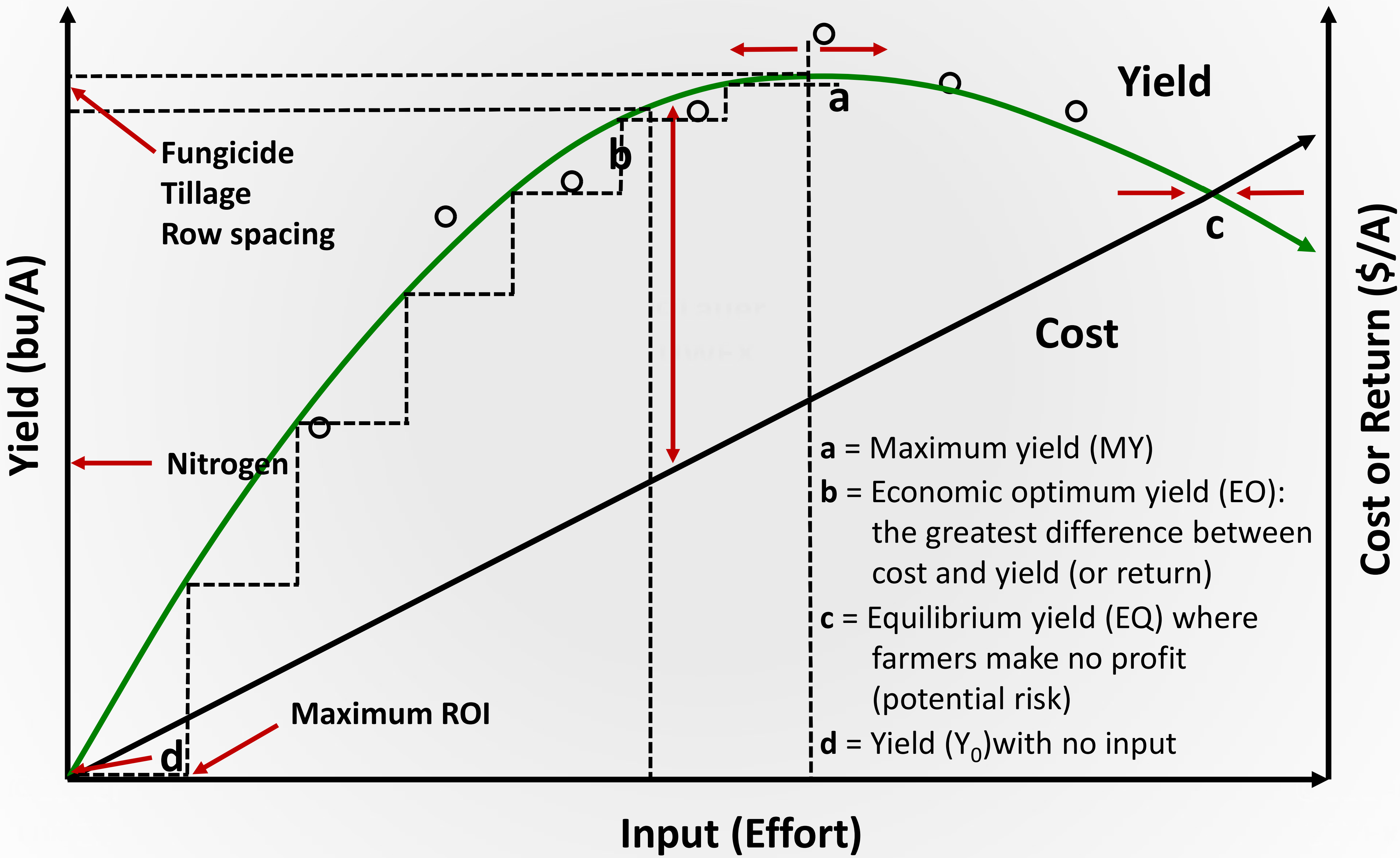
- Plant density
  - ✓ Has the most potential to move a farmer from current yield levels
  - ✓ Might be the place to start when moving off the yield plateau.
  - ✓ Plant densities for maximum yield are increasing as newer hybrids are commercialized.
- Row spacing
  - ✓ Narrower is better
  - ✓ Decision has low impact on yield
- Seeding depth
  - ✓ 1.5 - 2 inches

Yield Components of Corn

Number of rows
Kernels per row



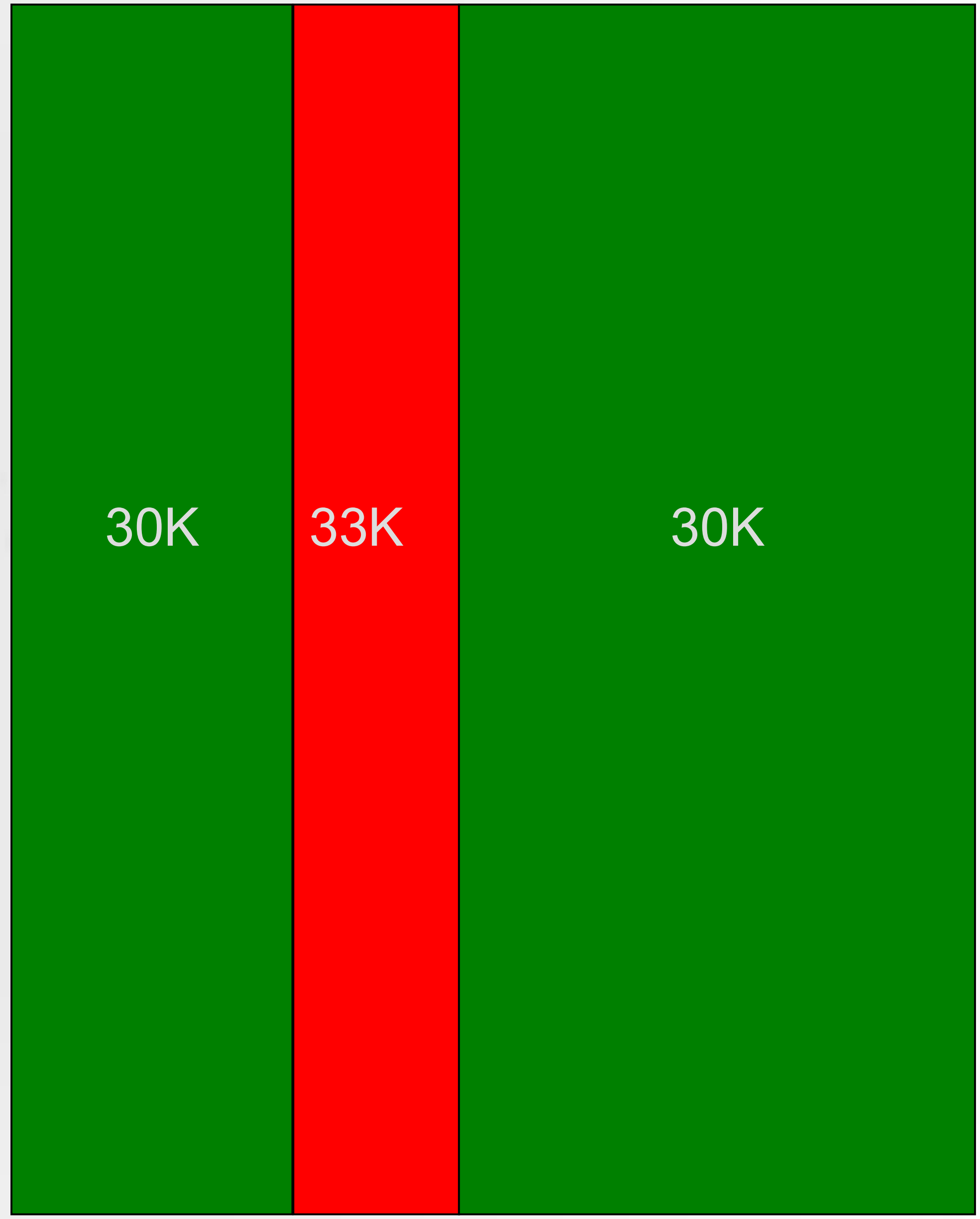
Determining Maximum Yield v. Economic Optimum Yield



Find the plant density that maximizes yield for each field …

<u>Reference strips for testing plant density</u>

- Field specific
- At least one strip per field. Total of 3-4 strips per farm.
- Increase plant population 10% in one-strip.
  - ✓ Plant majority of field to normal plant density
  - ✓ Ideally 2-3 strips per field



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Thanks for your attention!
Questions?

Photo by Roger Schmidt

Corn Row Width and Plant Density– Then and Now Corn Research on Row Spacing

WARNING: There may be an inherent bias in trials reported due to the publication process. NS data are not often published.

>30 inches

- Early 1900 to 1950 corn was "check" planted in 40- to 44-inch row spacing.
  - ✓ Limited by width of a horse.
  - ✓ Afforded weed control in lieu of herbicides
- Development of hybrid corn, herbicides, irrigation made it apparent that plant arrangement (row spacing and plant density) was limiting yield.
- Grain yield increases were consistent when narrowing rows from 36-, 38- or 40-inches to 30-inches in Wisconsin. The average increase was 5%, and ranged from -1 to +15%

<30 inches

- Recent resurgence in grower interest to use one planter to establish corn, soybeans, and/or sugar beet.
- Grain yield increases with row spacing narrower than 30-inches in 7 of 11 AJ references.
  - ✓ Increases are larger and more consistent in the northern Corn Belt.
- Silage yield increases with row spacing narrower than 30-inches in 4 of 6 AJ references.

Michigan Row Spacing Study

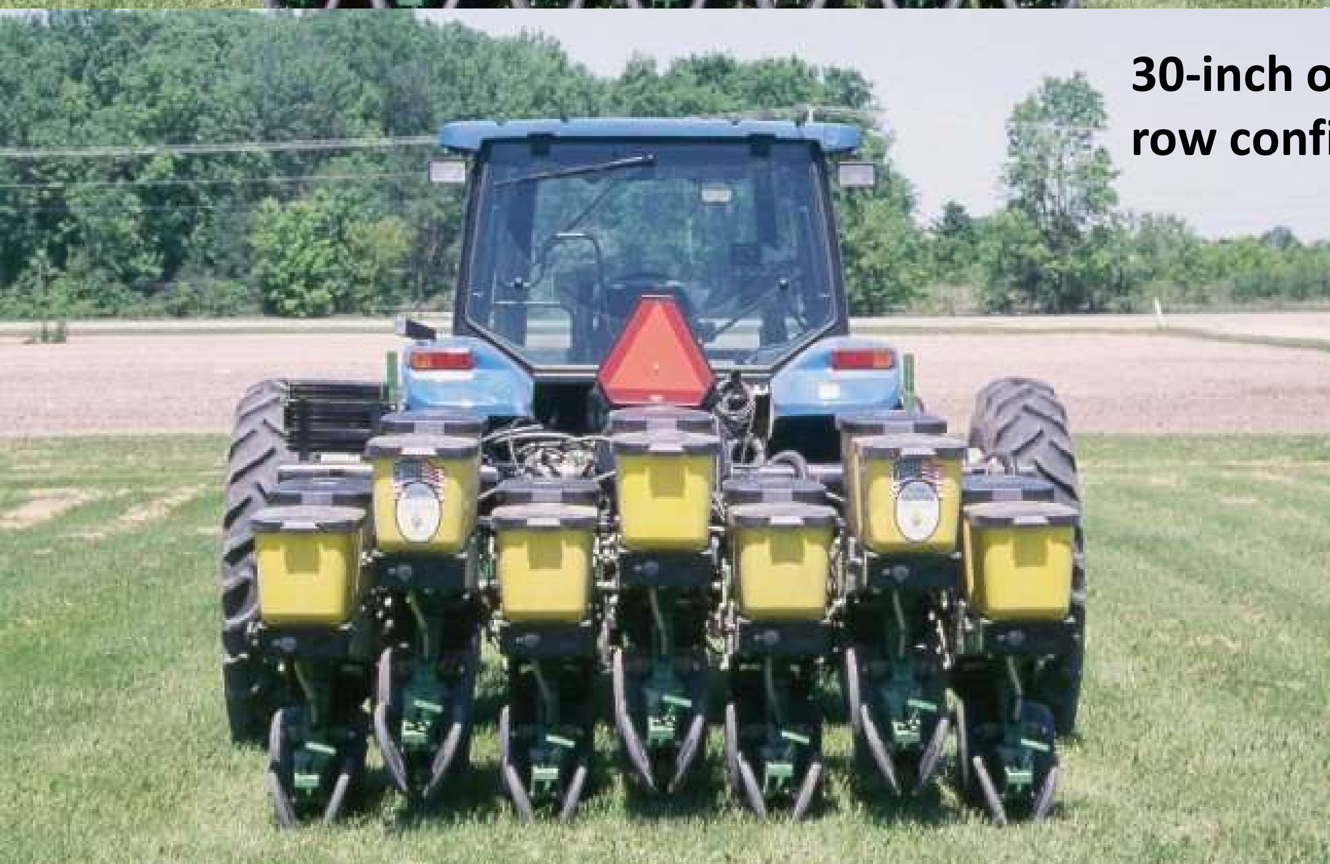
Materials and Methods

- 15 total site-years
  (5 Sites x 3 Years)
- 4 hybrids per Site
- 5 populations per site:
  23000, 26400, 29800, 33200, 36500 plants/A
  (52000, 59000, 67000, 74000, 82000 plants ha^{-1})
- 3 row widths: 15-, 22-, and 30-inches (38-, 56-, 76-cm)
- 2640 total plots

Widdicombe and Thelen, 2002 (AJ 94:1020)

15-inch or 38-cm row configuration

30-inch or 76-cm row configuration



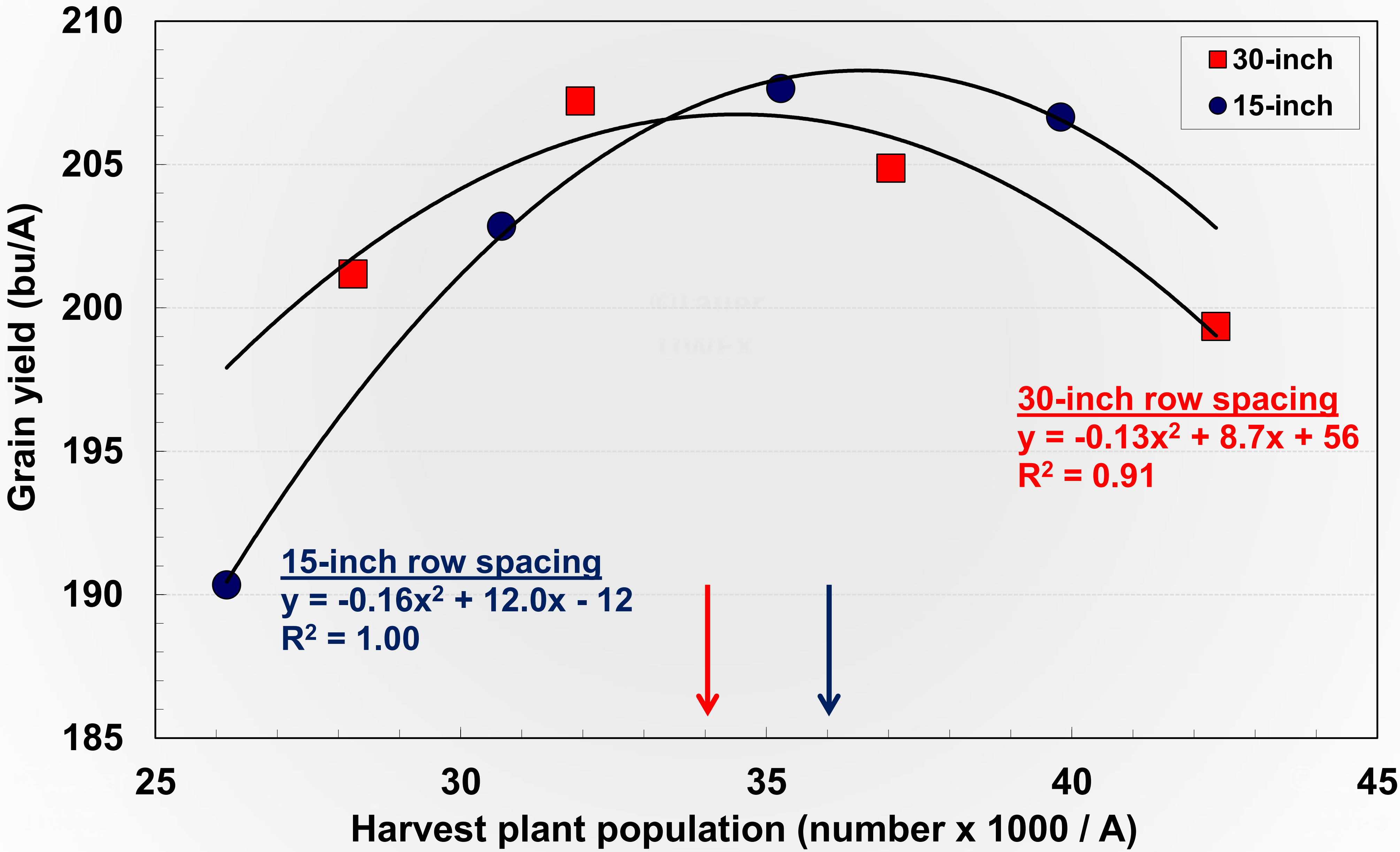
Corn response to row width in Michigan

Each value is the mean of 880 plots.

Row width	Forage yield	Grain yield	Grain moisture	Stalk lodging
Inches	T/A	Bu/A	%	%
30	8.74 c	177 c	19.6 a	1.60 b
22	8.98 b	181 b	19.2 b	1.92 a
15	9.19 a	184 a	19.2 b	1.65 b

Widdicombe and Thelen, 2002 (AJ 94:1020)

Corn Grain Yield Response to Row Spacing and Plant Density



Lauer, 1997-1999, Janesville, WI

Tillage

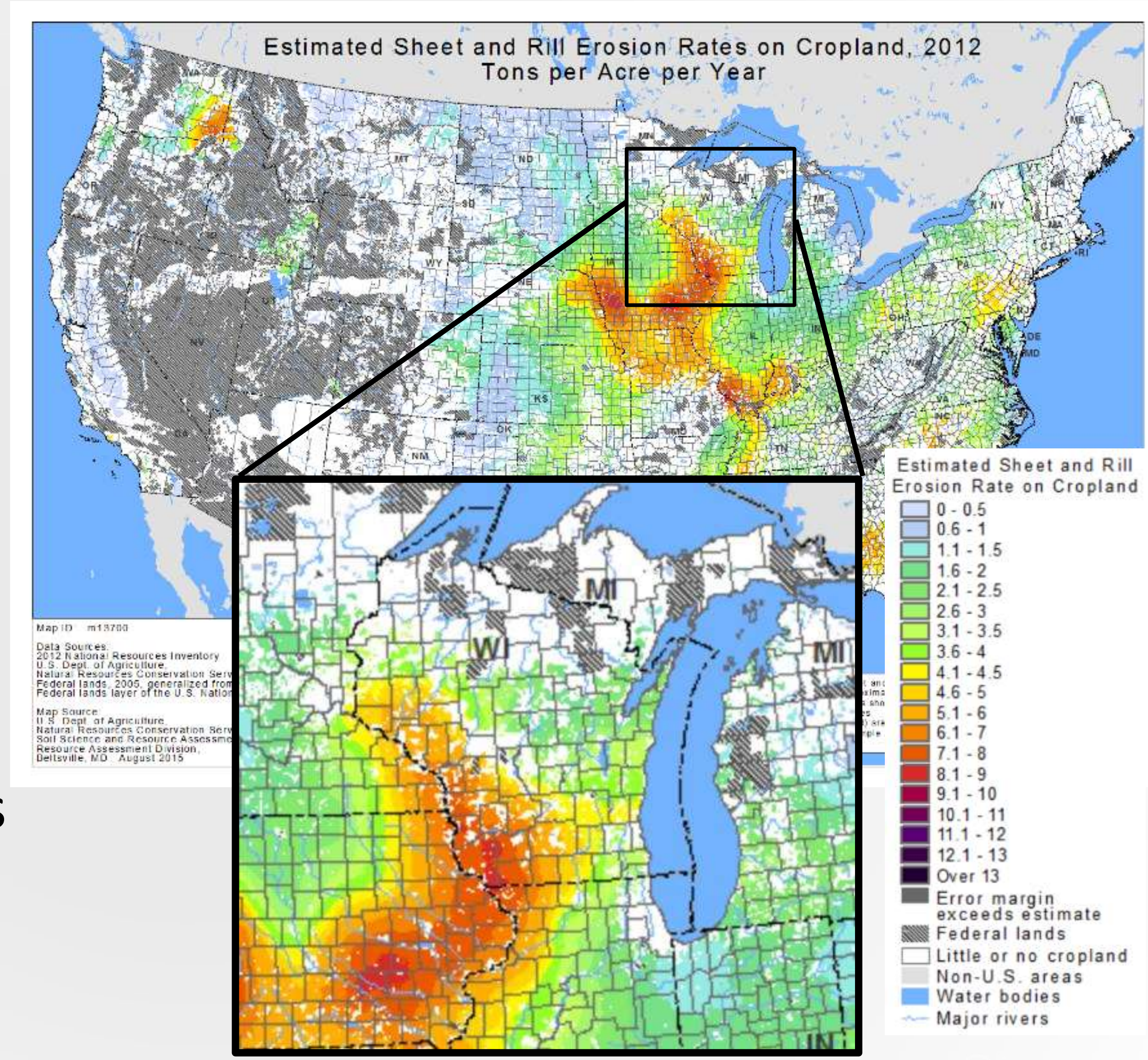
- Tillage used to be about …
  - ✓ Controlling weeds
  - ✓ Incorporating residue
  - ✓ Seedbed preparation
- Now, it is about spring stand establishment.
  - ✓ Excellent herbicides
  - ✓ Planter technology developments
- Planting season= Challenge for NT
  Pollination & Grain-fill= Benefit for NT
- Tillage not necessary, except in continuous corn.
  - ✓ Don't treat tillage like religion
  - ✓ Develop no-till skills
  - ✓ Don't throw away your chisel plow
- Do you have reason to suspect compaction?
  - ✓ How was it caused?
  - ✓ Sub-soil?

Photo by Dick Wolkowski

Photo by Mike Rankin

Tillage in Wisconsin

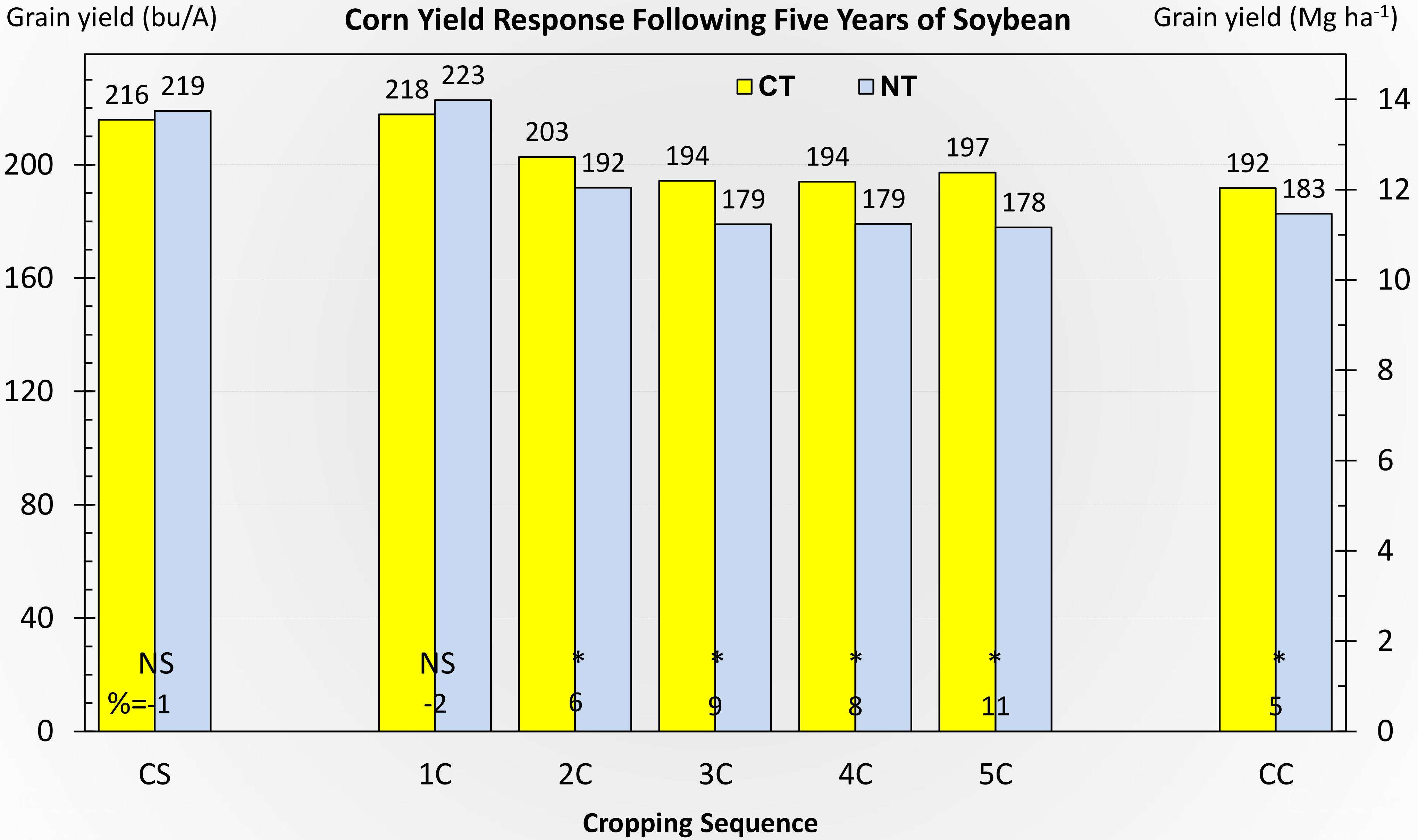
- Wisconsin production
  - ✓ Soybean: 47.0 bu/A average yield (USDA-NASS 2019)
  - ✓ Corn: 168 bu/A average yield (USDA-NASS 2019)
  - ✓ $3 billion industry for WI
- Challenges in Wisconsin
  - ✓ Cold, compacted soils
  - ✓ Connection to bedrock
  - ✓ Challenging slopes
  - ✓ Tillage
- Current recommendations
  - ✓ Yearly crop rotation
  - ✓ No-tillage
  - ✓ 15-in row spacing (Soybean)
  - ✓ 30-in row spacing (Corn)



(USDA, NRCS 2012)

Slide source: Derek Potratz

Tillage does not affect corn yield in CS/1C, but improves yield in 2C to 5C and CC.



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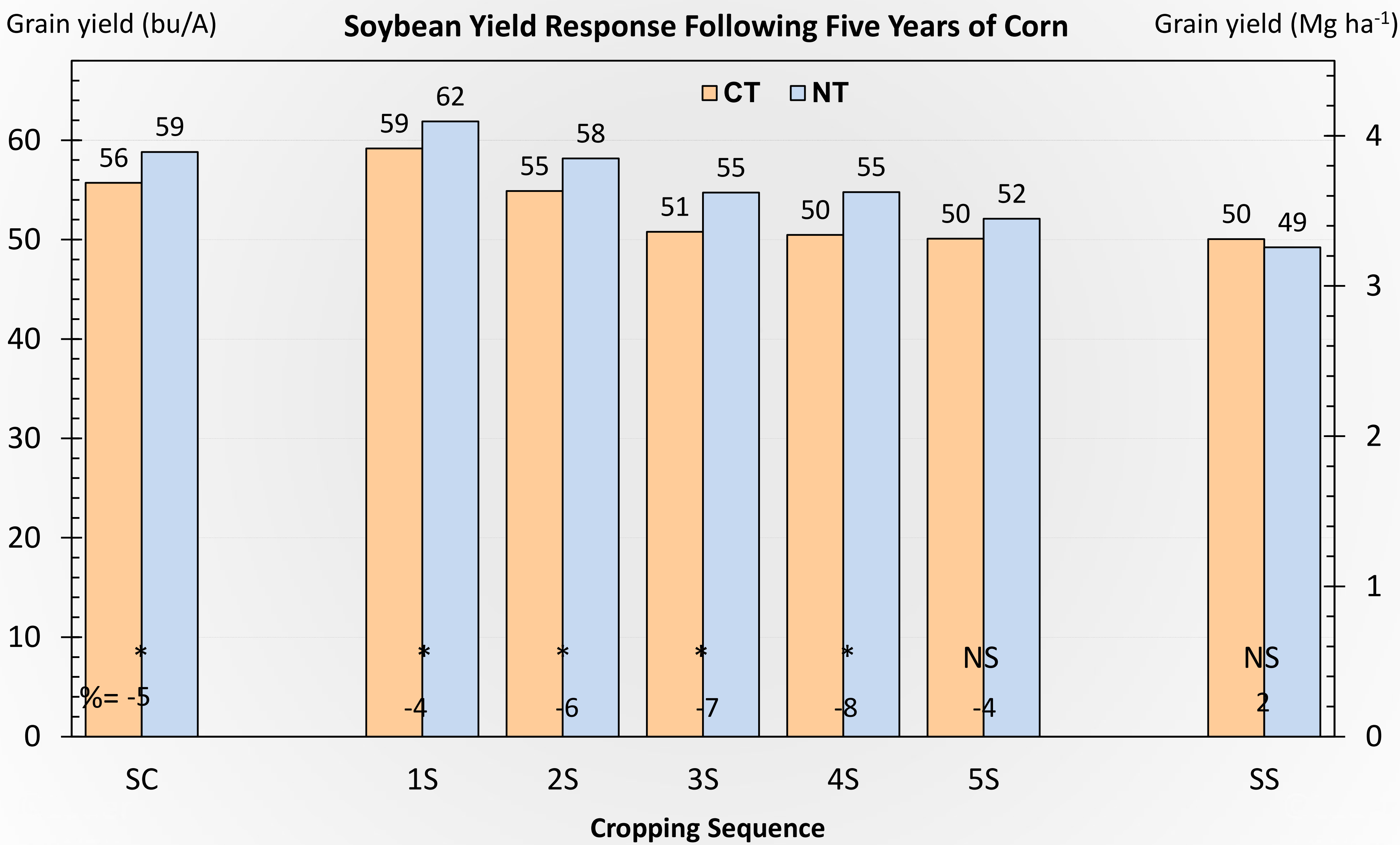
Lauer, 1996-2015 (Arlington, Control treatments)

No-till increases soybean yield in CS and 1S to 4S.



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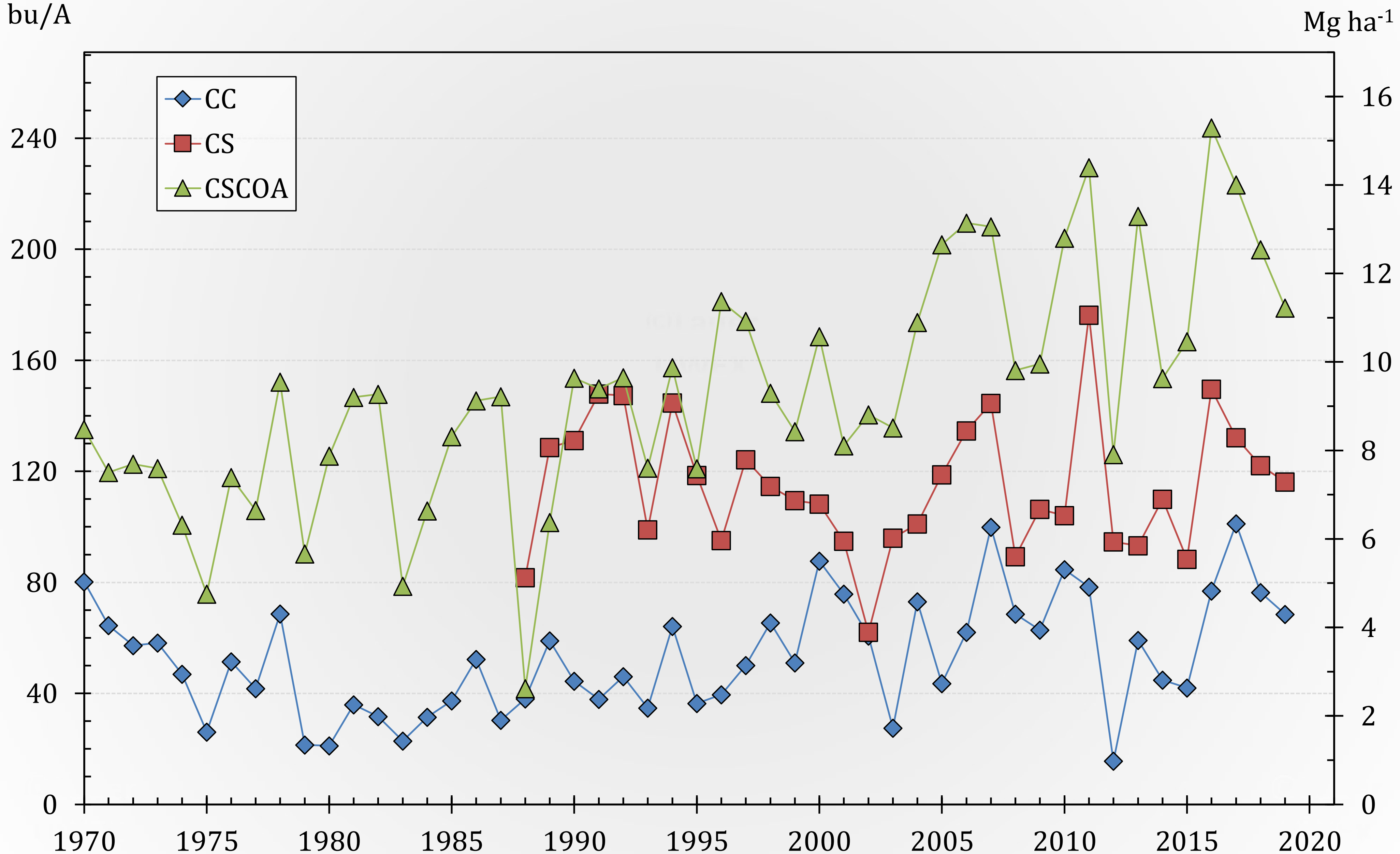
Lauer, 1996-2015 (Arlington, Control treatments)

Soil Fertility

- It's not the place to cut costs.
- Follow extension recommendations
- Soil test and only apply needed nutrients:
  - ✓ Use cheapest form of fertilizer per unit of N, P, or K and apply efficiently
  - ✓ Use manure and legume credits to reduce purchased fertilizer costs
  - ✓ Don't cut back on overall N supplied unless over applying
  - ✓ Don't use micronutrients unless soil test recommends

Corn Yield at 0 lb N/A



Lauer, 2019 (Lancaster)

Nutrients Removed by Corn at Harvest

Corn	P_2O_5 (lbs)	K_2O (lbs)
Per Yield Unit		
Grain, per bushel	0.38	0.29
Silage, per ton (65% moisture)	3.6	8.3
Per Area		
Grain, 175 bushels per acre	67	51
Silage, 24 tons per acre (65% moisture)	86	199

In 2018, a ton of corn stover is equivalent to:

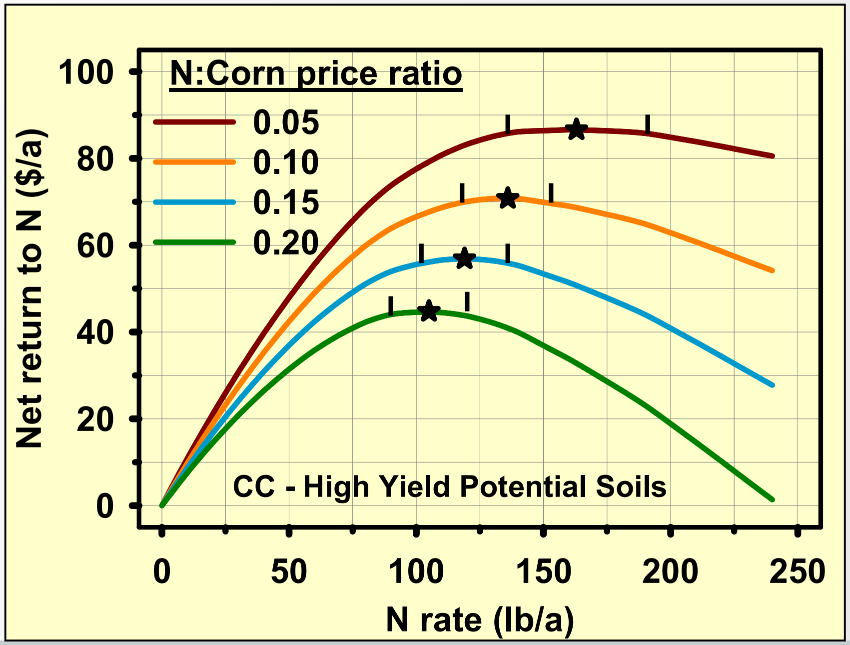
N= $7.89

P= $2.84

K= $18.03

derived from UW NPM Fast Facts

A range of N rates can produce profitable yields. Economics clearly drives the profitable N rate.



N:Corn Price Ratio Table*

Color Key for ratio (see other side): 0.05, 0.10, 0.15, 0.20

Price of N = [$/ton fertilizer x (100 / % N in fertilizer)] / 2000

Price of N ($/lb N) \ Price of Corn ($/bu corn)	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00	5.25	5.50
0.25	0.10	0.09	0.08	0.08	0.07	0.07	0.06	0.06	0.06	0.05	0.05	0.05	0.05
0.30	0.12	0.11	0.10	0.09	0.09	0.08	0.08	0.07	0.07	0.06	0.06	0.06	0.05
0.35	0.14	0.13	0.12	0.11	0.10	0.09	0.09	0.08	0.08	0.07	0.07	0.07	0.06
0.40	0.16	0.15	0.13	0.12	0.11	0.11	0.10	0.09	0.09	0.08	0.08	0.08	0.07
0.45	0.18	0.16	0.15	0.14	0.13	0.12	0.11	0.11	0.10	0.10	0.09	0.09	0.08
0.50	0.20	0.18	0.17	0.15	0.14	0.13	0.13	0.12	0.11	0.11	0.10	0.10	0.09
0.55	0.22	0.20	0.18	0.17	0.16	0.15	0.13	0.13	0.12	0.12	0.11	0.11	0.10
0.60	0.24	0.22	0.20	0.18	0.17	0.16	0.14	0.14	0.13	0.13	0.12	0.11	0.11
0.65	0.26	0.24	0.22	0.20	0.19	0.17	0.16	0.15	0.14	0.14	0.13	0.12	0.12
0.70	0.28	0.25	0.23	0.22	0.20	0.19	0.18	0.16	0.16	0.15	0.14	0.13	0.13
0.75	0.30	0.27	0.25	0.23	0.21	0.20	0.19	0.18	0.17	0.16	0.15	0.14	0.14
0.80	0.32	0.29	0.27	0.25	0.23	0.21	0.20	0.19	0.18	0.17	0.16	0.15	0.15

*to use an online calculator go to http://www.soils.wisc.edu/extension/

University of Wisconsin Nitrogen Guidelines for Corn

N:Corn Price Ratio (see table on other side)

Soil[1]	Previous Crop	0.05	0.10	0.15	0.20
		lbs N/acre (total to apply)[2]			
loamy: high yield potential soils	**Corn**, Forage legumes, Legume vegetables, Green manures[5]	**190**[3] 170--------210[4]	**165** 155----180	**150** 140---160	**135** 125----150
	Soybean, Small grains[6]	**140** 125-------160	**120** 105----130	**105** 95--115	**90** 80----105
loamy: medium yield potential soils	**Corn**, Forage legumes, Legume vegetables, Green manures[5]	**145** 130------160	**125** 115----140	**115** 105---125	**105** 95---110
	Soybean, Small grains[6]	**130** 110--------150	**100** 85------120	**85** 70---95	**70** 60---80
sands/ loamy sands	Irrigated—**All crops**[5]	**215** 200-----230	**200** 185----210	**185** 175---195	**175** 165---185
	Non-irrigated—**All crops**[5]	**140** 130---150	**130** 120---140	**120** 110---130	**110** 100---120

[1] To determine soil yield potential, consult UWEX publication A2809 or contact your county agent or agronomist.

[2] Includes N in starter.

[3] Maximum return to N (MRTN) rate.

[4] Profitability range within $1/acre of MRTN rate.

[5] Subtract N credits for forage legumes, legume vegetables, animal manures, green manures.

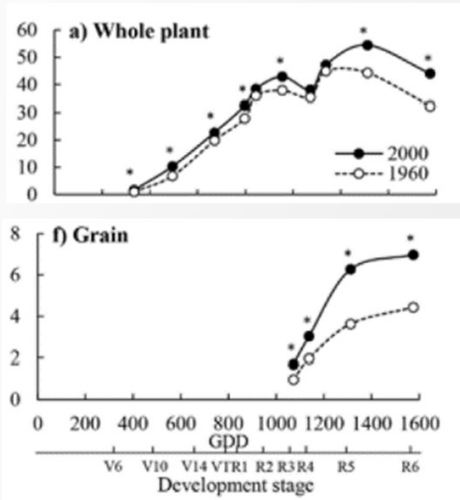
[6] Subtract N credits for animal manures and second year forage legumes.

1-11-2012-7M

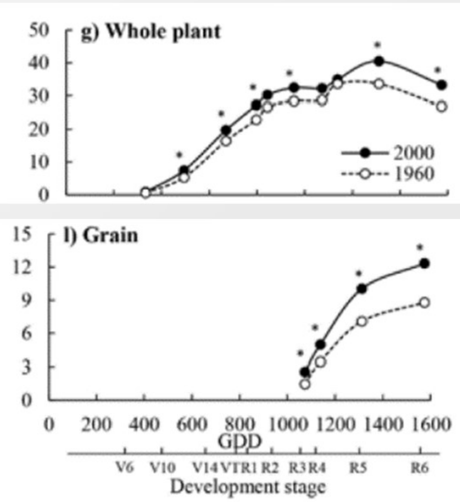
Laboski, 2012

Nutrient Content of Corn (Whole-plant and Grain)

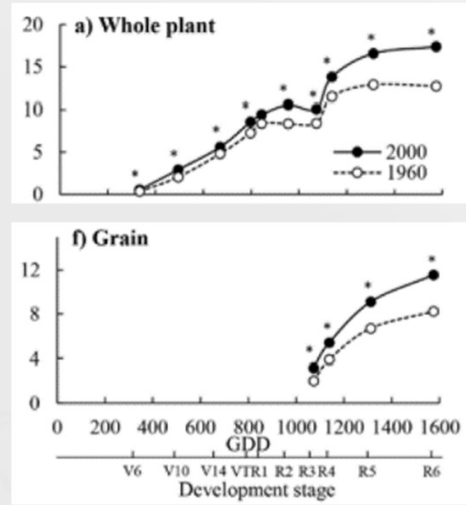
Calcium (kg ha^{-1})



Magnesium (kg ha^{-1})



Sulfur (kg ha^{-1})



Iron (g ha^{-1})

Copper (g ha^{-1})

Zinc (g ha^{-1})

Manganese (g ha^{-1})

Boron (g ha^{-1})

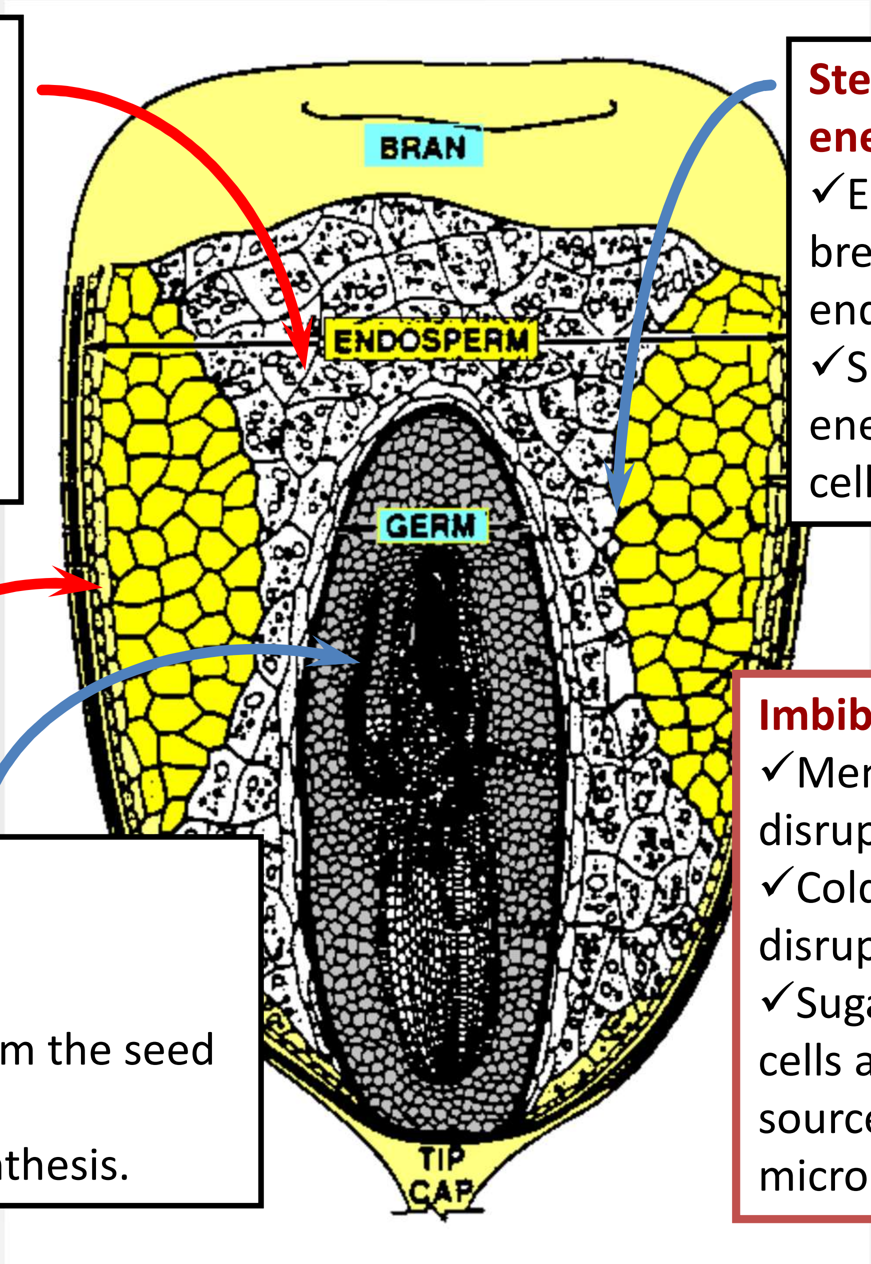
Woli et al., 2017. AJ 109:751

Seed Treatments

- Take home message … The number of days from planting to emergence is a key factor determining the amount of seedling disease infecting the crop.
- Growers must do ALL of the right things to minimize early season STRESS
- It is hard to make money raising “runts”
- Rain is a growers best friend or worst enemy
  - ✓ Rainfall - soon after planting that results in saturated or nearly saturated soils - is a bigger factor on yield than is date of planting or tillage type
  - ✓ Grower’s today plant large numbers of acres of corn each day-increasing the at risk acres when a major weather front comes through

Germination can be divided into a number of distinct phases:

Step 1: Imbibition.
✓Water and oxygen move slowly into the kernel through the pericarp.
✓Membranes rehydrate
✓Hormones and enzymes are activated.



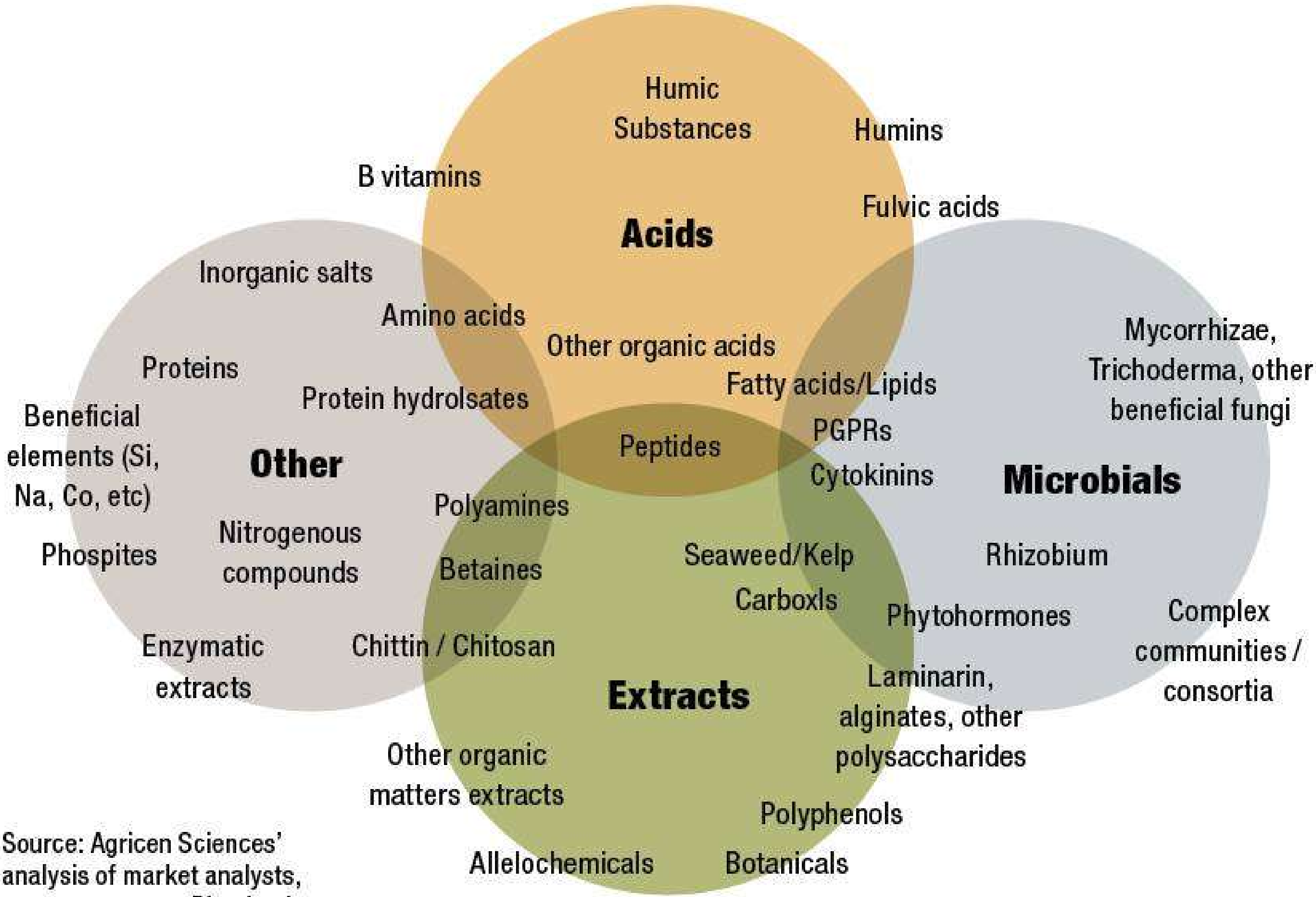
Pericarp(bran)

Step 2: Starch breakdown and energy remobilization
✓Enzymes begin to breakdown starch in the endosperm.
✓Sugars supply embryo with energy for metabolism and cell division.

Step 3. Cell elongation and differentiation
✓Radicle emerges first.
✓The plumule emerges from the seed and then from the soil.
✓Seedling begins photosynthesis.

Imbibitional chilling
✓Membrane rehydration is disrupted by free radicals
✓Cold water is much more disruptive than warm water.
✓Sugars and salts leak from the cells and kernel. Providing a food source for pathogens and other microbes.

A Very Broad Landscape of Emerging Products



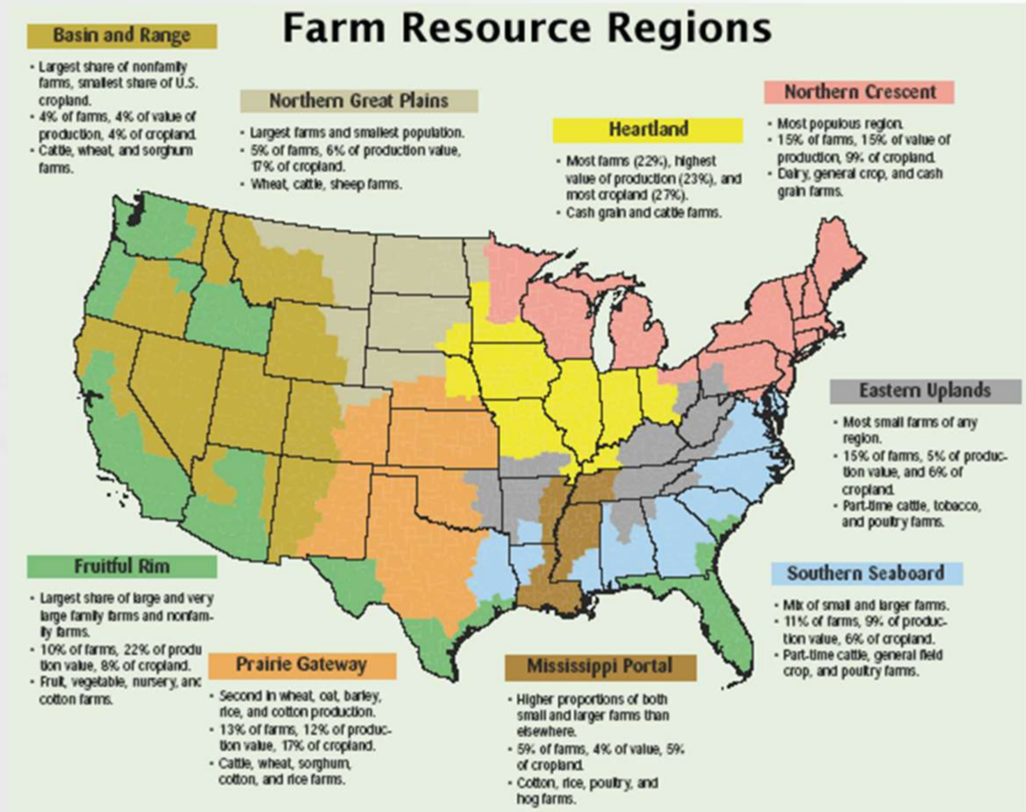
Source: Agricen Sciences' analysis of market analysts, survey papers on Biostimulants

Desirable Forage Characteristics

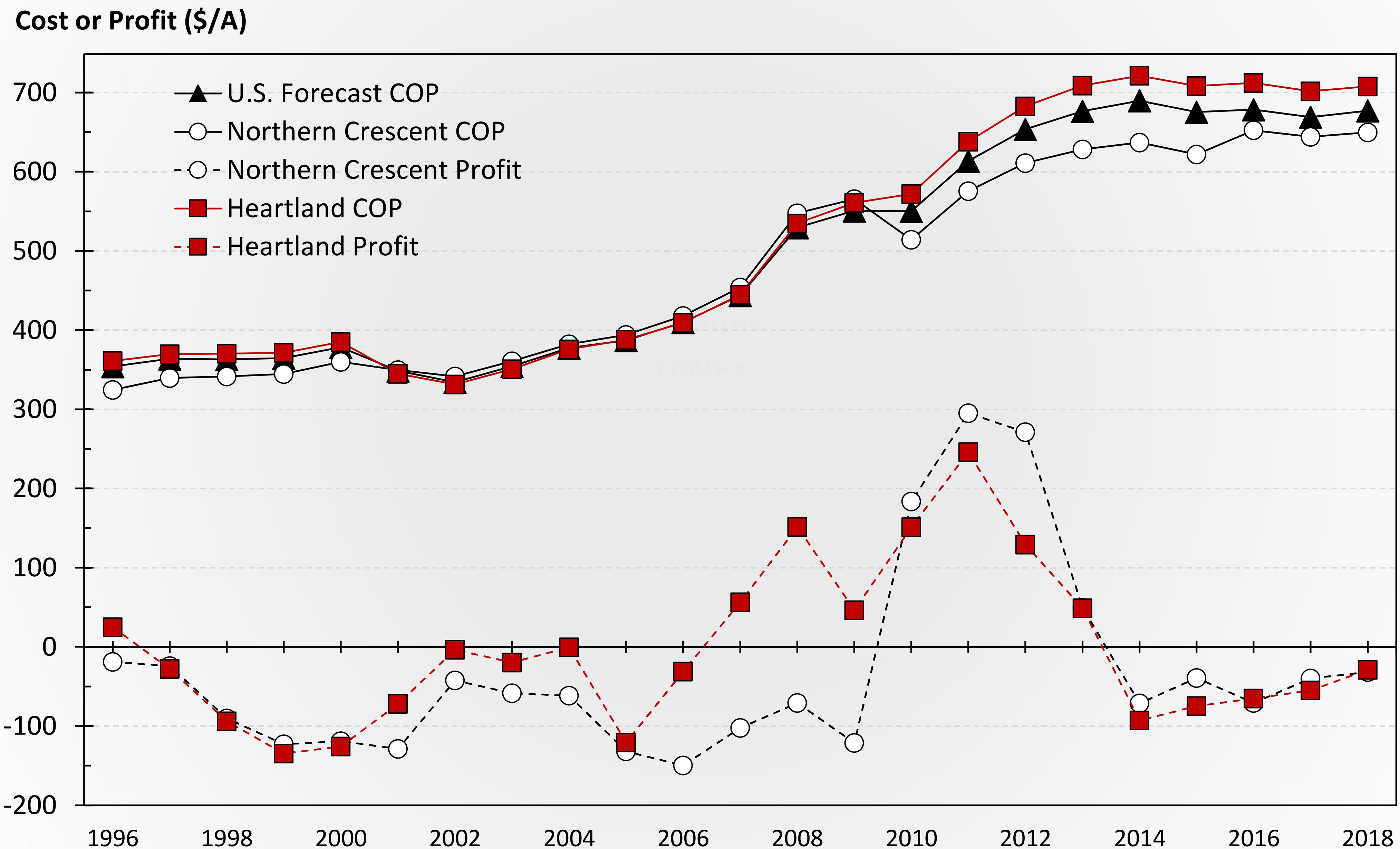
- What makes a good forage? (Carter et al., 1991)
  - ✓ High yield
  - ✓ High energy (high digestibility)
  - ✓ High intake potential (low fiber)
  - ✓ High protein
  - ✓ Proper moisture at harvest for storage
- Ultimate test is animal performance
  - ✓ Currently Milk2006 is our best predictor for performance (Schwab - Shaver equation)
    - ➢ Milk91: ADF
    - ➢ Milk95: NDF
    - ➢ Milk2000: NDF, NDFD, and Starch
    - ➢ Milk2006: NDF, NDFD, and Starch (adjustments)
    - ➢ Milk????: new 2021 NRC guidelines
    - ➢ Other: UW= TTNDFD, Cornell= uNDF (240 h)

USDA-ERS Cost of Production Data Materials and Methods

- USDA COP estimates since 1975
- Based on the actual costs incurred by producers
  - ✓ Survey base conducted every five years.
  - ✓ Annual Agricultural Resource Management Survey (ARMS) has been used to modify the survey base since 1996.
  - ✓ Excludes costs for marketing and storage.
  - ✓ ARMS data collection starts during the fall when production practice and cost data are collected, and finishes in the spring when a follow-up interview collects data about whole-farm costs like overhead, interest, and taxes.
  - ✓ Each farm sampled in the ARMS represents a known number of farms with similar attributes so that weighting the data for each farm by the number of farms it represents provides a basis for calculating estimates.



USDA-ERS Cost of Production Estimates for Corn



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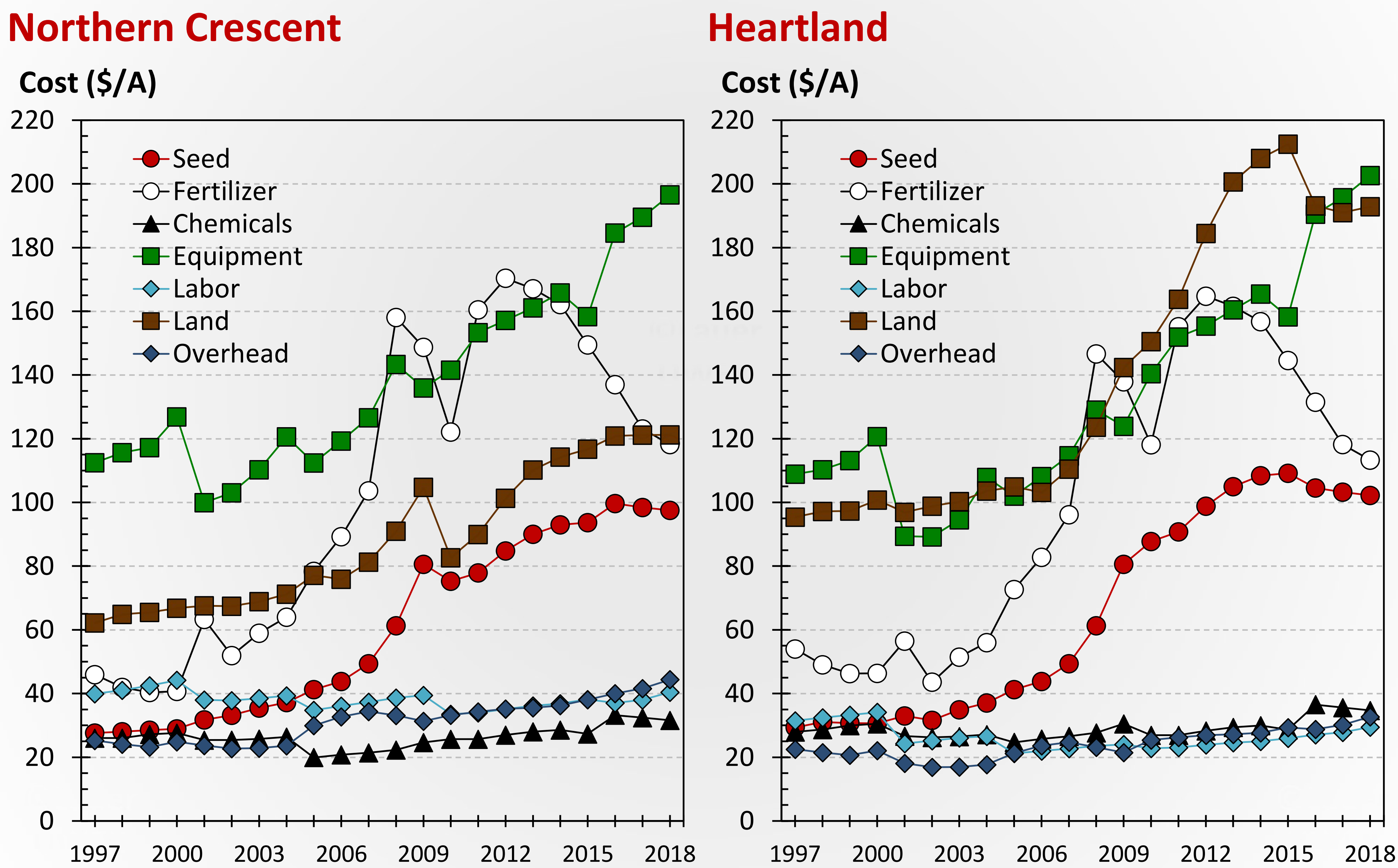
USDA-ERS: http://www.ers.usda.gov/data-products/commodity-costs-and-returns.aspx#historic1

USDA-ERS Cost of Production Estimates for Corn



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USDA-ERS: http://www.ers.usda.gov/data-products/commodity-costs-and-returns.aspx#historic1

Secondary and Micronutrients

Corn Era Hybrid Nutrient Concentration and Accumulation of Secondary and Micronutrients

Krishna P. Woli,* John E. Sawyer, Matthew J. Boyer, Lori J. Abendroth, and Roger W. Elmore*

ABSTRACT

Studies are limited that focus on change in concentration and accumulation of secondary and micronutrients in corn (*Zea mays* L.) plant fractions and across corn hybrid development periods. This research was conducted in 2007 and 2008 to evaluate the partitioning of secondary and micronutrients across vegetative and reproductive stages at the plant-fraction level for 1960- and 2000-era hybrids. Two popular hybrids for each era were grown, with measurement of nutrient concentration and content in several plant and grain fractions. Secondary and micronutrient concentrations in plant fractions were lower in 2000- than 1960-era hybrids with most nutrients, except ear shoots and tassels for certain nutrients. However, nutrient content was consistently greater in 2000- compared to 1960-era hybrids in the whole plant and fractions at most development stages, except tassels and ear shoots. In tassels, nutrient content was mostly smaller in 2000-era hybrids, but in ear shoots content was similar. The accumulation rates of most nutrients per growing degree day (GDD) were greater in the reproductive period for 2000-era hybrids, but similar among eras in the vegetative period. Remobilized nutrients from vegetative to reproductive components were similar between era hybrids, except Ca

During the past 40 yr corn (*Zea mays* L.) breeding along with improved nutrient management and environmental conditions have contributed significantly to yield gains and closing the yield gap (Tollenaar, 1989; Duvick, 1992; Khush, 1999; Ciampitti and Vyn, 2013). As a valuable staple food worldwide, corn provides carbohydrates, proteins, and minerals for humans and animals (Chen et al., 2016). The enhancement in corn yield has also resulted in an increase of the amount of crop residue remaining (Ferreira et al., 2014). The nutrient concentration and amount of crop residues determine the amount of nutrients returned to the soil and are important for nutrient cycling (Moschler et al., 1972). However, there is increased interest in crop residue removal for use as biofuel, animal feed, animal bedding, and many other functions that may increase secondary and micronutrient export from the field (Ferreira et al., 2014).

From the viewpoint of sustainable production, nutrient management ideally should provide a balance between nutrient inputs and outputs over the long term (Bacon et al., 1990). Nutrient uptake requirements by plants are determined by many factors, including productivity level, use efficiency, and nutrient availability in soils. To sustain soil fertility levels, especially those with large uptake and removal, nutrients removed by crop

Woli et al., 2017. AJ 109:751

Grain Marketing and Pricing Decisions

Action
1. Store or Wait to Price
2. Delayed Pricing Contract
3. Buy Put Options
4. Minimum price contract

Up

Futures

Action
1. Basis Contract
2. Sell Cash and Buy Futures or Call Options
3. Minimum Price Contract with Fixed Basis

Strengthening ← **Basis**

Expected Change for Futures and Basis

Basis → **Weakening**

Action
1. Hedge
2. Hedged-To-Arrive
3. Buy Put Options

Futures

Action
1. Cash Sales
2. Forward Contract

Down

Source: Dr. John Ferris, Michigan State University

Top 10 most common yield limiting factors …

- And NO, it isn't about inputs.
- The three most important management decisions are:

Hybrid Selection,

Hybrid Selection,

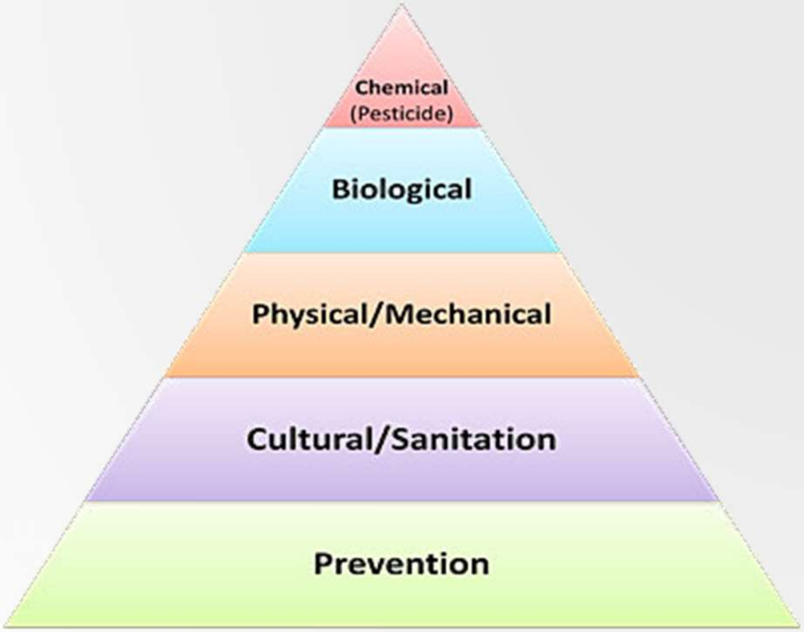
Hybrid Selection.

- Hybrid selection is main driver for delivering technology to the farm gate.
- The main management objective is to reduce stress on the corn plants during the growing season …

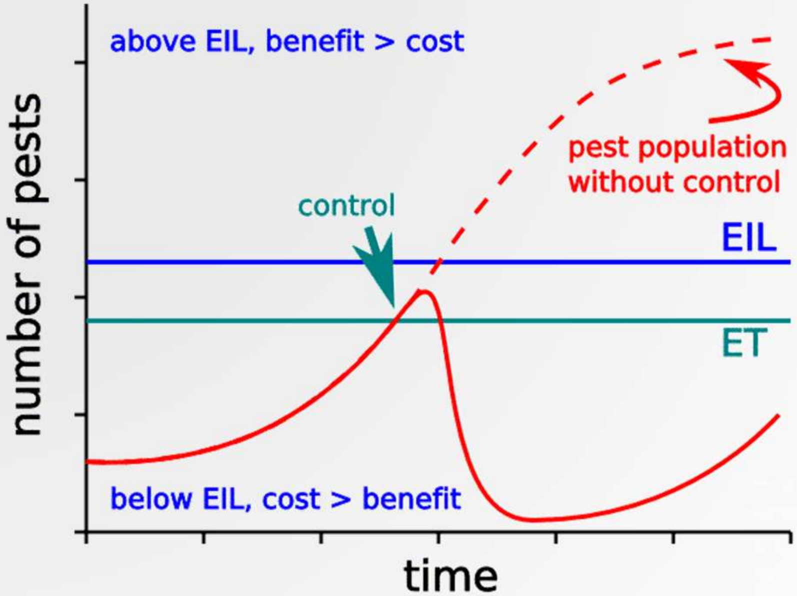
Crop Insurance and Government programs

- Crop Insurance = “Safety net”
  - ✓ Often required for operating loans
- Market Facilitation Program
  - ✓ “No one wants it”
  - ✓ Ideal = market driven by trade & demand
- Science-based vs Hazard-based approach to technology
- “Freedom to Farm”
- USDA Farm Bills
- Regulation
  - ✓ EPA
  - ✓ FDA
  - ✓ USDA

Pest Control



- Weeds > Insects > Diseases
- Scouting & Timeliness are key
- Emerging issues
  - ✓ Development of CRW resistance to Bt
  - ✓ Weed resistance to glyphosate
  - ✓ Corn nematodes

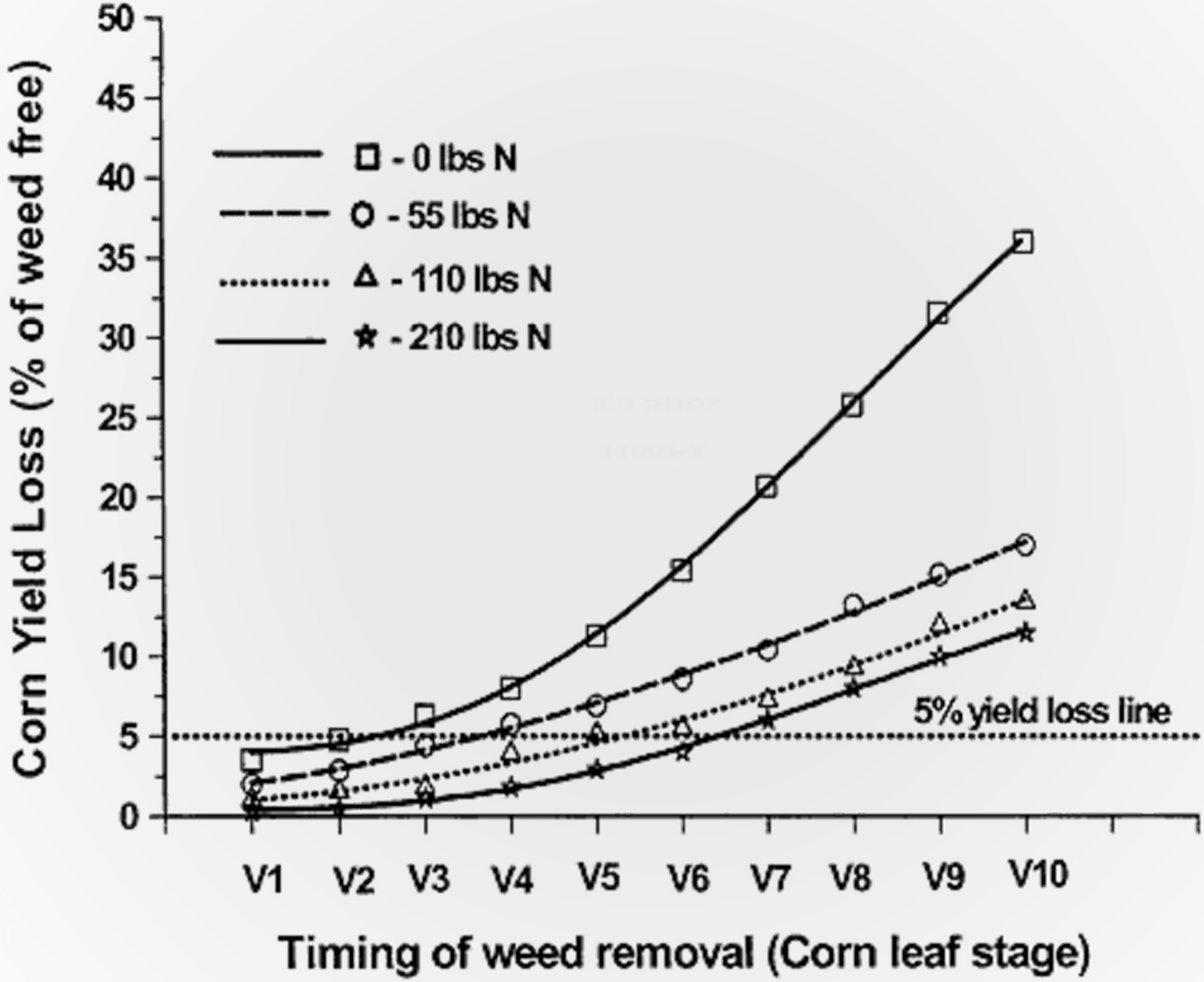


EIL Figure credit: Ed Zaborski, University of Illinois

Timely Weed Control

- Early season weed competition costs us yield in high yield environments.
- Yield cost of delaying weed control
  - ✓ Critical periods of competition
  - ✓ Timing
  - ✓ Weed density

Yield Cost of Delaying Weed Control

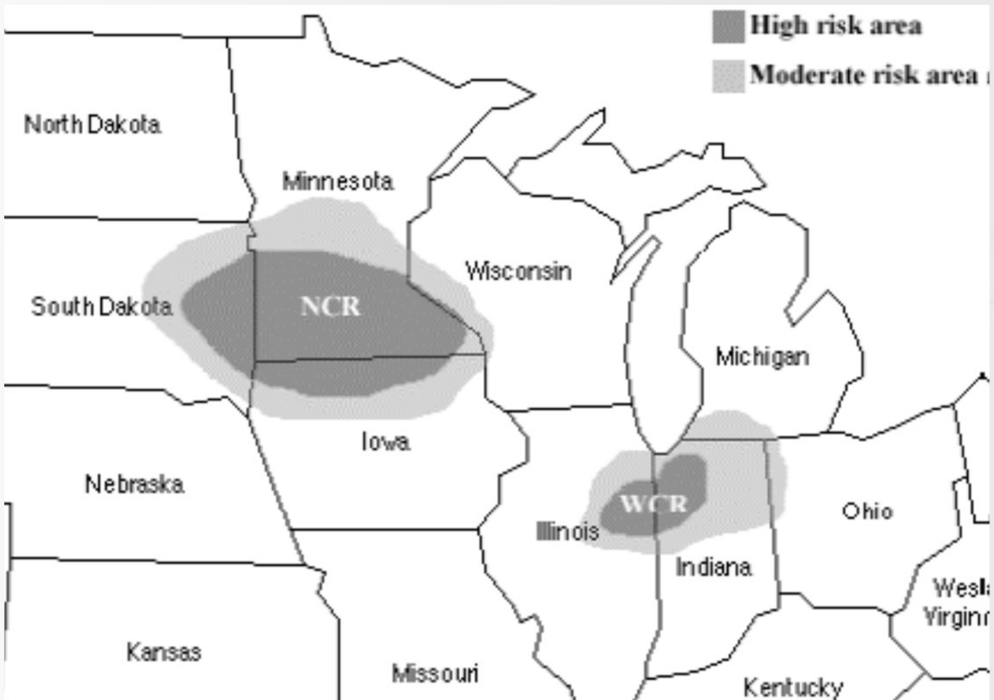


Knezevic et al. (2003)

Insect Management

- Its all about scouting and timing!
- Insects are adapting

Corn rootworm
(*Diabrotica sp.)*



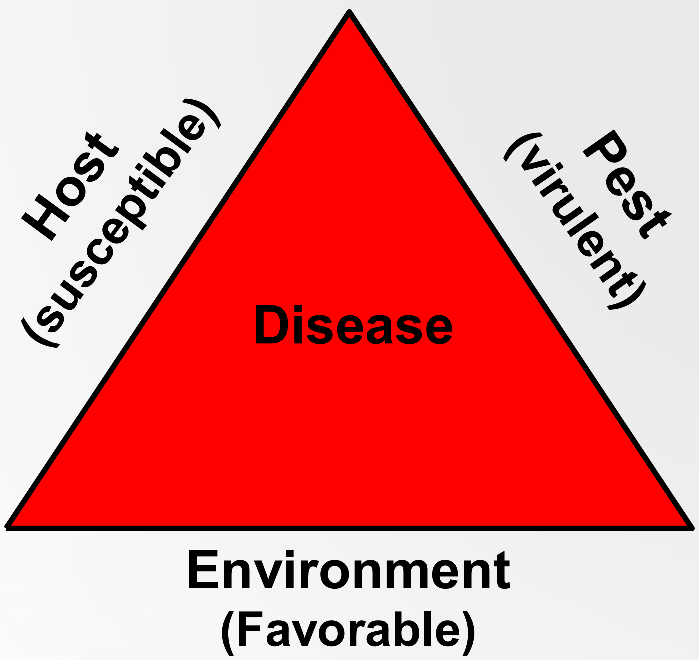
Photos: Rice

Disease Management

- “What is good for the crop is good for the pest.”
- Disease management goal is to improve corn canopy leading to yield increase and disease decrease.
- Genetic resistance is the cheapest control
- Scout for these in particular…
  - ✓ Anthracnose
  - ✓ Northern Corn Leaf Blight
  - ✓ Diplodia
  - ✓ Fusarium/Gibberella
- Foliar applied fungicides ?

Guidelines for Using a Fungicide on Hybrid Corn

- Thinking about spraying? Consider:
  - ✓ hybrid susceptibility,
  - ✓ disease pressure at VT,
  - ✓ weather conditions at VT,
  - ✓ previous crop,
  - ✓ the amount of crop residue present ,
  - ✓ fungicide and application cost ,
  - ✓ grain price, and
  - ✓ directions & restrictions on label



- In general, a fungicide application is not recommended on resistant hybrids.
- On susceptible hybrids, a fungicide application may be warranted if disease is present on the third leaf below the ear leaf or higher on 50 percent of the plants at tasseling.
- With intermediate hybrids, a fungicide need only be applied if conditions are favorable for disease development
  - ✓ Spray if disease is present on the third leaf below the ear leaf or higher on 50 percent of the plants at tasseling, **and**
  - ✓ the weather is warm and humid, **and**
  - ✓ the field has a history of Gray Leaf Spot and/or Anthracnose, **and**
  - ✓ >35 percent corn residue is present.

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Materials and Methods

- Relative maturity belts (1992)
- UW Hybrid trials (1973-2013)
  - ✓ Ask seed companies for:
    - ➢ Relative maturity rating (since 1973)
    - ➢ Transgenic events (since 1996)
    - ➢ Seed treatments (since 2005)
- Objectives/Questions:
  - ✓ Yield vs RM - How does it look?
  - ✓ Where is the optimum RM for a site?
  - ✓ Has the optimum changed over time?
- Analysis
  - ✓ Calculate GRM for every hybrid
  - ✓ Regress to find optimum GRM
  - ✓ Regress optimum GRM over years

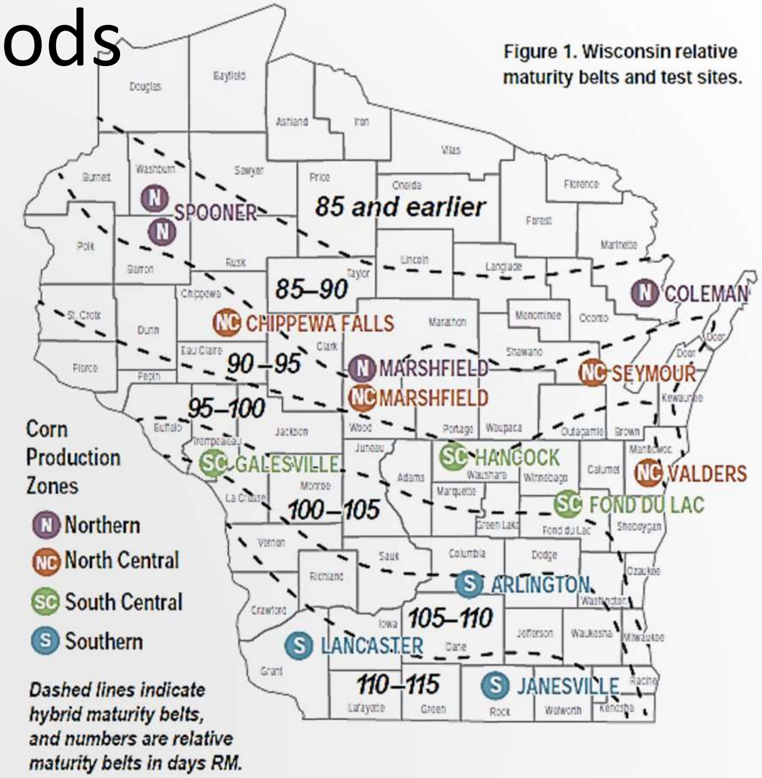
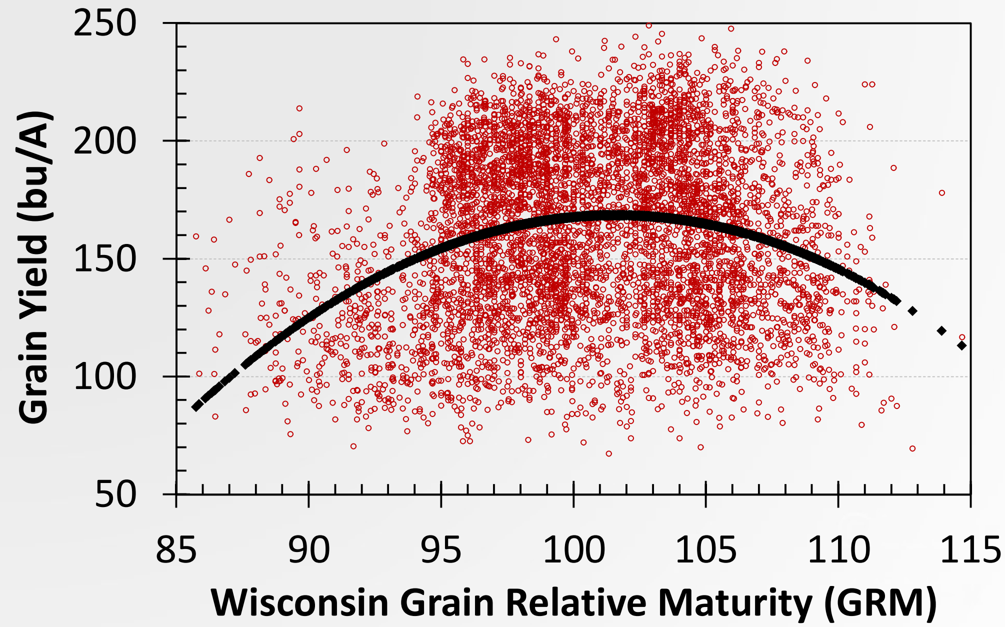
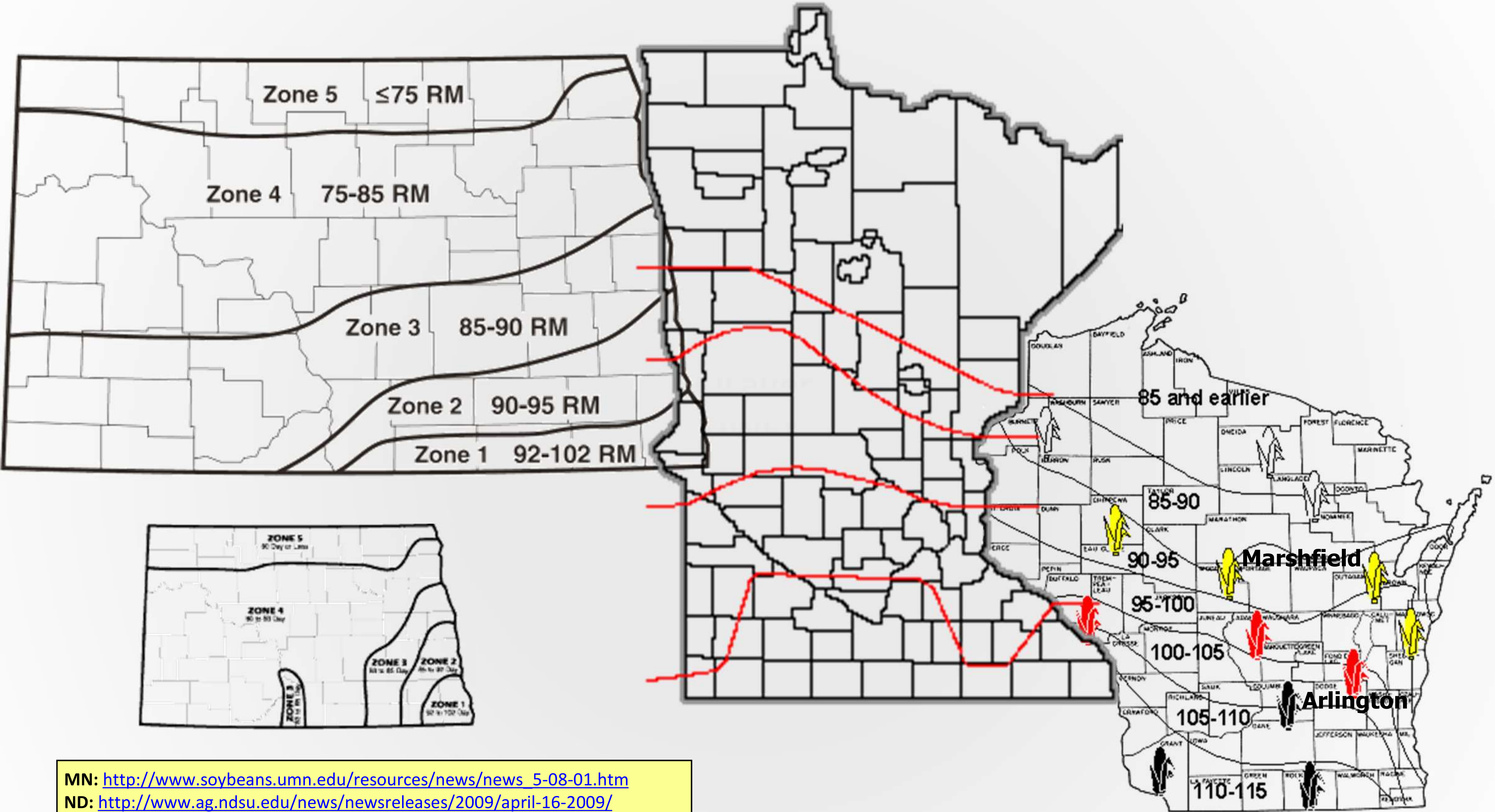


Figure 1. Wisconsin relative maturity belts and test sites.



Fond du Lac, 1974-2013
N- 5962 GxEs

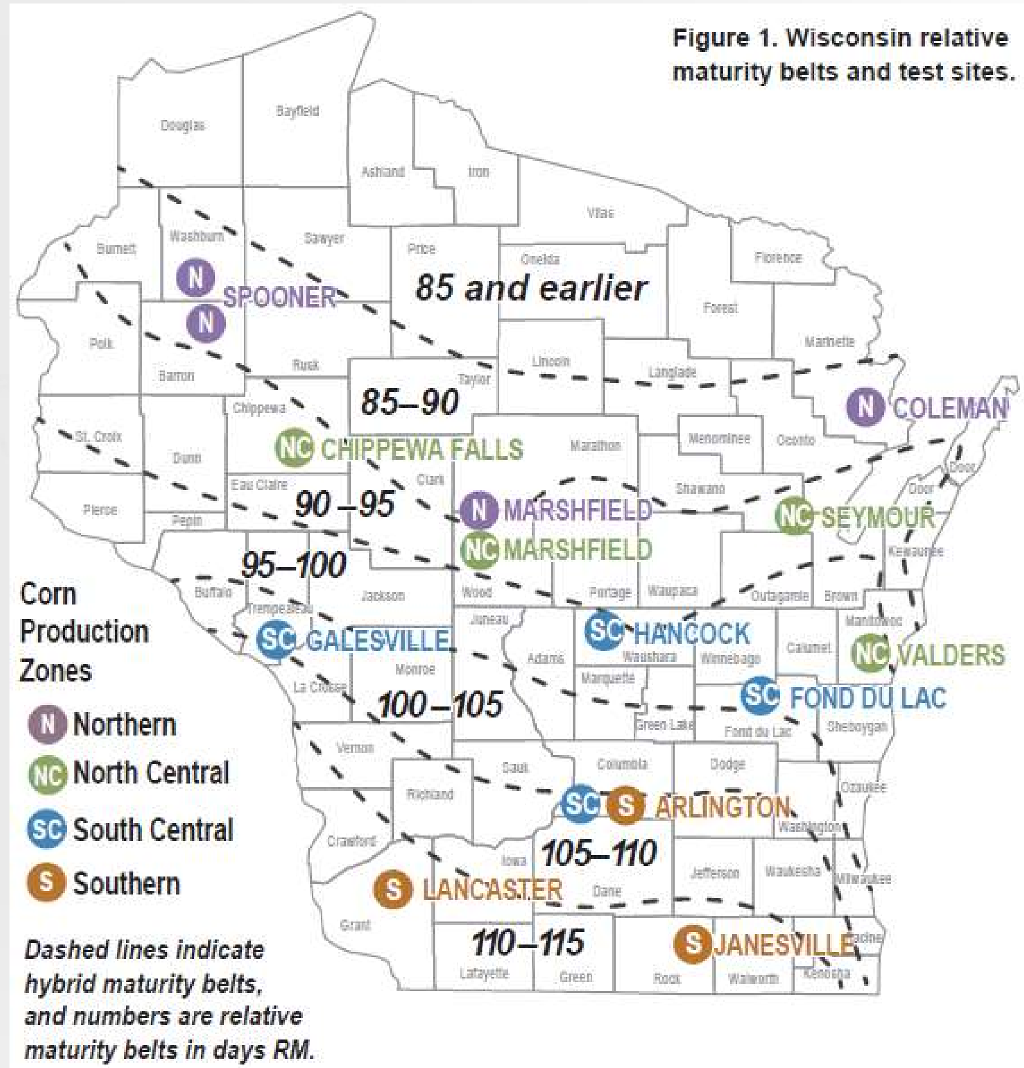
Northern Corn Maturity Belts



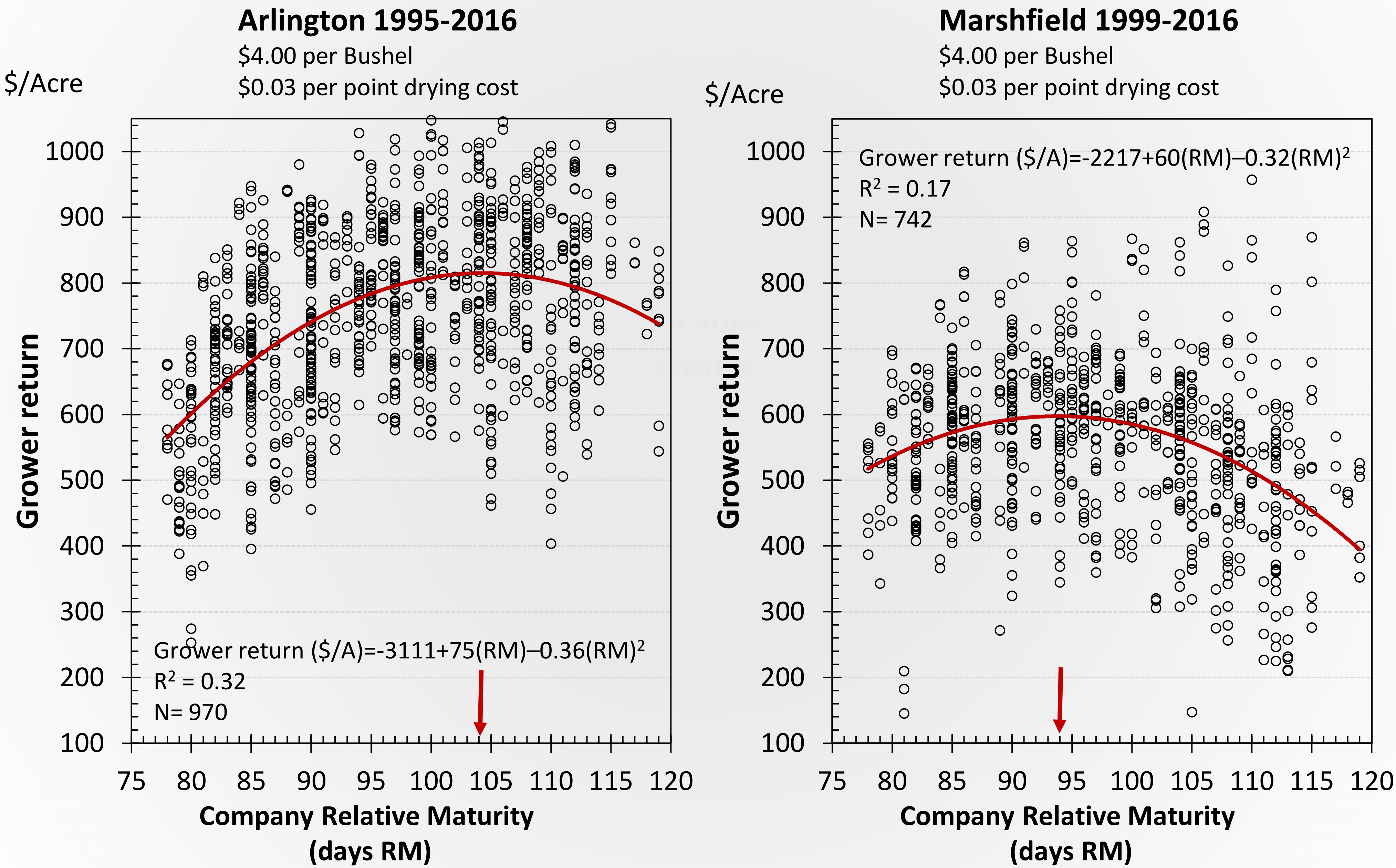
MN: http://www.soybeans.umn.edu/resources/news/news_5-08-01.htm
ND: http://www.ag.ndsu.edu/news/newsreleases/2009/april-16-2009/ndsu-offers-guidelines-for-late-planting-of-small-grains-and-corn/
WI: http://corn.agronomy.wisc.edu/HT/2009/2009Text.aspx

Materials and Methods

- Experiment began in 1995
- Locations per year = 3 to 5
  - ✓ (Reps = 3 to 4)
- Total of 14 to 16 corn hybrids, 2 from each RM group
  - ✓ Relative maturity range = 79 to 119 days
  - ✓ 80 d RM
  - ✓ 85 d RM
  - ✓ 90 d RM
  - ✓ 95 d RM
  - ✓ 100 d RM
  - ✓ 105 d RM
  - ✓ 110 d RM
  - ✓ 115 d RM



It all boils down to economics (drying cost) …



Lauer, unpublished

Optimum relative maturity (days RM) for three corn production systems

System:Drying Cost ($ / point bu)	Grain price ($/bu)		
	$3.00	$4.00	$5.00
Commercial:$0.06	98	100	102
On-Farm:$0.03	103	104	105
Livestock:$0.00	110	110	110

Lauer, 1995-2016 (Arlington)

Optimum relative maturity (days RM) for three corn production systems

System:Drying Cost ($ / point bu)	Grain price ($/bu)		
	$3.00	$4.00	$5.00
Commercial:$0.06	88	90	92
On-Farm:$0.03	93	94	95
Livestock:$0.00	NR	NR	NR

Lauer, 1999-2014 (Marshfield)

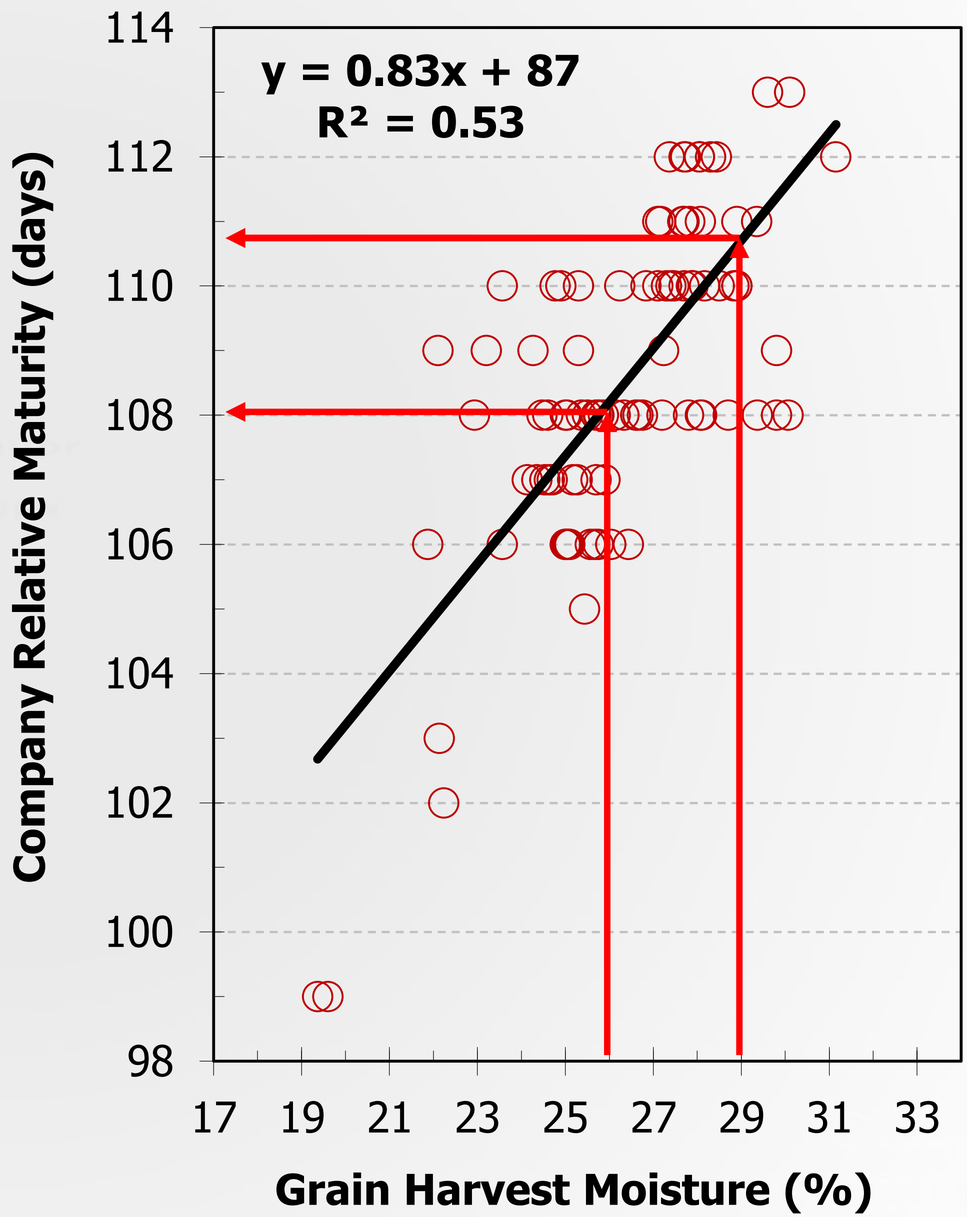
Optimum Corn Relative Maturity Recommendations

- Climate change
  - ✓ Updated USDA winter hardiness map
- Non-adapted hybrid have:
  - ✓ Lower yield: ~ 2 bu/A per RM unit
  - ✓ Higher drying cost: 2009= $0.90 per bu
  - ✓ Greater lodging potential, if too early
- No standard within industry
  - ✓ MN RM method (1929 -2006)
  - ✓ AES method
  - ✓ GDU method
  - ✓ Other methods: OCHU, FAO, CRM
- UW Approach: Table 2
  - ✓ Grain Relative Maturity (GRM)
  - ✓ Silage Relative Maturity (SRM)

Method for Determining WI Relative Maturity

GRM = Grain Relative Maturity, SRM = Silage Relative Maturity

- For every hybrid, we know:
  - ✓ Company Relative Maturity
  - ✓ Grain (or Silage) harvest moisture
- Regress Company RM on Grain moisture for each hybrid and back-calculate
- For example:
  - ✓ All hybrids at 26% moisture = 108-d GRM
  - ✓ All hybrids at 29% moisture = 111-d GRM
- Results in Table 2
  - ✓ GRM = Hybrid average across all locations
  - ✓ SRM uses a similar method, except Forage harvest moisture is used
- "Bottom line:" Maturity can be compared between companies



Arlington, Late-trial, 1998
N= 92 hybrids

A “Grand Experiment” is going on in the countryside …

"Traits do not add to yield … traits protect yield."

Well managed normal hybrids can yield the same as transgenic hybrids. Transgenic hybrids yield at the top AND bottom of a performance trial.

Pros

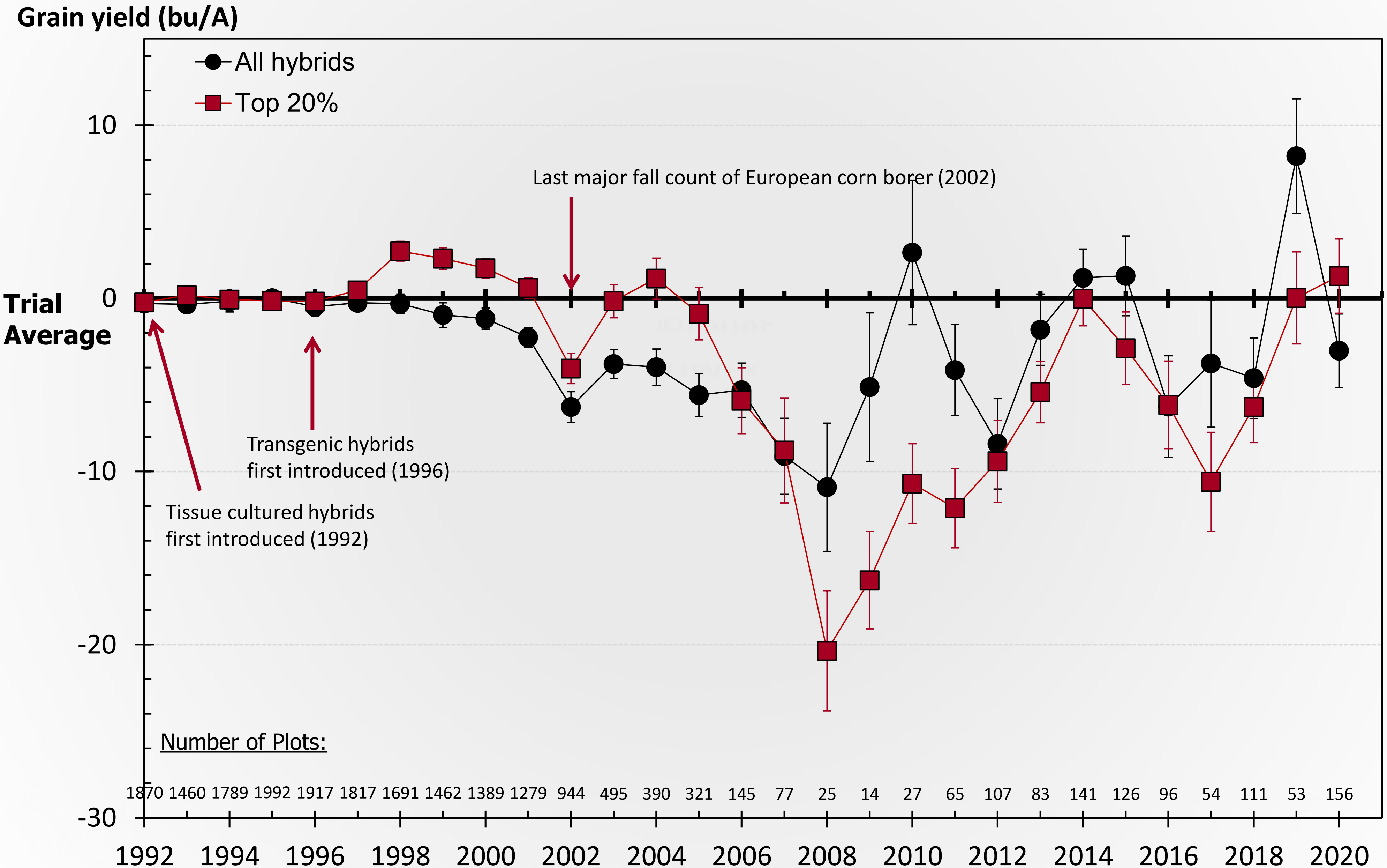
- Efficacy: Less pesticide use
- Disruption of pest cycles
  (MN ECB: no more 7 year cycle)
- Eased management challenges
  - ✓ Scouting: False security
  - ✓ Improved timeliness of operations
  - ✓ Improved human and crop safety
  - ✓ Perceived risk decrease (BYE)
- Created ancillary industries
- Potential
  - ✓ Decreased soil erosion
  - ✓ Pest control
  - ✓ Nutrition
- Speeded along IP process
  - ✓ (may also be a con)

Cons

- Initial consumer rejection, slow acceptance
- Perception that ALL transgenics are high performing and effective
- Unknown implications for the Midwest U.S. cropping system (corn-soybean)
- Debate: Yield lag v. Yield drag
- Development of normal hybrids is lagging behind.
  - ✓ Have yield increases stopped?
- Technology fees
  - ✓ Cost: When is enough money enough? Research and "Ramp-up" expenses
  - ✓ Patent expiration

Relative performance of conventional corn hybrids

Grain yield difference (bu/A) = hybrid average – trial average



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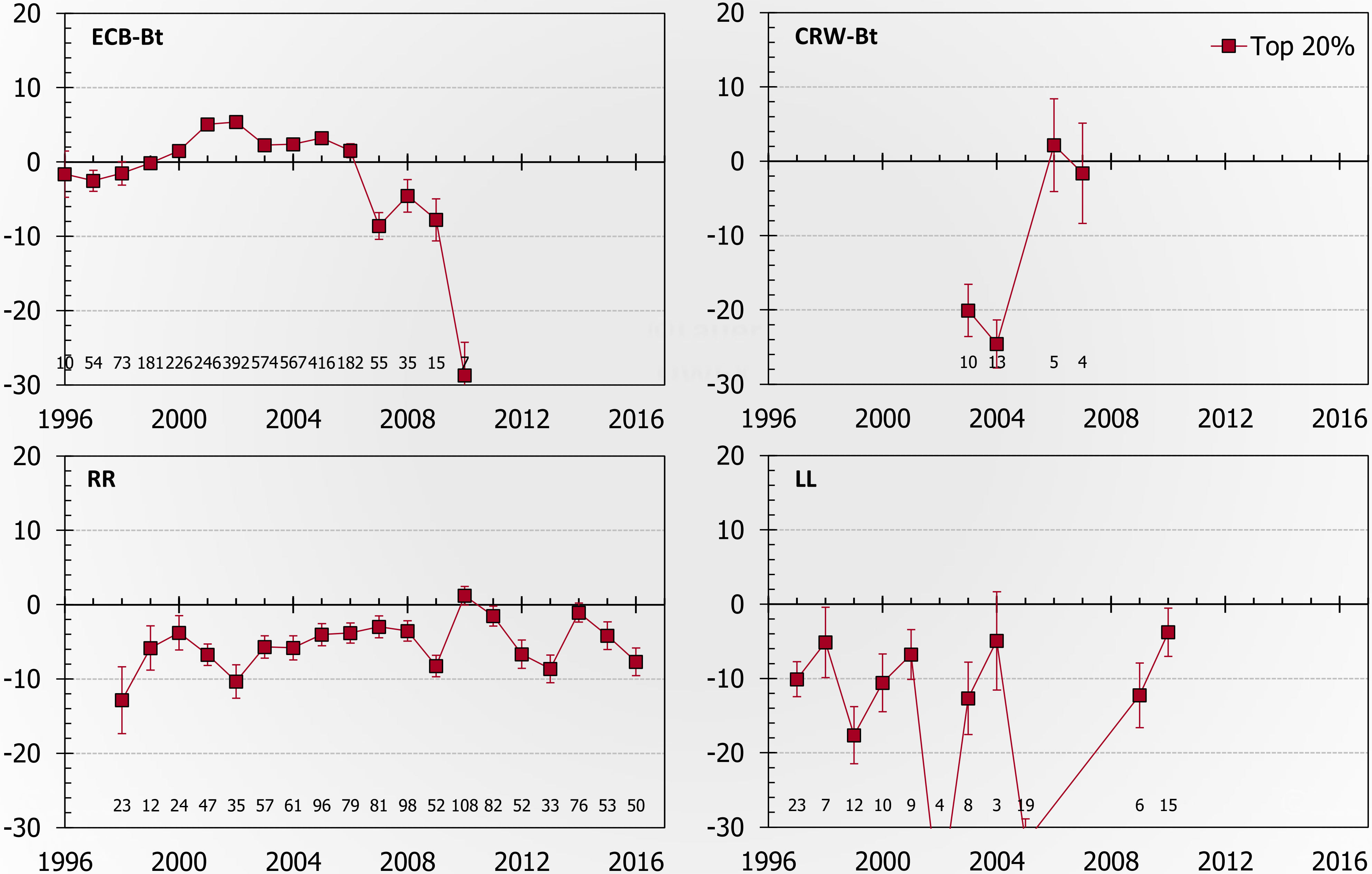
Lauer, UW Hybrid Trials (E & L), 2020

Relative performance of Single-stack hybrids

Grain yield difference (bu/A) = transgenic average – trial average

The number of plots used for the Top 20% is shown on the X-axis.



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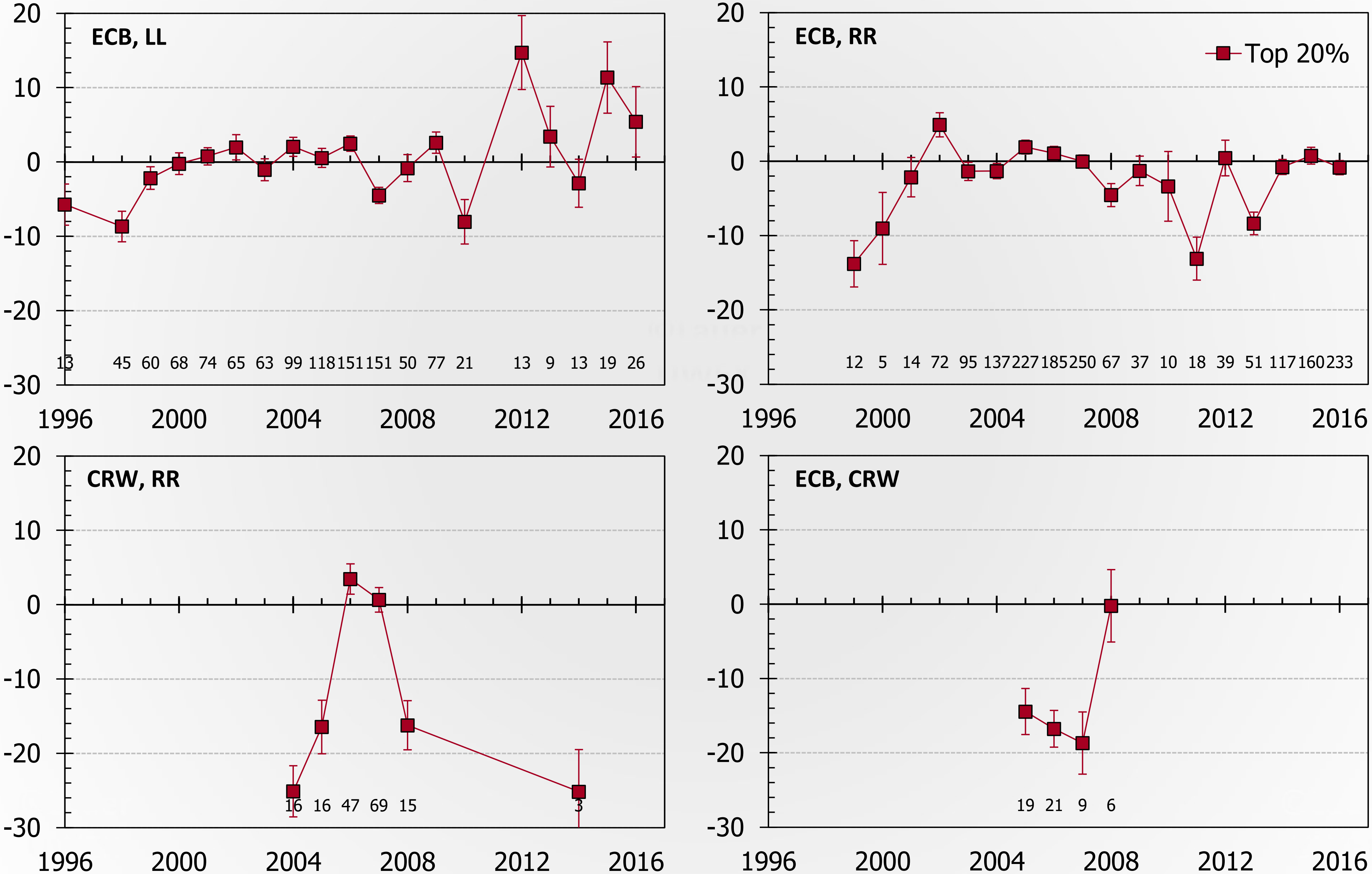
Lauer, UW Hybrid Trials, 2016

Relative performance of Double-stack hybrids

Grain yield difference (bu/A) = transgenic average – trial average
The number of plots used for the Top 20% is shown on the X-axis.



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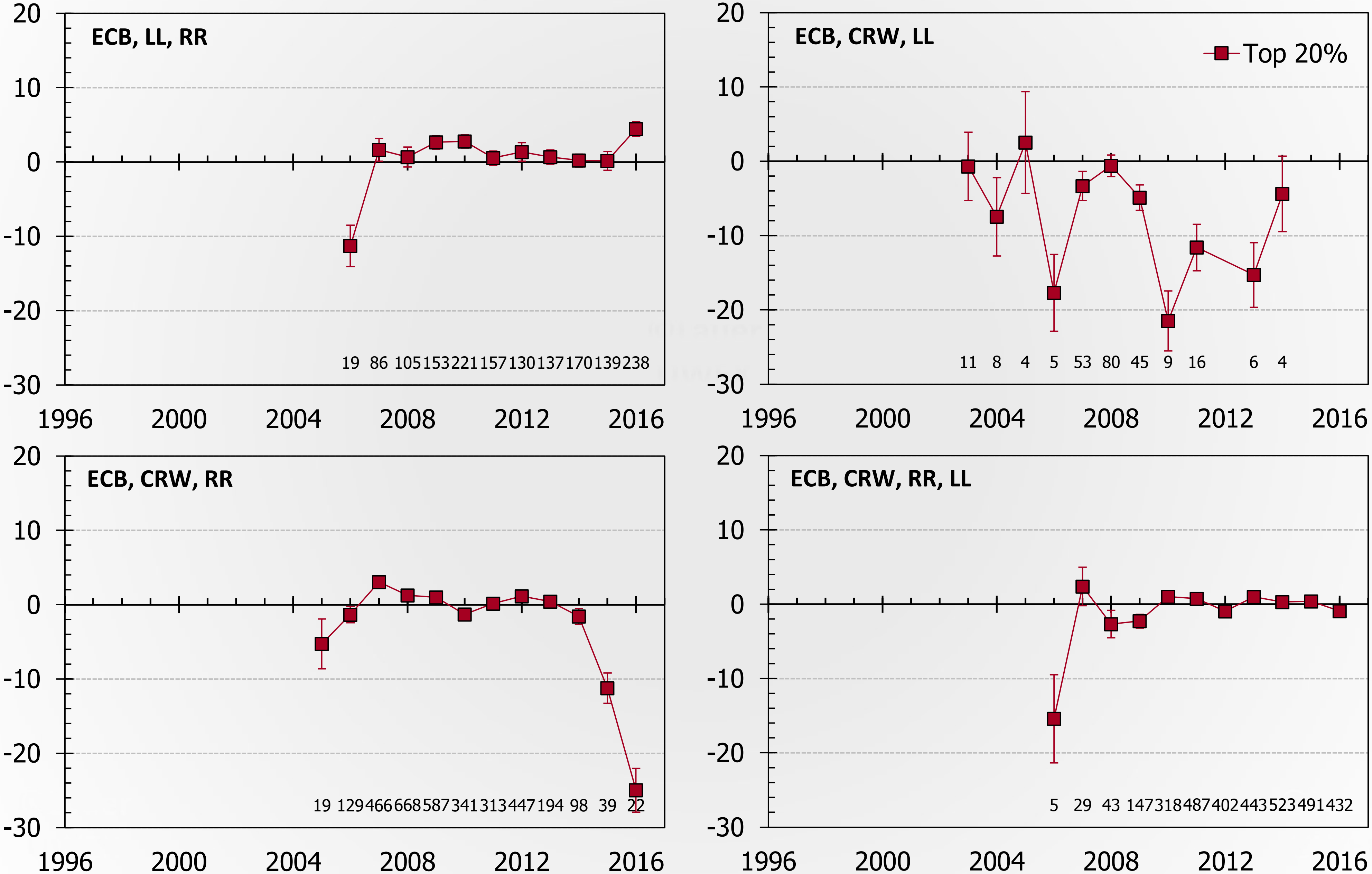
Lauer, UW Hybrid Trials, 2016

Relative performance of Triple- and Quad-stack hybrids

Grain yield difference (bu/A) = transgenic average – trial average

The number of plots used for the Top 20% is shown on the X-axis.



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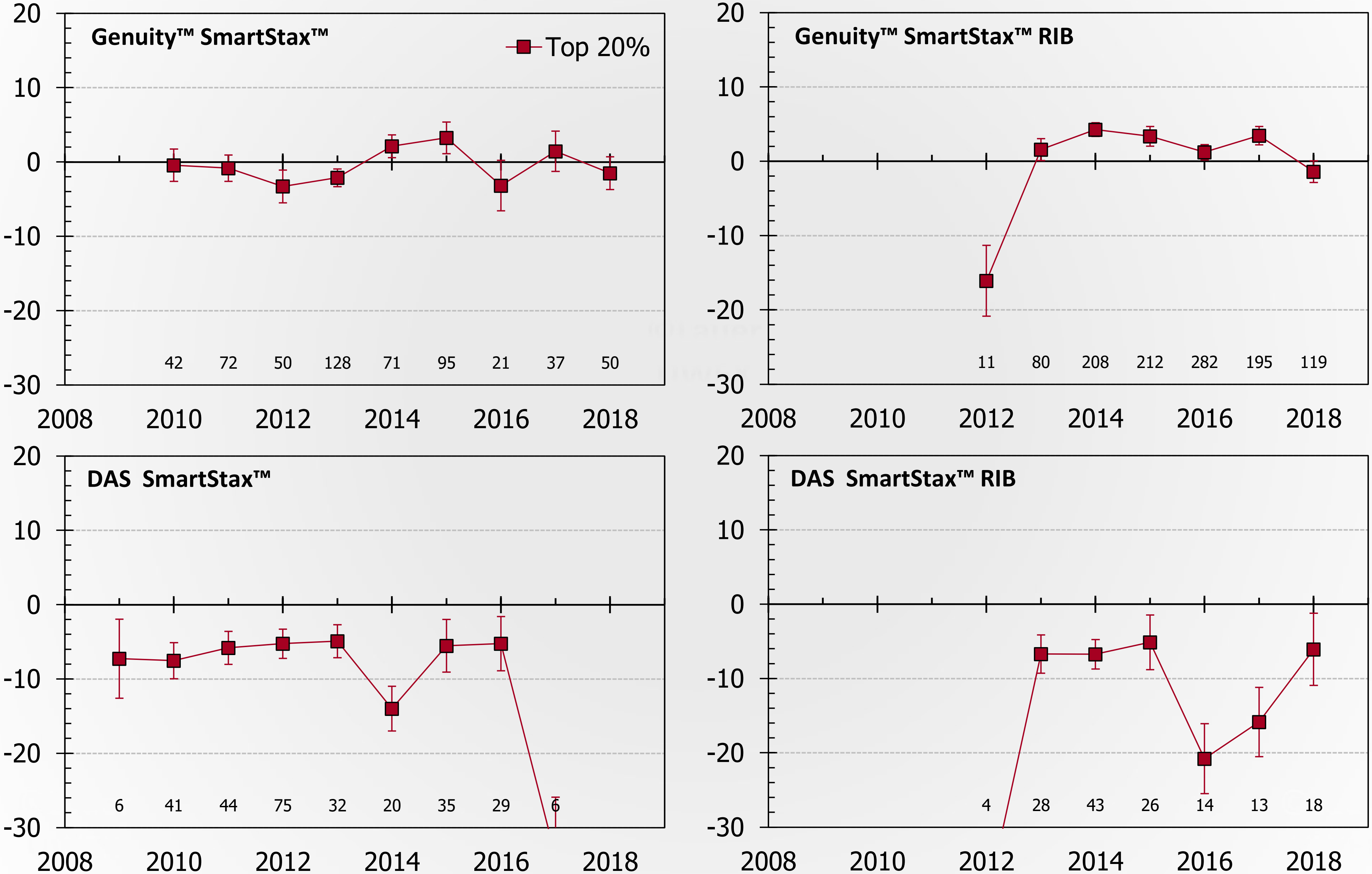
Lauer, UW Hybrid Trials, 2016

Relative performance of Specific Transgenic Technologies

Grain yield difference (bu/A) = transgenic average – trial average

The number of plots used for the Top 20% is shown on the X-axis.



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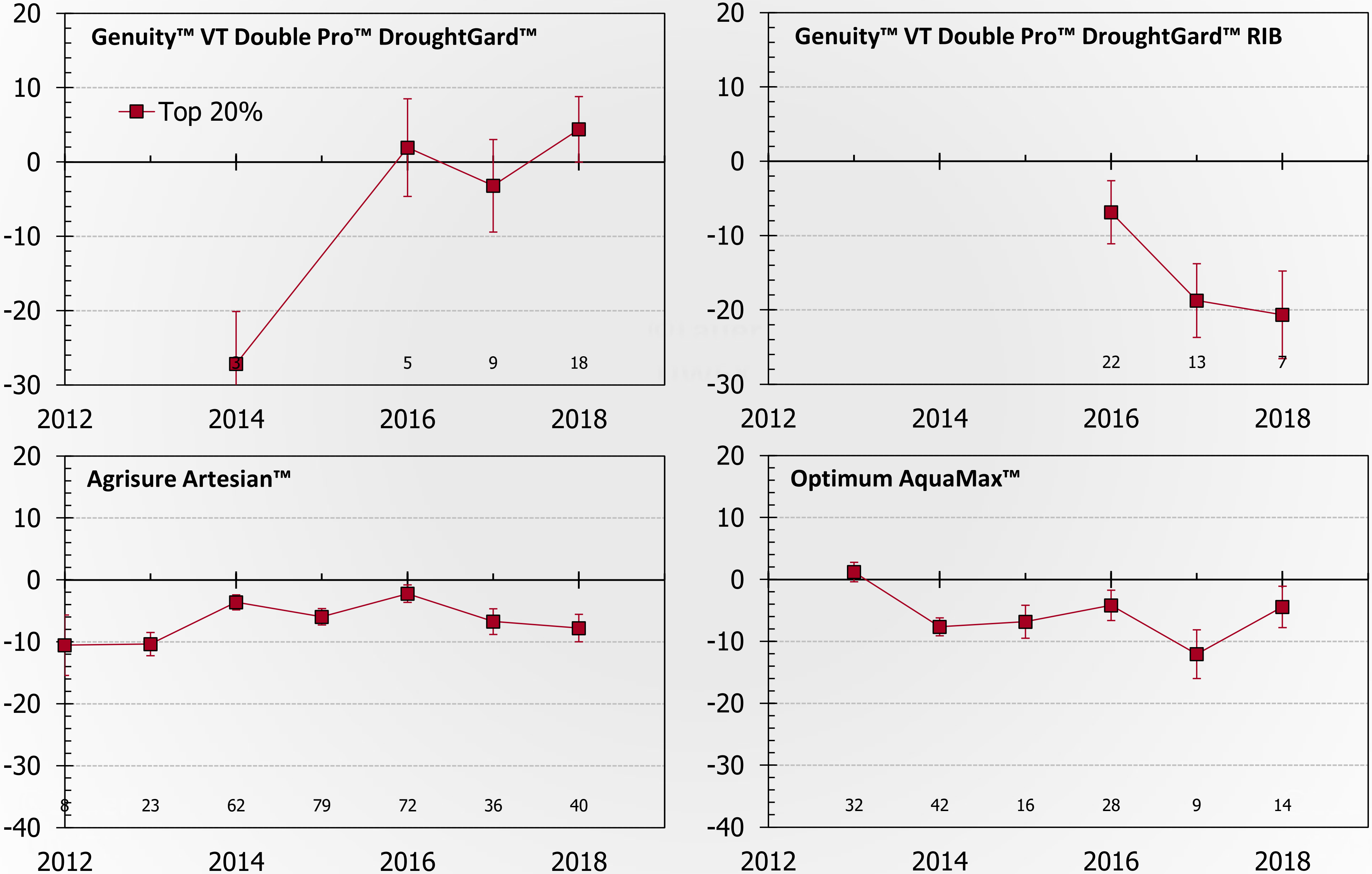
Lauer, UW Hybrid Trials, 2018

Relative performance of Specific Technologies and Traits

Grain yield difference (bu/A) = transgenic average – trial average

The number of plots used for the Top 20% is shown on the X-axis.

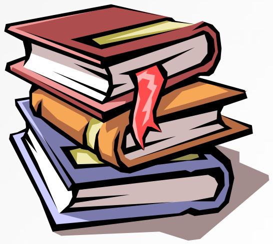


http://corn.agronomy.wisc.edu

Lauer, UW Hybrid Trials, 2018

Diseases at Emergence

	Lesions on stems	Root rot	Cool, wet soil	Warm, wet soil	Seed rot
Phytophthora	X	X		X	X
Pythium	X	X	X		X
Fusarium	X	X		X	
Rhizoctonia	X	X		X	X



Efficacy of Corn Seed Treatments

Disease	Favorable Environment	Captan	Maxim	Apron
Rhizoctonia	Rainfall followed by cool and then warm weather	Good	Good	Poor
Fusarium	Warm, wet soil	Good	Excellent	Poor
Pythium	Likes cold and wet	Poor	Poor	Excellent
Helminthosporium	??	Good	Good	Poor
Penicillium	??	Good	Good	Poor
Aspergillus	??	Good	Good	Poor

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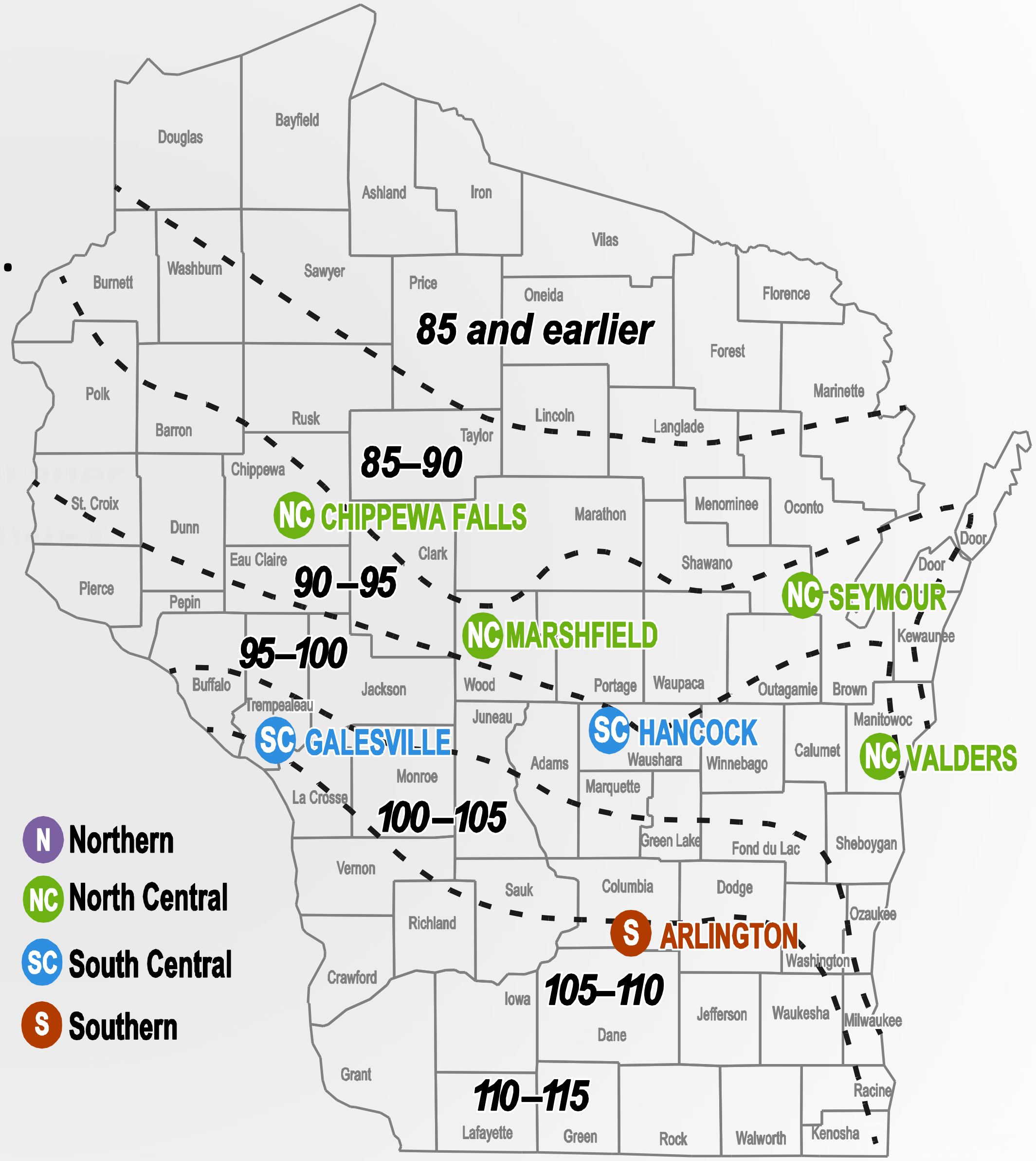
Materials and Methods
Corn Seed Treatment Evaluation

- Objective: To test the efficacy of corn seed treatments on stand establishment and yield.
- 3 Years and 7 locations:
  - ✓ 2013, 2014, and 2015
  - ✓ Arlington, Chippewa Falls, Galesville, Hancock, Marshfield, Seymour, Valders
- 6 replications per location
- 2884 plots
- Precision planter @ 34,100
- 2 hybrids per location
- 14 corn seed treatments



College of Agricultural & Life Sciences
UNIVERSITY OF WISCONSIN–MADISON

http://corn.agronomy.wisc.edu

Materials and Methods
Corn Seed Treatment Evaluation

Seed Treatment	Details
Acceleron	Alligience @ 0.01 + Trilex @ 0.0125 + Vortex @ 0.0625
Acceleron + Poncho 250	Alligience @ 0.01 + Trilex @ 0.0125 + Vortex @ 0.0625 + Poncho @ 0.25
Acceleron + Poncho 500	Alligience @ 0.01 + Trilex @ 0.0125 + Vortex @ 0.0625 + Poncho @ 0.5
Acceleron + Poncho 500 + Votivo	Alligience @ 0.01 + Trilex @ 0.0125 + Vortex @ 0.0625 + Poncho/Votivo @ 0.6
Acceleron + Poncho 1250	Alligience @ 0.01+Trilex @ 0.0125+Vortex @ 0.0625+Poncho @ 1.25
Acceleron + Poncho 1250 + Votivo	Alligience @ 0.01+Trilex @ 0.0125+Vortex@ 0.0625+Poncho/Votivo @ 0.6+Poncho @0.75
Avicta Complete Corn	Avicta Complete Corn @ 0.784
Avicta Complete Corn + Dynasty	Avicta Complete Corn @ 0.784 + Dynasty @ 0.0025
Avicta Complete Corn 1250	Avicta Complete Corn @ 0.784 + Cruiser @ 0.75
CruiserMaxx Corn 250	Maxim Quattro @ 0.064 + Cruiser @ 0.25
CruiserMaxx Corn 500	Maxim Quattro @ 0.064 + Cruiser @ 0.5
CruiserMaxx Corn 1250	Maxim Quattro @ 0.064 + Cruiser @ 1.25
Maxim Quattro	Maxim Quattro @ 0.064
Untreated Check	---

Materials and Methods

Protocol for evaluating Ascend® Plant Growth Regulator

- Evaluated in 2012 and 2016 at 11 locations
- 2016= Four treatments
  - ✓ Ascend® In-furrow
  - ✓ Ascend® Foliar
  - ✓ Ascend® In-furrow + Foliar
  - ✓ Untreated

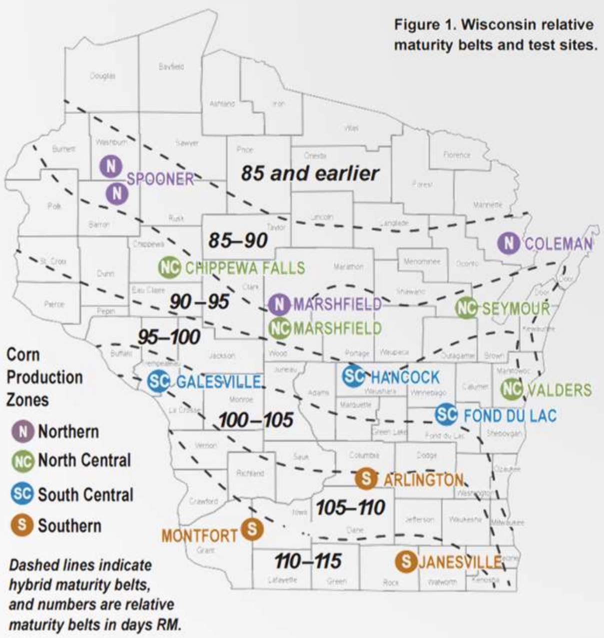


Figure 1. Wisconsin relative maturity belts and test sites.

ASCEND®

PLANT GROWTH REGULATOR

Hormone compounds to stimulate plant growth.
Concentrations based on biological activity.

ACTIVE INGREDIENTS
*Cytokinin, as Kinetin 0.090%
*Gibberellic Acid 0.030%
*Indole Butyric Acid 0.045%
OTHER INGREDIENTS 99.835%
TOTAL 100.000%

*Contains 0.03 oz. cytokinins/qt.
*Contains 0.015 oz. indole butyric acid/qt.
*Contains 0.01 oz. gibberellic acid/qt.

KEEP OUT OF REACH OF CHILDREN

CAUTION

FIRST AID	
If in eyes	• Hold eye open and rinse slowly and gently with water for 15-20 minutes. • Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eye. • Call a poison control center or doctor for treatment advice.
If on skin or clothing	• Take off contaminated clothing. • Rinse skin immediately with plenty of water for 15-20 minutes. • Call a poison control center or doctor for treatment advice.
Have the product container or label with you when calling a poison control center or doctor, or going for treatment. **HOTLINE NUMBER**: In case of medical emergency call 1-877-424-7452.	

Read additional precautionary statements found inside booklet.

SHAKE WELL BEFORE USING.

EPA Reg. No. 9779-335

EPA Est. No. 63603-KS-
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WINFIELD   AgriSOLUTIONS

Corn grain yield (bu/A) response to Ascend® Plant Growth Regulator (Root Enhancer)

Location	Ascend® Foliar	Untreated	LSD(0.10)
Arlington	227	229	NS
Chippewa Falls	135	**149**	5
Coleman	261	270	NS
Fond du Lac	203	202	NS
Galesville	226	225	NS
Hancock	**224**	218	6
Janesville	136	146	NS
Lancaster	159	**178**	10
Marshfield	145	**157**	11
Seymour	200	201	NS
Valders	243	223	NS
All locations	196	200	NS

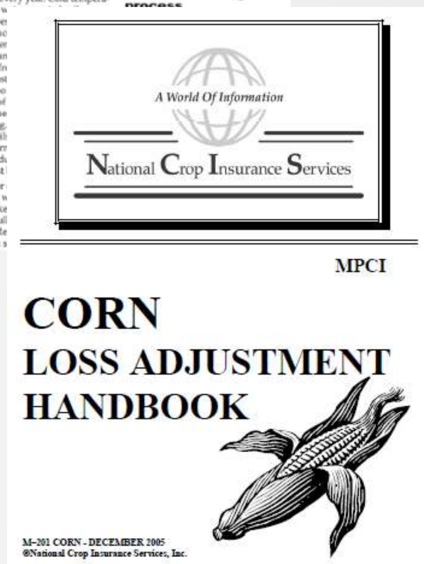
Lauer, 2012

Corn grain yield (bu/A) response to Ascend® Plant Growth Regulator (Root Enhancer)

Location	Ascend® In-furrow	Ascend® Foliar	Ascend® In-furrow + Foliar	Untreated	LSD(0.10)
Arlington	270	268	256	272	NS
Chippewa Falls	196	178	184	180	NS
Coleman	215	218	221	214	NS
Fond du Lac	238	247	241	246	NS
Galesville	233	241	231	231	NS
Hancock	216	**228**	219	**230**	10
Janesville	259	255	256	253	NS
Marshfield	208	211	215	211	NS
Montfort	254	257	255	267	NS
Seymour	209	204	199	204	NS
Valders	226	214	226	219	NS
All locations	230	229	228	230	NS

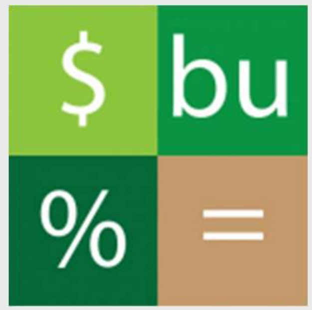
Lauer, 2016

Decision Making Tools for Dealing with Crop Stress



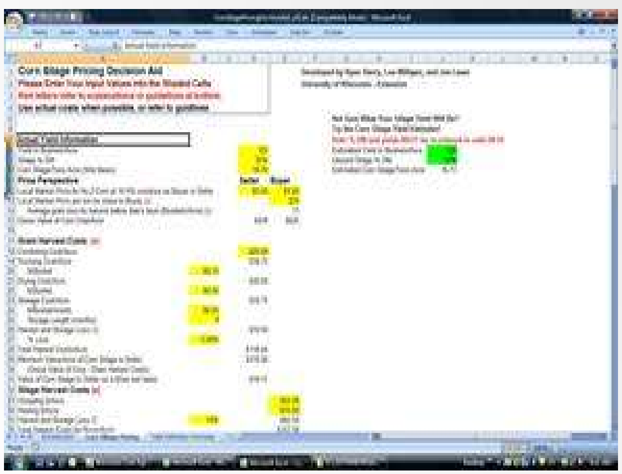
Smartphone apps

- ✓ "Crop Calculators"
  - ➢ Silage moisture adjuster
  - ➢ Maturity date predictor

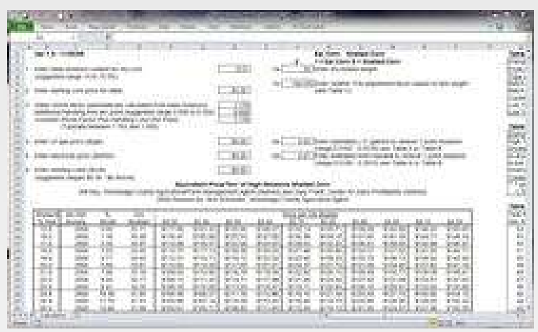


Harvest field loss calculator

Corn Silage Pricing



HMC Pricing



http://corn.agronomy.wisc.edu

Impact on grain yield (% loss) of various factors occurring during corn development.

Factor	VE	V6	V12	V18	R1	R6
Frost <28F	0	100	100	100	100	0
Hail (max)	0	0	72	90	100	0*
Drought/Heat (%/day)	--	--	3	4	7	0
Flooding<48h	Severe	0	0	0	0	0

What about fertility, disease, insects, weeds and pesticides?