Latest & Most Promising No-Till Research

Vinayak Shedekar and Randall Reeder

The Ohio State University

Latest & Most Promising No-Till Research - overview

Lessons learned so far, some examples of the latest, practical research	Looking ahead – up and coming advances in research and technology
• What have we learned from 60-years of no-till research and practice? • Weed control • Soil health, carbon markets etc. • Co-benefits (water quality) • Cover crop integration • ~~Equipment innovations (Planters, residue management, cover crop seeding)~~	• New ways of farming – e.g. strips • Smart water management • Digital Ag & data revolution –Drones –Robots –Automation –Sensors –Big Data, Artificial Intelligence, Machine Learning

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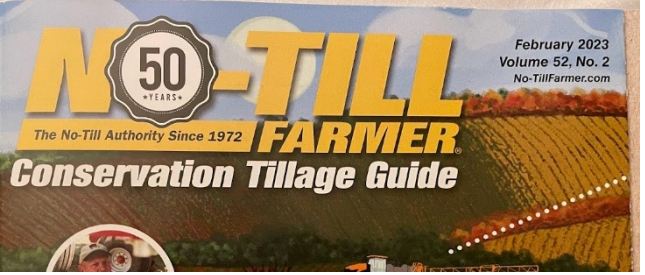
What have we already learned in 60 years?

What have we already learned in 60 years?

- ✓ No-till needs **residue** to succeed
- ✓ **Cover crops** speed up the transition
- ✓ **Living roots** feed the microbes
- ✓ **Biology** is the third leg of the stool (physical, chemical)
- ✓ **Soil health** will enhance nutrient and water use efficiency
- ✓ No-till is the gateway to **Regenerative Ag**



No-Till Farmer, Feb. 2023 Issue

YOUR NO-TILL HISTORY NO-TILL FARMER

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World's Longest Continuing No-Till Plots Hit 60

Interviews with 90-year-olds Glover Triplett, Bill Richards & others discuss the 'ground zero' of no-till science.

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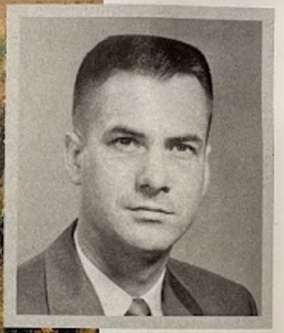
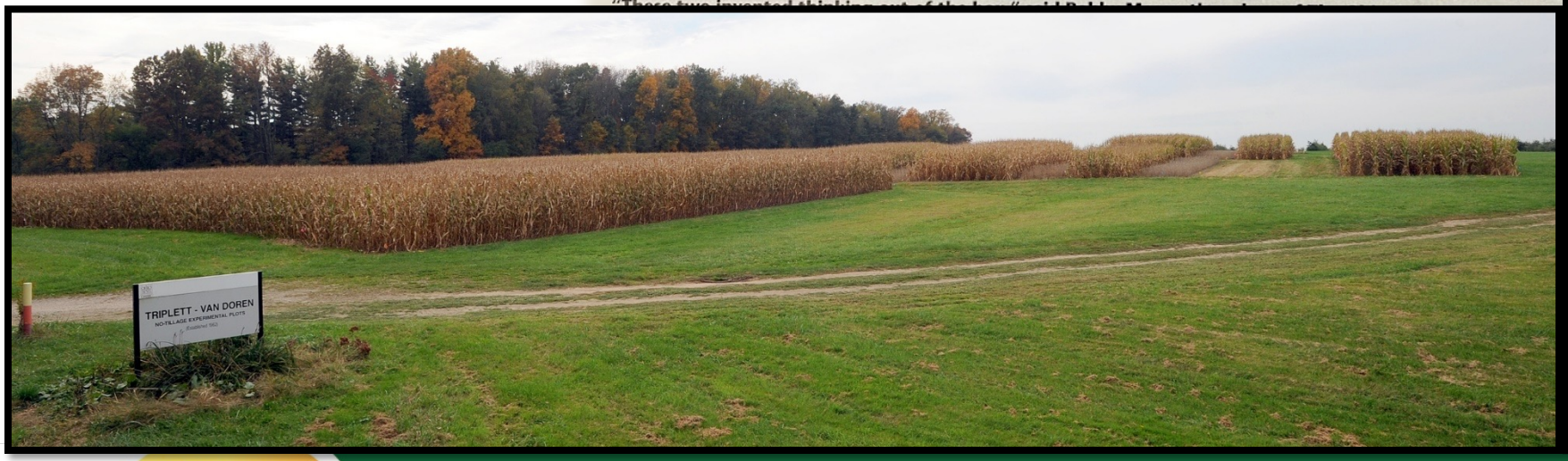
Dave Van Doren



Glover Triplett

Wooster, Ohio (1962)
Hoytville, Ohio (1963)



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When is no-till NOT no-till?

“Until the soil heals from abusive tillage, it’s only transitional no-till”

- Jerry Grigar

Jerry Hatfield & Randall Reeder
Crops & Soils magazine
November–December 2018

Published November 15, 2018

No-till is not really no-till until the soil achieves a physical, biological, and chemical balance typical after several years of continuous no-till. Early years of no-till research must be identified as “transitional no-till.” Any interruption of continuous no-till with a tillage operation resets the soil clock, and the changes are not realized and may even be reversed. In this overview, we present the case for why no-till systems achieve the positive results on soil properties and why not disturbing the soil is necessary to restore soil functionality. Earn 1.5 CEUs in Soil & Water Management by reading this article and taking the quiz at www.certifiedcropadviser.org/education/classroom/classes/612.

By Jerry Grigar, USDA-NRCS, East Lansing, MI; **Jerry L. Hatfield**, National Laboratory for Agriculture and the Environment, Ames, IA; and **Randall Reeder**, The Ohio State University

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What is it and how does it differ from ‘true’ no-till?

Transitional no-till

Soil changes under no-till are gradual and depend on continuous use of no-till practices. Changes in soil aeration, earthworm populations, fertility, water infiltration, available water capacity, soil structure, water-stable aggregates (WSAs), soil organic matter (SOM), humus, and microbial buildup require time to develop. Hatfield et al. (2017b) demonstrated changes in soil required a stable microclimate in the upper soil profile for the biological systems to properly function and to facilitate changes in soil quality. Without soil biological activity, there is no humus (Clapperton, unpublished, 2012) and no change in the soil properties (Hatfield et al., 2017b). When transitioning to no-till, Monsanto (unpublished, 1994) noted the following:

“No-till systems do not mix residue in the soil. This means organic matter breaks down in the top several inches of soil. Studies of long-term no-till show the soil organic matter levels can increase by 100% in the surface 2 inches of the soil profile. With most soils, it will take several years (three to six) of continuous no-till before the effect is noticeable.”

The accumulation of SOM on the surface impacts the soil physical, chemical, and biological properties and affects soil health and crop productivity over time. Disruption of a no-till system by any form of tillage in any of the transitional years negates all of these beneficial changes (Reicosky, 2015).

If a farm family has 1,000 acres of soybeans planted no-till after corn and 1,000 acres of corn planted after fall chisel plow and spring disking, how many acres of this 2,000-acre corn–soybean rotation are no-tilled? Most people, including the federal government agencies, would say “1,000 acres no-till.” The more accurate answer is zero! Soil that is tilled every second (or third) year is not no-till. This is “rotational tillage,” which is the most typical practice for Midwest farmers with a corn and soybean crop rotation. According to Ohio State University, greater than 75% of corn planted is after fall chisel plowing of the previous crop (Hoorman et al., 2009).

Shallow vertical tillage units disrupt the entire soil surface to a depth of 1 to 4 inches, leaving the soil fractured and loose with crop residue broken up and mixed with the soil. Shallow tillage is widely used with continuous corn as an aid to breaking up the corn stalks. Even if that is the only tillage pass before planting corn, it is not no-till.

In this overview, we present the case for why no-till systems achieve the positive results on soil properties and why not disturbing the soil is necessary to restore soil functionality. Soils are a critical part of the infrastructure required for the production of food, feed, and fiber and are often ignored as foundational to meeting these needs (Hatfield et al., 2017a). Hatfield (2014) showed how soil degradation threatens future productivity and is the result of soil management practices that disturb the upper soil profile.

What is no-till?

Adding crop residue year after year on the soil surface provides carbon and nitrogen “food” for soil microorganisms. Crop residue is important to kick-start the biological, chemical, and physical transformation of soil to obtain full no-till ecosystem functionality. This blanket of crop residue helps to increase soil moisture and reduce soil temperature and soil water evaporation. This crop residue is also necessary to moderate the soil microclimate and reduce the raindrop energy, directly impacting the soil surface (Hatfield and Prueger, 1996). Cooler soil temperatures are more favorable for increasing microbiological activity,

Photo courtesy of the United Soybean Board.

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VS

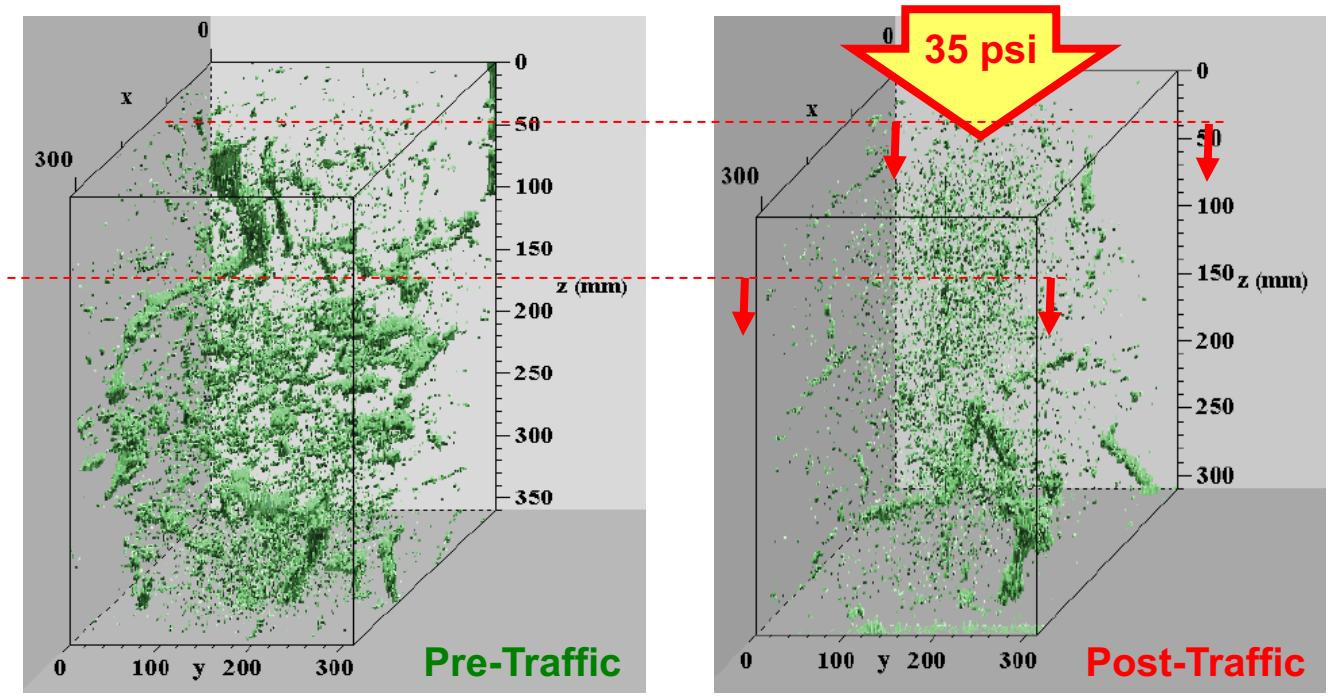
Recent, significant research

When is no-till not no-till?
<u>Occasional Tillage</u>?

When is no-till NOT no-till?

If soil suffers from Compaction

- BEFORE vs AFTER transitioning to no-till?
- Axle load & tire pressure
- Mechanical vs cover crops



(Source: Brunotte et al., vTI)

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Weed detection and management in no-till systems

Precision Weed Sensing

Wide area… Satellite

Small area… Drones

Individual weeds…. Cameras on ground equipment

Precision Weed Control

- **Precision spray systems**
- **Machine vision weed sprayers**
- **Drones, Robots (e.g. Intra-row robotic weeder)**
- **Seed destructor!**

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Weed detection and management in no-till systems

Collect and destroy weed seeds (Australia)

- **Crush**
- **Collect, Pile and Burn**
- **High intensity light**

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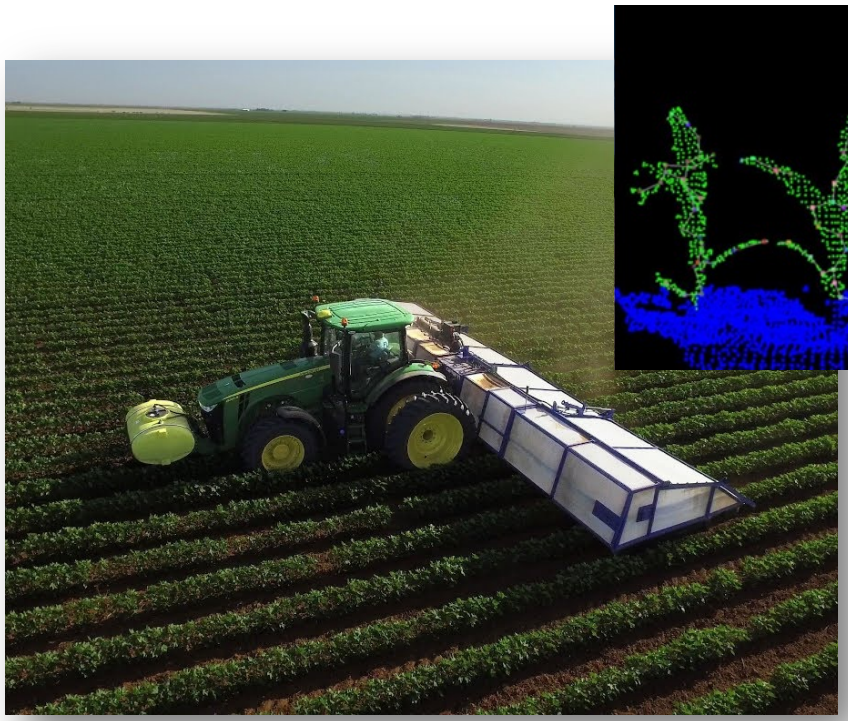
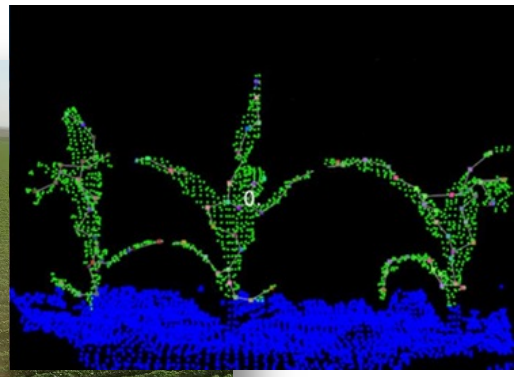
Computer vision and machine learning to target herbicide application to weeds





Blue River (John Deere)

(Source: www.jd-ces-2022.s3-website-us-east-1.amazonaws.com)

ecoRobotix

(Source: www.ecorobotix.com)

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Soil health and carbon

- No-till and Cover crops
  - enhance soil health
  - Sequester carbon
- How can long-term no-till farmers get C credits?
- What about greenhouse gases?

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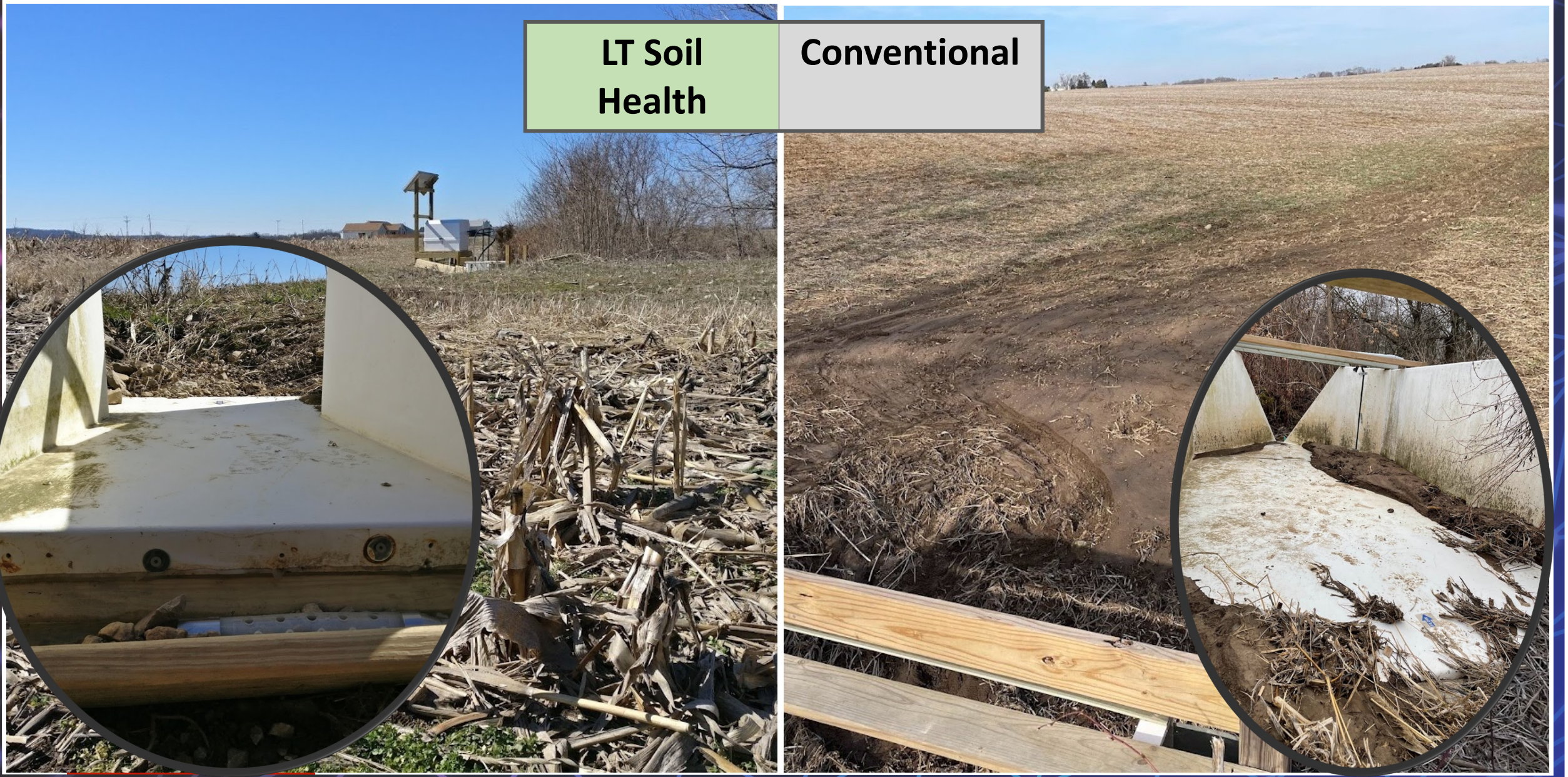
CAUTION
No-Till and greenhouse gas emissions

- **“Some Climate Smart Ag management practices may promote nitrous oxide or methane emissions”**
- **Need to evaluate an increase in Soil Organic Carbon with possible loss of**
  - **methane (25-80X) or**
  - **nitrous oxide (300X)**

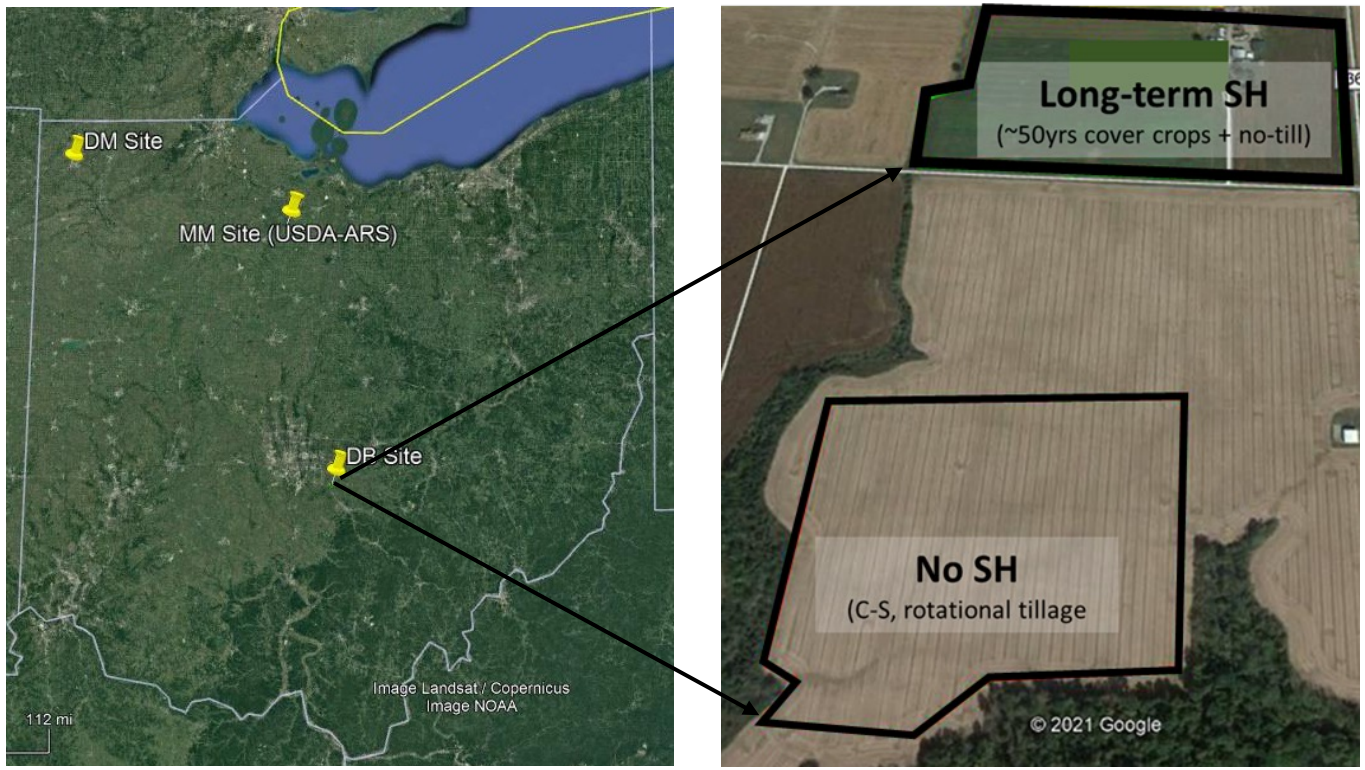
In “Responses of soil carbon sequestration to climate-smart agriculture practices: A meta-analysis” (Xiongxiong Bai)

No-Till and Soil Loss



No-till, cover crops, and water quality

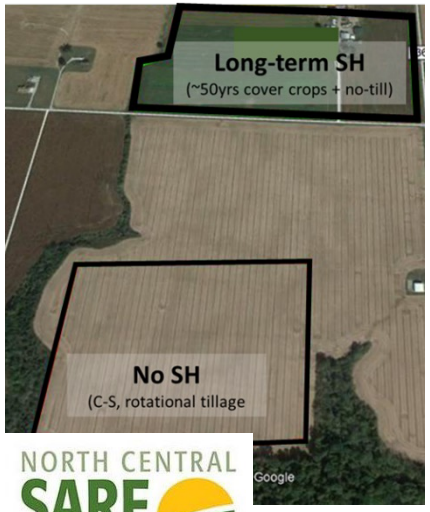
Does it matter if the soil health systems are…
Mature or, transitional vs under No SH Practices?



NCR SARE funded Research & Extension Grant (LNC20-439)

NORTH CENTRAL SARE
Sustainable Agriculture Research & Education

No-till, cover crops, and water quality



NORTH CENTRAL SARE
Sustainable Agriculture Research & Education

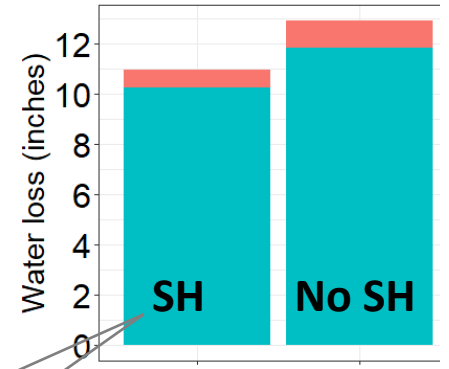
OutletType Surface Tile

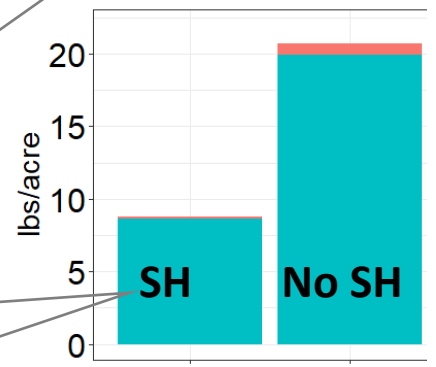
Mature SH vs No SH
Preliminary Results (2021)

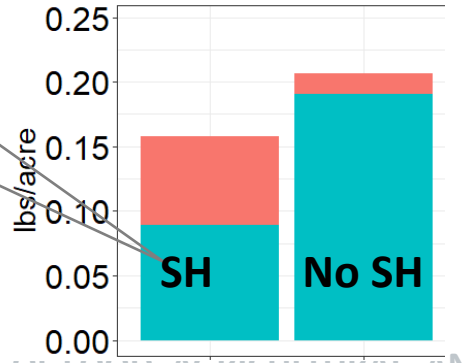
~2 in./yr (~15%)
less water discharge

12 lb/acre/yr (~50%)
less nitrate loss

0.05 lb/acre/yr (~25%)
less dissolved P loss







No-Till and Water Quality – subsurface placement

Injecting fertilizer and manure

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Nutrient value of healthy soil and cover crops

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McClarren Farm, NW Ohio

Sampling date: 10/25/2022

1.3 Tons DM/acre
C:N ratio of 19.6

1.26 Tons DM/acre
C:N ratio of 19.6

Photos by Alan Sundermeier (Oct. 2022)

Plant / Cover crop Tissue Testing

Cover crop planted	8/12/2022
A.Winter Pea	10 lb/a
Cow Pea	9 lb/a
Balansa Clover	0.72 lb/a
Med.Red Clover	1 lb/a
Berseem Clover	1.25 lb/a
Crimson clover	2 lb/a
Oats	6 lb/a
Cereal Rye	12 lb/a
TOTAL COST	**$36.41 /acre**

McClarren Farm (Sand A Field), NW Ohio

Nutrient	Nutrient Content	Nutrient Price	Nutrient Value
	lb/acre	$/lb	$/acre
Carbon	1146	$0.02	$22.92
Nitrogen	58	$0.30	**$62.14**
Phosphorus P2O5	9.7	$0.50	$9.33
Potassium K2O	62.1	$0.44	**$45.54**
Calcium	18.7	$0.03	$1.48
Magnesium	5.8	$0.03	$0.29
Sulfur	3.1	$0.55	$1.89
Zinc	0.047	**TOTAL VALUE**	**$143.59 /acre**
Iron	0.514		
Manganese	0.067		
Copper	0.014		
Boron	0.028		
Molybdenum	0.005		
Aluminum	0.322		

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Looking ahead – Most promising up and coming research and technology

Looking Ahead - Strip-cropping

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Looking Ahead - Strip-cropping

- Three field trials in 2022
- Variable conclusions with respect to yield advantage

efields.osu.edu

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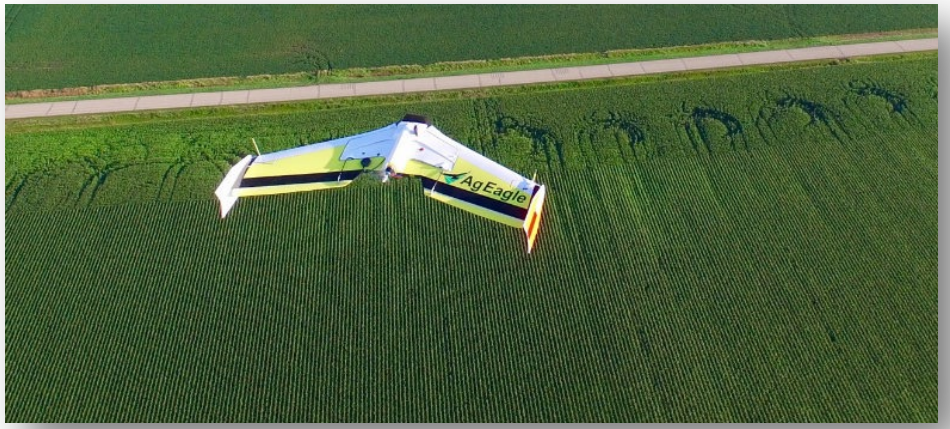
Drones / Swarms

- Weed detection
- Weed control
- Seeding cover crops
- Assessing cover crop establishment
- Assessing in-field variability (moisture, residue cover)

(Source: www.avinc.com/)

(Source: www.commercialuavnews.com)



(Source: www.expouav.com)

(Source: www.techcrunch.com)

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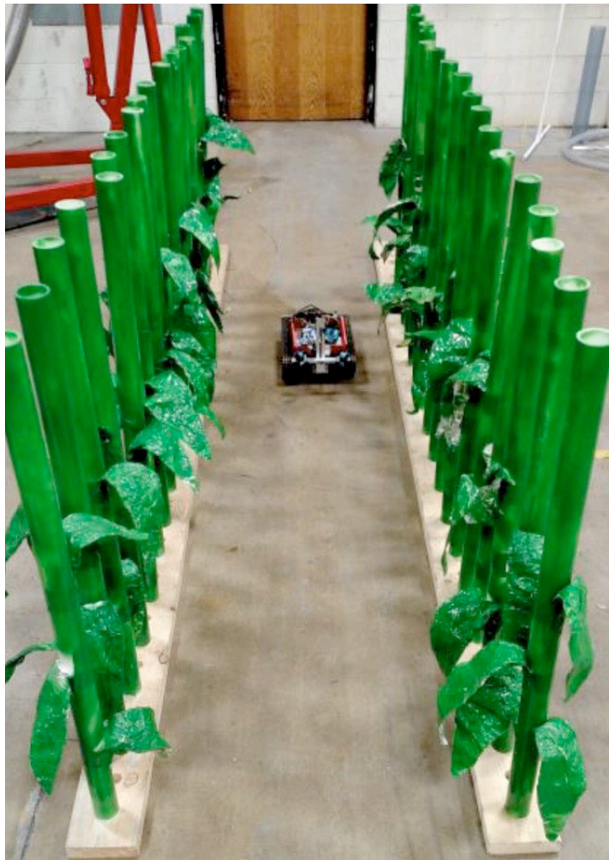
ROWbots for below-canopy sensing



TerraSentia, a crop scout robot

Images from Dr. Santosh Pitla, University of Nebraska

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Smart Water Management

360 RAIN™

Robotic Irrigation

(Source: www.360yieldcenter.com)

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Connected Farm, In-Field Sensor Networks (IoT)

cropx

ONFARM GROW INFORMED

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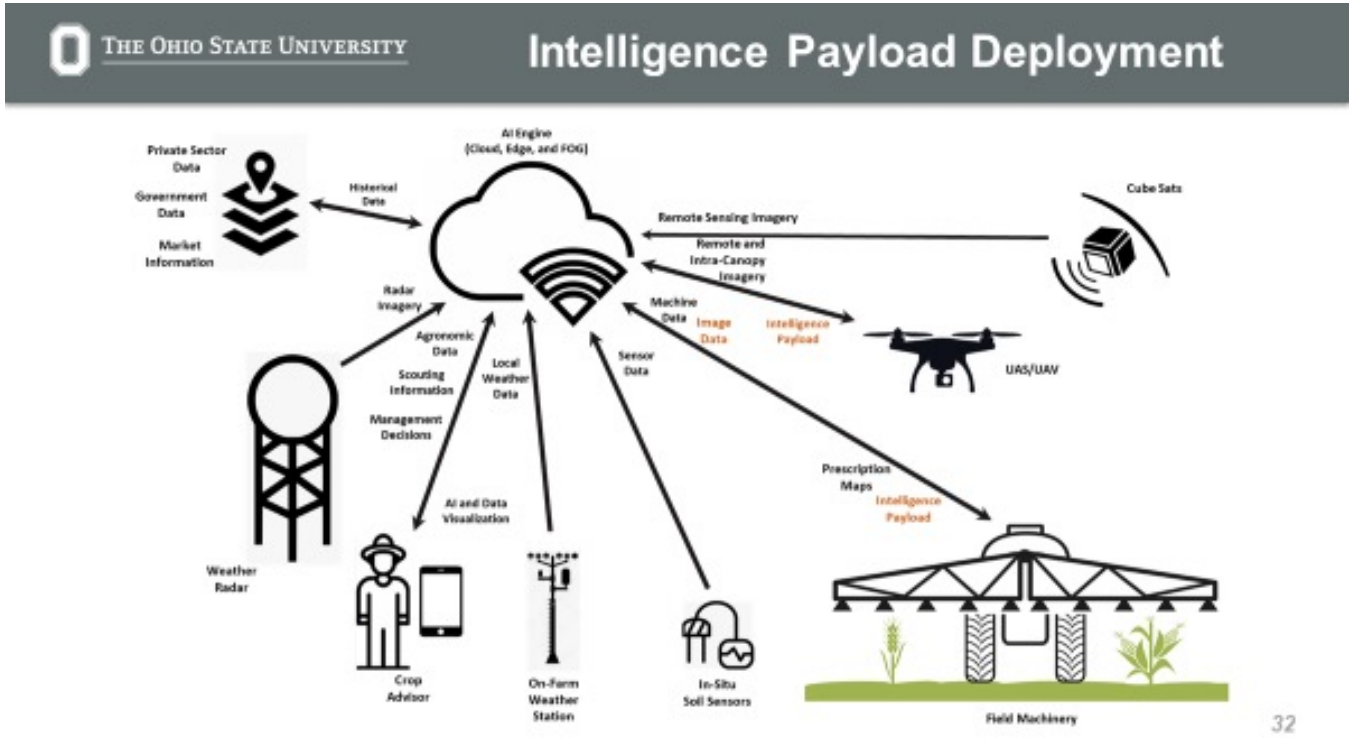

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Smaller, Autonomous, intelligent machines

- 4-row (instead of 40-row)
- Fully autonomous
- Working in swarms
- Farming as a Service (FaaS)

Sabanto Ag (Craig Rupp) - FaaS

(Source: https://twitter.com/i/status/1254060501807632385)

"As a general rule, machinery costs for a planting operation are $0.25/hp·hr – ours are down to $0.07/hp·hr."

- Craig Rupp, Sabanto Ag

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Smaller, Autonomous, intelligent machines

- **Intelligent robot swarms**

SwarmFarm - FaaS

Why would you invest in these?

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(Source: Glenn Randall CCA on Twitter)

(Source: Sabanto Ag on Twitter)

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Conservation Agriculture is a SYSTEM

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Looking ahead – promising ideas

- Fertility value of soil health and cover crops
- 4-row (instead of 40-row)
- Drones, Swarms
- Robots, ROWbots
- Sensors and big data
- Smart water management
- Strip-cropping
- Conservation Agriculture: It's a SYSTEM

Looking Ahead

What "parts" of a No-till System would you like to see research on?

What ideas are worthy of a deeper dive?

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Latest & Most Promising No-Till Research

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