Soil Stewardship: 40+ years of change

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How do we take care of our soil, to ensure continued productivity for future generations?

- Soil stewardship
- Soil conservation
- Soil tilth
- Soil structure, aggregation
- Soil health, quality
- Soil resilience

Soil Stewardship

- New ideas, old ideas, revolutionary ideas
- Can a system work? Vs. how improve it?
- One "best" way to do something? Or tradeoffs, balancing act
- Working together? Or not?
- Short term, long term

- Dust Bowl, severe soil erosion, severe loss of productivity
- Establishment of Soil Conservation Svc (now Natural Resources Conservation Svc, NRCS)
- Focus on soil erosion

1960s, 70s—But who cares?

- "Miracles" of modern chemistry, genetics, and machinery
- Masked degradation occurring to soil
- Compaction, erosion
- Kept adding more inputs, but still "cheap"

How have ideas changed?

- No-till and other conservation tillage
- Earthworms
- Cover crops
- Drainage

My personal 40-yr history

- Hired as "Applied Soil Physicist"
- Research / Teaching (unofficially Extension, grew w/time)
- First female professor in Agronomy Dept.
- Teach Soil Physics (Agry 560)
- Research on anything related to soil physical processes
  - No-till, and soil physical properties
  - Drainage
  - Earthworms
  - *Then later chemical transport through soils, preferential flow, cover crops*

No-till

- Work (60s, 70s) in Kentucky and Indiana started with work on sloping fields, primarily for erosion control. Very effective, reduced erosion, conserved water, increased yields

Shirley H. Phillips (from U.K. Hall of Distinguished Alumni website)

- His initial no-till work, done in collaboration with farmer Harry Young Jr. and county extension agent Reeves Davie → network, collaboration
- Until Young planted a corn field without tillage, Phillips had advocated conventional tillage and thorough seedbed preparation
- The first crop was impressive enough,……and Phillips, a previously committed "plow-man," was an advocate for the practice. → saw promise, worked to improve it
- He started a revolution among his colleagues in the U.K. Department of Agronomy → build network, encourage others to research and improve the system

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No-till

- *Work (60s, 70s) in Kentucky and Indiana started with work on sloping fields, primarily for erosion control. Very effective, reduced erosion, conserved water, increased yields*
- Farmers on "flat ground" asked if it might work for them. Interested in fuel and time savings, therefore economics.
- Purdue work expanded in 70s to flat ground. Found effective, but more challenging on poorly-drained soils.

No-till

- Not just a "practice" of not tilling, but a "system" that includes biology, fertility, ...
- Be patient (may be cooler early, but benefits soil later)
- Adequate drainage!!
- Details– seedslot closure, sidewall, down pressure, press wheels, starter N, ……..
- Details important! "I learned from my Dad to pay close attention to small details." (John Young, No-Till Farmer article)

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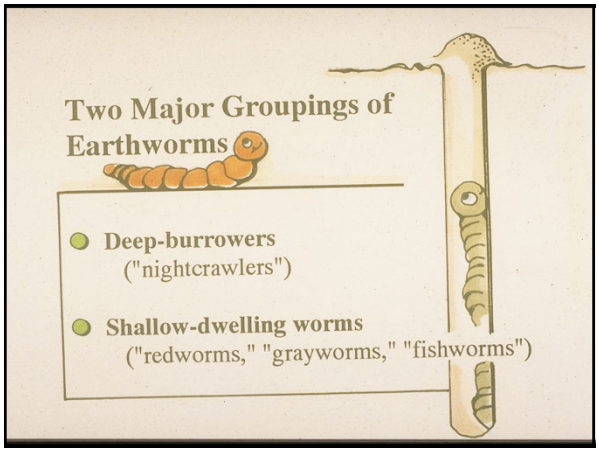
Do earthworms help NT work better?

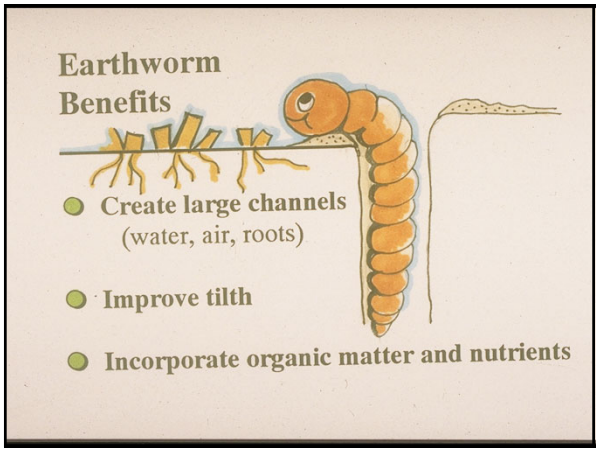
Earthworms:

How important are they in agriculture?



Earthworm species in Indiana

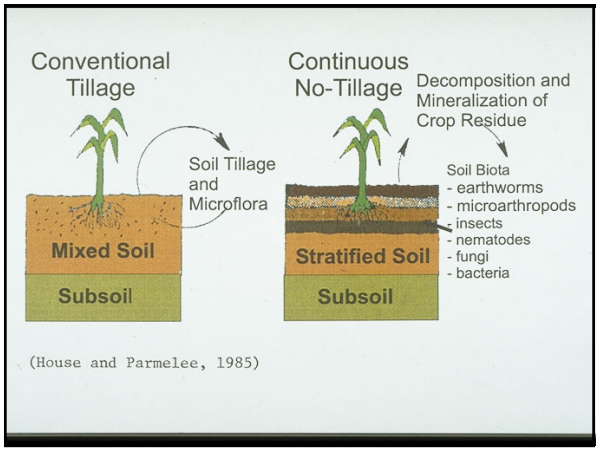
- *Lumbricus terrestris* ("nightcrawler"). "Anecic" earthworms (ie deep burrowers)
- "Endogeic" (shallow dwelling worms.) Genera of *Lumbricus, Aporrectodea, Octolasion*, others
- "Epigeic" (litter dwellers). Not generally present in cropped fields.
- Note that most earthworms in Indiana are not native, but came with European settlers, from similar soils, climate, and ag practices.
- Especially true in the glaciated portions of state, both ag fields and forests.



Water Infiltration

- Only 2 inches runoff total, during 9 yr. no-till corn, vs 16 inches runoff from conventional tillage, at Coshocton, Ohio watersheds. (Dr. Bill Edwards)

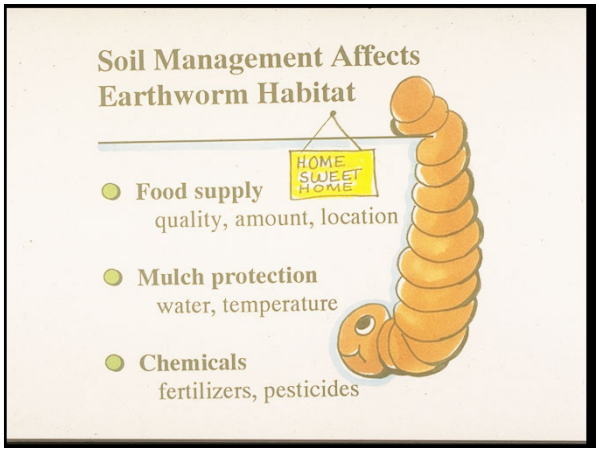
Note cast material lining the nightcrawler burrow walls. Casts are higher in nutrient availability than surrounding soil, because they are a mix of mineral soil and partially-decomposed organic materials.



New Zealand pasture soils

- Inoculated worm-free pastures with sod from field with high worm populations
  - Increased grass production
  - Increased water infiltration
  - Root mat broken down

1200/m^2	240/m^2	65/m^2
improved	edges	unimproved



Earthworm populations

(April, corn-bean rotation, SEPAC)

Tillage	Earthworms	per m^2	
	1987	1988	1989
Chisel	nd	44	67
Ridge-till	nd	189	178
No-till	156	133	211

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Reactions to my earthworm work at field days?

- A few were eager and intrigued
- Many were skeptical
- A few were laughing, shaking their heads, and wondering about what Purdue had done in hiring me

But a few years later, I was being asked to speak at no-till conferences all around the Midwest!

Earthworm results- April 1992

Earthworm "safari" across Indiana, Illinois

- Shallow-dwelling worms
  - No-till > conventional 8 sites
  - No-till = conventional 4 sites
  - No-till < conventional 2 sites
- Nightcrawlers present on:
  - 9 no-till sites
  - 3 conventional sites

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What about "seeding"?

- Several decade history of intensive tillage and monoculture corn
- Many farm fields had no nightcrawlers, although woods and pastures had them
- No-till increases earthworms, generally, but still fields without nightcrawlers
- Lack of source areas? Or soil properties a problem? Or…?
- Can they be "reintroduced"?

Objective

- To determine whether introduction of nightcrawlers into no-till fields would be successful on a variety of soil types in Indiana

Nightcrawler "seeding"

- No-till at least 3 years
- No "middens"
- Soybean residue, soybean/corn rotation
- April 1994 "seeding" (month when nightcrawlers most active)
- 2mx2m (6.6' x 6.6') squares received 80 adult nightcrawlers
- Soil was wet; residue present; protected worms from sun

Protecting nightcrawlers from sunlight

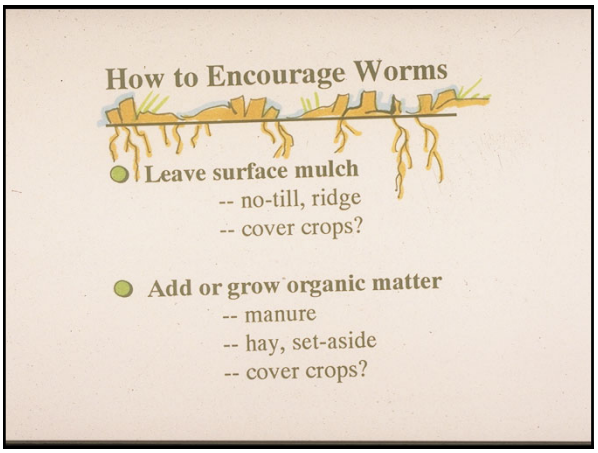
2m x 2m squares with 80 nightcrawlers

Results

- All sites had some survival, as evidenced by middens in spring 1995
- Spring 1996 showed large reductions
- Spring 1997, 1998, 1999 showed increased populations on some sites
- By spring 2000, the few remaining sites had leveled off, but continued to spread out
- Autumn counts less reliable

Implications

- Some success of seeding, but spread is slow
- Reasons for success/failure on diff. sites not clear
  - Soil type?
  - Residual chemicals?
  - Weak worms? Surface dry? Weather that day?
- Grass alleyways? Strips of cover crops? Rotation with hay?



"The plow is one of the most ancient and most valuable of man's inventions, but long before he existed, the land was in fact regularly plowed, and still continues to be thus plowed by earthworms."

- Charles Darwin, 1881

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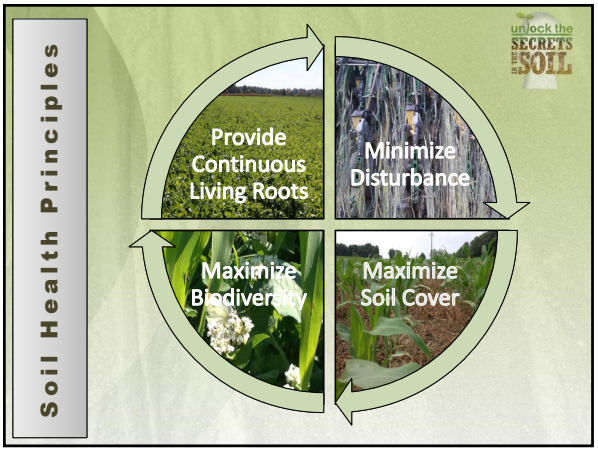

Cover crops

- Millenia
- Early exchange of farmer ideas and experiences w/ each other—Washington and Jefferson
- Fertility as main goal, but also soil structure, friability, erosion control.

Cover crops- early lessons

- Waksman and other soil microbiologists of 1910s and 20s
- Don't till under legumes in fall if won't plant cash crop until spring– will lose all the N that was gained.
- Timing of N release from various covers is also a modern concern, subject of studies.

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, improve soil quality
- Make better use of the resources and time available!

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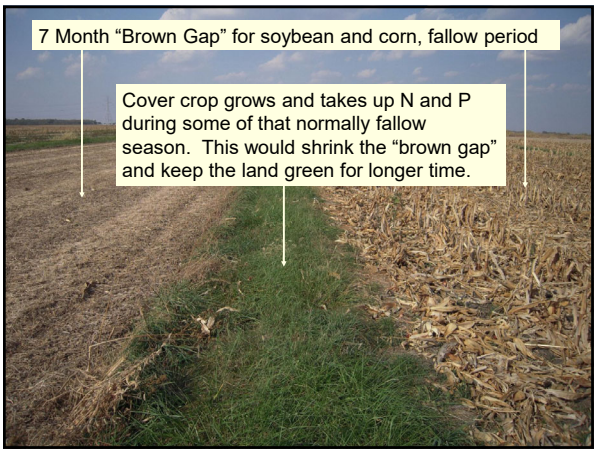

Cover crops are part of a system!

- 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!

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Three main categories of cover crops have different effects

- Grasses
- Brassicas
- Legumes



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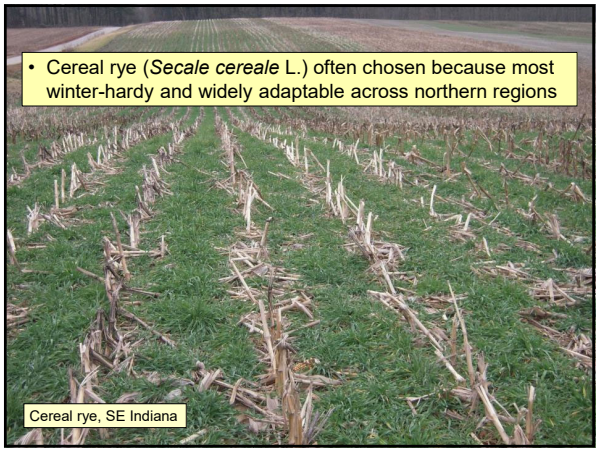

Cover Crop "Recipes"

Publication numbers:
AY-356-W (and MCCC-100)
AY-357-W (and MCCC-101)

Available at the Purdue Extension Store website: edustore.purdue.edu/

And
www.midwestcovercrops.org , go to "getting started" tab
Recipes now also available for all states in Midwest

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Cover crops to improve soil structure and organic matter

- Thought was to maximize top growth
- So then terminated cover crop late, lots of growth
- For tilled systems, took several tillage passes to get good seedbed
- For NT, gave challenges with planter working well in wet mat of partially-dying cover on surface
- Also issues with pests

Cover crops to improve soil structure and organic matter (2)

- *Thought was to maximize top growth*
- More recently, understanding is that ROOTS are most important for building soil structure, soil health, organic matter, biology.
- So don't need or want as much top growth, for many purposes
- Therefore can terminate earlier, shorter

Cover crops to improve soil structure and organic matter (3)

- *Thought was to maximize top growth*
- *More recently, ROOTS considered most important; so terminate earlier*
- Now, some interest in more top growth for other reasons– roller-crimping for weed control and heavy mulch; forage; "planting green";
- Many variations. Key is to know the main purpose(s) for that cover crop on that field.

Want more growth, but not too much!

- More growth reduces nitrate leaching more, and likely builds soil health faster
- But too much spring growth makes management more challenging, especially before corn
- Termination mgmt. is challenging, especially before corn. Learning curve that can impact farmers (and researchers!) greatly. Extension education, guidelines, workshops.
- Tradeoffs; consider purposes

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

~710 lb/A

~2500 lb/A

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May 16, 2016 SEPAC

Why are you planting a cover crop?

- What is the main purpose?
- What are the resource concerns?
- The main purpose(s), affect:
  - Selection of cover crop(s)
  - Management of cover crop(s)
- Details are very important!!!

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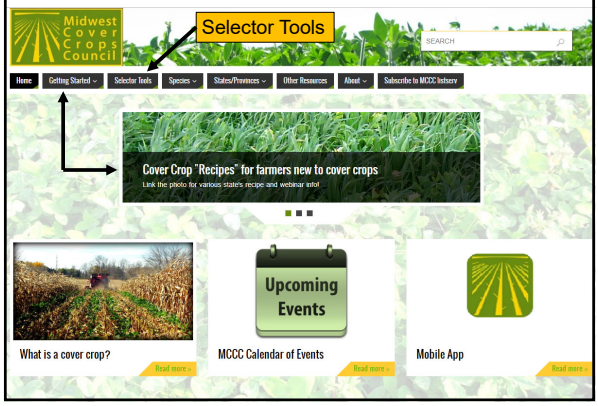
www.midwestcovercrops.org



Cover crops, NT vs. conventional?

- We used to suggest farmers do one transition at a time, ie, adopt no-till first, then after transition period, adopt cover crops
- Now we think that cover crops may help reduce or eliminate the "lag period" for no-till performance, by jump-starting the soil biology
- Cover crops are easier to implement in no-till systems, due to timing in fall, and termination or seedbed prep time in spring

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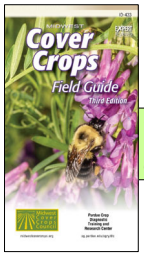
Systems approach

- Explicit consideration of the "system"
- Impacts on fertility (esp. N), weeds, insects (+, -), moisture, soil biology, SOM, aggregation
- Interactions with NT or tillage system, planter adjustments

Resources



www.midwestcovercrops.org

Cover Crop Selector Tools (link on top menu bars)

Check out the "recipes" under Getting Started tab! Including video/webinar of Indiana recipes explained in detail!

3rd Edition now available!

Purdue Extension Education Store
www.edustore.purdue.edu

Conservation Cropping Systems Initiative

www.ccsin.org

Also Google North Central SARE, for many resources on cover crops, sustainable ag

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