Cover Crops to Improve Soil Health and Reduce Soil Erosion

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Thanks to many colleagues over past 10 yrs!

- Midwest Cover Crops Council
  www.mccc.msu.edu

- Indiana Conservation Cropping Systems Initiative (CCSI)
  www.ccsin.org

- Corn Systems and Climate CAP
  www.sustainablecorn.org

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Rationale for cover crops

- A living, growing plant at times of year when we normally have nothing growing.
- Capture sunlight, feed soil organisms, sequester carbon, trap and recycle nutrients
- Make better use of the resources and time available!

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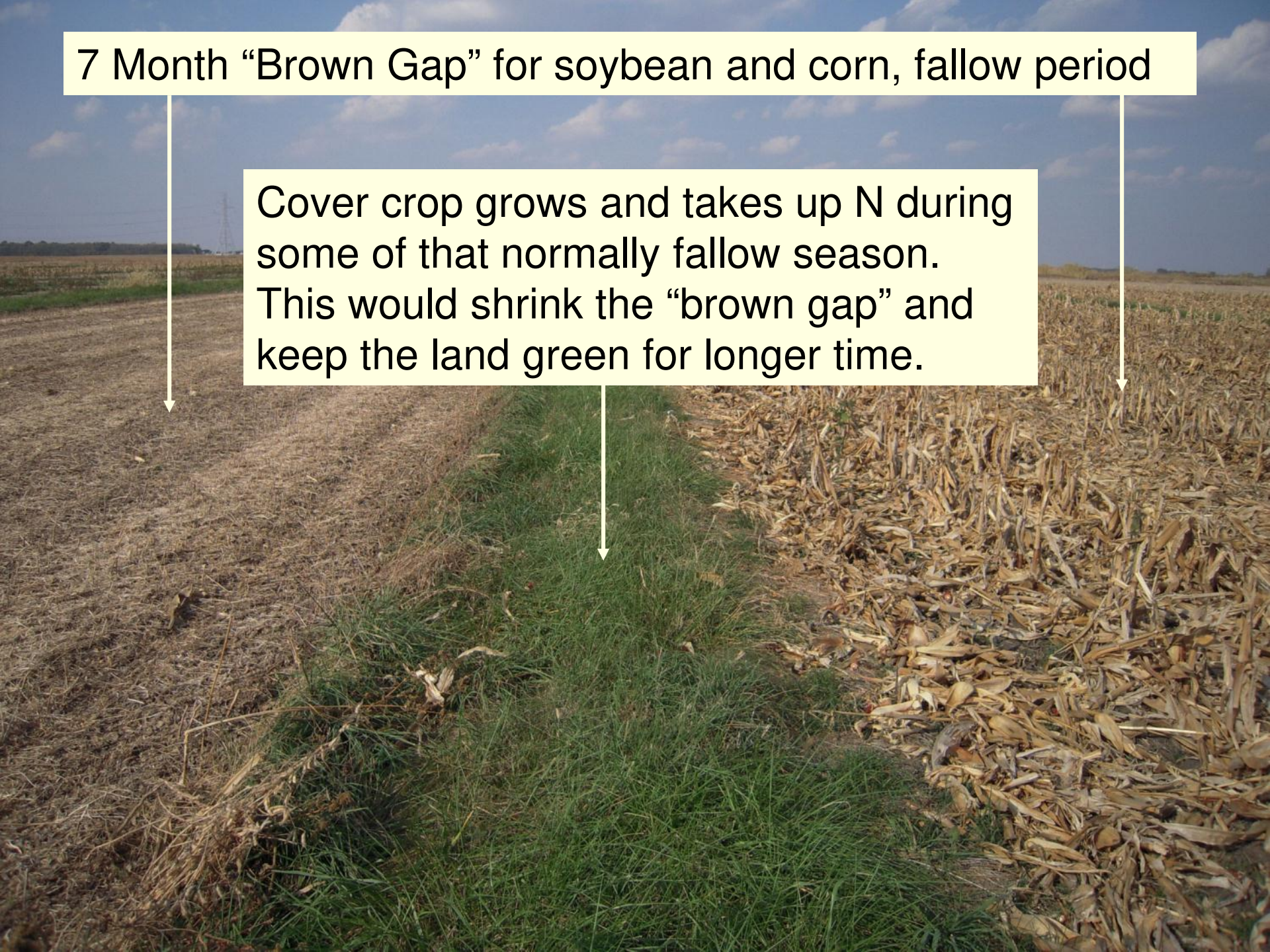
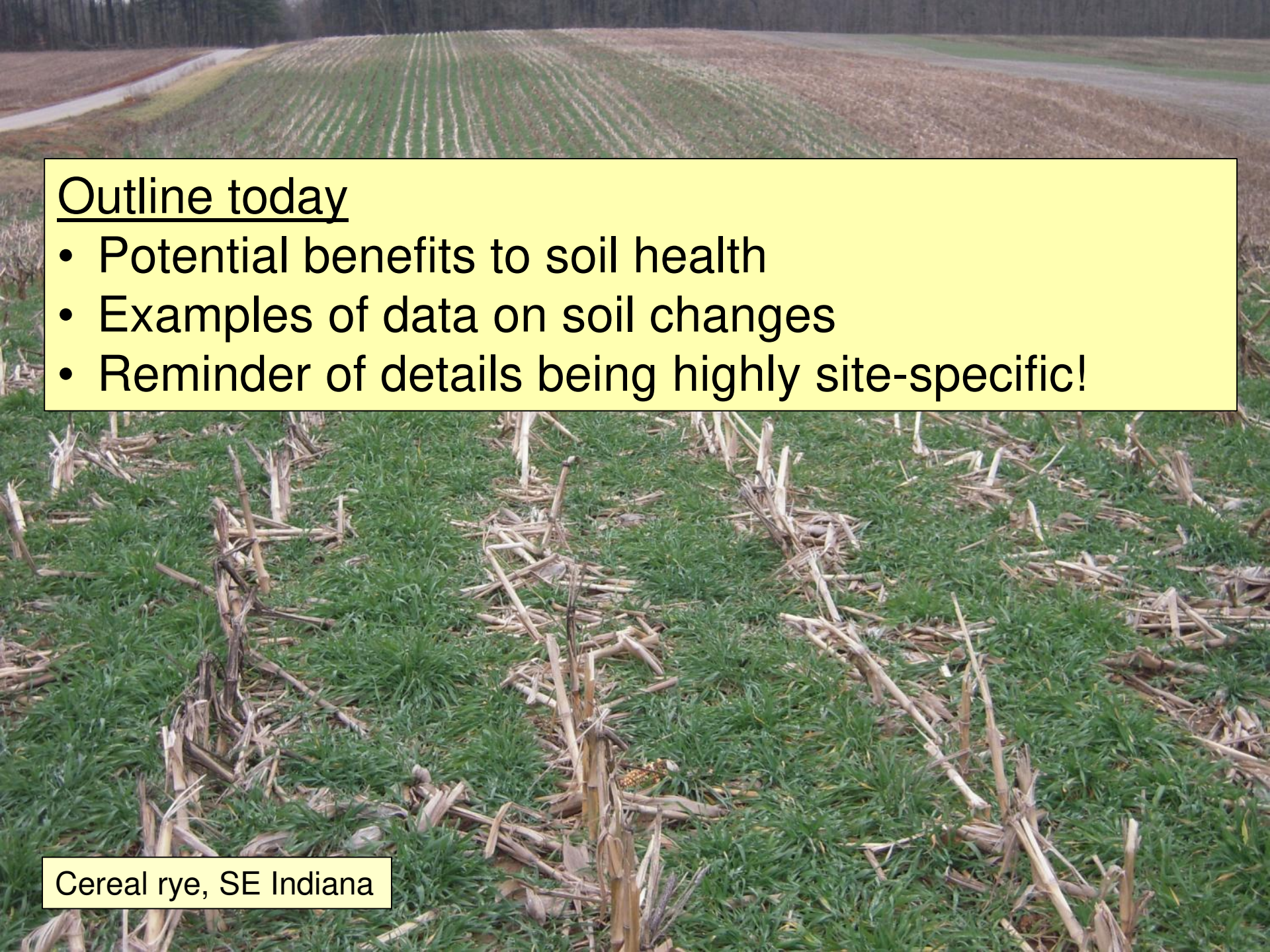

7 Month “Brown Gap” for soybean and corn, fallow period
Cover crop grows and takes up N during some of that normally fallow season. This would shrink the “brown gap” and keep the land green for longer time.

Cover crops are part of a system!

- Different potential benefits and challenges for each type of cover crop
- Must adapt cropping system, including nutrient mgmt, NT (tillage) system, manure, pest mgmt, crop rotation
- Learning curve—need to do homework!



Outline today

- Potential benefits to soil health
- Examples of data on soil changes
- Reminder of details being highly site-specific!

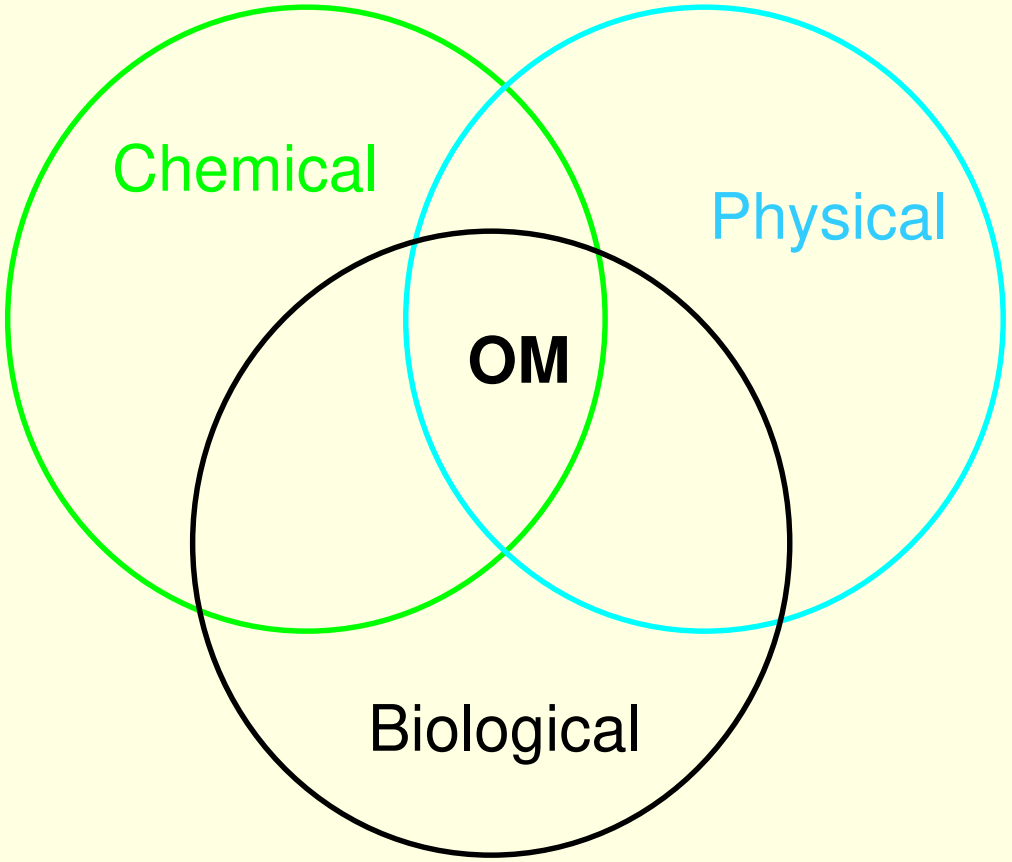
Cereal rye, SE Indiana

What are the potential benefits? (What are your main goals?)

- Nitrogen scavenger
- Nitrogen producer (legume)
- **Reduce erosion**
- **Improve soil quality– aggregation, infiltration, soil biological activity, rooting**
- **Increase soil organic matter (sequester C)**
- **Conserve soil moisture**
- Recycle nutrients
- Weed control, pest suppression, extra forage
- Increase crop yields over long-term, and decrease year-to-year variability in yields

Soil Health Indicators

- Physical
- Chemical
- Biological
- Organic Matter



Reviews used heavily for this talk

- Kaspar, T.C., and J.W. Singer. 2011. The use of cover crops to manage soil. In J.L. Hatfield and T.J. Sauer (eds.), Soil management: Building a stable base for agriculture. ASA/SSSA, Madison, WI.

- Blanco-Canqui et al. 2015. Cover crops and ecosystem services: Insights from studies in temperate soils. Agron. J. 107:2449-2474.

Classic purpose of cover crops—to cover the soil to reduce erosion

- Studies have measured reductions in soil erosion and water runoff
  - Protection of soil surface by living plants and dead residues, even in NT
  - Anchor surface residues, reducing their mvmt.
  - Less detachment by raindrops, flowing water
  - Increased infiltration
  - Greater surface storage
  - Slowed water velocity of runoff
- Also reductions in wind erosion

After Simulated Rainfall

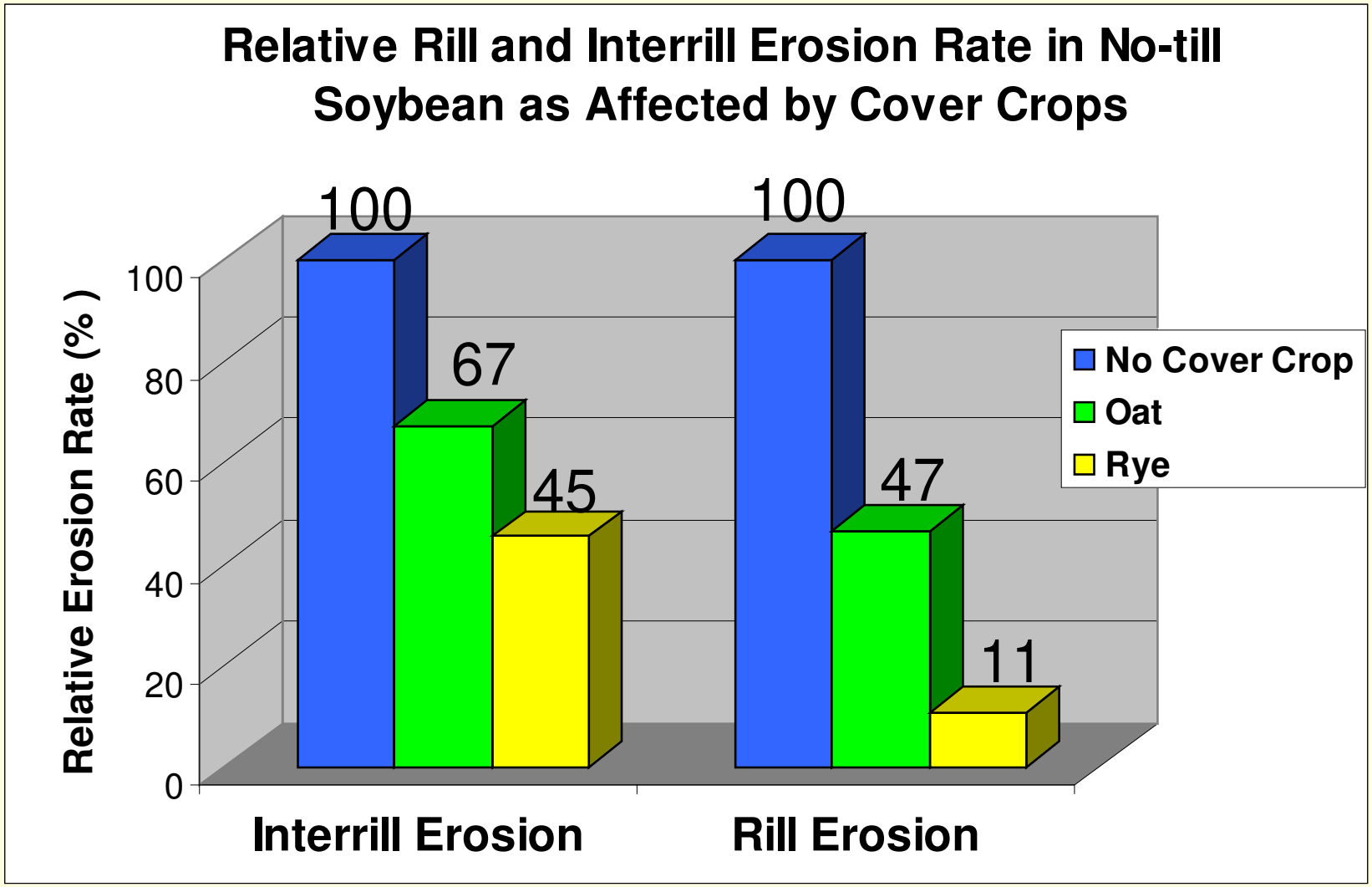
NO COVER CROP

OAT COVER

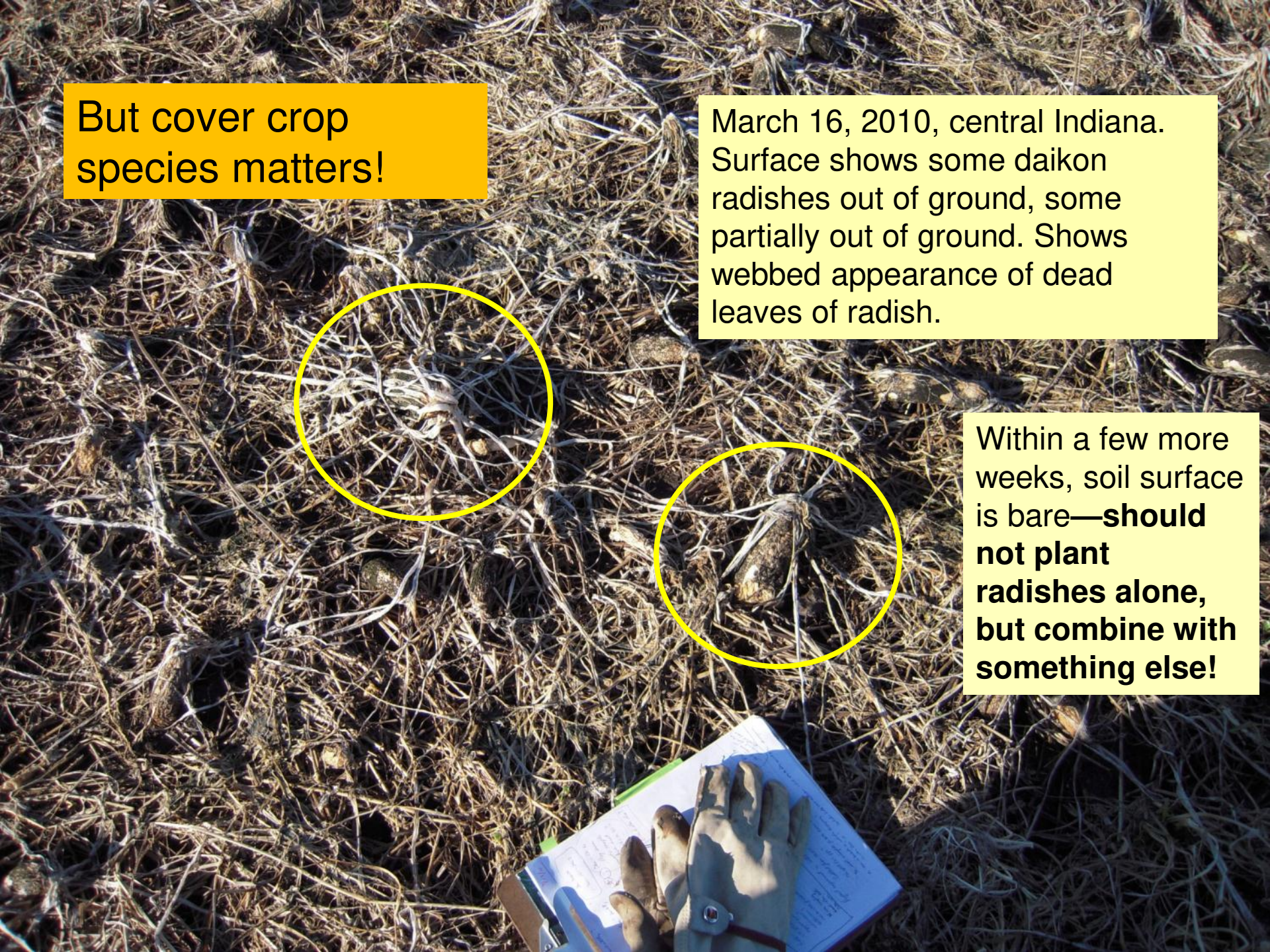
RYE COVER

Tom Kaspar, Iowa

Relative Erosion



Kaspar et al., 2001, J. Soil Water Conserv.

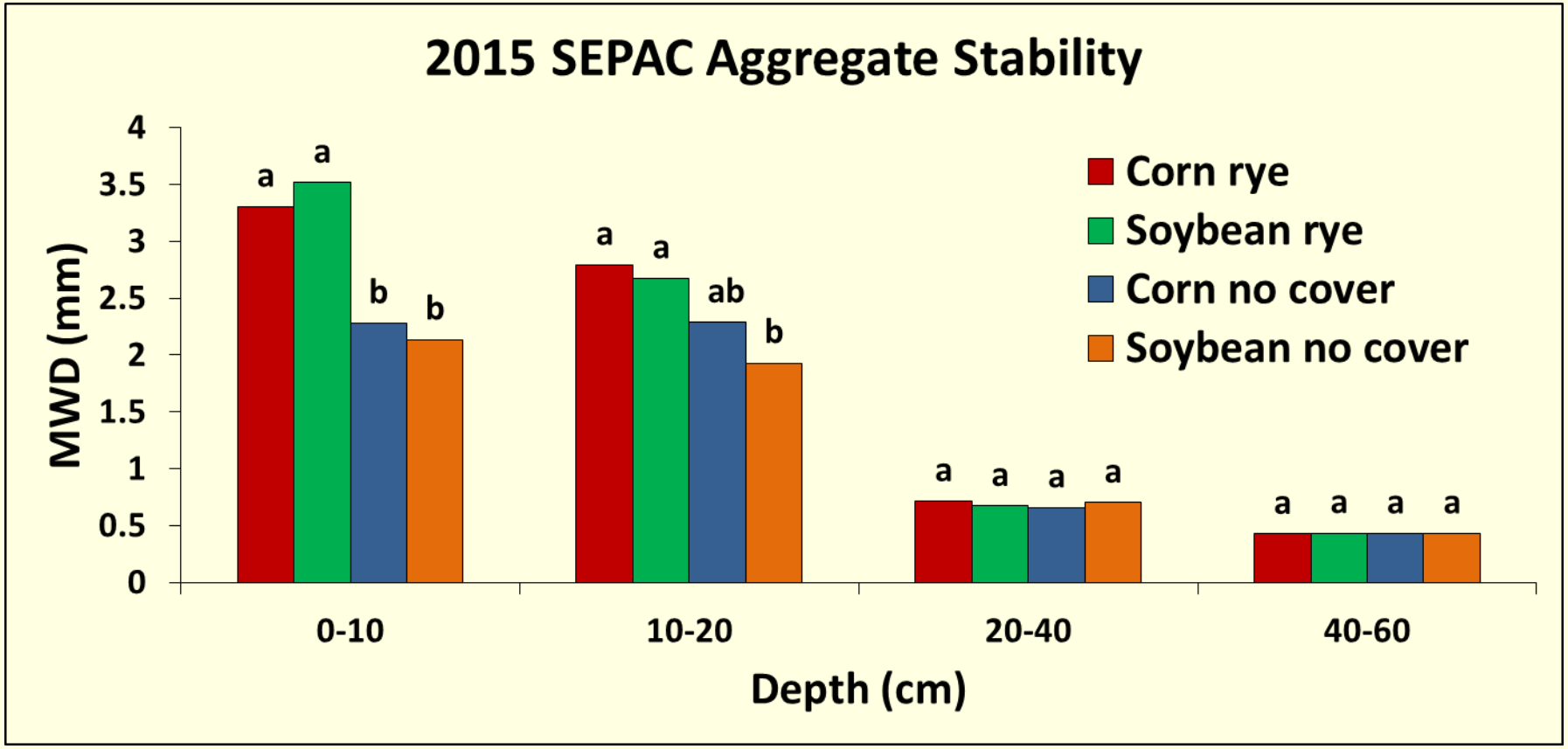

But cover crop species matters!
March 16, 2010, central Indiana. Surface shows some daikon radishes out of ground, some partially out of ground. Shows webbed appearance of dead leaves of radish.
Within a few more weeks, soil surface is bare—**should not plant radishes alone, but combine with something else!**

Corn silage land with and without a cereal rye cover crop

Tom Kaspar, Iowa

Soil physical properties improved

- Aggregation (esp. fibrous-rooted)–
  - cover crop roots enmesh particles;
  - exudates feed microbes which then produce polysaccharides that “glue” particles together
- Porosity, permeability (esp. tap-rooted)
  - Deep roots, macropores, can aid water infiltration, aeration, rooting
- Soil surface protected, plus better aggregation, can mean less crusting or erosion
- Roots give strength to soil for trafficability



Rorick, Frank, Kladivko

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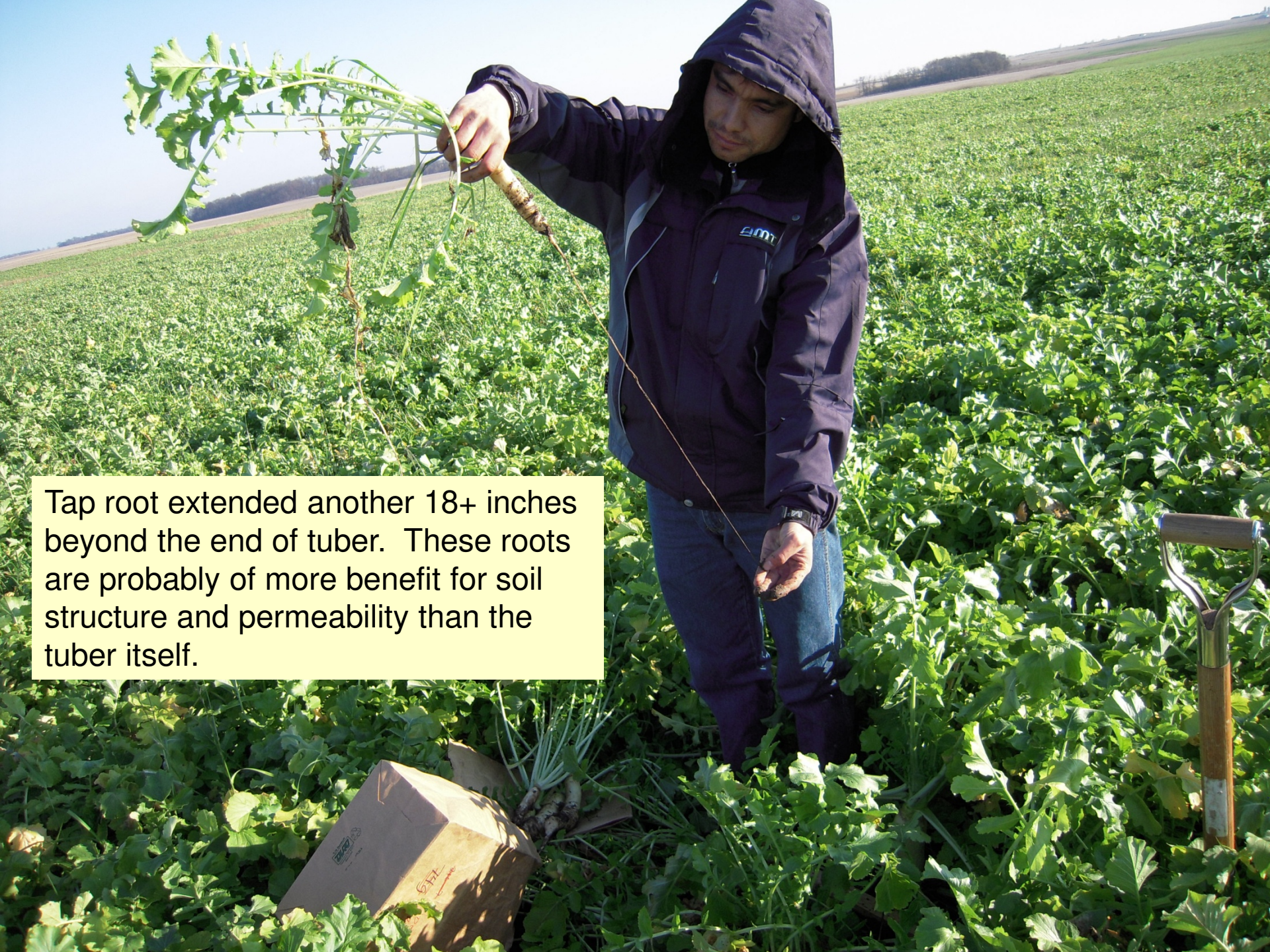
Cover Crops and No-Till Soil Structure

T. Kaspar, Iowa

Roots or shoots?

- When building soil quality, esp. with NT, the cover crop ROOTS are probably more significant than the shoot growth
- Still need good shoot growth for erosion control, mulch effects for moisture conservation, weed suppression, etc.


Tap root extended another 18+ inches beyond the end of tuber. These roots are probably of more benefit for soil structure and permeability than the tuber itself.

Cover crops and soil organic matter

- Potential to increase soil organic matter (SOM) or soil organic carbon (SOC)
  - Greater inputs of biomass
  - Less erosion losses
  - Perhaps slower decomp., if wetter/cooler
- Studies show slow increases (compared to no cover crop), or sometimes no change
- Many factors affect the rate of change, and the ability to detect the changes—site specific

Factors affecting magnitude of SOC changes with cover crops (or any changes)

- Cover crop biomass production (more)
- Cover crop species, mixes, roots/shoots
- Years of cover crop use (more)
- Soil texture, initial SOC (clay)
- Tillage mgmt. (no-till)
- Climate (production, decomp., weather)
- Ability to detect– number of samples, strict control of depth, variations w/ row position and short-term crop history, lab methods

Amount of growth affects the magnitude of cover crop impacts on soil or cash crop!

~710 lb/A

~2500 lb/A

Cereal Rye Cover Crop Effect on Soil Quality in a Corn Silage-Soybean System after 10 years

- **A rye cover crop "increased" total soil organic matter (SOM) in the top 4 inches (10 cm) from 4.8% to 5.3%, or ½% change in SOM**
  - (spring biomass production ~2.8 Mg/ha after silage, 0.5 Mg/ha after soybean)
- **44% greater particulate organic matter (POM) in top 2 inches (5 cm)**
- **38% greater potentially mineralizable N (PMN) in top 2 inches (5 cm)**

These are really hard measurements to make – 400 cores in 3.7 acres

Iowa data

Moore et al. 2014

More examples of SOC changes

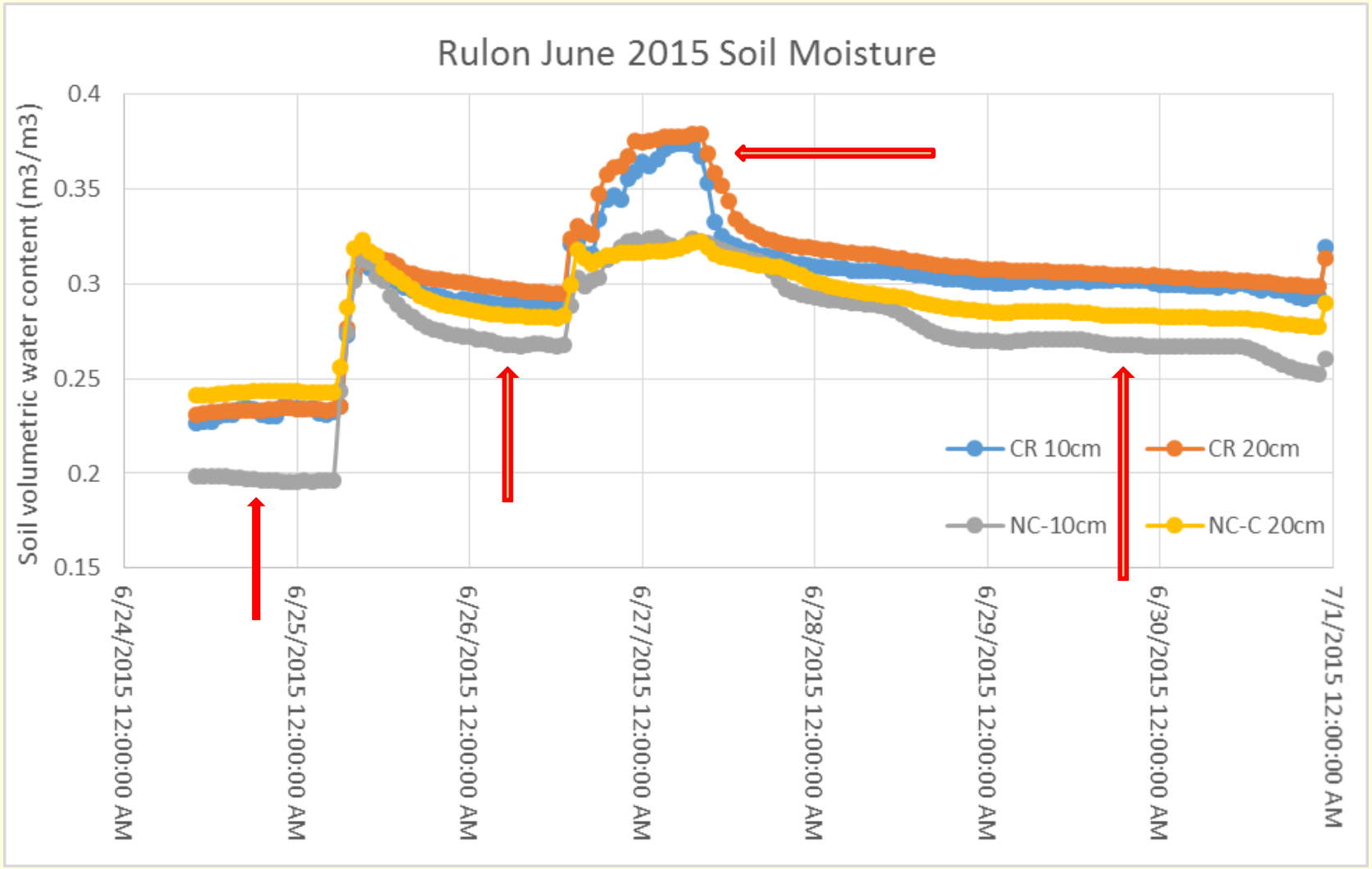
- Using data from 37 studies worldwide, meta-analysis (Poeplau and Don, 2015) estimated gain of ~0.3 Mg/ha/yr to 22cm depth (approx. 0.01% yearly gain in SOC)
- Blanco-Canqui (semi-arid), 0.1-1.0 Mg/ha/yr gain of SOC, cover+NT vs NT alone
- Olson (IL), hairy vetch+cereal rye, sequestered: 0.9, 0.5, 0.1 Mg/ha/yr under NT, chisel, moldboard, respectively (12 yr)

Review by Blanco-Canqui et al., 2015, Agron. J. 107:2449-2474

Soil moisture

- Effects on soil moisture are complex
- While living, cover crops transpire water, so may dry soil more than fallow field—good or neutral or bad, depending……
- After termination, cover crop residues often increase infiltration, decrease evaporation, leaving more moisture in soil for crop use. Can be benefit in summer.

Example soil moisture effects that sometimes occur.
CCSI project; cereal rye terminated April 17; then corn grown.



~1000 kg/ha cereal rye at termination

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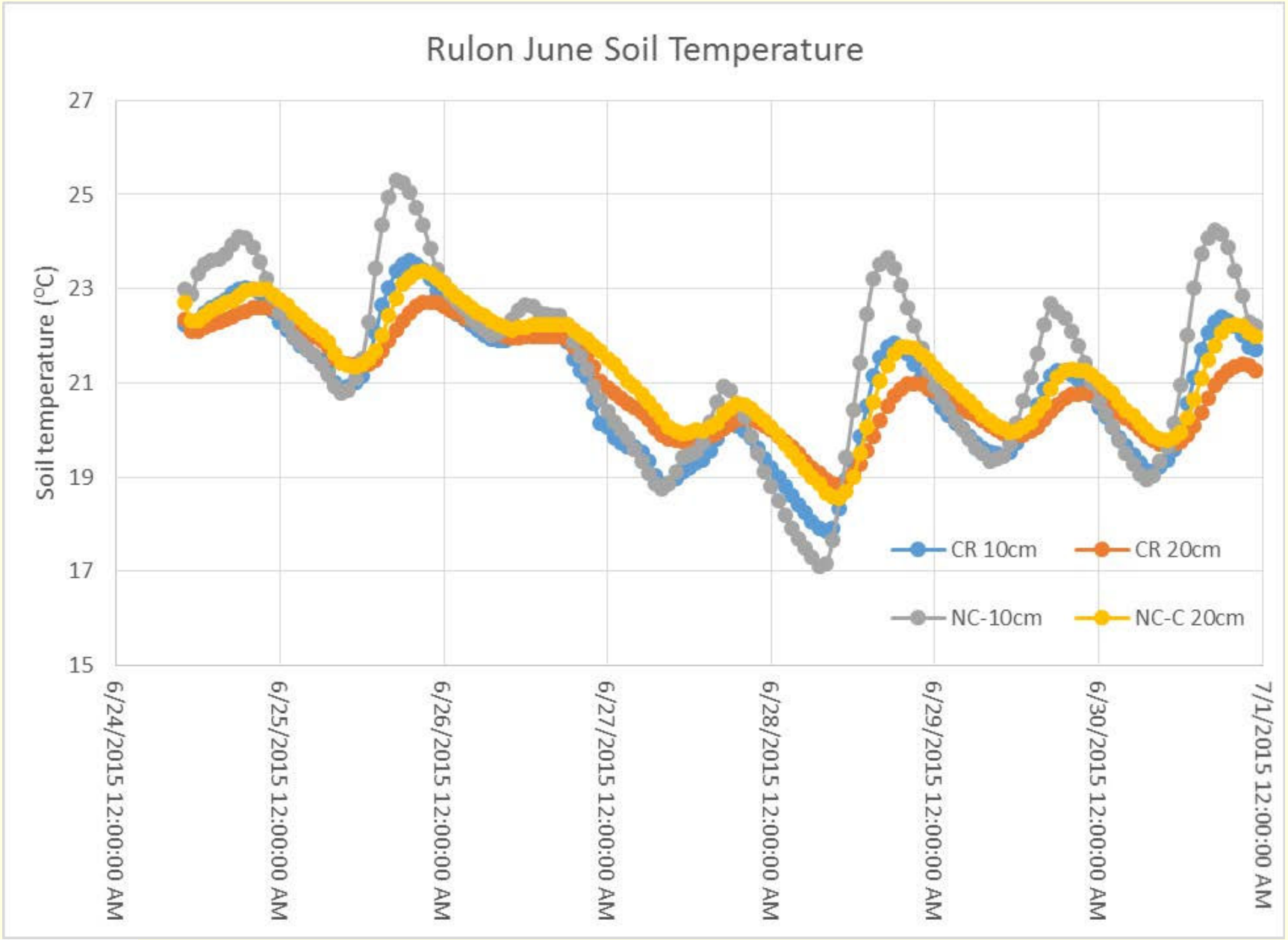

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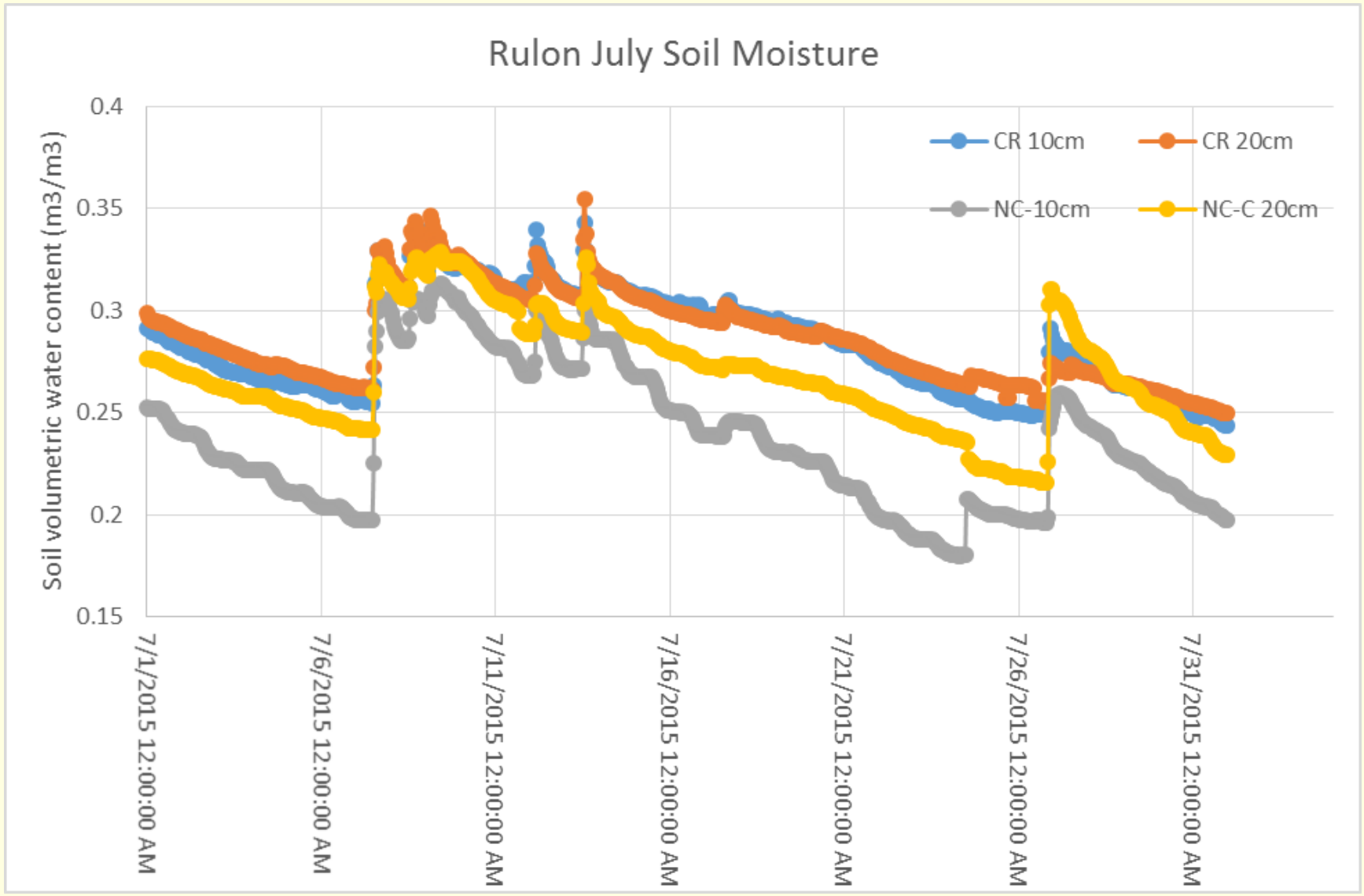

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Rye Cover Crop Effect on Plant Available Water after 12 years (Iowa)

- A rye cover crop increased soil water storage capacity (plant available water) in the top 30 cm by 18%, which is equivalent to an extra 0.75 cm of water every time the upper 30cm of soil was rewetted by rainfall.
- The rye cover crop does use water in the spring, but in 5 out of 7 years this was replenished by the time of main crop planting.
- In most years after cover crop termination water contents in the upper 30 cm were higher following a rye cover crop in the summer.

Basche et al., 2015

Effects on cash crop rooting?

- Chen and Weil (2010, 2011) studied forage radish, rapeseed, cereal rye, vs no cover, under different levels of compaction
- More corn roots grew deeper after radish and rapeseed > rye > no cover, in compacted plots
- They suggested mix of radish or rapeseed for deep root growth, and cereal rye for surface mulch, as way to access deep water plus conserve surface moisture

Soil biology

- Plant growth during normally “fallow” period (Sept-Nov, March-April) provides more food for soil organisms
- Diversity of plant materials may also increase diversity of soil biological community
- Soil organic matter maintained or increased

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Crusting inhibits seedling emergence, especially on low organic matter soils

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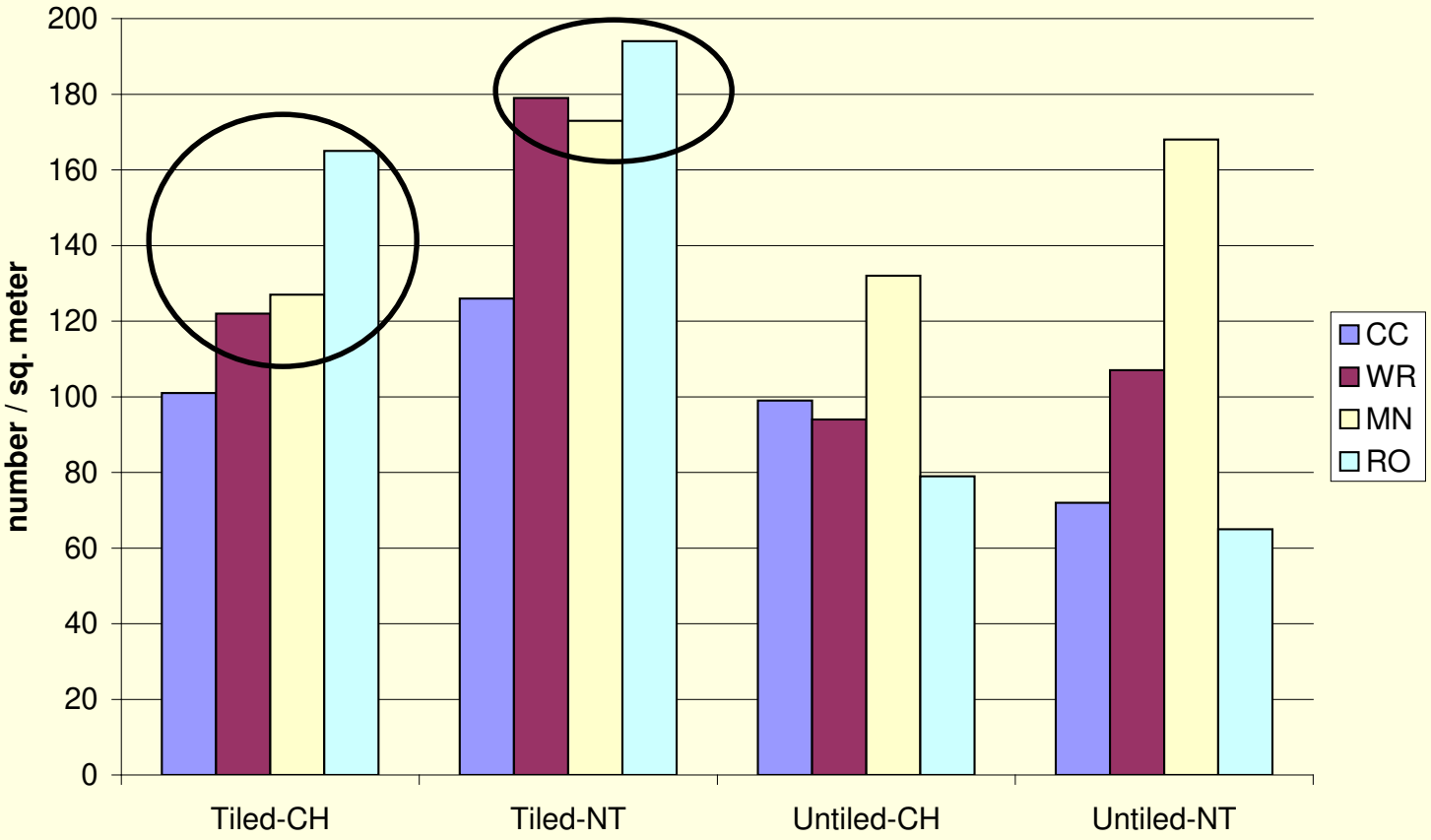
Southeastern IN (SEPAC)

- Evaluated practices to improve soil structure and crop productivity on poorly-drained, low organic matter, poorly structured silt loam
- Earthworm populations were generally higher in:
  - No-till vs. chisel
  - Tiled vs. untiled
  - Covers, rotation, manure vs. control
- Soil physical properties tended to be improved by cover crops and rotation

Earthworm populations, spring 1994



CC=Cont.corn, no cover
WR=Wheat or cereal rye cover
MN=Manure (mostly poultry)
RO=Rotation with hay crop

Shallow-dwelling earthworm counts, after 10 years of treatments. Clermont silt loam, SEPAC

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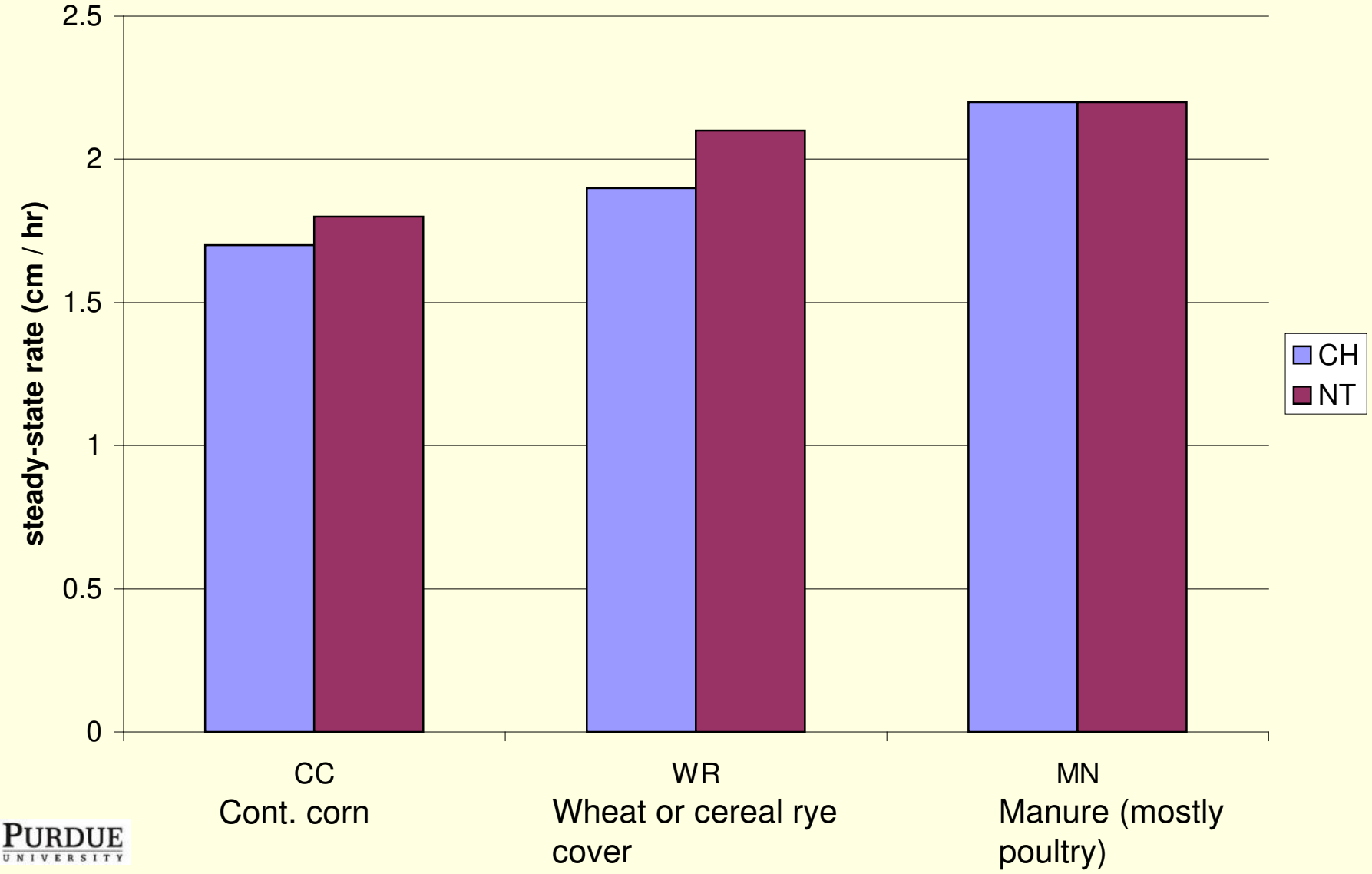
Infiltration rate, tiled subfield, 1991



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Other soil biology?

- Evidence for greater biomass and/or activity of bacteria, fungi, micro- and meso-fauna
- Arbuscular mycorrhizal fungi
- Soil enzyme activity
- Diversity of populations
- Methods for measurements, plus interpretations for practical use, are still evolving. Potential is great but the impacts aren't clear yet!

Potential impacts for Midwest/Ontario

- Soil health and crop productivity
- Conservation of soils resource base
- Water quality
- Resilience to stresses from climate variations
- Magnitude of effects is site-specific!

But much more work needed to take full advantage of the possibilities!

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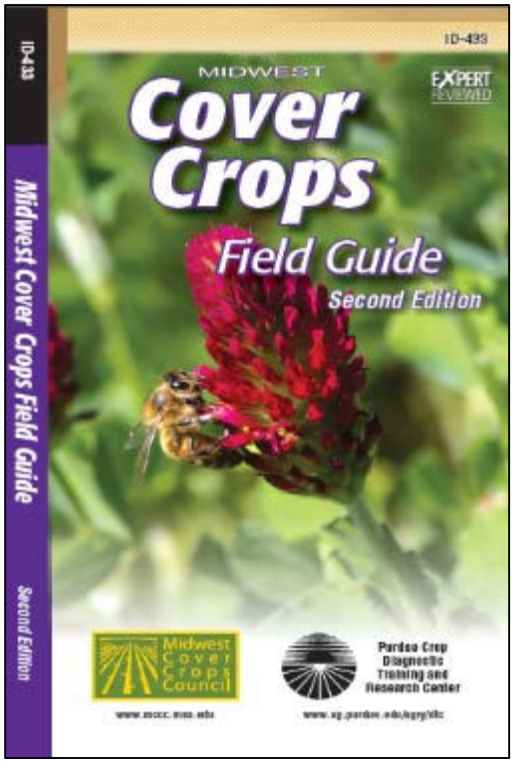
Resources



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