



Impact and Lessons Learned:
Indiana Conservation Cropping Systems Initiative (CCSI) CIG project, 2012-2018, On-Farm Soil Health Sites

Dr. Eileen Kladviko, Lisa Holscher, Jennifer Boyle-Warner, Barry Fisher, Joe Rorick, Dr. Stacy Zuber
Purdue University, CCSI, IASWCD, NRCS
(and a cast of hundreds across the state and region!)

Thanks to:

- Dr. Stacy Zuber, for data analysis, interpretation of soil health tests
- Farmers, conservation partners, for their work on this project!
- NRCS, Indiana Soy, Indiana Corn, for funding this Conservation Innovation Grant (CIG)

Lessons learned—always tricky!

- “wish we had known that, thought of that, heard that from others, questioned that...”
- “It won’t work” is not something that “can do” people like to pay attention to.
- “We have a different or better idea and attitude, we are committed to making this work,” is what “can do” people say, at start of new project.
- Our “lessons learned” are offered as ideas to consider, on potential pitfalls, improvements, and areas for further development, to potentially improve outcomes and learning.

Background

- Indiana Conservation Partnership (ICP)
 - 8 gov’t and univ organizations (NRCS, IASWCD, ISDA, SSCB, Purdue, FSA, IDEM, IDNR)
 - Actively collaborating over 30+ yrs, on conservation education and programs
 - Since 2009, a key program is CCSI (Conservation Cropping Sys Initiative), to improve soil health on Indiana cropland through education and tech assistance
- Collaboration and partnerships are key!



CCSI—Cons.Innov.Grant (CIG)

- We were getting lots of questions about new soil biology/soil health tests, from farmers, conservation partners, etc.
- How useful might those tests be?
 - Could they distinguish different mgmt. systems?
 - Could they monitor change over time?
 - Would they be worth the cost (\$\$\$) for Indiana conditions?

Overall motivation for CIG project

- Enhance soil health education and successful adoption of soil health systems across IN
- More demo/research sites across IN, as locations for training and outreach, data collection
- Harness the power and experience of innovative conservation farmers, to help educate other farmers, conservation field staff, ag professionals
- Foster greater partnerships and team-building at local level, w/ ICP, farmers, CCAs, industry



Goals/obj. of NRCS-CIG project

- Integrate long-term NT, cover crops, and associated practices, into productive, profitable, sustainable systems
 - Demonstrate and quantify impacts of CCS on improving soil health
 - Provide training and education to field staff, farmers, ag professionals; including utilizing innovative farmers as teachers/mentors
 - Spark greater successful adoption of CCS



Implementation of field studies

- Core team (~10-12)—IASWCD, Purdue research/extension scientist, NRCS, state soil cons staff, CCSI agronomists, state commodity orgs; program mgr; met regularly
- 4 quadrants of state as “regional hubs”, each with 3 farmers, some w/ Purdue or SWCD farms
- Developed criteria for farmer cooperators: active NT or strip till; yield monitor; access to field records; willing to conduct replicated strip trial for 3 yrs; long-term experience w/ CCS*; track record of promoting conservation; effective communication skills.
 - ***Note—this helped education but probably hurt research sensitivity**



17 sites across IN

- 12 farmer sites
- 3 Purdue Ag Ctrs
- 2 others

Variety of Trts

- Most sites have cover vs. no cover strips
- Most sites are long-term no-till
- Conventional neighbors

Soil Health Sampling

- Collected in 2013, 2015, 2016, & 2018
- Timing: V3-V6 in corn (Typically during June)
- To depth of 0-8 inch
- In each plot, at least 30 soil cores collected & homogenized before shipped with ice packs to commercial laboratories.



Implementation of field studies (2)

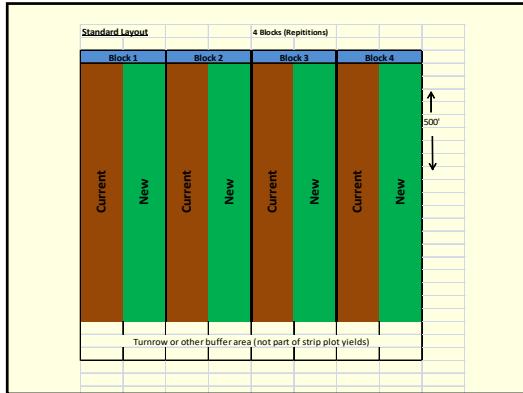
- Regional “hub” working groups established
 - Field staff from ICP, some initially appointed by their state-level leadership, others invited by core team
 - To assist w/ planning and hosting regional hub field days, workshops, trainings
 - To conduct field sampling on farmer-cooperator and SWCD sites
 - Became team-building exercise



Implementation of field studies (3)

- Sampling protocols developed
 - Soil and plant samples as in proposal
 - Details of timing, depths, interactions w/ commercial labs discussed/decided and written up for teams. Improved details in Yr 2.
- Contact person established for each farmer site, as the extent of sampling details became apparent. They organized the local helpers for each sampling event.
- At least 4 sampling events each year per site
- Lots of sampling work, lots of data!

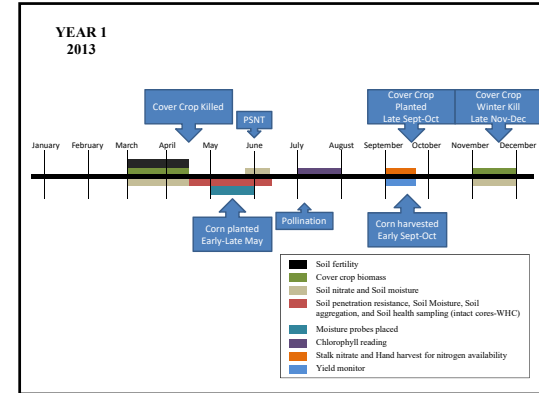




Measurements made in CCSI project

- **Cover crop**—growth (biomass), N%, N content in biomass, fall and spring
- **Soil**—
 - nitrate/ammonium-N(fall, spring, PSNT), std fertility (A&L), temp, moisture
 - [four commercial soil health tests](#)
 - Some sites w/ sensors for temp and moisture; aggregation, penetration, bulk density, water retention curve (water holding capacity)
- **Cash crop**—yield (corn also SPAD, stalk nitrate)

PURDUE UNIVERSITY Conservation Cropping Systems Initiative



Personnel- not enough for the data

- One M.S. student per year, for the more standard tests (biomass, nitrate, yield) and selected sites more detailed (aggregation, penetrometer, sensors)
- Soil health tests new and challenging. Additional funds from NRCS for last 2 yrs, for postdoc to analyze those data.

PURDUE UNIVERSITY Conservation Cropping Systems Initiative

Commercial Soil Health Tests

- Biological
 - Phospholipid Fatty Acid (PLFA)
 - Earthfort Biological Soil Analysis
- Physical, Chemical, & Biological
 - Cornell Comprehensive Assessment of Soil Health (CASH)
- Chemical & Biological
 - Haney Soil Health Tool

PURDUE UNIVERSITY Conservation Cropping Systems Initiative



Challenges

- Treatment comparisons different for all farmer cooperators. Diff soils, location (desired) but also diff cover and cash crops, degrees of NT or tillage, crop rotation, fertility mgmt.
- Some sites ended up w/ treatments not very diff from each other
- Others had true cover vs. no cover comparison, but also long-term NT history
- Difficult to obtain all metadata from farmers
- Some local field staff initially not supportive

PURDUE UNIVERSITY Conservation Cropping Systems Initiative

Solutions developed

- Found conventional comparison site for some farmer cooperators. Not perfect, but similar soil. Showed more diffs.
- Program mgr phoned farmers during each season to get metadata while fresh in mind. Done one yr, but too time-consuming!


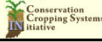
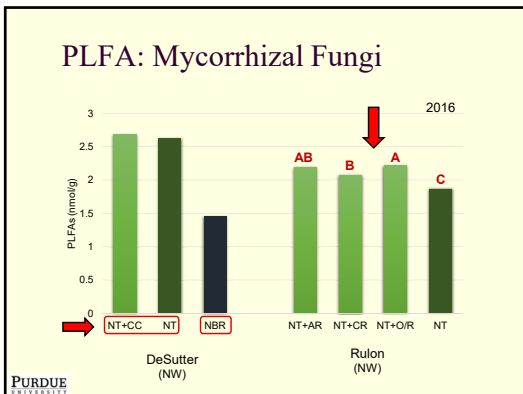
Lessons learned, recommendations

- Develop and follow rigid criteria for farmer selection, incl exemplary record-keeping skills
- Solicit potential farmer names from conservation field staff, commodity groups, plus core team.
- Consider pairing experienced conservation farmer w/ farmer just starting conservation systems. Mentoring; also better comparison if similar soils; expands new audience at events






Lessons learned, recommendations

- Start w/ more conventional fields! Or degraded fields! Then monitor progression w/ time after adoption of cover crops, NT, other CCS.
 - Maintain control plots, for comparison
 - Generally improvements measurable faster when starting w/ conv.
 - Even long-term CCS farmers pick up new fields and need to build them up.



Lessons learned, recommendations

- Monitor soil health over longer time (>5yr)
- Be consistent in sampling, because it matters!
 - Time of year
 - Cash crop
 - Row position
 - Depth
 - Soil health lab and specific tests

Lessons learned, recommendations

- Consider having narrower range of treatment options, to better compare across sites
- Acknowledge limitations of on-farm research, w/ farmers managing dynamically
- Consider restricting numbers and types of measurements, to a few key measures in a few well-defined areas of field (vs. Tier 1 list)

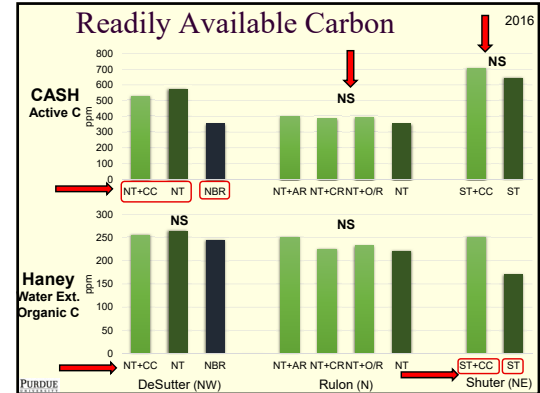
Lessons learned, recommendations

- **Data analysis and interpretation!**
- Many tests, sampling times, sites
- Commercial soil health tests were complicated, no easy interpretation, no experience w/ most of the tests, no thresholds (in their infancy)
- Lack of comparability across labs, even for same general test.
- Lack of consistent meaning of current interpretations given

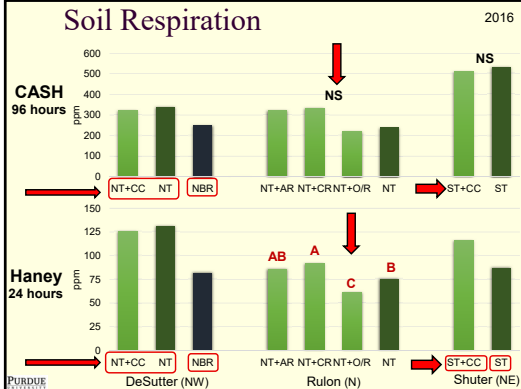


Cornell (CASH) & Haney Tests

- **Active C and Water Extractable Organic C**
 - Both measure fraction of soil organic matter that is easy for microbes to use.
 - Food for microbes
- **Soil Respiration**
 - Measures potential activity of microbes in soil.
 - How much CO₂ released in certain amount of time.



Soil Respiration



Lessons learned, recommendations

- **Full-time data analyst needed!**
 - Ph.D.-level scientist for analysis
 - Plus database mgr would be helpful
- Meta-data collection needs more work
- Timely analysis, interpretation, and reporting to cooperators, needs more attention and personnel




Lessons learned, recommendations

- Provide required annual training for volunteer samplers, to clarify procedures, emphasize important points. Not all have experience.
- Or, consider contracting the sampling to agronomist or Extension Educator w/ field sampling experience
- Tradeoff of sampling consistency vs. team-building and learning from watching season progress




Recommendations

- Choose your lab and test(s), then stick with it.
- Pick your spot(s).
- Be consistent.
- Track changes over time.
- Interpret with caution.
- Focus on large management changes.




Choose your lab and test(s), then stick with it.

PLFA Measurements	2015 Ward Laboratories (ng/g)	2017 Missouri Soil Health Assessment Center (nmol/g)
Total Microbial Biomass	1790	103.8
Total Bacteria	1083	58.7
Total Fungi	101	1.78
Mycorrhizal Fungi	23	4.35
Protozoa	8.4	0.71



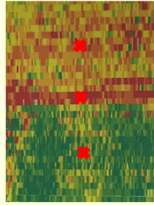

Recommendations

- Choose your lab and test(s), then stick with it.
- Pick your spot(s).
- Be consistent.
- Track changes over time.
- Interpret with caution.
- Focus on large management changes.




Pick your spot(s).

- Choose a few locations in your field.
- Mark those points—GPS
- Pull multiple soil samples from 20-30 ft diameter area and combine to send to lab.

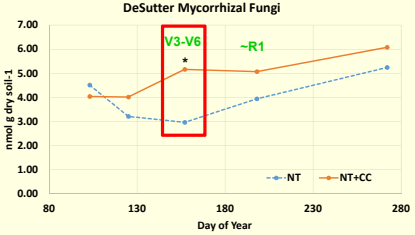



Recommendations

- Choose your lab and test(s), then stick with it.
- Pick your spot(s).
- Be consistent.
- Track changes over time.
- Interpret with caution.
- Focus on large management changes.



Be consistent—Timing




nmol/g dry soil-1

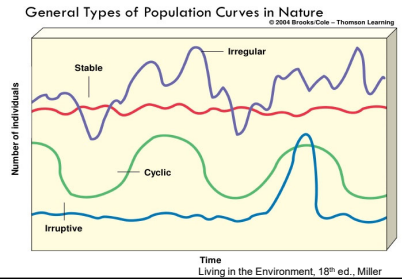
Day of Year

Legend: -●- NT, -●- NT+CC

Jennifer Woodyard M.S. Thesis

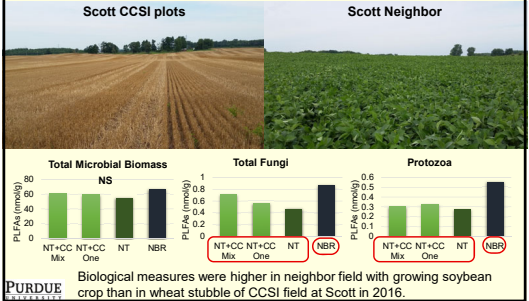


Challenges of Soil Health Tests



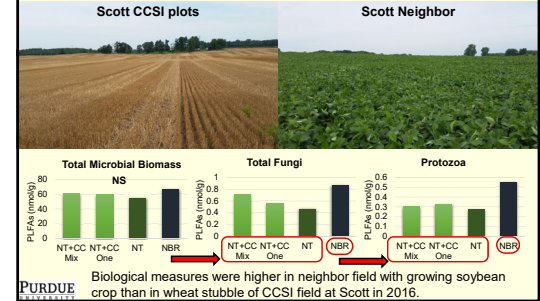
Be consistent—Cash Crop

2016 Soil Health Sampling



Be consistent—Cash Crop

2016 Soil Health Sampling

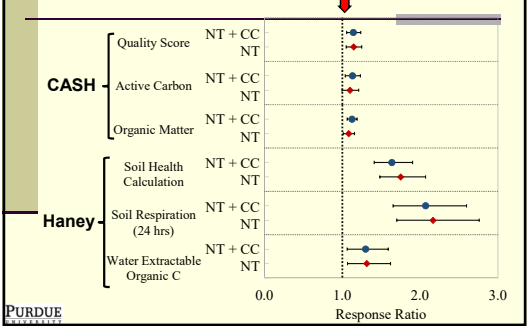


Recommendations

- Choose your lab and test(s), then stick with it.
- Pick your spot(s).
- Be consistent.
- Track changes over time.
- Interpret with caution.
- Focus on large management changes.

Track changes over time.

$$RR = \frac{2015}{2013} \text{ OR } \frac{2016}{2013}$$




Recommendations

- Choose your lab and test(s), then stick with it.
- Be consistent.
- Pick your spot(s).
- Track changes over time.
- Interpret with caution.
- Focus on large management changes.

Recommendations

- Choose your lab and test(s), then stick with it.
- Pick your spot(s).
- Be consistent.
- Track changes over time.
- Interpret with caution.
- Focus on large management changes.



Focus on large management changes.

CASH Quality Score

NT+CC NT NBR


More likely to detect differences

VUJC Strip

Haney Soil Health Calculation


NT+CC NT NBR

DeSutter (NW)



Recommendations

- Choose your lab and test(s), then stick with it.
- Pick your spot(s).
- Be consistent
- Track changes over time.
- Interpret with caution
- Focus on large management changes.



For more details, check out our Extension Publication!



Publication number: AY-366-W

Available at: www.edustore.purdue.edu



Individual Site Reports are available on CCSi website: www.ccsin.org




Lessons Learned article (open access)

- On CCSi website
- From J. Soil Water Cons. (2019) 74:12A




Speaker Contact: kladivko@purdue.edu



Creating riches below the surface.

On-Site Research tab-Contains:

- Reports
- Field protocols
- Extension pub.
- Lessons Learned article



ON-SITE

WHAT SAMPLE WHEN	Early Spring		Late Spring		Late Summer/Harvest		Late Fall	
	CCSI	Conv.	CCSI	Conv.	CCSI	Conv.	CCSI	Conv.
Basic Soil Fertility 0-6		X						
Ammonium Nitrate 0-12 only		X						
Ammonium Nitrate 0-12 only							X	
Cover Crop Biomass							X	
Plant Population								
Soil Moisture								
PELA								
Cornell								
SNRPT								
MycoRhizal Assessment								
Late Season Stake Nitrate								
Yield								

SAMPLE RUN #1: Early Spring

Timing
Just before cover crop termination.
It is important to sample before cover crops have been terminated.

Parameters

- Basic Soil Fertility – 0-6" **Conventional Sites ONLY**
- Soil Nitrate and Ammonium – 0-12" and 12-24" **CCSI sites only**
- Cover Crop Biomass

Fields NOT in corn for 2016

- Winter Wheat, Oats – No Spring Sampling
- Soybeans – All samples will be pulled

Supplies

CCSI Provided

- Sample Bags
 - Standard Soil Sample Bags
 - Paper "Grocery" Bags
- Hula Hoops (supplied 2013 / Year 1)
- Grass Shears (supplied 2013 / Year 1)
- Pre-populated Lab Forms
- Mailing Labels

Provided Locally

- Soil Probe
- CLEAN Sampling Buckets (2-3)
 - 1- Soil Fertility
 - 2- Soil Nitrate and Ammonium

ON-SITE RESEARCH PARTICIPATING SITES

CCSI Interview File
From 2012-2016
Research file with
These returns are
These documents
They may not be
Dunkle, Estabrook
Sensinger, Doherty
Dunkle, Agosti
Gunnarson, Elgert
Merrill, Adams
Mika, Brooks-Smith, Vogel, County
Dan, DeGutter, Fourteen County
Lara, Luffmeyer, Rippey County
Carrington, Mika, Clark County
Rodney, Rubin, Hamilton County
Jenna, Scott, Hancock County
Mika, Shuler, Madison County
Just, Stahl, Warrick County
BROCK, Patten, Warrick County
Don, Wisnack, DeWitt County
VLAJIC, Dubois County
Rogel, Wansong, Decatur County
Mika, Wansong, Adams County

Journal of Soil and Water Conservation - State-
farm assessment, Lessons learned,
CCSI 2012 CCA Final Report (public)

PURDUE
UNIVERSITY

**Conservation
Cropping Systems
Initiative**

Speaker Contact: kladivko@purdue.edu

ccsin.org

Conservation Cropping Systems Initiative

HOME | [About Us](#) | ABOUT | **DO** | DONATE | CONTACT

On-Site Research tab-
Contains:

- Reports
- Field protocols
- Extension pub.
- Lessons Learned article

Creating riches below the surface.

PURDUE
UNIVERSITY