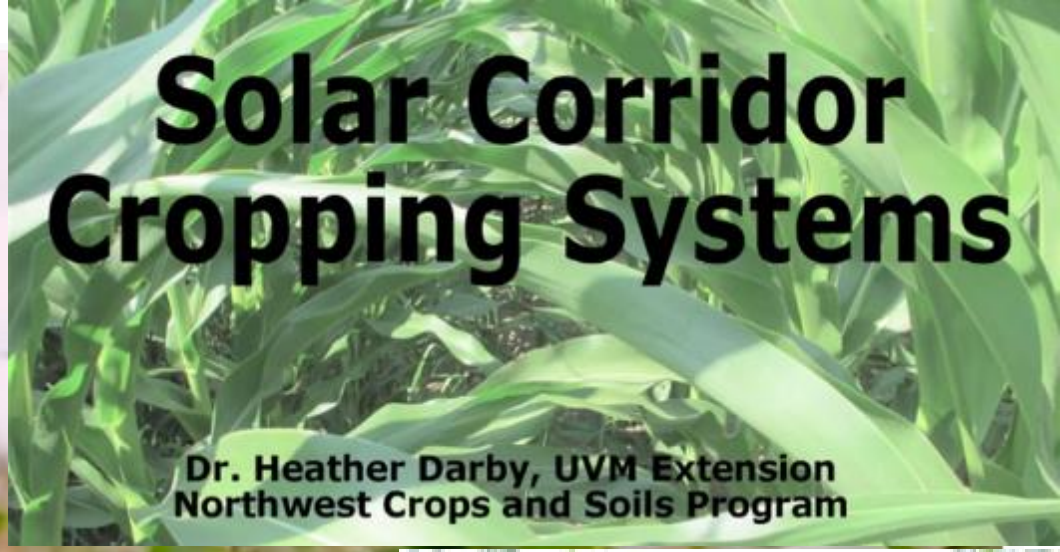

Enhancing Soil Health
with Solar Corridors
Joel Gruver
WIU Agriculture

LeRoy Deichman – **SCPS** pioneer

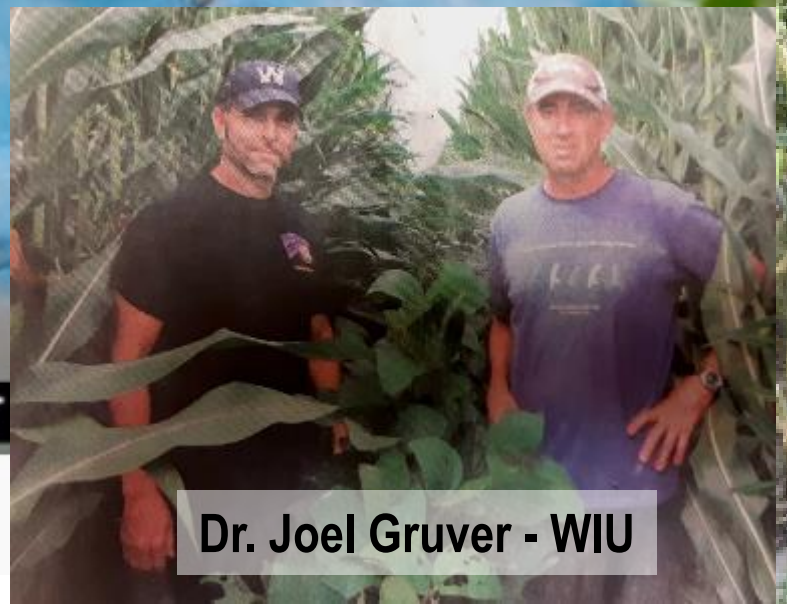
Bob Recker

independently arrived at the
Solar Corridor concept through first studying
strip intercropping

Dr. Erin Silva - UW



Wide Row Corn, Intercropping, Relay Cropping



Dr. Robert Kremer et al.,
U of MO were the first!

PRACTICAL FARMERS OF IOWA
COOPERATORS' PROGRAM Farmer-Led Research

EXPERIMENT

2020

Staff Contact
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Planting Corn in 60-in. Row-Widths for Interseeding Cover Crops

In a Nutshell:

- This was the third year of on-farm research trials designed to evaluate planting corn in 60-in. row-widths for the purpose of improving the success of interseeding cover crops to the corn in early summer, while n
- Fred Abels, Nathan Anderson, Jeff corn in two row-widths (30- and 60-in. omass production and corn yields between

3 years of PFI coordinated investigation of SCS on farms across IA

Key Findings:

- Compared to 30-in. row-widths, co lower yields at four of the five farms.
- After three years of trials, corn yields from 60-in. row-widths have been reduced on average by 12% compared to corn grown in 30-in. row-widths.

Cooperators

Fred Abels – Holland
Nathan Anderson – Aurelia
Jeff Olson – Winfield
Tim Sieren – Keota
Mark Yoder – Leon

Funding

USDA-NRCS
Walton Family Foundation

BACKGROUND

Widening the corn row is a version of the solar corridor crop system concept which "is designed for improved crop productivity based on highly efficient use of solar radiation by integrating row crops with drilled or solid seeded crops in broad strips (corridors) that also facilitate establishment of cover crops for year-round soil cover."[1] Previous PFI on-farm research from 2018 and 2019, saw four farms report no difference in corn yields between the 30- and 60-in. row-widths, while six other farms reported yields reduced by 6 to 30% in the 60-in. row-widths compared to the 30-in. row-width.[2,3] These mixed results aligned with

At left, cover crops growing between 60-in.-wide cornrows at Tim Sieren's on July 17, 2020. *At right*, after corn was harvested, cover crops are evident in the strips where corn was planted in 60-in. row-widths at

Livestock Grazing

Soil Health

Crop health

Water Quality

Solar Corridors → Cover Crop Performance ↑

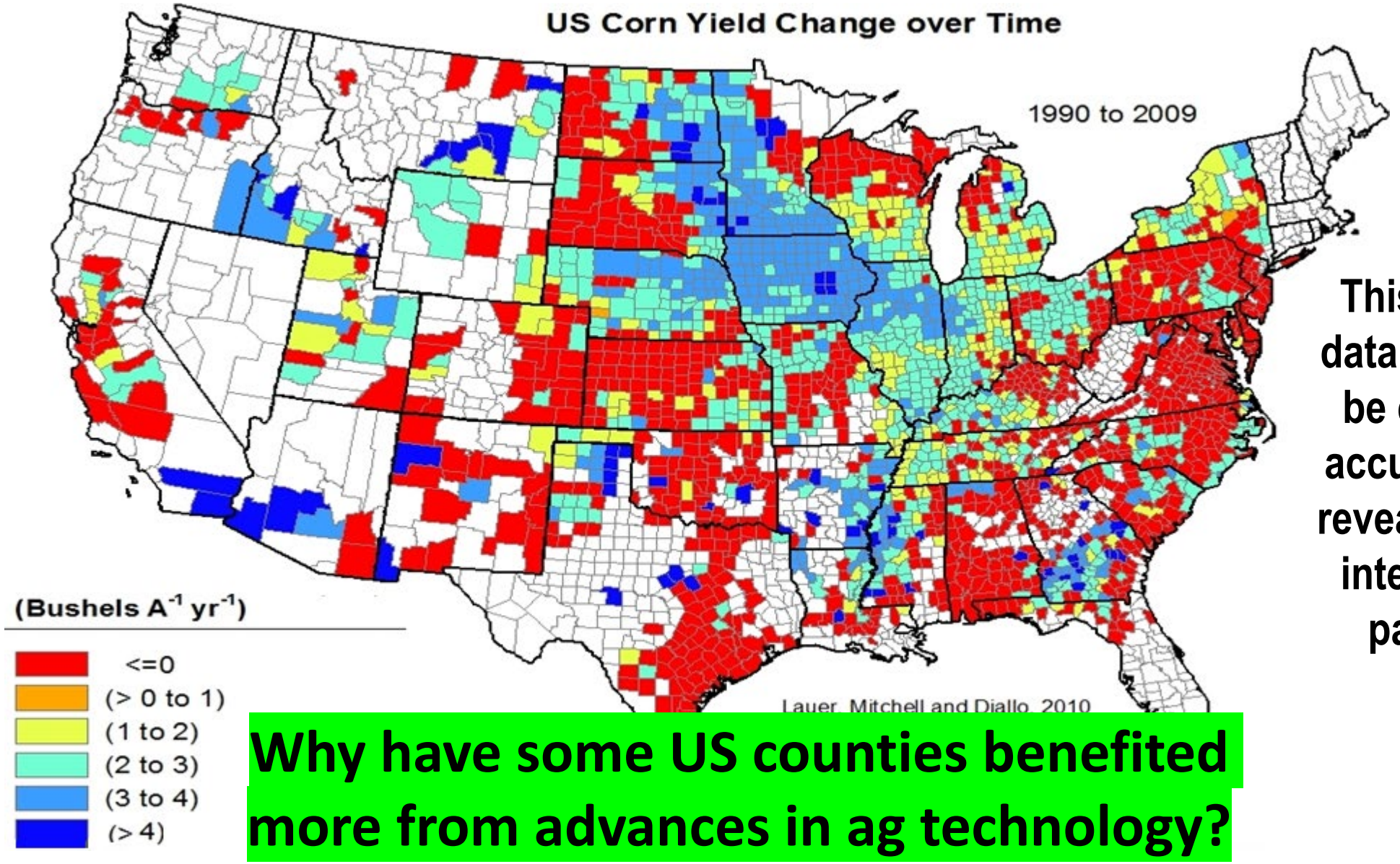
Relay Crops

Full Season Manure Application

Secondary Cash Crops

Carbon Farming

Yield increases in recent decades have not been uniformly distributed!

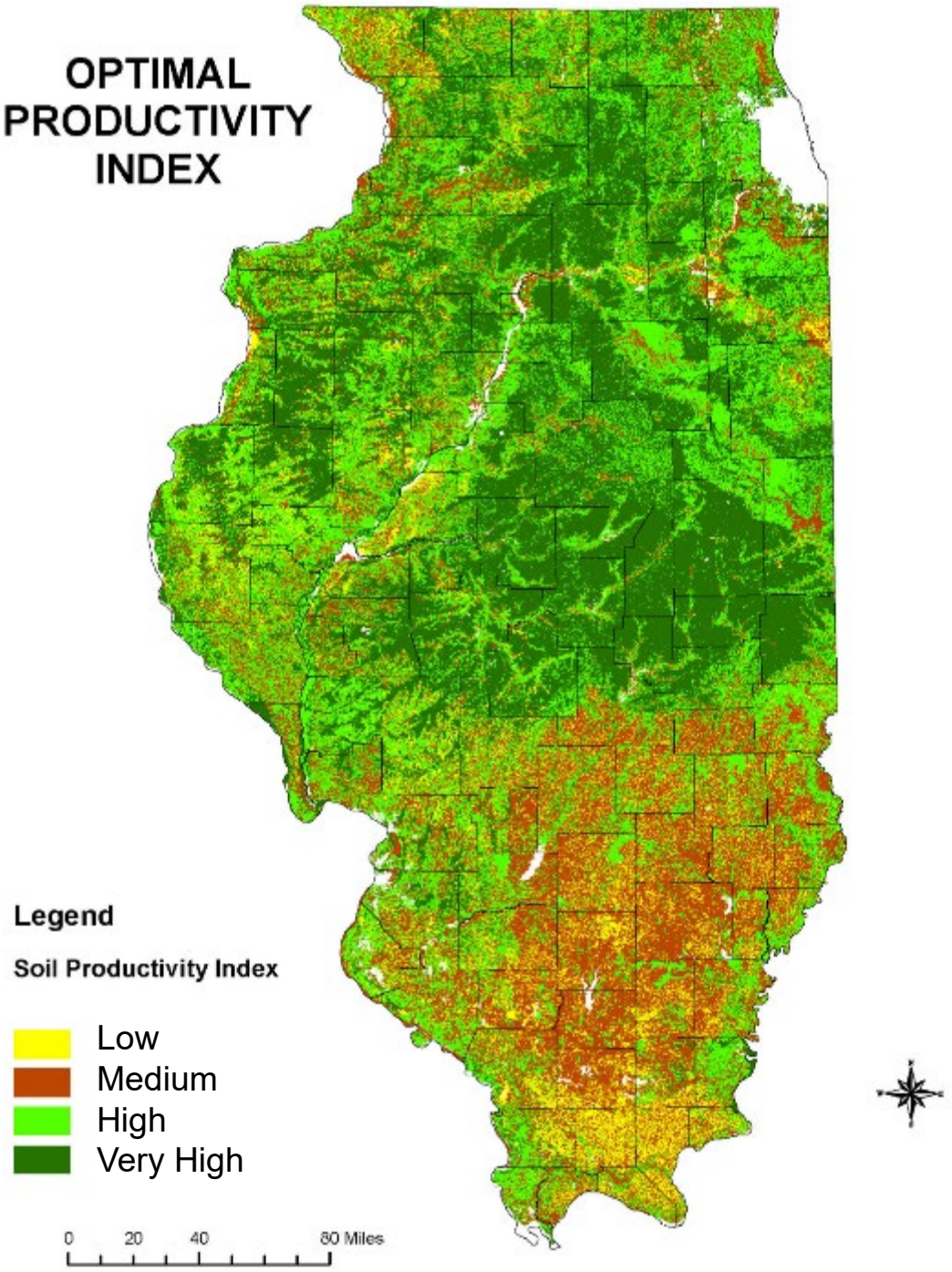


This USDA data may not be entirely accurate but reveals some interesting patterns

Why have some US counties benefited more from advances in ag technology?

IL

OPTIMAL PRODUCTIVITY INDEX



Main drivers of productivity

rooting depth & plant available water

x

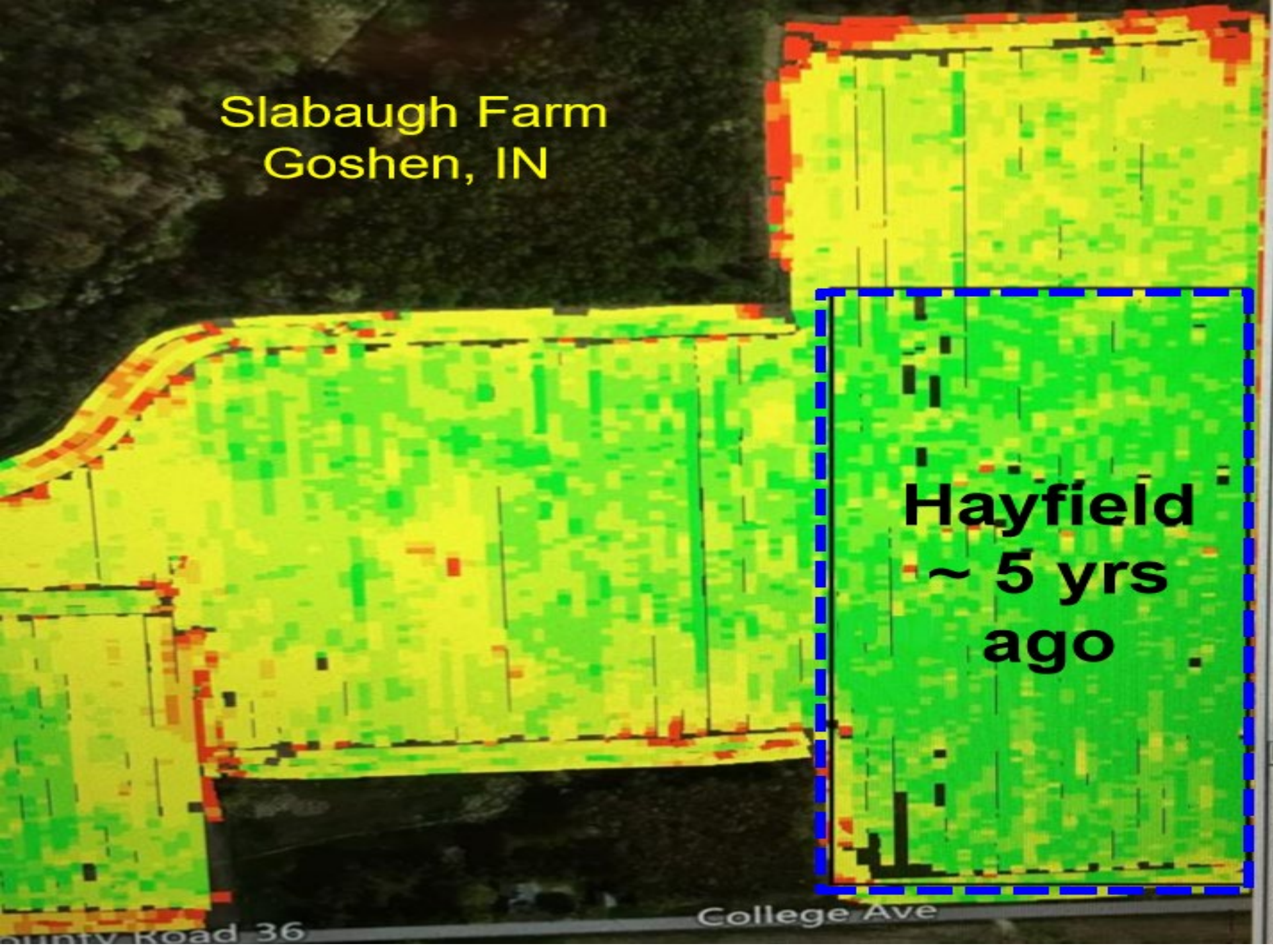
Management


VERY INTENSIVE
MANAGEMENT CAN
PRODUCE VERY HIGH YIELDS

For many reasons,
CORN WARRIOR management
is unlikely to happen on most farms
any time soon…

but ALL farms benefit from…

SCOM acts as a fulcrum that leverages input/tech investments into yield/profit



Yield (Dry)

Transparency - 100 %

Yield (Dry)
(bu/ac)

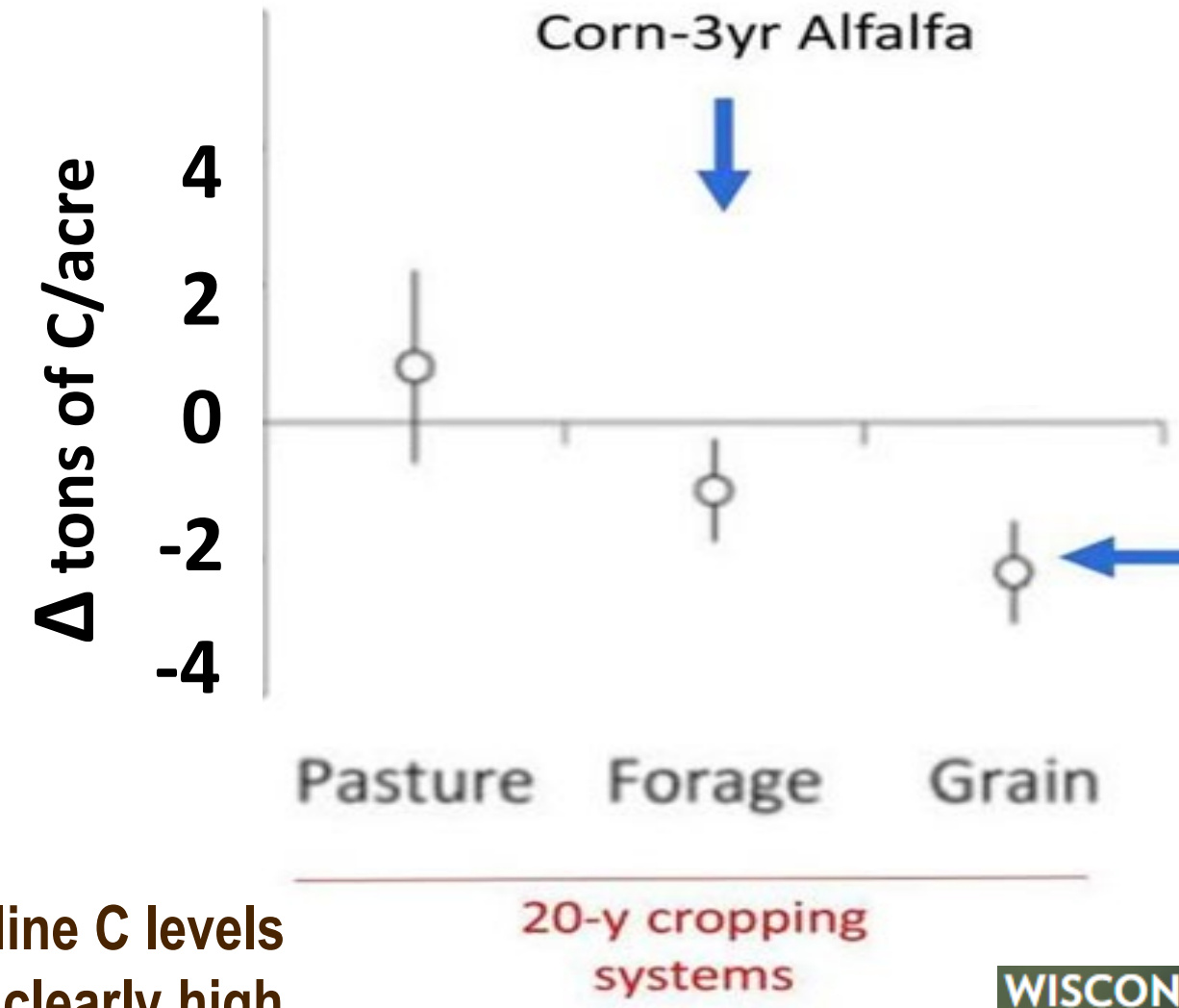
221.53	-	399.38	(9.
195.51	-	221.53	(11.
164.04	-	195.51	(11.
83.26	-	164.04	(11.
63.11	-	83.26	(11.
50.42	-	63.11	(11.
5.03	-	50.42	(10.

uniform management = higher & more consistent yields where the field has higher SOM

Statistics(Selected / All)

Minimum	--- / 5.033 bu/ac
Maximum	--- / 399.38 bu/ac
Average	--- / 130.43 bu/ac
Total	--- / 10,041 bu
Area	--- / 76.99 ac
Length	--- / 209,575 ft
Count	--- / 21836

Change in C in the top 3 feet of the WICST (1989-2009)



Continuous corn
Corn-Soybean
Corn-Soybean-Wheat ORG

Current grain production systems aren't very good at building SOM

Baseline C levels were clearly high at this site

WISCONSIN INTEGRATED CROPPING SYSTEMS TRIAL

modified from Sanford. 2014. in: *Soil Carbon*

Increasing Labile Soil Carbon and Nitrogen Fractions Require a Change in System, Rather Than Practice

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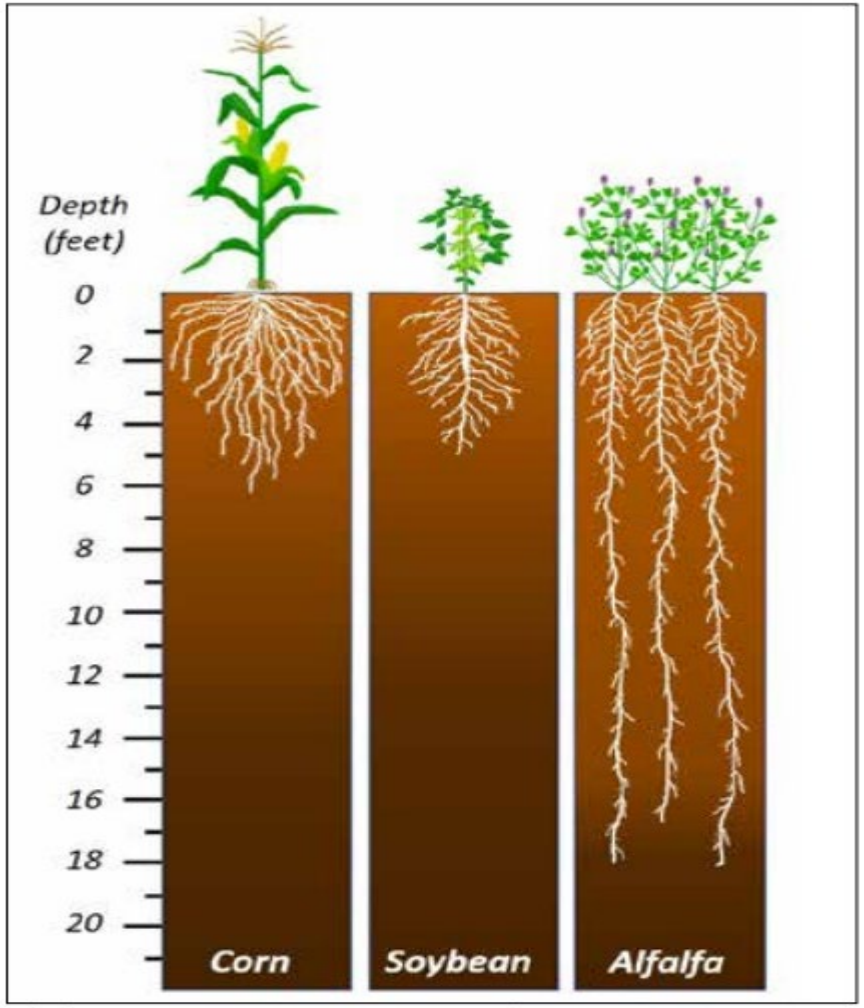
The influence of tillage, carbon (C) and nitrogen (N) inputs and perennialization on labile fractions of soil organic matter (SOM) has been widely investigated, but research on the temporal and depth variation of labile C and N fractions in long-term agroecosystems representative of the US Corn Belt is lacking. In this

These results suggest that perennialization is required to really shift the needle on SOM fractions in the highly fertile prairie soils of the Corn Belt

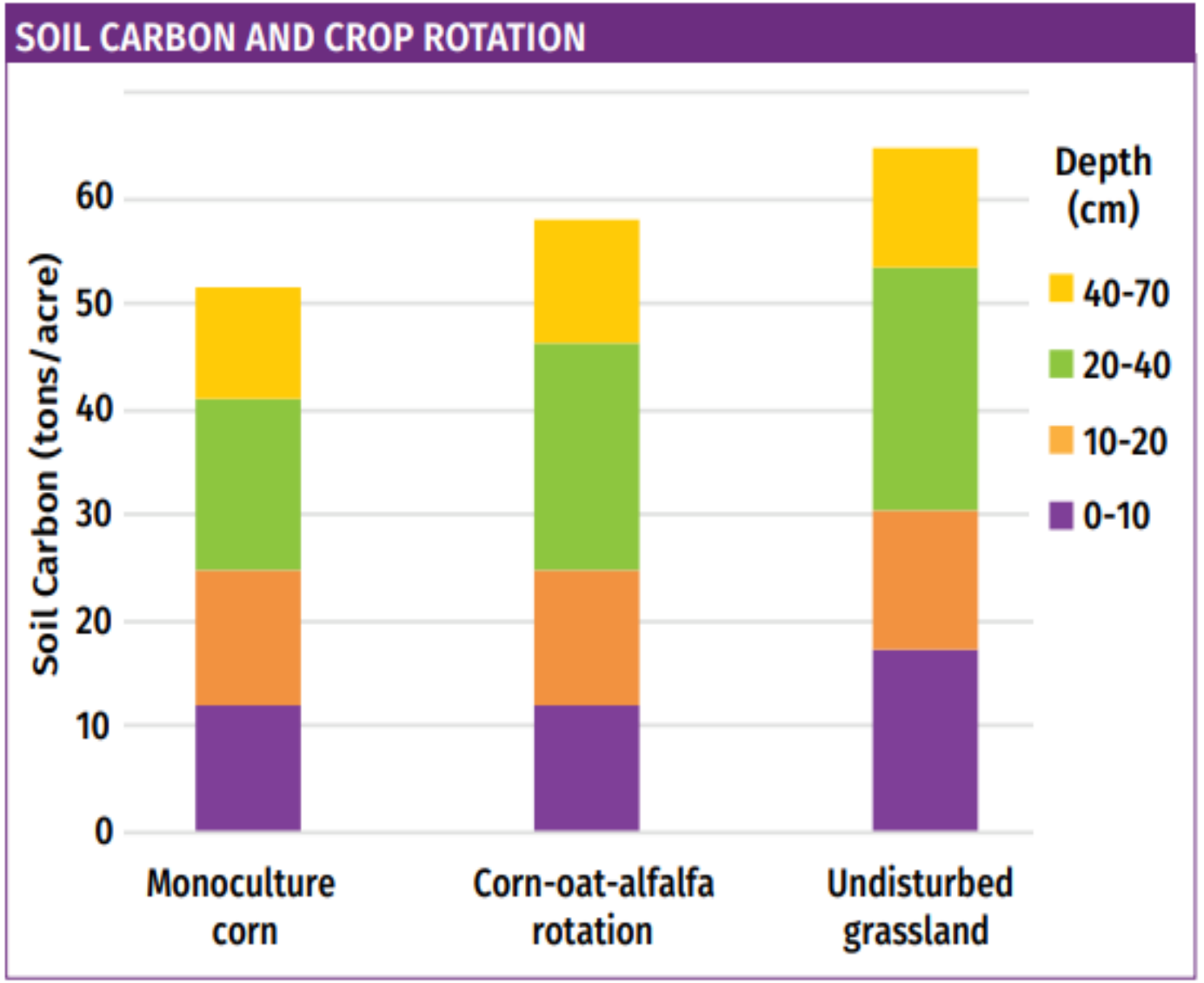
These results suggest sampling timing and depth for PMN, POXC, and C-min need to be standardized to optimize their use as soil health indicators and that shifts in the system toward perenniality will be required to increase labile C and N fractions on the highly fertile Mollisols of the US Corn Belt.

Abbreviations: CAAA, corn–alfalfa–alfalfa–alfalfa; CC, continuous corn; C-min, mineralizable carbon; COA, organic corn–oat/alfalfa–alfalfa; CS, strip-till corn–no-till soybean; CSW, organic corn–soybean–winter wheat–oat cover crop interseeded with berseem clover; PAS, pasture; PMN, potentially mineralizable nitrogen; POXC,

Shifting to perennial crops is a soil building option that currently doesn't appeal to many farmers



Alfalfa roots commonly extend up to 16 feet into the soil, much deeper than other crops. The deep root system holds soil in place and creates channels that promote water infiltration, biological activity in the root zone, and improved nutrient cycling.



An experiment in Iowa showed that rotating corn with alfalfa results in an increase in soil carbon, particularly at greater soil depths.

https://www.alfalfa.org/pdf/alfalfaenvironment2.pdf

CCs can perennialize annual cropping systems

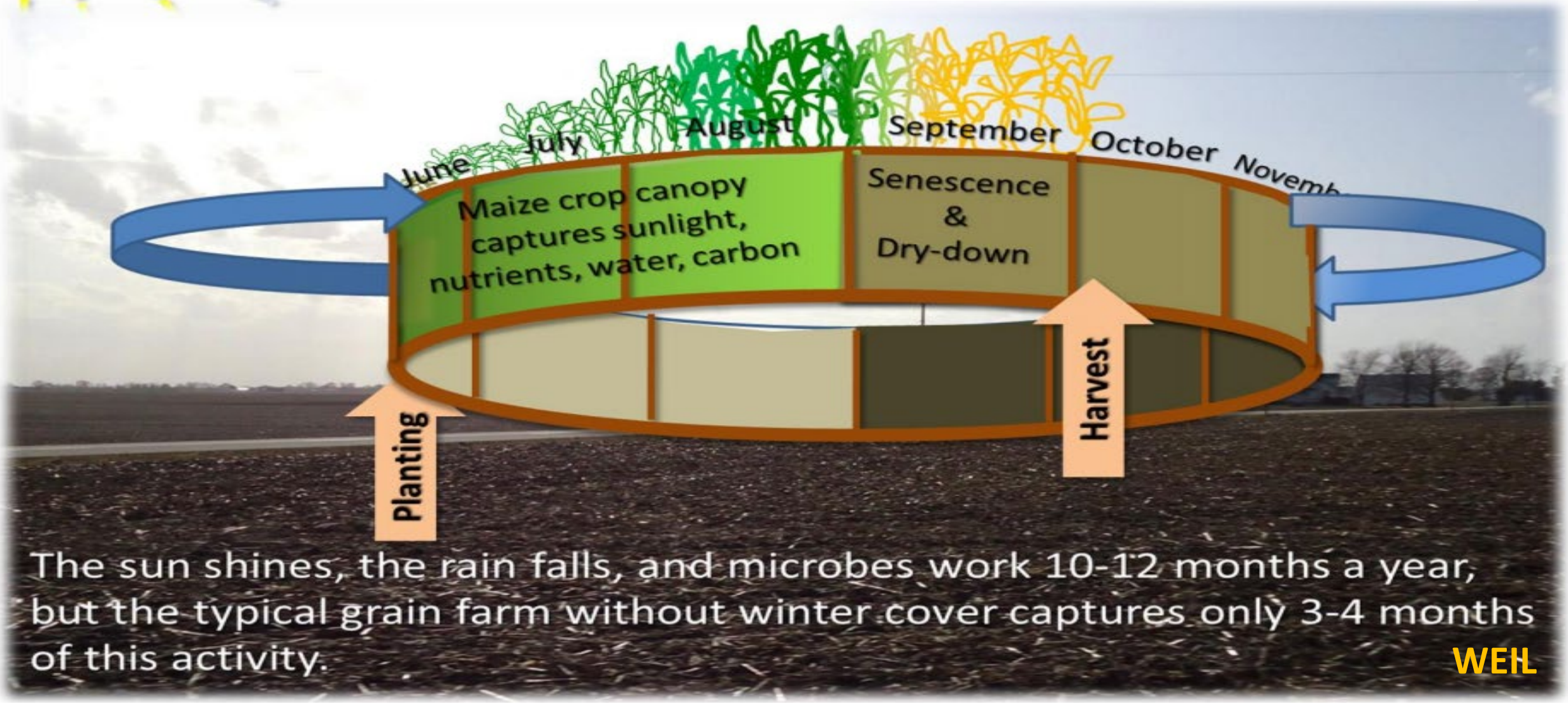
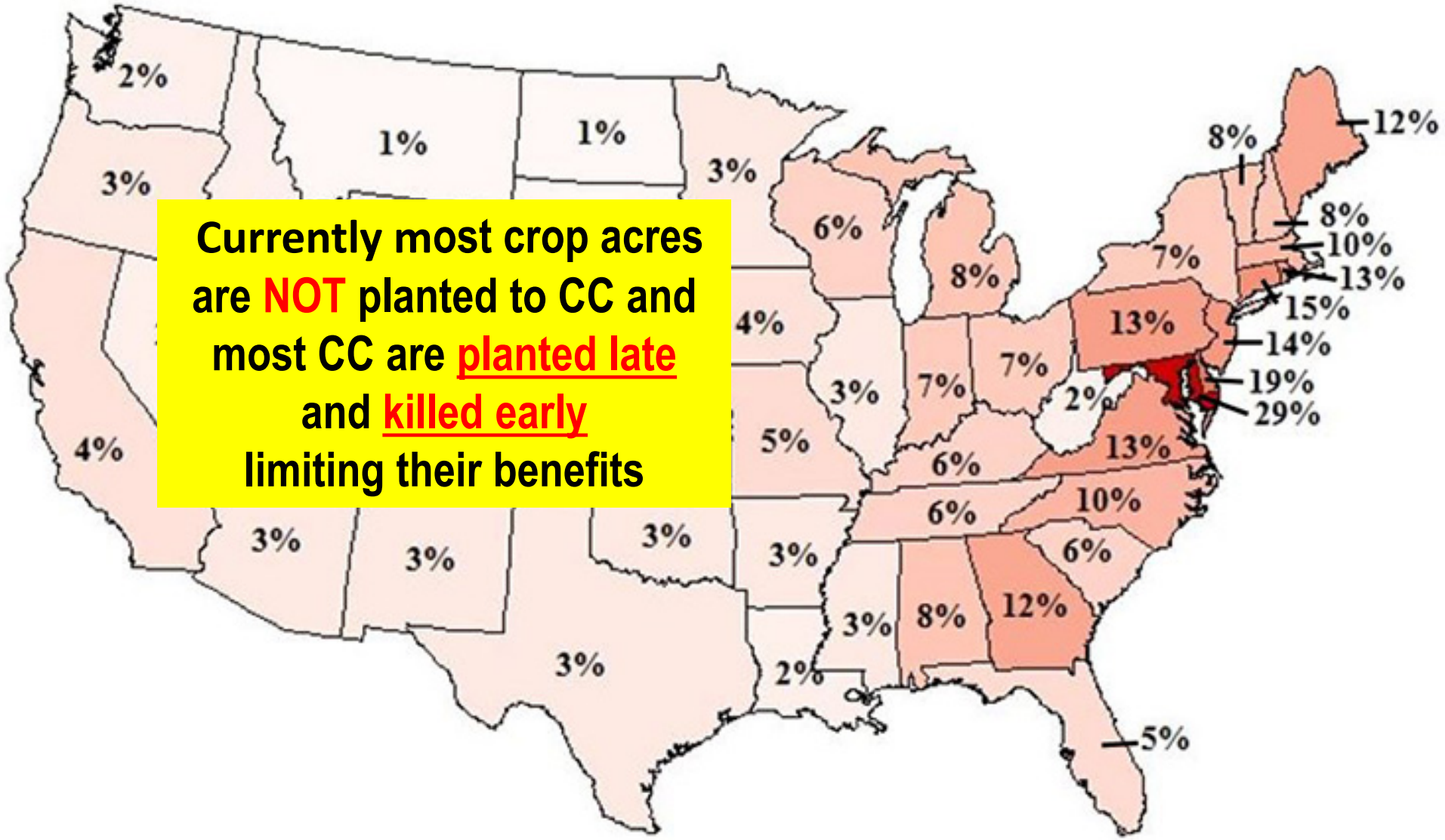


Figure 1. Cover Crops as a Share of Cropland Acres, U.S., 2012-2017
(Rounded to Nearest Percent)



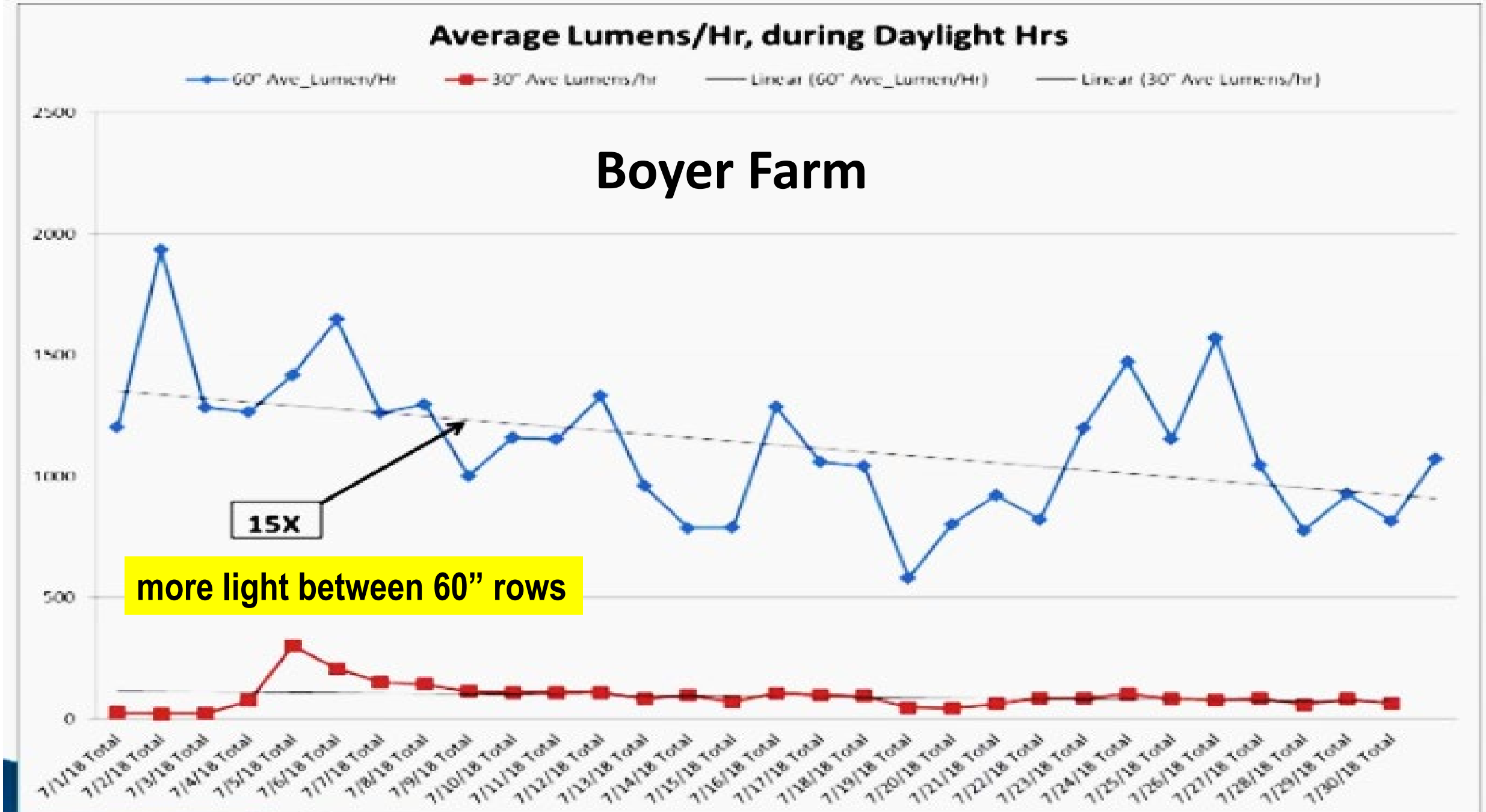
Data Source: Author Calculation from USDA Censuses of Agriculture

fdd

Opening Up Opportunities No-Tilling 60-Inch Corn

By Julia Gerlach posted on February 28, 2020 | Posted in Seeding & Planting, Cover Crops, Nutrient Management, Soil Health

While yield benefits are a work in progress, growers say interseeding wide-row corn produces high amounts of cover crop biomass and nitrogen.


Average Lumens/Hr, during Daylight Hrs
60" Ave_Lumens/Hr
30" Ave Lumens/hr
Linear (60" Ave_Lumens/Hr)
Linear (30" Ave Lumens/hr)
2500
2000
1500
1000
500
0
Boyer Farm
15X
more light between 60” rows
7/1/18 Total
7/2/18 Total
7/3/18 Total
7/4/18 Total
7/5/18 Total
7/6/18 Total
7/7/18 Total
7/8/18 Total
7/9/18 Total
7/10/18 Total
7/11/18 Total
7/12/18 Total
7/13/18 Total
7/14/18 Total
7/15/18 Total
7/16/18 Total
7/17/18 Total
7/18/18 Total
7/19/18 Total
7/20/18 Total
7/21/18 Total
7/22/18 Total
7/23/18 Total
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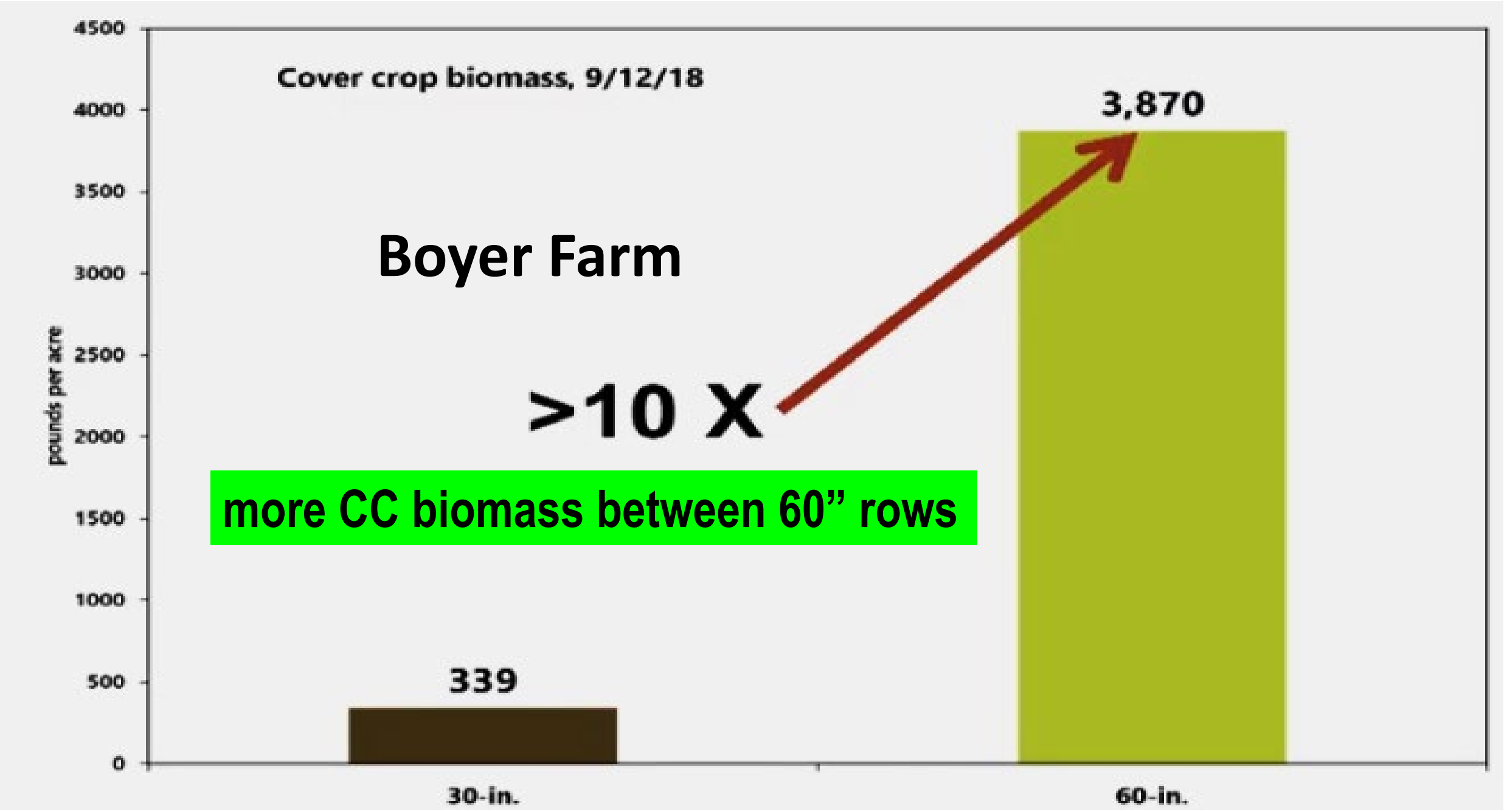
7/29/18 Total
7/30/18 Total


Cover crop biomass, 9/12/18
4500
4000
3500
3000
2500
2000
1500
1000
500
0
pounds per acre
3,870
Boyer Farm
>10 X
more CC biomass between 60” rows
339
30-in.
60-in.

PFI

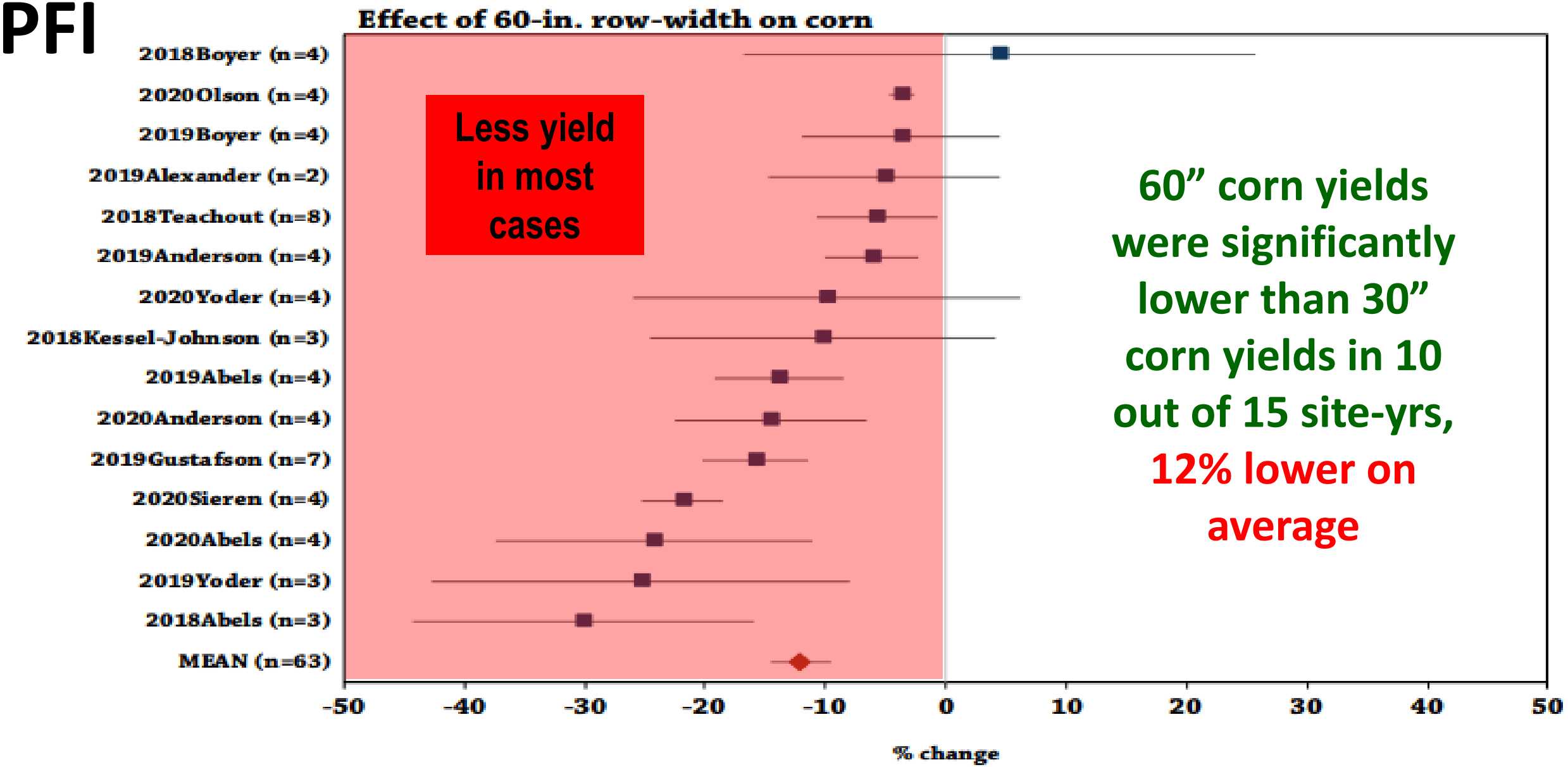


FIGURE 2. Effect on corn yield of 60-in. row-widths from all 15 sites from 2018 to 2020 as well as the overall mean. Points represent the average percent change in corn yield resulting from 60-in. row-widths compared to 30-in. row-widths. Error bars represent 90% confidence intervals. Width of bars indicate the amount of variation (the wider the bars, the more variation). Bars that encompass 0 indicate no statistical difference in yield between 60- and 30-in. row-widths. Bars that do not encompass 0 indicate significant yield decline resulting from 60-in. row-widths.

Keys to maintaining yield in 60” corn

- Even Emergence
- Seed Placement
- Planting conditions
- No-Till Vs. Till
- Population
- Nutrients application
- Hybrid Selection

MORE important when plants are closer together

close to standard

Indexed to row

some flex hybrids are better adapted

35 gallons 28%

GOALS when assembling a CC mix for 60" corn

- $$$$$ Grazing? $$$$$
- Weed Control
- Fixing Nitrogen? High energy process
- Over Winter or Winter Kill or
- DIVERSITY! BOTH!

Example

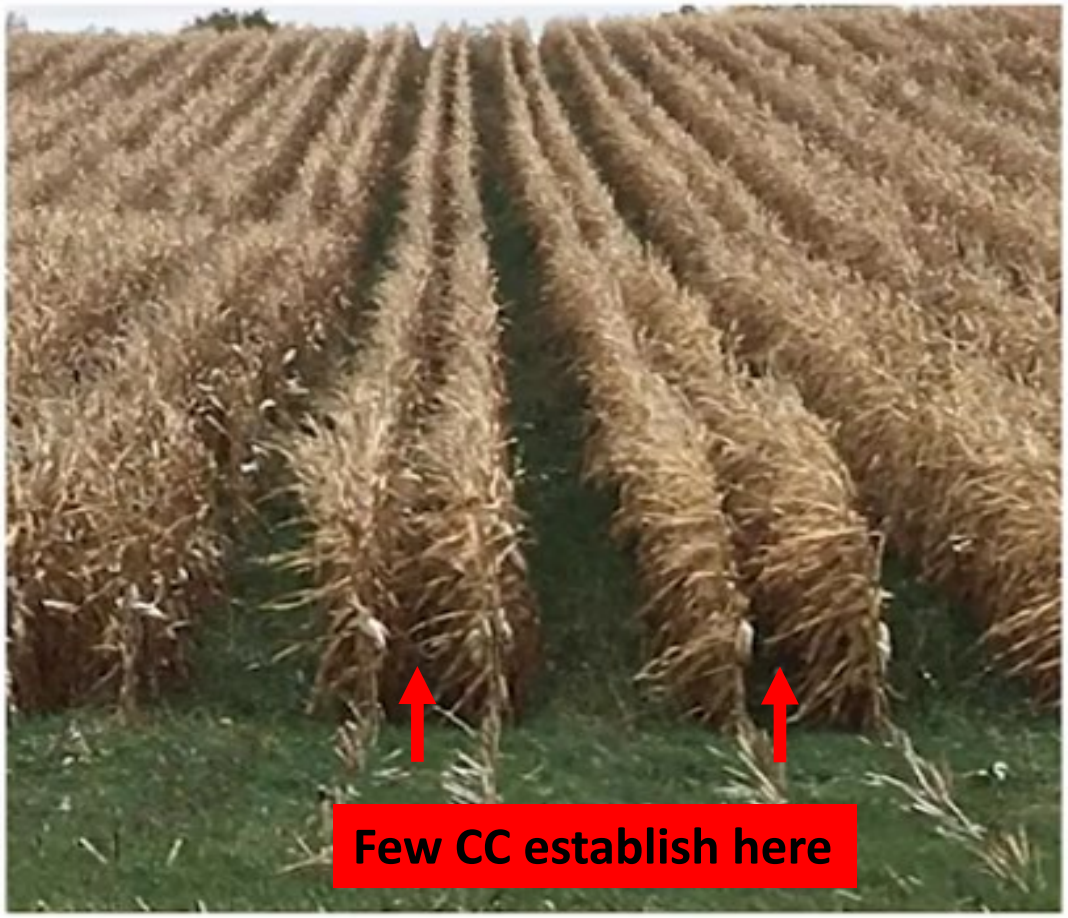
Cover Crop Mix

- Medium Red Clover
- Buckwheat
- Iron & Clay Cowpeas! — Consistent performer
- Golden German Foxtail Millet
- VNS Hairy Vetch
- Everleaf 126 Oats
- Dwarf Essex Rape
- Sunn Hemp
- Flax
- Annual Ryegrass
- Cost Per Acre for seed $18 = low seeding rates

MIX of cool season and warm season species

Higher rates may be needed in fields w/ higher weed pressure

60-30-60-30

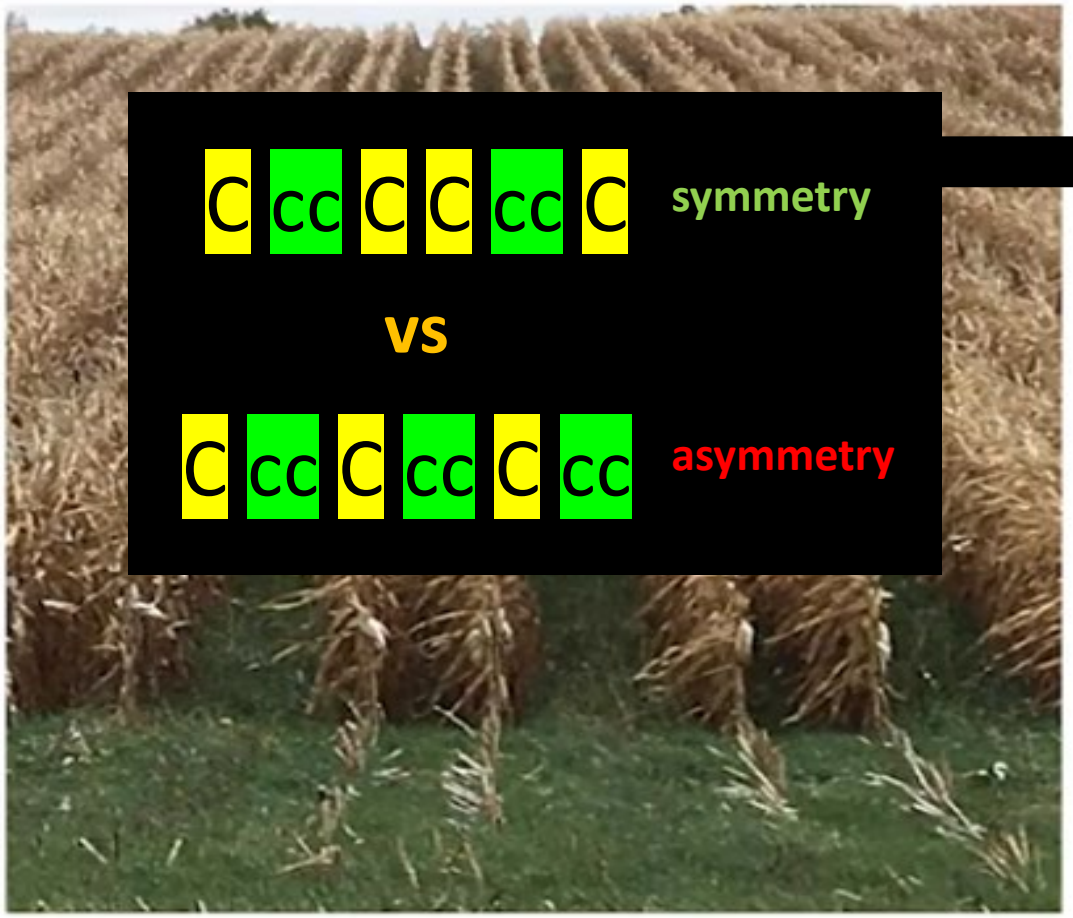


Non-uniform CCs have legacy effects

Issues

- Strips the following year
- Harder to plant
- Nutrient application
- Cover Crop mixes .

60-30-60-30



Issues

- Strips the following year
- Harder to plant ?
- Nutrient application
- Cover Crop mixes .

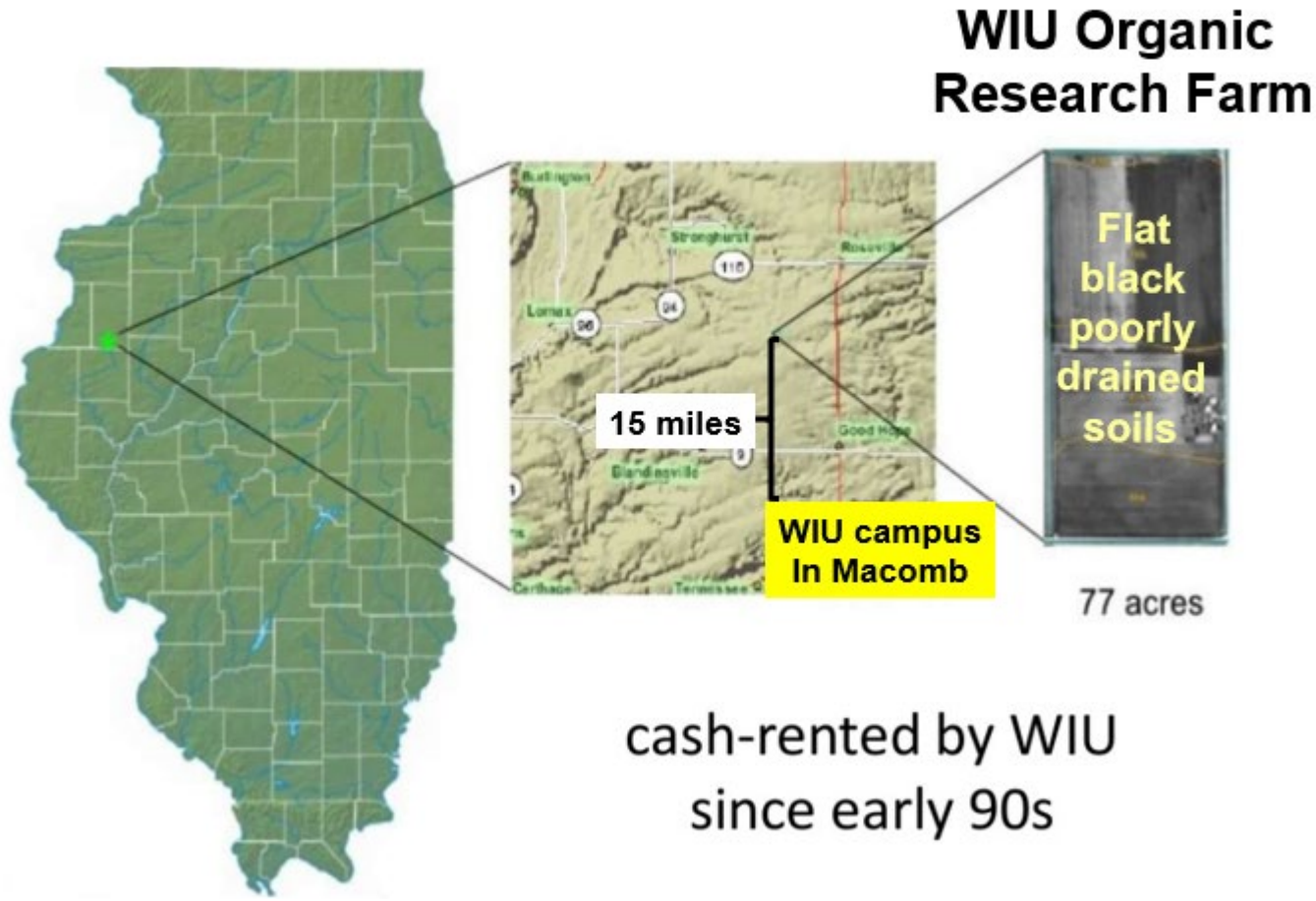
SOIL Rx

60-30-60-30

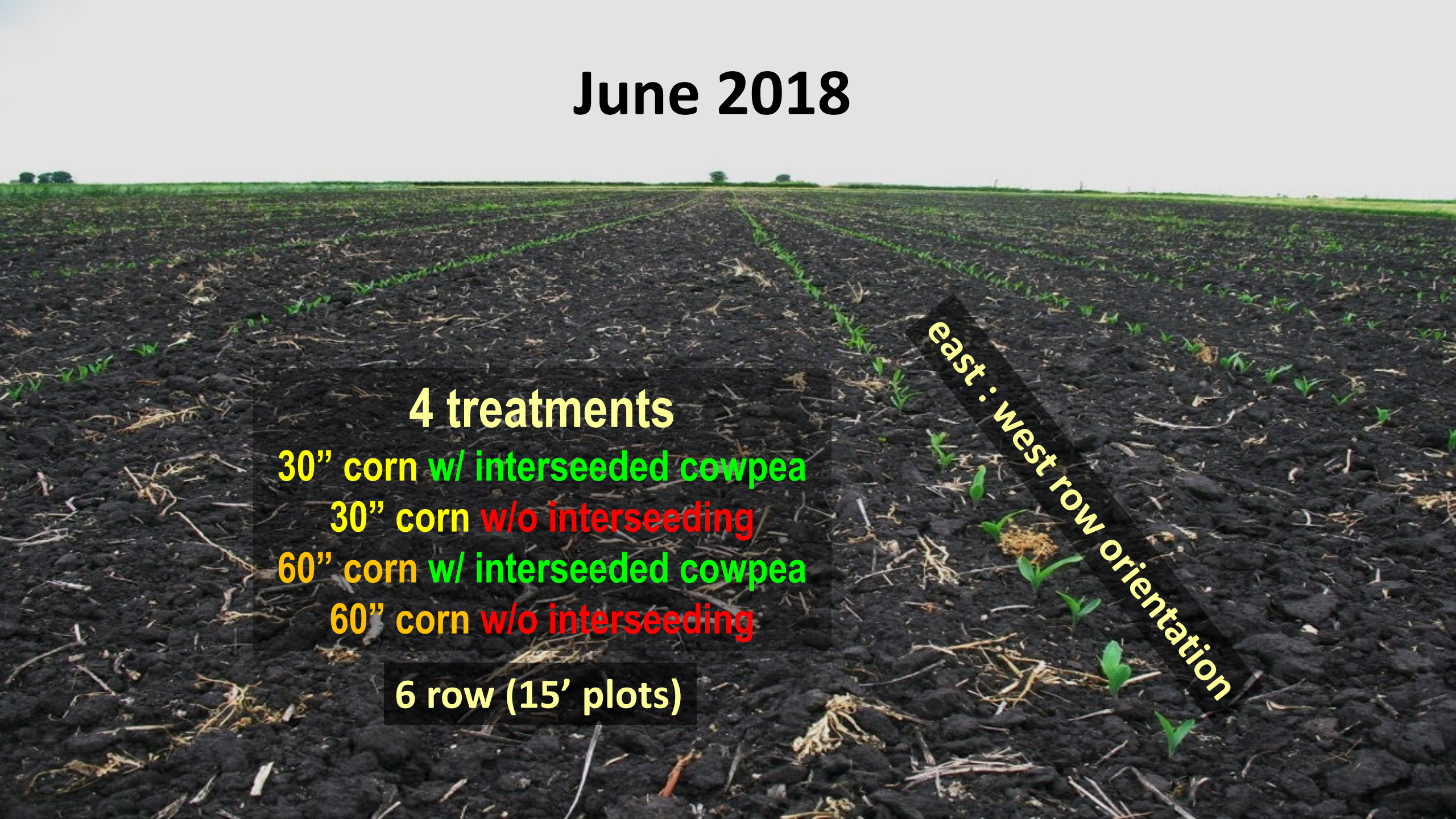
Issues

- Strips the following year
- Harder to plant
- Nutrient application
- Cover Crop mixes .

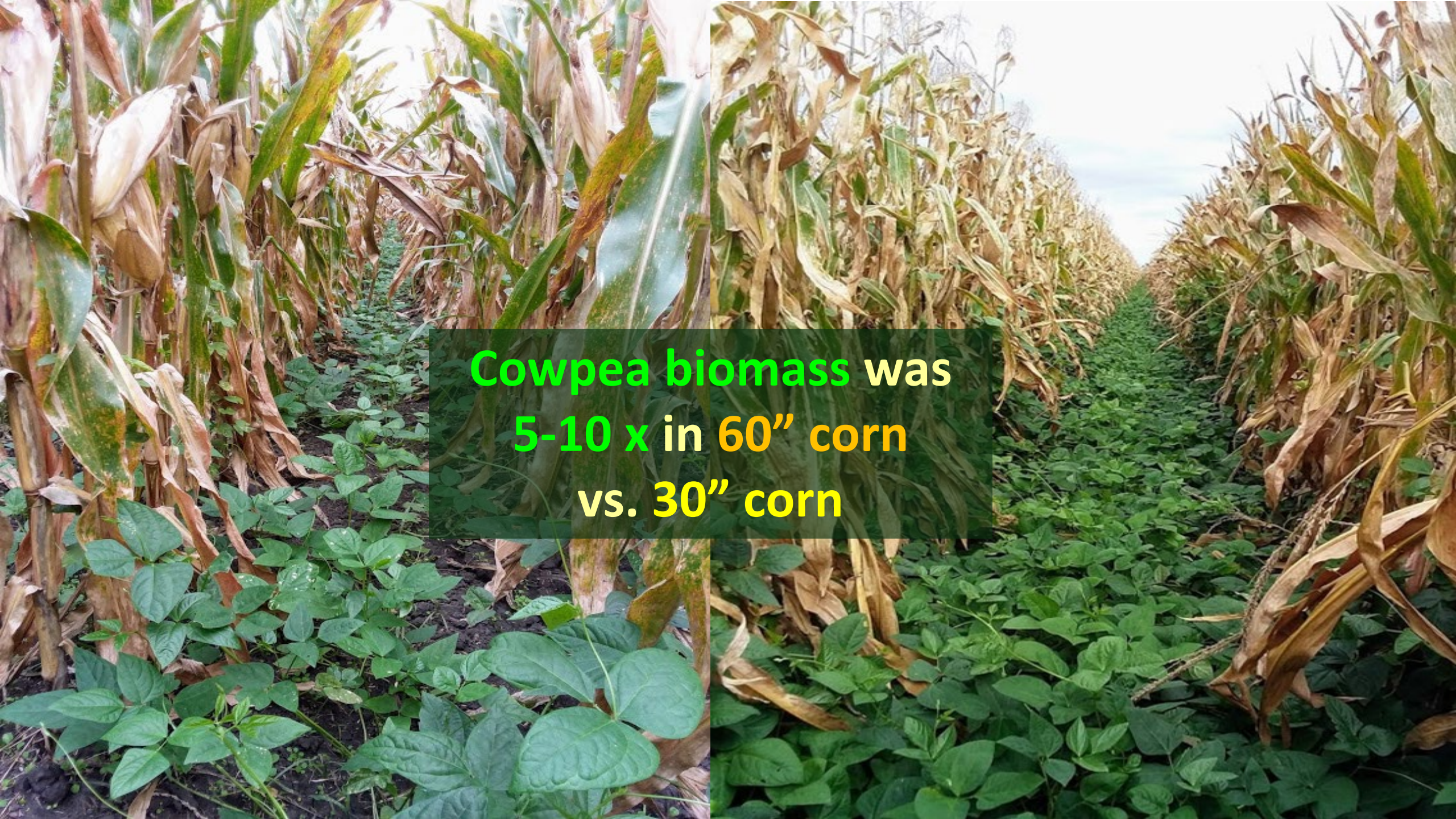
Solar Corridor concepts have been investigated for 3+ years (2018, 2019, 2020, 2021) at the WIU Organic Research Farm in Roseville, IL



June 2018


4 treatments
30” corn w/ interseeded cowpea
30” corn w/o interseeding
60” corn w/ interseeded cowpea
60” corn w/o interseeding
6 row (15’ plots)
east : west row orientation

“Iron&Clay” cowpeas were planted @ v5 using a 1 row push planter


Cowpea biomass was
5-10 x in 60” corn
vs. 30” corn


60” corn yielded
~ 24% less
than 30” corn

POSITIVE impact of intercropped cowpea in 2018 on oat biomass in 2019

	Crop in 2018	Corn row spacing	Cowpea intercrop	Oat biomass (lbs/a)	
Rep 1	grain corn	30"	yes	3564.2	+18%
	grain corn	30"	no	2997.0	
Rep 2	grain corn	30"	yes	3405.4	+35%
	grain corn	30"	no	2520.6	
Rep 3	grain corn	30"	yes	3723.0	+27%
	grain corn	30"	no	2940.3	
	grain corn	60"	yes	3768.4	+22%
	grain corn	60"	no	3087.8	
	popcorn	60"	yes	3995.3	+29%

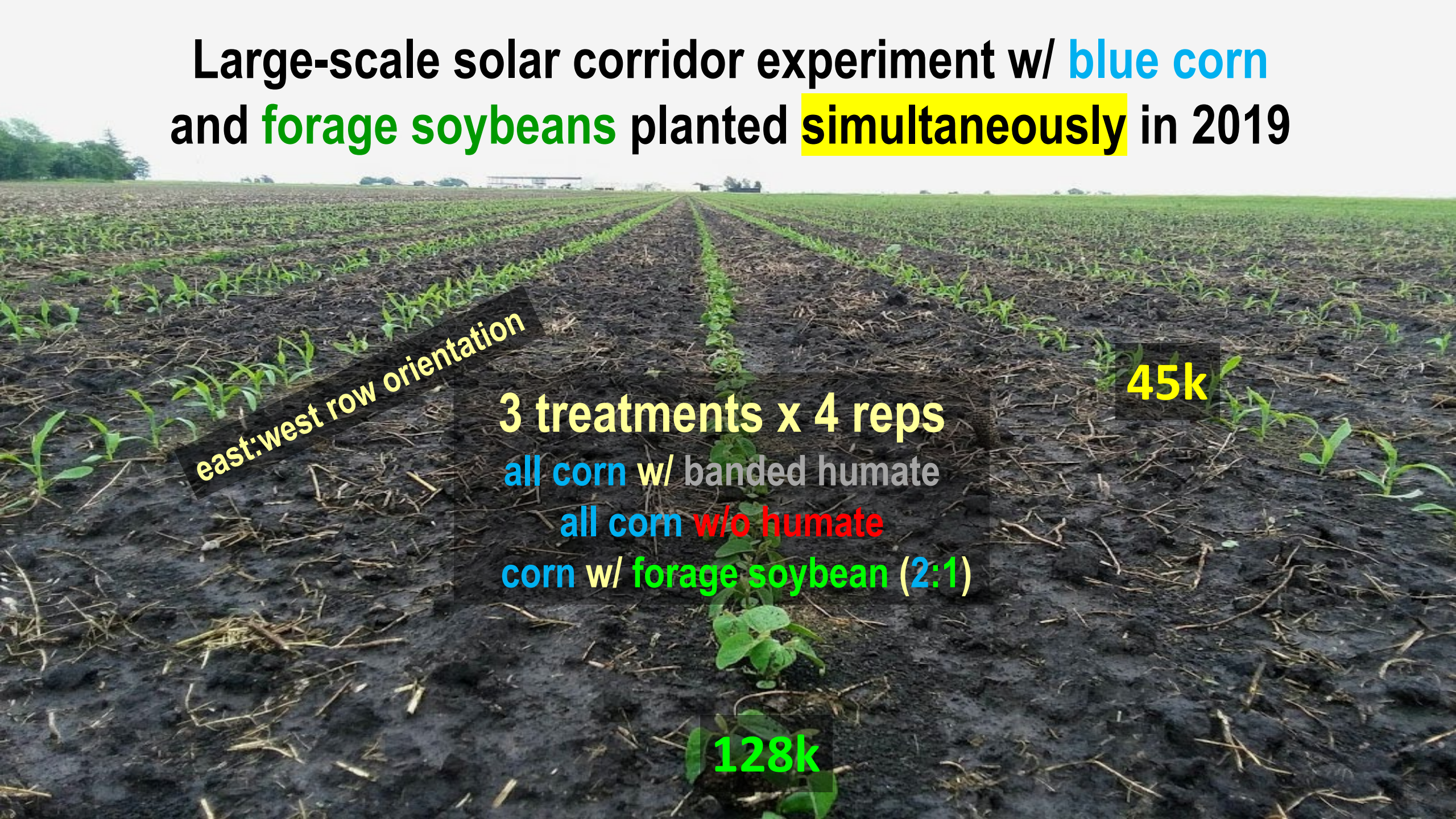
3192 avg following 30" corn

+13.3%

3617 avg following 60" corn

60" plots were unreplicated in 2018

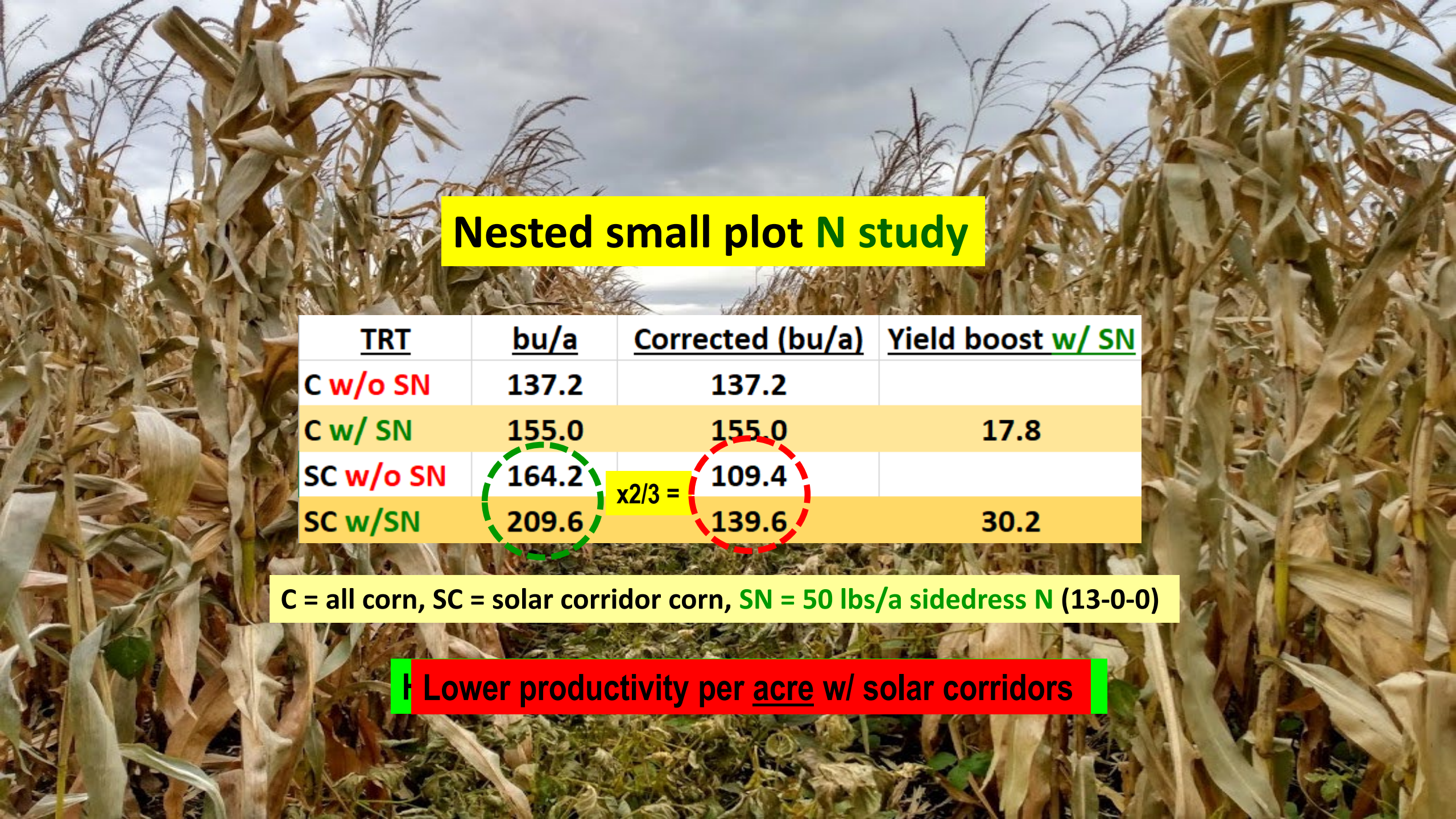
Large-scale solar corridor experiment w/ blue corn and forage soybeans planted simultaneously in 2019



Uniform management across the field after planting


Faster in-row canopy development in rows with corn planted @ 45k
but a high level of weed control was achieved across all plots


Solar corridor corn yielded
~ 13% less than all corn



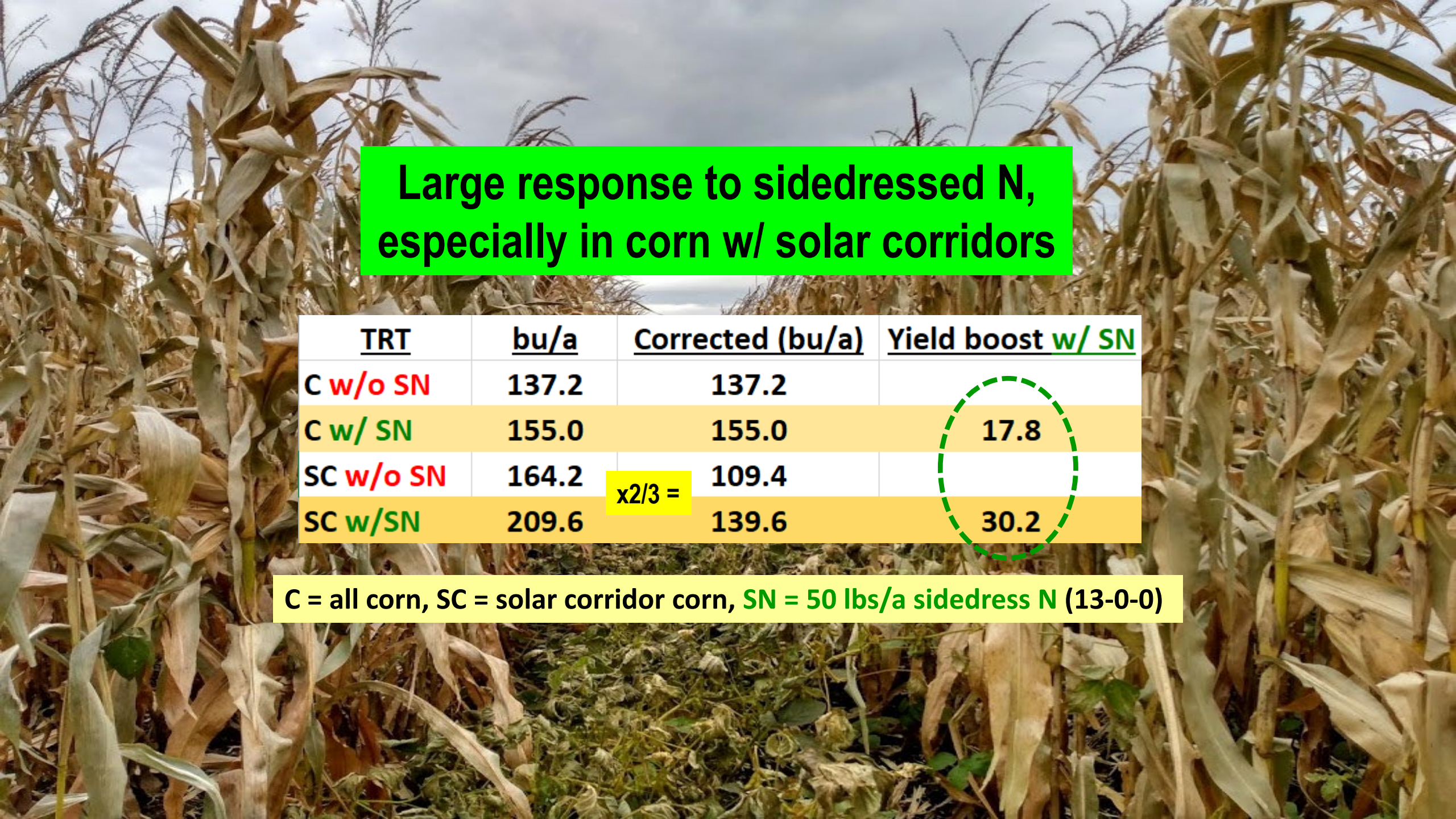
Nested small plot N study

TRT	bu/a	Corrected (bu/a)	Yield boost w/ SN
C w/o SN	137.2	137.2	
C w/ SN	155.0	155.0	17.8
SC w/o SN	164.2	109.4	
SC w/SN	209.6	139.6	30.2

x2/3 =

C = all corn, SC = solar corridor corn, SN = 50 lbs/a sidedress N (13-0-0)

H Lower productivity per acre w/ solar corridors



Large response to sidedressed N, especially in corn w/ solar corridors

TRT	bu/a	Corrected (bu/a)	Yield boost w/ SN
C w/o SN	137.2	137.2	
C w/ SN	155.0	155.0	17.8
SC w/o SN	164.2	109.4	
SC w/SN	209.6	139.6	30.2

x2/3 =

C = all corn, SC = solar corridor corn, SN = 50 lbs/a sidedress N (13-0-0)

Field 1 A - forage soybeans planted every 3rd row with corn on 6/9 (target population = 128k/a)

	(grams)	(grams)				
row ID	dry biomass+bag*	dry biomass	lbs/a	lbs/a corrected**	lbs N/a***	
1	648	437	5596.3	1865.4	74.6	
2	633	422	5404.2	1801.4	72.1	
3	[illegible]				65.2	
4	[illegible]				57.7	
5	[illegible]				60.8	
6	599	388	4968.8	1656.3	66.3	
7	590	379	4853.5	1617.8	64.7	
8	512	301	3854.6	1284.9	51.4	
9	559	348	4456.5	1485.5	59.4	
10	713	502	6428.6	2142.9	85.7	

Forage soybeans planted a few weeks later w/o corn produced ~50% more DM

2 solar corridor studies in 2020

Large-scale study with 2:1 configuration
north : south row orientation

16 plots, 6 x 30”rows x 1200’

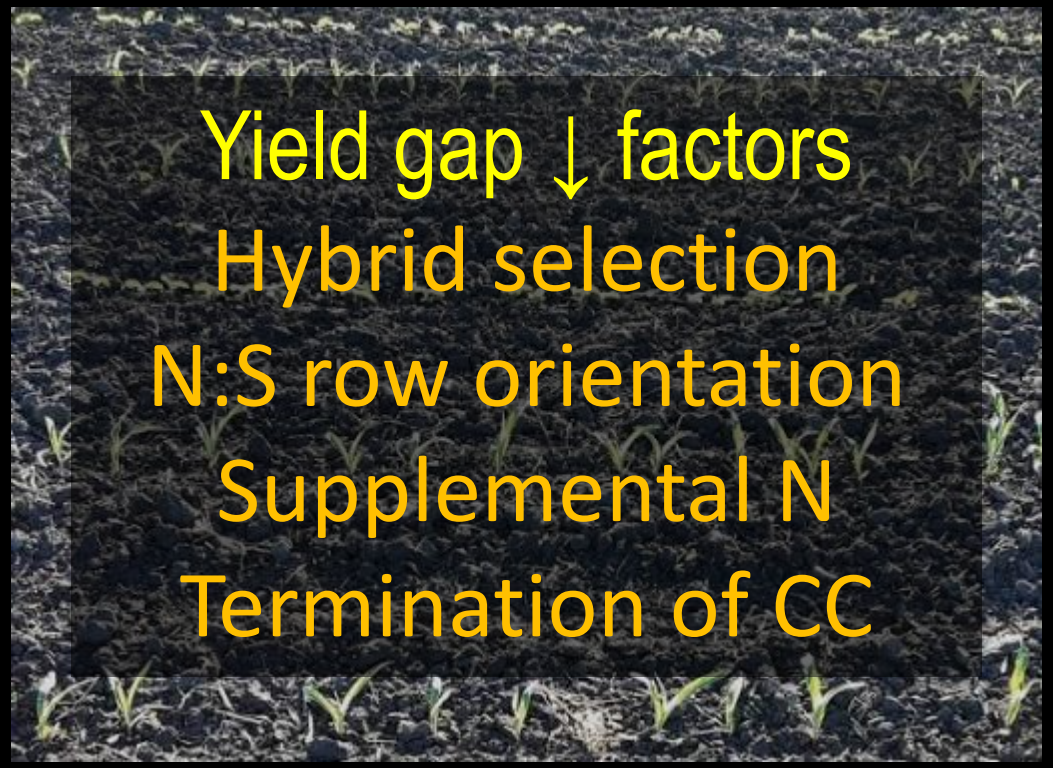
planted 6/3

Smaller-scale study
with 1:1 configuration
east : west row orientation

8 plots, 6 x 30”rows x 490’

planted 6/4

Study targeted @ reducing yield gap in solar corridor corn



4 treatments

CCCCCC

CCCCCC + N

CCSCCS + N

CCSCCS chop + N

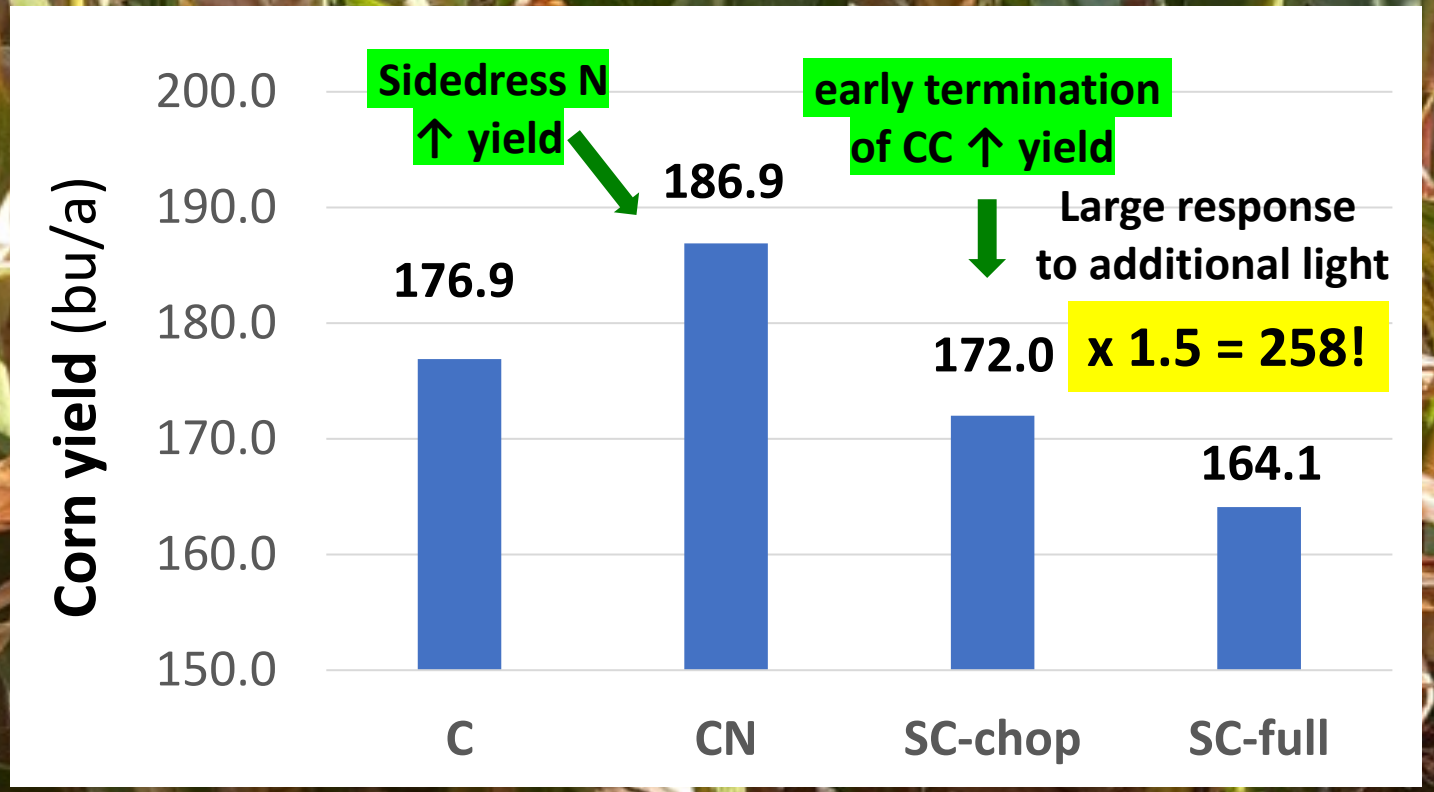
128k

GHO 63T1 **corn &** ***Derry*** **forage soybean - 2:1 configuration**

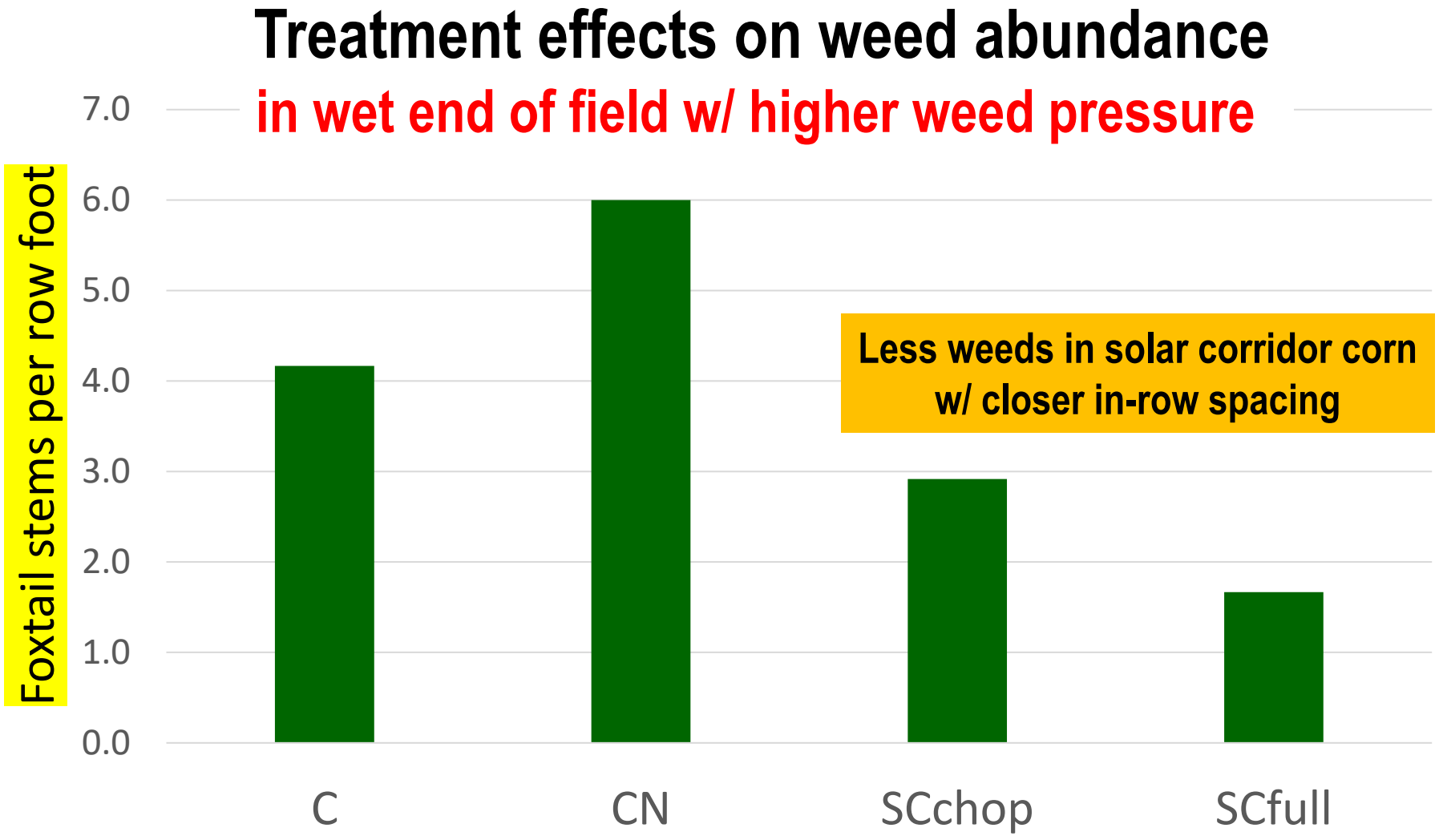
30k vs 45k

north : south row orientation

Rep 1 – weigh wagon weights



Most of the experiment had good weed control



C = 30” corn

CN = 30” corn w/ sidedress N

SCchop = solar corridor corn, CC chopped

SCfull = solar corridor corn, CC unchopped

Smaller-scale, multi-year study
w/ corn & CC rows alternating in time & space

2 treatments

CSCSCSC

(low diversity system)

C4C4C4C

(high diversity system)

60k vs 162k

east:west row orientation

preceded by spring planted CC mix

1 ton/a pelletized litter


Low diversity
High diversity
Corn
in 2021


CC mix = oats, winter peas, fava bean, buckwheat, COWPEA, SOYBEAN

Key conclusions after 3 years of SCS research

Synchronous planting of corn and CCs followed by standard weed management practices is an efficient system that requires no specialized equipment or field operations (2019&2020)

CCs planted in solar corridors (synchronously and @v5) produce much greater biomass than CCs interseeded in 30” corn (2018-20)

Crops following solar corridors have higher yields (2019&2020)

Configurations other than 1:1 (aka 60”) can work well (2019&2020)

Tight in-row spacing = excellent weed control in SCS corn

Corn hybrids differ in how they respond to SCS (2020) and better selection criteria are needed

Late planting of corn (2019 & 2020) is likely to have reduced yield response to additional light

Most direct way to benefit from biomass grown in corridors

Novel high value applications of SCS?

Future Research???

To date, we have focused primarily on the aboveground components of the SCS story

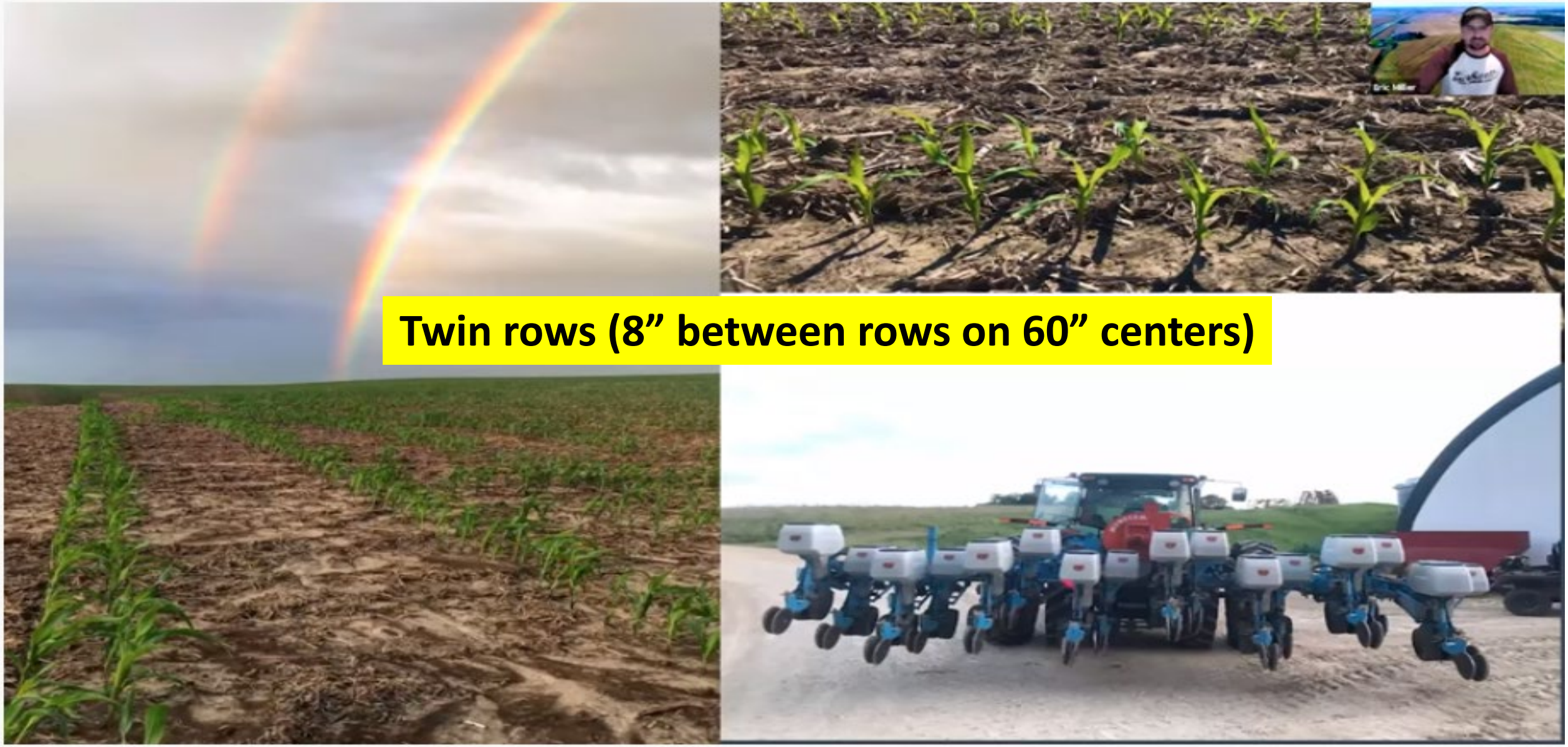
We are looking forward to gaining a better understanding of how SCS impact soil N dynamics, microbial activity and aggregate properties.

Farmer innovation is driving the future of SCS

Meet Eric Miller

142 views • Oct 20, 2020

3 0 SHARE SAVE ...



Twin rows (8” between rows on 60” centers)

Interseeding 60-Inch Corn for Improved ROI - Farminar

https://www.youtube.com/watch?v=9x4ET8M2v5s

2,738 views • Jan 27, 2021

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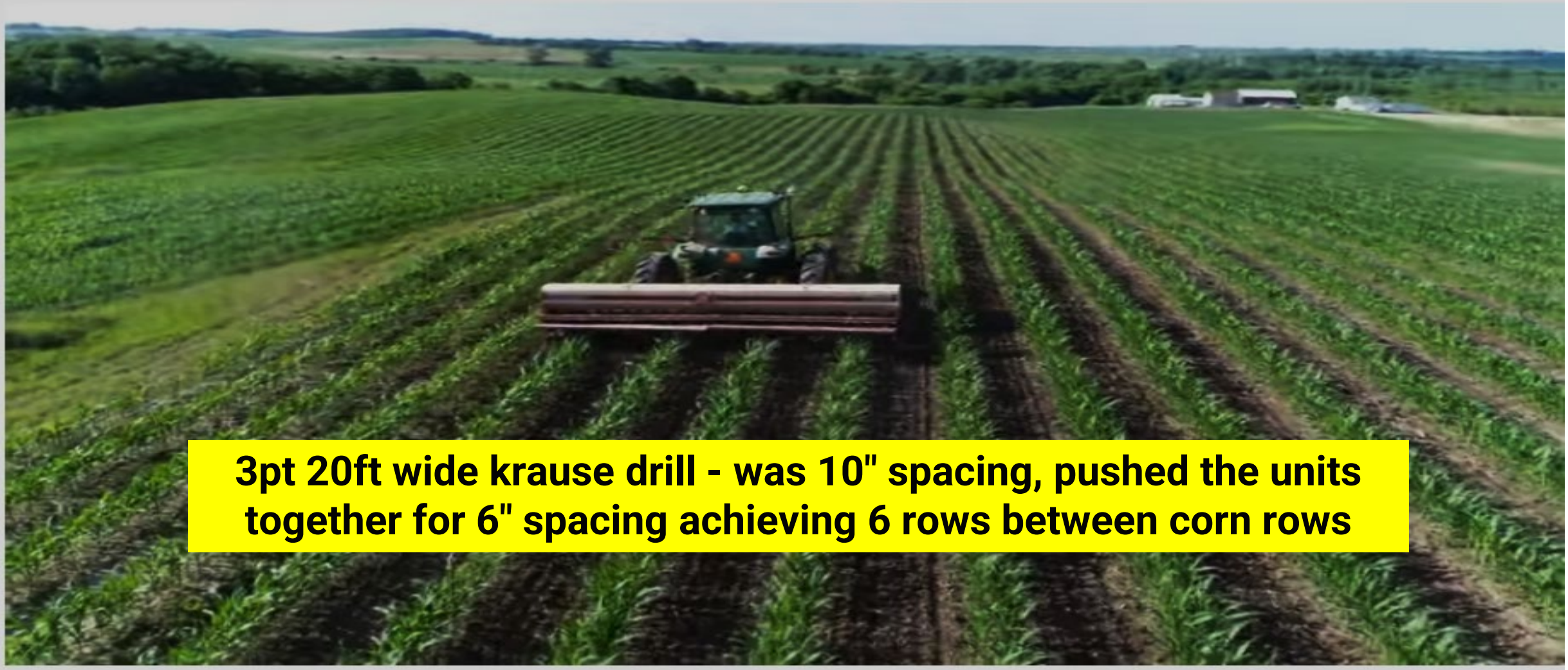

Interseeding cover crops into twin 60" wide corn

558 views • Jul 21, 2020

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Interseeding 60-Inch Corn for Improved ROI - Farminar

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#1 reason to plant SCS

Peckman Farm, PA

https://twitter.com/ben_peckman/status/1318145303321726976/photo/2

Key takeaways

SCS systems are likely to have lower corn yields w/o TARGETED management

Management for minimizing yield loss includes hybrid selection, full populations, early planting, indexed fertility, twin rows, N/S orientation, good weed control before planting CCs

Proven benefits include large increases in CC performance (high biomass, N fixation, nutrient scavenging, winter hardiness, forage value…) and higher yields of following crops

Additional benefits (documented and anecdotal)

Biodrilling ↑

Good fit w/ organic farming systems

Soil health indicators ↑

SOM ↑ shallow and deep

Greatest benefit on lower productivity soils???

Yield stability ↑

Drought tolerance ↑

Perennialization (w/ or w/o perennial species)

Soil/Crop management strategies for enhancing root growth and function

All of these strategies have their place but

SOLAR CORRIDOR SYSTEMS

may be the most practical option
for implementing the last strategy

•Grow strategic sequences of crops/cover crops to maximize a positive cycle of root zone improvement