Bob Recker independently arrived at the Solar Corridor concept through first studying strip intercropping.
Dr. Erin Silva - UW

Dr. Joel Gruver - WIU

University scientists recently began investigating Solar Corridor Systems. Dr. Robert Kremer et al., U of MO were the first!

Wide Row Corn, Intercropping, Relay Cropping
3 years of PFI coordinated investigation of SCS on farms across IA

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 maintaining corn yields.
- Fred Abels, Nathan Anderson, Jeff Olson, Tim Sieren, and Mark Yoder planted corn in two row-widths (30- and 60-in.) to observe corn biomass production and corn yields between row-widths.

Key Findings:

- Compared to 30-in. row-widths, corn yields were significantly lower at farms across IA.
- 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.

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.”[12] 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.[23] These mixed results aligned with earlier reports that the 30-in. row-widths provided the ideal conditions for the establishment of cover crops during summer, while the 60-in. row-widths were larger than necessary for establishing cover crops.

At left, cover crops growing between 60-in.-wide corn rows 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 Tim Sieren’s farm.
Livestock Grazing

Crop health

Solar Corridors → Cover Crop Performance ↑

Relay Crops

Secondary Cash Crops

Full Season Manure Application

Carbon Farming

Soil Health

Water Quality
Yield increases in recent decades have not been uniformly distributed! Why have some US counties benefited more from advances in ag technology? 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?
Main drivers of productivity:

- Rooting depth
- Plant available water

Legend:

Soil Productivity Index

- Low
- Medium
- High
- Very High
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...

SOMON acts as a fulcrum that leverages input/tech investments into yield/profit
uniform management = higher & more consistent yields where the field has higher SOM

Slabaugh Farm
Goshen, IN

Hayfield ~ 5 yrs ago
Change in $C$ in the top 3 feet of the WICST (1989-2009)

Baseline C levels were clearly high at this site

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

Baseline C levels were clearly high at this site
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.
Shifting to **perennial crops** is a soil building option that currently doesn’t appeal to many farmers.

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

CCs can perennialize annual cropping systems

The sun shines, the rain falls, and microbes work 10-12 months a year, but the typical grain farm without winter cover captures only 3-4 months of this activity.
Currently most crop acres are NOT planted to CC and most CC are planted late and killed early limiting their benefits.
While yield benefits are a work in progress, growers say interseeding wide-row corn produces high amounts of cover crop biomass and nitrogen.
Boyer Farm

more light between 60” rows
Boyer Farm

more CC biomass between 60" rows

Cover crop biomass, 9/12/18

>10 X

3,870 pounds per acre

339 pounds per acre
60” corn yields were significantly lower than 30” corn yields in 10 out of 15 site-yrs, 12% lower on average.
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  or BOTH!
- Over Winter or Winter Kill
- DIVERSITY!

Example Cover Crop Mix

- Medium Red Clover
- Buckwheat
- Iron & Clay Cowpea
- Golden German Foxtail Millet
- VNS Hairy Vetch
- Everleaf 126 Oats
- Dwarf Essex Rape
- Sunn Hemp
- Flax
- Annual Ryegrass
- Cost Per Acre for seed $18

MIX of cool season and warm season species

Consistent performer

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

= low seeding rates
Few CC establish here

Non-uniform CCs have legacy effects

- 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.

Symmetry vs. Asymmetry
60-30-60-30

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

BAND N here
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)
“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**

<table>
<thead>
<tr>
<th>Crop in 2018</th>
<th>Corn row spacing</th>
<th>Cowpea intercrop</th>
<th>Oat biomass (lbs/a)</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>grain corn</td>
<td>30”</td>
<td>yes</td>
<td>3617</td>
<td>+29%</td>
</tr>
<tr>
<td>grain corn</td>
<td>30”</td>
<td>no</td>
<td>3768.4</td>
<td>+13.3%</td>
</tr>
<tr>
<td>grain corn</td>
<td>60”</td>
<td>yes</td>
<td>3617</td>
<td>+29%</td>
</tr>
<tr>
<td>grain corn</td>
<td>60”</td>
<td>no</td>
<td>3087.8</td>
<td>+13.3%</td>
</tr>
<tr>
<td>grain corn</td>
<td>30”</td>
<td>yes</td>
<td>3723.0</td>
<td>+27%</td>
</tr>
<tr>
<td>grain corn</td>
<td>30”</td>
<td>no</td>
<td>2520.6</td>
<td>+27%</td>
</tr>
<tr>
<td>grain corn</td>
<td>30”</td>
<td>yes</td>
<td>3405.4</td>
<td>+35%</td>
</tr>
<tr>
<td>grain corn</td>
<td>30”</td>
<td>no</td>
<td>2997.0</td>
<td>+35%</td>
</tr>
<tr>
<td>grain corn</td>
<td>30”</td>
<td>yes</td>
<td>3564.2</td>
<td>+18%</td>
</tr>
<tr>
<td>grain corn</td>
<td>30”</td>
<td>no</td>
<td>2940.3</td>
<td>+18%</td>
</tr>
<tr>
<td>60” plots</td>
<td>were unreplicated in 2018</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3192 avg following 30” corn

3617 avg following 60” corn
Large-scale solar corridor experiment with blue corn and forage soybeans planted simultaneously in 2019.

3 treatments x 4 reps:
- All corn with banded humate
- All corn without humate
- Corn with forage soybean (2:1)
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

<table>
<thead>
<tr>
<th>TRT</th>
<th>bu/a</th>
<th>Corrected (bu/a)</th>
<th>Yield boost w/ SN</th>
</tr>
</thead>
<tbody>
<tr>
<td>C w/o SN</td>
<td>137.2</td>
<td>137.2</td>
<td></td>
</tr>
<tr>
<td>C w/ SN</td>
<td>155.0</td>
<td>155.0</td>
<td>17.8</td>
</tr>
<tr>
<td>SC w/o SN</td>
<td>164.2</td>
<td>109.4</td>
<td></td>
</tr>
<tr>
<td>SC w/ SN</td>
<td>209.6</td>
<td>139.6</td>
<td>30.2</td>
</tr>
</tbody>
</table>

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

- Lower productivity per acre w/ solar corridors
### Large response to sidedressed N, especially in corn w/ solar corridors

<table>
<thead>
<tr>
<th>TRT</th>
<th>bu/a</th>
<th>Corrected (bu/a)</th>
<th>Yield boost w/ SN</th>
</tr>
</thead>
<tbody>
<tr>
<td>C w/o SN</td>
<td>137.2</td>
<td>137.2</td>
<td></td>
</tr>
<tr>
<td>C w/ SN</td>
<td>155.0</td>
<td>155.0</td>
<td>17.8</td>
</tr>
<tr>
<td>SC w/o SN</td>
<td>164.2</td>
<td>109.4</td>
<td></td>
</tr>
<tr>
<td>SC w/ SN</td>
<td>209.6</td>
<td>139.6</td>
<td>30.2</td>
</tr>
</tbody>
</table>

C = all corn, SC = solar corridor corn, SN = 50 lbs/a sidedress N (13-0-0)
Forage soybeans planted every 3rd row produced ~1600 lbs of DM/a & ~65 lbs of N/a.

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

4 trts x 4 reps
1 year

16 plots, 6 x 30”rows x 1200’
planted 6/3

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

2 trts x 4 reps
multi-year

8 plots, 6 x 30”rows x 490’
planted 6/4
Study targeted @ reducing yield gap in solar corridor corn

Yield gap ↓ factors
Hybrid selection
N:S row orientation
Supplemental N
Termination of CC

4 treatments
CCCCCC
CCCCCC + N
CCSCCS + N
CCSCCS chop + N

GHO 63T1 corn & Derry forage soybean - 2:1 configuration
128k
30k vs 45k
north : south row orientation
### Corn Yield (bu/a)

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Yield</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>176.9</td>
</tr>
<tr>
<td>CN</td>
<td>186.9</td>
</tr>
<tr>
<td>SC-chop</td>
<td>172.0</td>
</tr>
<tr>
<td>SC-full</td>
<td>164.1</td>
</tr>
</tbody>
</table>

Rep 1 – weigh wagon weights

- **Sidedress N** increases yield
- **Early termination** of CC increases yield
- **Large response** to additional light

\[ \times 1.5 = 258! \]
Most of the experiment had good weed control.

Treatment effects on weed abundance in wet end of field w/ higher weed pressure

- C = 30” corn
- CN = 30” corn w/ sidedress N
- SCchop = solar corridor corn, CC chopped
- SCfull = solar corridor corn, CC unchopped

Less weeds in solar corridor corn w/ closer in-row spacing.
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

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.

Future Research???
Farmer innovation is driving the future of SCS
Almost all corn acres in 2020

60" corn in 2019 and 2020 in Dubuque County IA
Twin rows (8” between rows on 60” centers)

Interseeding 60-Inch Corn for Improved ROI - Farminar

https://www.youtube.com/watch?v=9x4ET8M2v5s
3pt 20ft wide krause drill - was 10" spacing, pushed the units together for 6" spacing achieving 6 rows between corn rows
Neighbor’s cattle graze for cost of CC seed.
#1 reason to plant SCS
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 ↑
- Soil health indicators ↑
- SOM ↑ shallow and deep
- Yield stability ↑
- Greatest benefit on lower productivity soils???
- Drought tolerance ↑
- Good fit w/ organic farming systems
- Perennialization (w/ or w/o perennial species)
- Good fit w/ organic farming systems
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.

- Prevent development of physical, chemical and/or biological barriers to root growth
- Alleviate existing physical, chemical and/or biological barriers to root growth
- Plant crops on soils for which they are well adapted
- Treat seeds/roots with biological inoculants to enhance root-enhancing biological relationships
- Grow strategic sequences of crops/cover crops to maximize a positive cycle of root zone improvement