Agronomic and Environmental Assessment of Cover Crops in Illinois

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Outline

Why to include cover crops?

What we hear and what we know

Objectives

Materials & Methods

Activities to date at RCs and farm sites

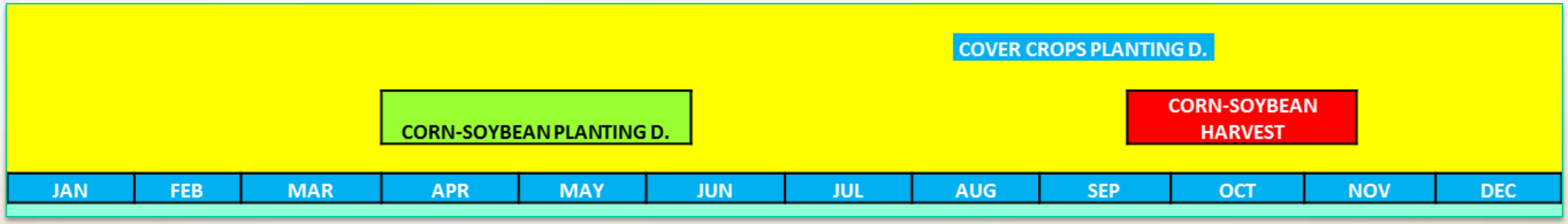
Challenges

Preliminary results

Next steps

Cover crops?

A crop planted between periods of regular cash crop



Why include CC?

- Soil erosion control
- Nutrient cycling
  - ✓ Water quality
  - ✓ Air quality
- Improvement of soil properties

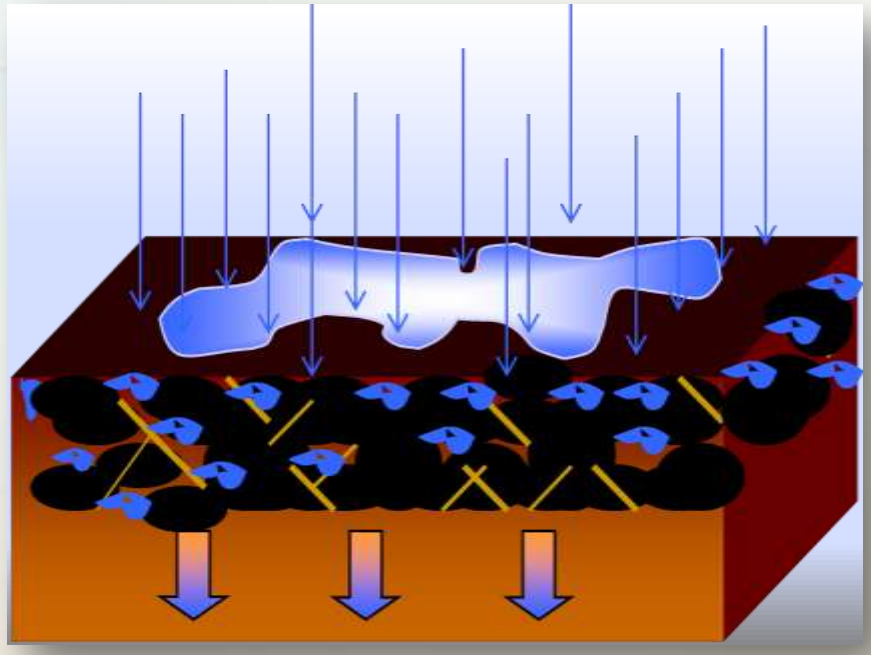
Ecosystem Services

Why include CC?

Organic Matter

Dry season

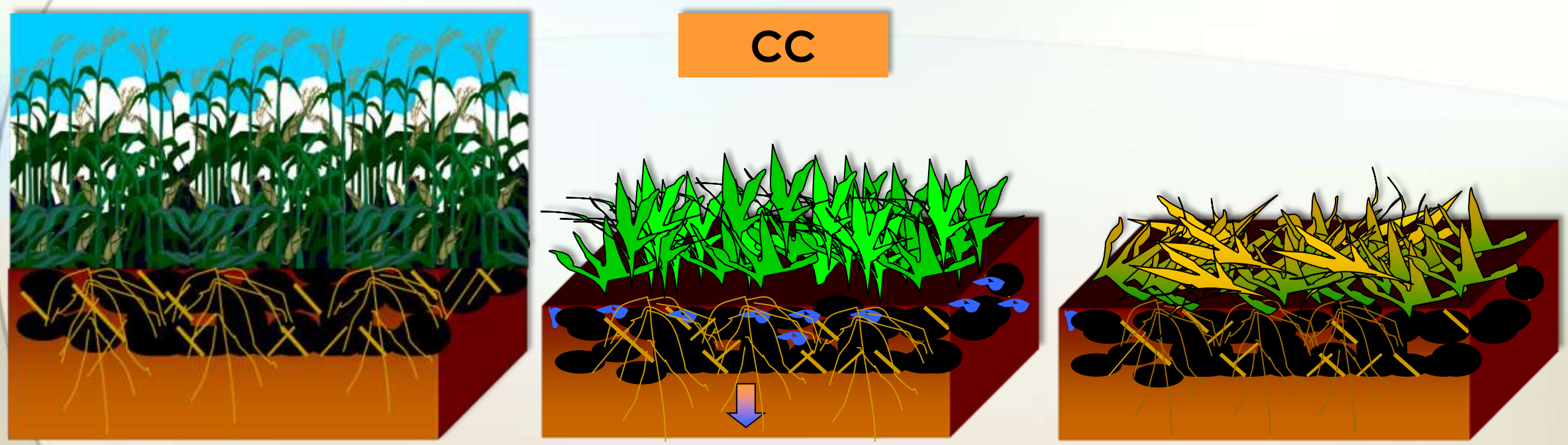
Nitrate-N build up



Wet season

Nitrate-N flushed

Why include CC?



Dry season
Nitrate-N build up

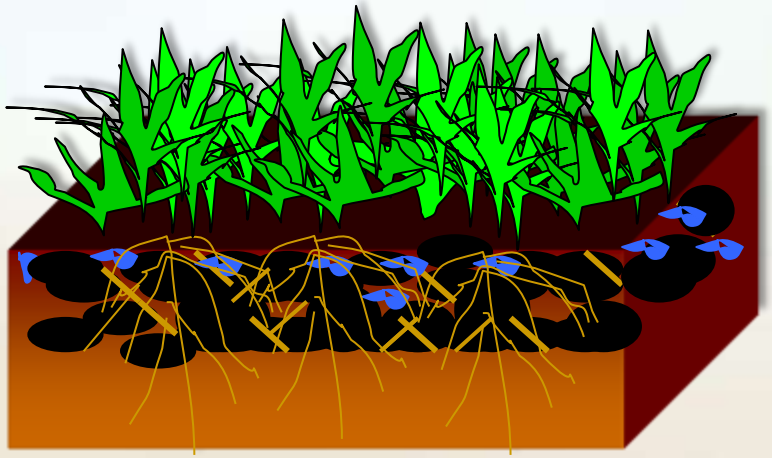
Wet season
Nitrate-N uptake by cover crop

Planting
Residue decomposition provides N to following crop

Why include CC?

- Improvement of Soil Properties
  - KEY to SUSTAINABILITY

CC

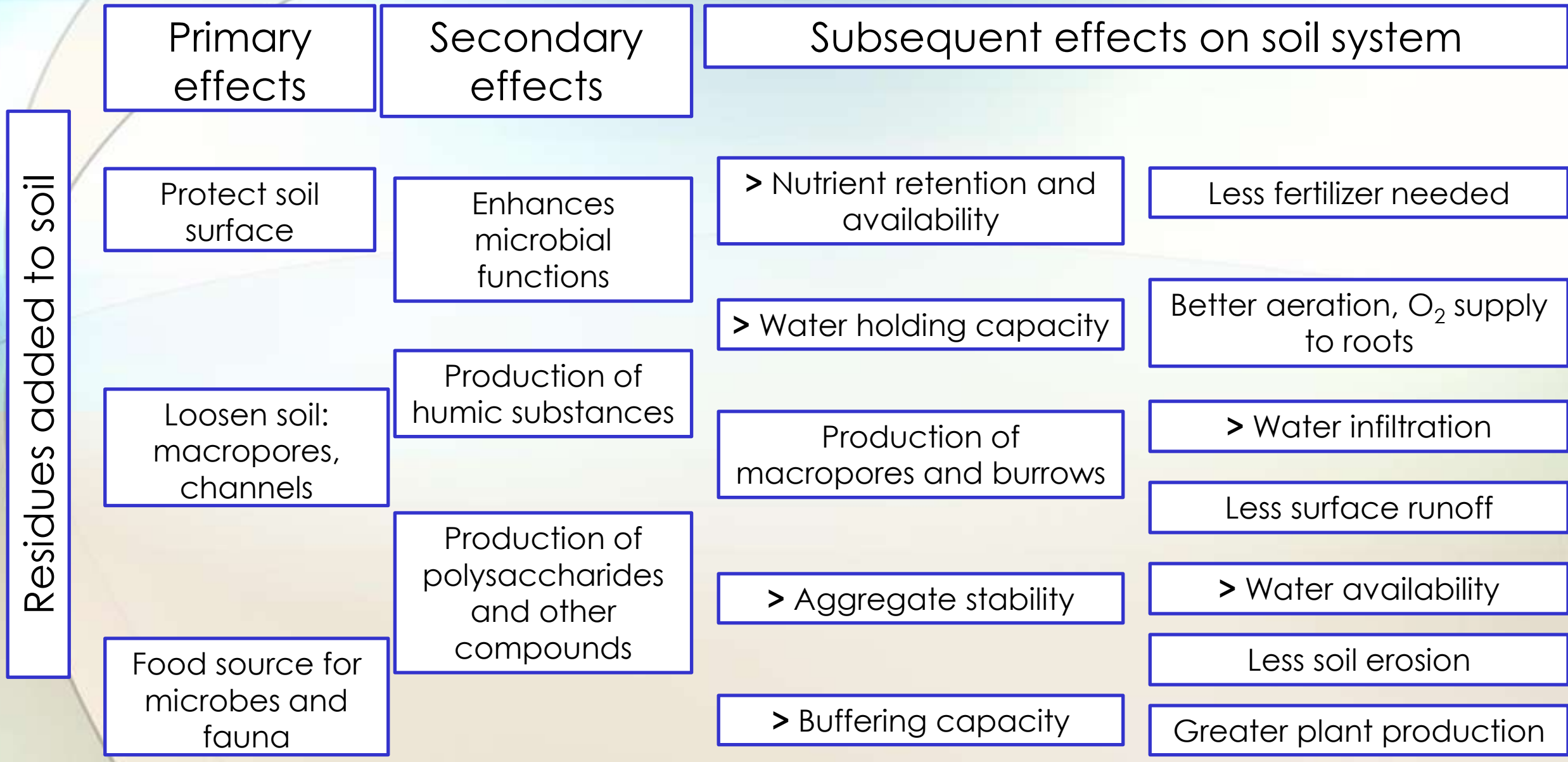


Biomass

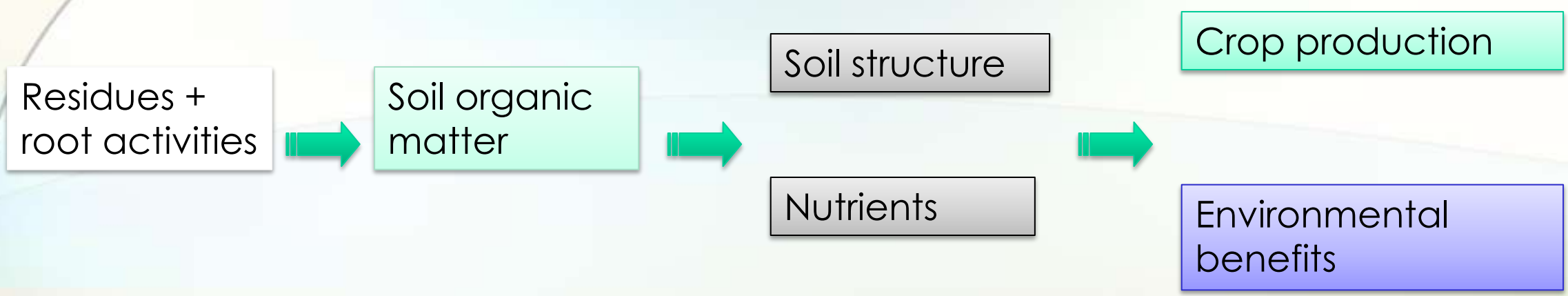
Root activities

Residues

Residues


Residues added to soil
Primary effects
Secondary effects
Subsequent effects on soil system
Protect soil surface
Loosen soil: macropores, channels
Food source for microbes and fauna
Enhances microbial functions
Production of humic substances
Production of polysaccharides and other compounds
> Nutrient retention and availability
> Water holding capacity
Production of macropores and burrows
> Aggregate stability
> Buffering capacity
Less fertilizer needed
Better aeration, O_2 supply to roots
> Water infiltration
Less surface runoff
> Water availability
Less soil erosion
Greater plant production

Why include CC?



Great variability due to environment & management

Importance

- Issues such as increasing population and gulf hypoxia make the intelligent management of farms increasingly more important, and cover cropping may be a way of maximizing fertilizer efficiency and increasing yields…

Newest addition to CP

- Cover Crops have been adopted as a cost-share conservation program with USDA-NRCS
  - ✓ Reimbursement to cover seed and seeding

USDA NRCS

June 2012

Cover Crops
Funding Opportunities to Try Them

Environmental Quality Incentives Program

- NRCS program
- First time producers and / or land where cover crops haven't been planted before.
- Up to 3 annual payments—allows for cover crops to be tried for up to 3 years, but could be for 1 or 2 years if producer prefers.
- Payments based on seed mixture used
- Must meet NRCS Cover Crop standard seeding requirements
- Applications compete – highest environmental benefits get approved

2012—Payment Rates (flat rates)

Legumes--$38.76 per acre
Winter Kill Species--$29.98 per acre
Grasses / Cereal Grains--$35.46 per acre
Species Mix--$42.46 per acre

Legumes: the use of legumes as cover crops to improve soil quality, decrease erosion, and provide nitrogen for subsequent crops. Legume species may be perennial or annual.

Winter Kill Species: The use of species that will be planted early enough to ensure adequate growth prior to a killing frost. The species will be planted to provide erosion control, capture excess nutrients, and improve soil condition. Species such as forage radishes and oats will meet the intent of this scenario.

Grasses / Cereal Grains: The use of species that will be planted early enough to ensure adequate growth prior to a killing frost. The species will be planted to provide erosion control, capture excess nutrients, and improve soil condition. Species such as winter cereals and annual ryegrass will meet the intent of the scenario.

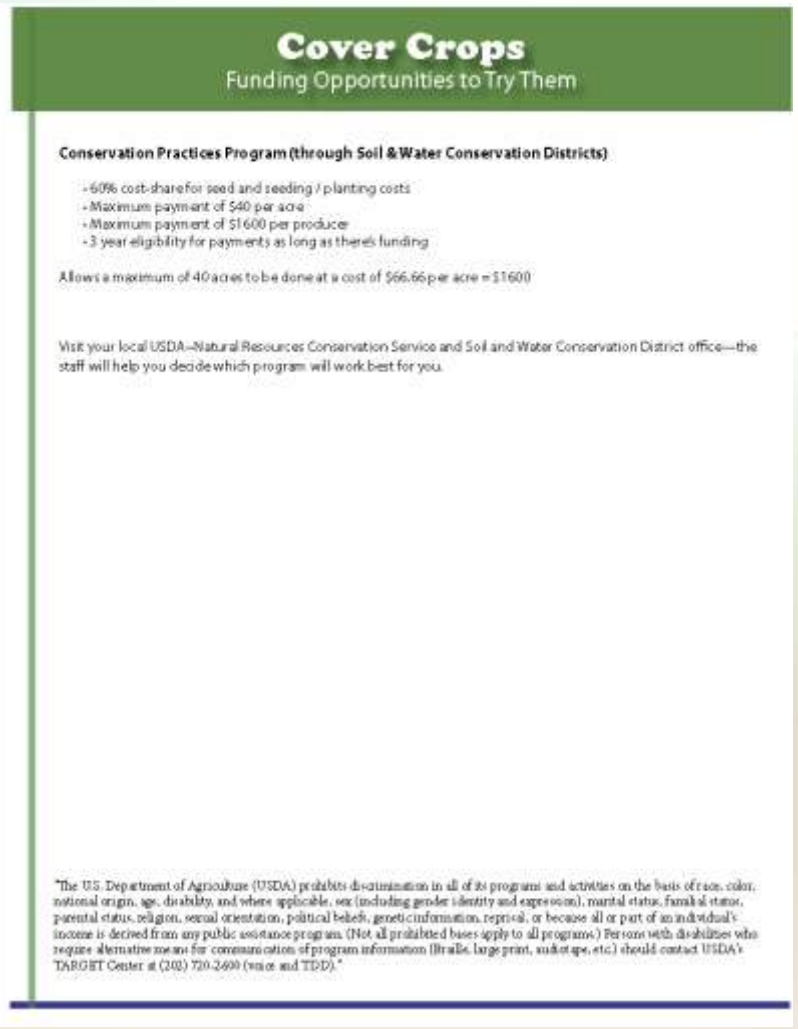
Species Mix: The use of species to achieve multiple benefits. The mixtures my include annual, perennials, or mixtures of each. Additionally the mixtures may include winter killed species grown in combination with non-winter killed species.

Conservation Stewardship Program (NRCS)

- 5 year contract with annual payments
- Conservation benefits of farmer's current system + benefits of enhancements selected
- Maximum payment--$40,000 per year per person
- Enhancements for cover crops
  1. Continuous Cover Crops
  2. Use of Cover Crop Mixtures
  3. Use of Deep-Rooted Cover Crops to Break Up Soil Compaction
  4. Plant a Cover Crop to Scavenge Residual Nitrogen

Farmers choose # of acres to plant cover crops on during the 5 years of the contract

Helping People Help the Land



Cover Crops
Funding Opportunities to Try Them

Conservation Practices Program (through Soil & Water Conservation Districts)

- 60% cost-share for seed and seeding / planting costs
- Maximum payment of $40 per acre
- Maximum payment of $1600 per producer
- 3 year eligibility for payments as long as there's funding

Allows a maximum of 40 acres to be done at a cost of $66.66 per acre = $1600

Visit your local USDA–Natural Resources Conservation Service and Soil and Water Conservation District office—the staff will help you decide which program will work best for you.

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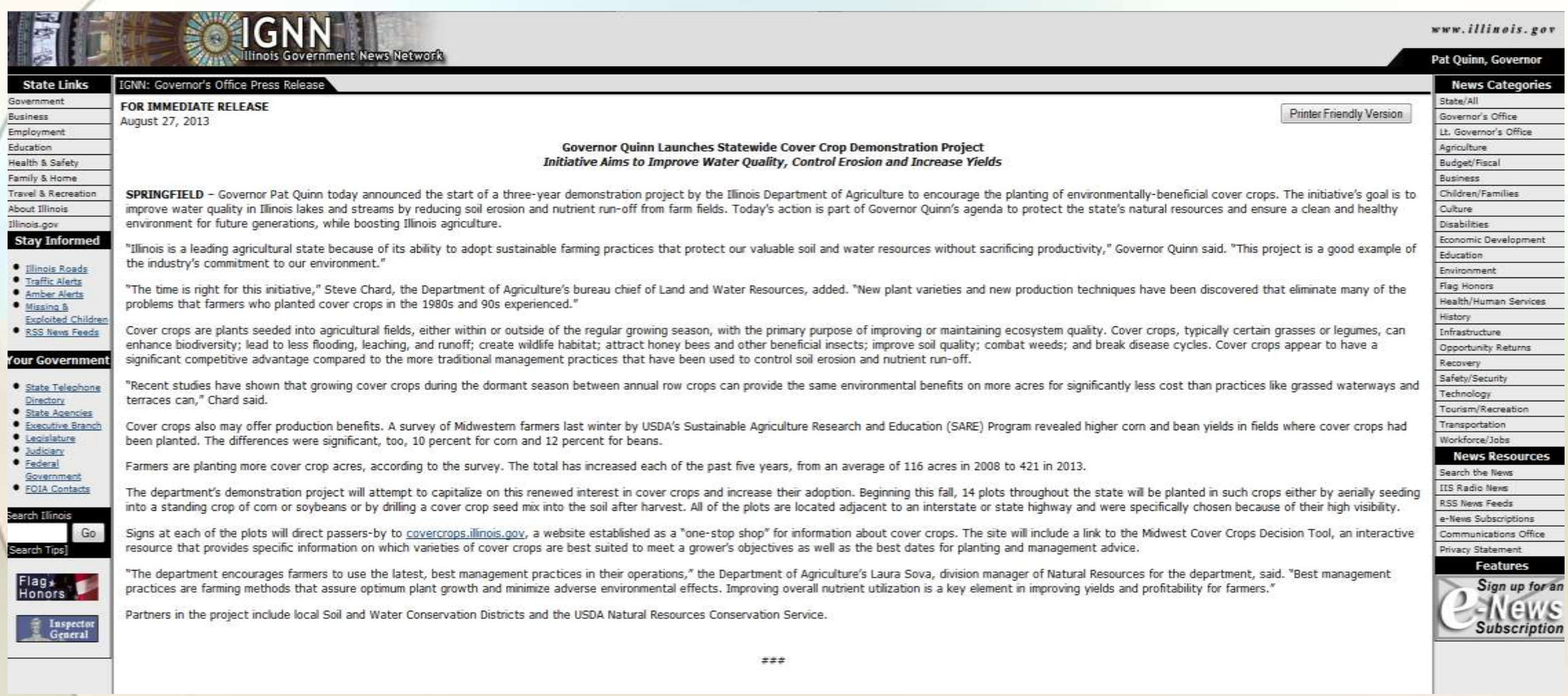
2013 Governor Queen's Initiative



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August 27, 2013

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Governor Quinn Launches Statewide Cover Crop Demonstration Project
Initiative Aims to Improve Water Quality, Control Erosion and Increase Yields

SPRINGFIELD – Governor Pat Quinn today announced the start of a three-year demonstration project by the Illinois Department of Agriculture to encourage the planting of environmentally-beneficial cover crops. The initiative's goal is to improve water quality in Illinois lakes and streams by reducing soil erosion and nutrient run-off from farm fields. Today's action is part of Governor Quinn's agenda to protect the state's natural resources and ensure a clean and healthy environment for future generations, while boosting Illinois agriculture.

"Illinois is a leading agricultural state because of its ability to adopt sustainable farming practices that protect our valuable soil and water resources without sacrificing productivity," Governor Quinn said. "This project is a good example of the industry's commitment to our environment."

"The time is right for this initiative," Steve Chard, the Department of Agriculture's bureau chief of Land and Water Resources, added. "New plant varieties and new production techniques have been discovered that eliminate many of the problems that farmers who planted cover crops in the 1980s and 90s experienced."

Cover crops are plants seeded into agricultural fields, either within or outside of the regular growing season, with the primary purpose of improving or maintaining ecosystem quality. Cover crops, typically certain grasses or legumes, can enhance biodiversity; lead to less flooding, leaching, and runoff; create wildlife habitat; attract honey bees and other beneficial insects; improve soil quality; combat weeds; and break disease cycles. Cover crops appear to have a significant competitive advantage compared to the more traditional management practices that have been used to control soil erosion and nutrient run-off.

"Recent studies have shown that growing cover crops during the dormant season between annual row crops can provide the same environmental benefits on more acres for significantly less cost than practices like grassed waterways and terraces can," Chard said.

Cover crops also may offer production benefits. A survey of Midwestern farmers last winter by USDA's Sustainable Agriculture Research and Education (SARE) Program revealed higher corn and bean yields in fields where cover crops had been planted. The differences were significant, too, 10 percent for corn and 12 percent for beans.

Farmers are planting more cover crop acres, according to the survey. The total has increased each of the past five years, from an average of 116 acres in 2008 to 421 in 2013.

The department's demonstration project will attempt to capitalize on this renewed interest in cover crops and increase their adoption. Beginning this fall, 14 plots throughout the state will be planted in such crops either by aerially seeding into a standing crop of corn or soybeans or by drilling a cover crop seed mix into the soil after harvest. All of the plots are located adjacent to an interstate or state highway and were specifically chosen because of their high visibility.

Signs at each of the plots will direct passers-by to covercrops.illinois.gov, a website established as a "one-stop shop" for information about cover crops. The site will include a link to the Midwest Cover Crops Decision Tool, an interactive resource that provides specific information on which varieties of cover crops are best suited to meet a grower's objectives as well as the best dates for planting and management advice.

"The department encourages farmers to use the latest, best management practices in their operations," the Department of Agriculture's Laura Sova, division manager of Natural Resources for the department, said. "Best management practices are farming methods that assure optimum plant growth and minimize adverse environmental effects. Improving overall nutrient utilization is a key element in improving yields and profitability for farmers."

Partners in the project include local Soil and Water Conservation Districts and the USDA Natural Resources Conservation Service.

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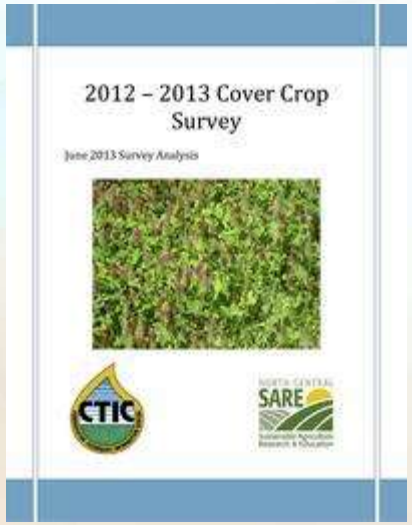

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The differences were significant, too, 10 % for corn and 12 % for beans.

Farmers are planting more cover crop acres, according to the survey.
The total has increased each of the past five years,
from an average of 116 acres in 2008 to 421 in 2013.

But…

THIS WE KNOW FROM RESEARCH…

CC effects on corn yield (Miguez & Bollero 2005)

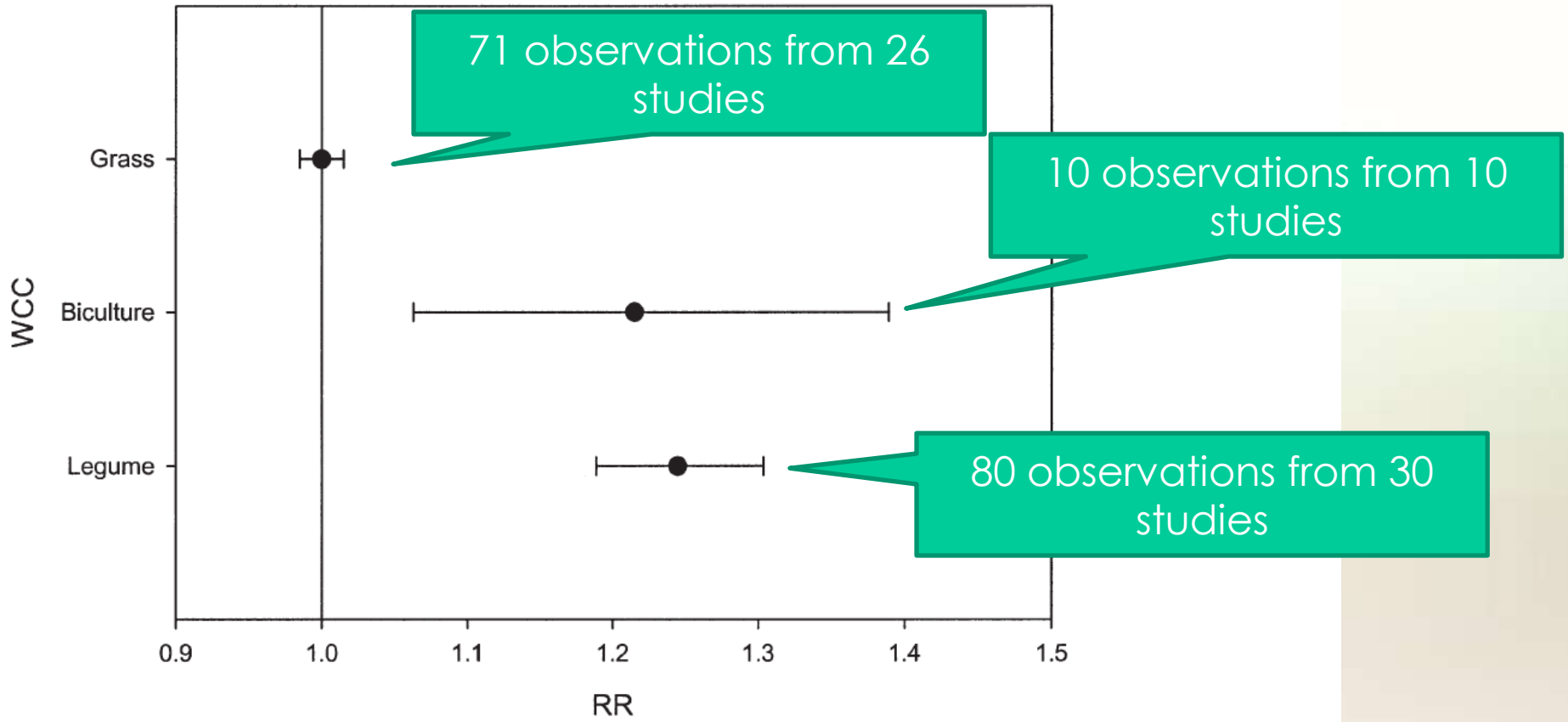
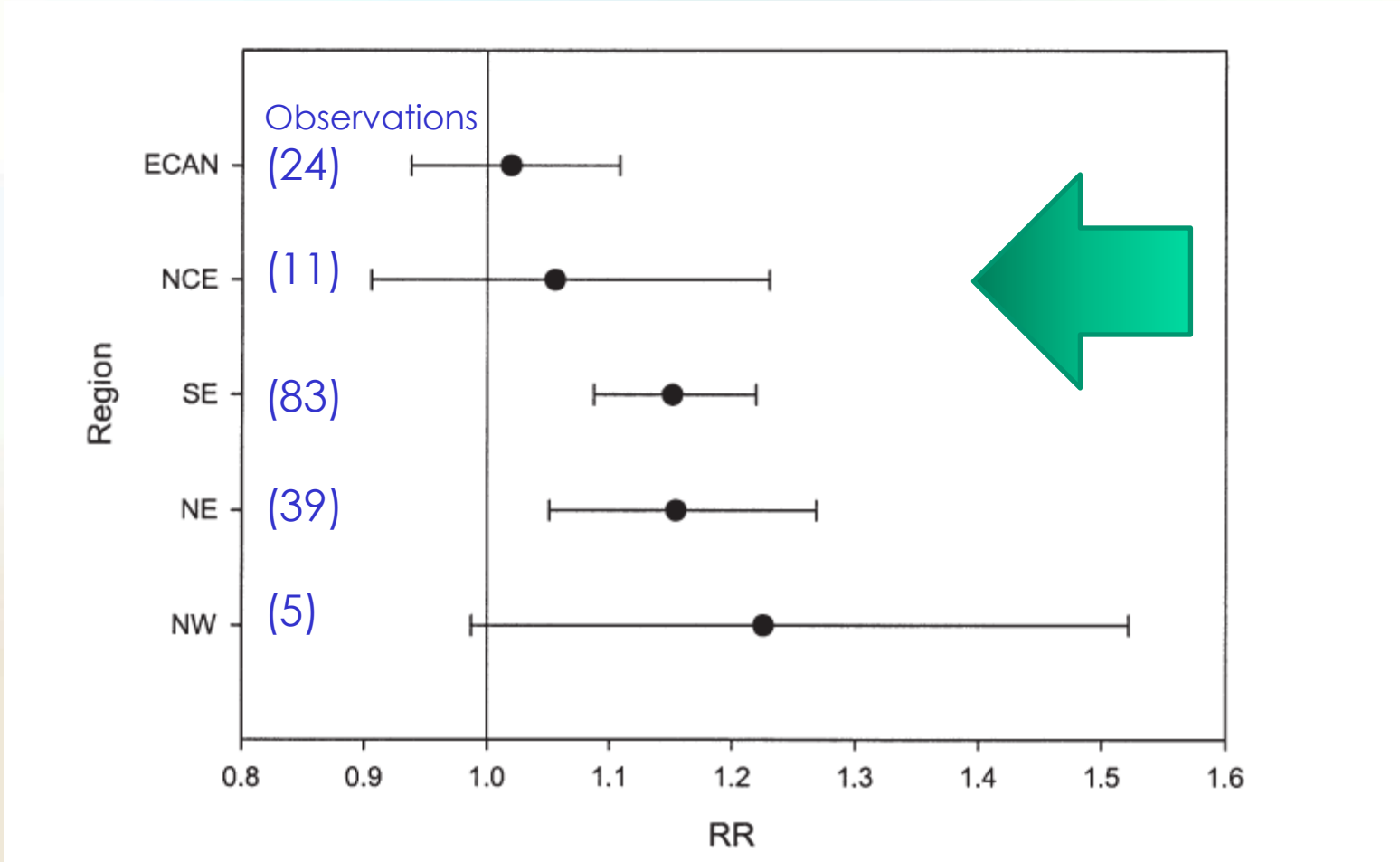


Fig. 3. Mean response ratio [yield of corn following winter cover crops/yield of corn following no cover (RR)] and 95% confidence interval (horizontal bars) for the three levels of winter cover crop (WCC).

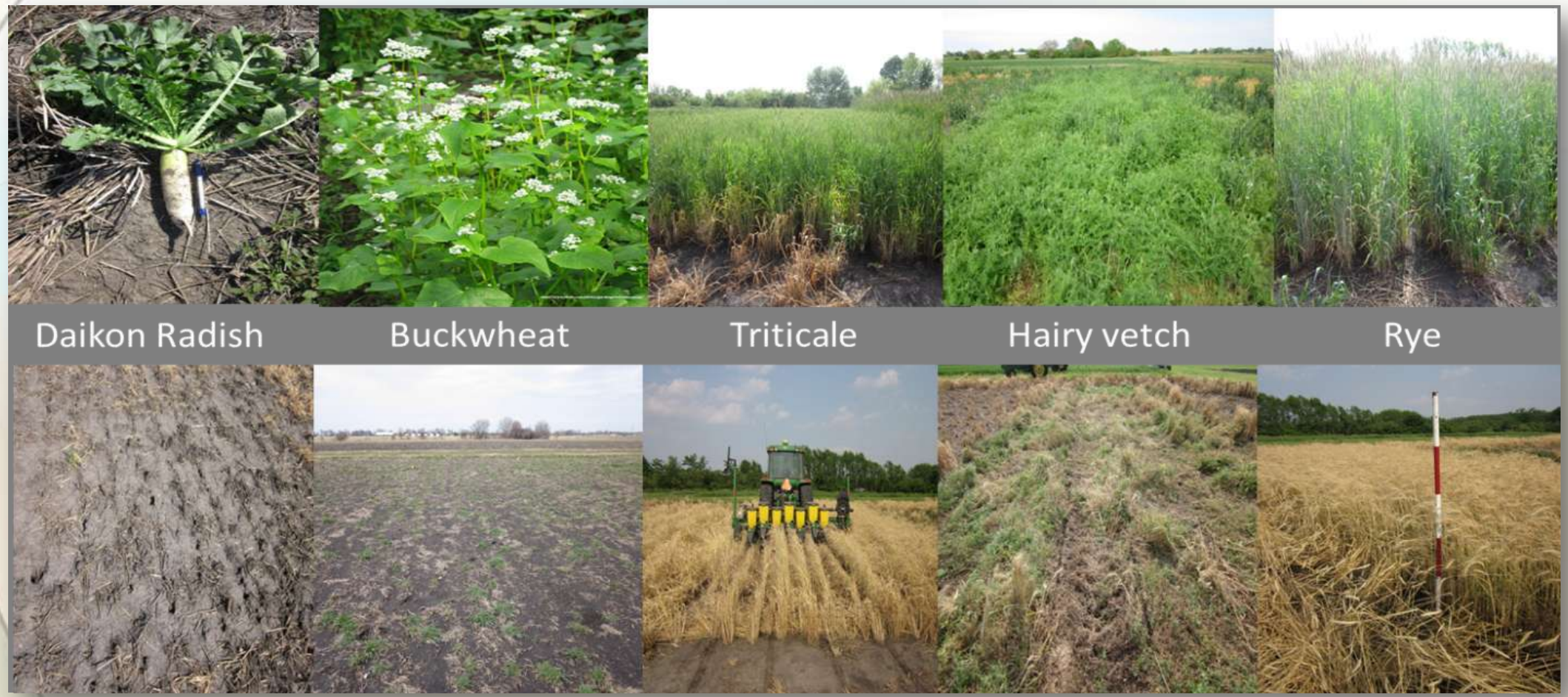
CC effects on Yield (Miguez & Bollero 2005)



CC effects on soils (Villamil et al. 2006; 2008)

- No till systems including cc of hairy vetch or mixtures vetch and rye have more soil organic matter (SOM), water aggregate stability (WAS), plant available water, and less available P and N
  - ✓ After 7 years of treatments

CC effects on soils and yield (Acuna & Villamil, 2014)



CC effects on soils and yield (Acuna & Villamil, 2014)

- Conventional system, soybean crop
- Short term effects evaluated
  - ✓ After 1 cover crop season - 2 fields 2 years
    - Soil properties – no change except for available N
    - Yields – not different from controls

In Illinois?

- Marginal area for CC
  - ✓ Shorter growing season
  - ✓ Narrow window for plant growth in the fall
    - Less biomass accumulation & associated benefits
  - ✓ Spring growth generally suppressed
    - Less biomass accumulation & associated benefits
- Use of tillage could negate the benefits form cover crops
  - ✓ Or not…

Importance

- Adoption remains low:
  - ✓ Cover Cropping practices have not picked up by most (~90%) local corn-soybean rotation farmers (Singer et al 2007)

Objectives

- Develop a comprehensive set of trials to look at effects of cover crops in both on-farm and on-station sites
- Measure the effect of cover crops in scavenging N
- Evaluate the effect of cover crops on commercial crop yields and on economic returns
- Evaluate the effect of tillage on crop and soil responses to cover crops

Cover Crops

Daikon radish (Raphanus sativus)
Improved soil aeration
Overall pest control
Nutrient capture

Hairy Vetch (Vicia villosa)
Soil improvement
Nitrogen fixation
Weed suppression

Cereal Rye (Secale cereale)
Nutrient capture
Erosion control
Good in mixtures

Annual Ryegrass (Lolium multiflorum)
Nutrient capture
Erosion control
Weed/nematode control

Rapeseed (Brassica napus)
Subsoil improvement
Deep nutrient capture
*Weed/Nematode control

Red Clover (Trifolium pratense)
*Improving soil stability and WHC
*Nitrogen fixation
*Weed suppression

Spring Oats (Avena sativa)
*Nutrient capture
*Weed suppression

Materials & Methods

Experimental Design

Cover Crop After Soybean Harvest (Before Corn Planting)

↓Good to cross-plant 10 ft on outside ends of each block

Rep 1	Clover	40-foot cross-alley, planted	None	Rep 3
	Ryegrass		Canola	
	Canola		Hairy vetch	
	None		Radish	
	Radish		Clover	
	Hairy vetch		Ryegrass	
	20-ft alley, planted			
Rep 2	Radish		Ryegrass	Rep 4
	None		Radish	
	Canola		Canola	
	Hairy vetch		Clover	
	Clover		Hairy vetch	
	Ryegrass		None	

↑Should cross-plant 10 ft of crop here (in each block) to divide tillage treatments

Spring tillage done before planting.

Cover Crop After Corn Harvest (Before Soybean Planting)

	<-40 ft->			
Rep 1	None	40-foot cross-alley, planted	Spring oats	Rep 3
10 ft	Cereal rye		Cereal rye	
	Spring oats		None	
	Canola		Radish	
	Radish		Canola	
	Ryegrass		Ryegrass	
Rep 2	Spring oats		Radish	Rep 4
	None		Ryegrass	
	Radish		Canola	
	Cereal rye		None	
	Canola		Spring oats	
	Ryegrass		Cereal rye	

Crop that follows CC		
Corn		Soybean
Canola		Canola
Clover		Spring oats
Hairy vetch		Cereal rye
None		None
Radish		Radish
Ryegrass		Ryegrass

Materials & Methods

- Experimental Design
  - ✓ Split block design of factors tillage and cover crops with 4 reps
  - ✓ Nested within crops and locations
    - Established at 4 research centers in fall 2012
    - Established at 2 sites in Southern Illinois in 2013
      - Dixon Springs UI and SIU Carbondale
- Statistical Analysis
  - ✓ Mixed procedure in SAS 9.3
    - When several depths, repeated measures approach with an autoregressive model for the variance-covariance matrix of the residuals

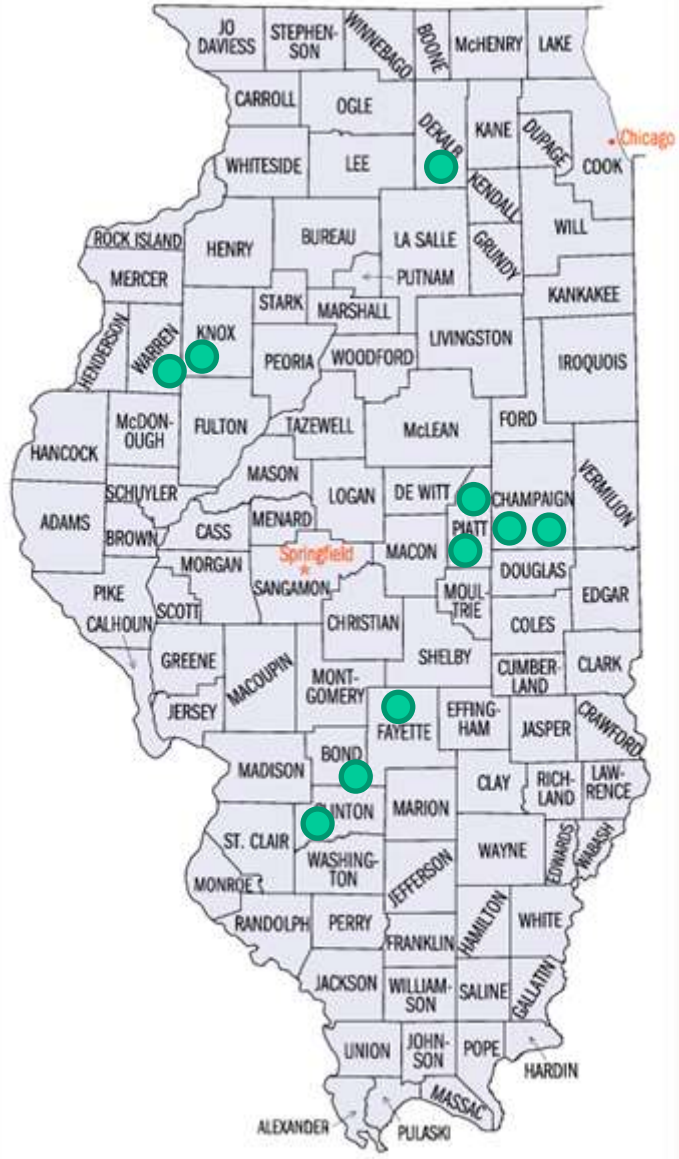
Materials & Methods

- At farm sites:
  - ✓ One cover crop of choice compared with no cover ; 4 reps on either corn or soybean fields
    - 10 sites established in fall 2013

Possible layout for on-farm (farmer fields) cover crop trials

<----------direction of flight and of crop rows---------->

PLOT			
	Strip of cover crop 40 ft or so wide at the edge of field		
1	30 ft x 400 ft	Cover crop	Rep 1
2	30 ft x 400 ft	Control	
3	30 ft x 400 ft	Control	Rep 2
4	43 ft x 400 ft	Cover crop	
5	43 ft x 400 ft	Cover crop	Rep 3
6	34 ft x 400 ft	Control	
7	34 ft x 400 ft	Control	Rep 4
8	30 ft x 400 ft	Cover crop	
	Rest of field planted to cover crop.		



Materials & Methods

- At Research sites
  - ✓ Fall 2012
    - 4 sites established
    - Cover crop hand seeded following harvest of cash crops
      - Between 9/9 – 10/15 at all sites
      - Seeding rates followed MCCC recommendations
    - Soils sampled up to 3ft for full characterization of research sites

Cover crop	Seeding rate (lbs/acre)
Cereal rye	90
Spring oats	60
Clovers and hairy vetch	20
Ryegrass	15
Radish	8
Canola (rape)	5

Materials & Methods

- At Research sites
  - ✓ Spring 2013
    - Biomass sampling of overwintering cover crops and weeds
    - Soil sampling and determination of available N up to 3ft
    - Cash crop planting
  - ✓ Challenges:
    - Spring operations were all delayed by frequent rain in Apr and May 2013 preventing deep soil sampling at one of the RCs and all soil sampling at another
    - Late planting

Materials & Methods

- At Research sites
  - ✓ Summer - fall 2013
    - 2 additional sites established in southern IL
    - Cover crop hand seeded on standing crops
      - Seeding rates and dates followed MCCC recommendations
      - 2nd -3rd week of Sept at all sites
    - Soils sampled up to 3ft for
      - Full characterization at new sites
      - Available N at established sites
    - Cash crop harvested
      - Yields recorded
  - ✓ More challenges

Materials & Methods

- At farm sites
  - ✓ 10 sites established in fall 2013
    - Cover crop aerially seeded following MCCC recommendations
    - Detailed agronomic information collected for each site
    - GPS coordinates for revisiting and sampling
    - Soils sampled up to 3ft for full characterization of farm sites
- Recruitment of collaborating farmers continues

Results

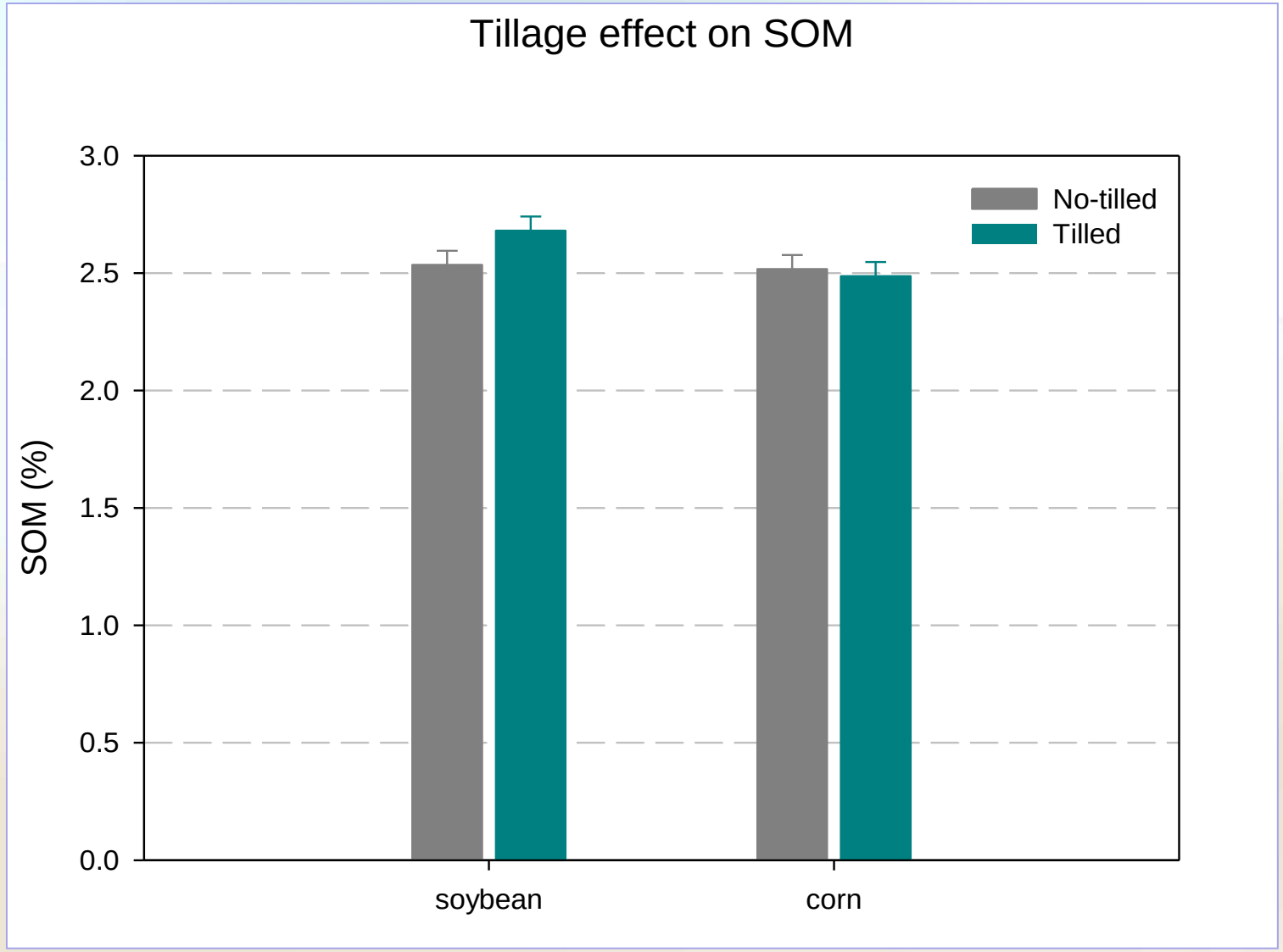
Fall 2012 Characterization of sites

Soil property	Depth	Crop 2012		SE
	ft	soybean	corn	
pH	1	6.3	6.1	0.3
	2	6.1	6.0	
	3	6.5	6.4	
SOM	1	3.6	3.6	0.4
(%)	2	2.6	2.4	
	3	1.6	1.5	
CEC	1	18.3	19.7	2
meq/100gr	2	20.8	21.2	
	3	19.7	19.5	
Available P	1	9.3	9.2	0.8
ppm	2	4.6	4.1	
	3	5.7	4.7	
Exchangeable K	1	83.1	91.6	13.2
ppm	2	69.0	65.6	
	3	68.0	62.4	

Results

Effect	DF	DF	F	Value
crop	1	6.13	0.44	0.5324
till(crop)	2	363	3.32	0.0372
D(crop)	4	475	441.25	<.0001
till*D(crop	4	475	0.6	0.6649

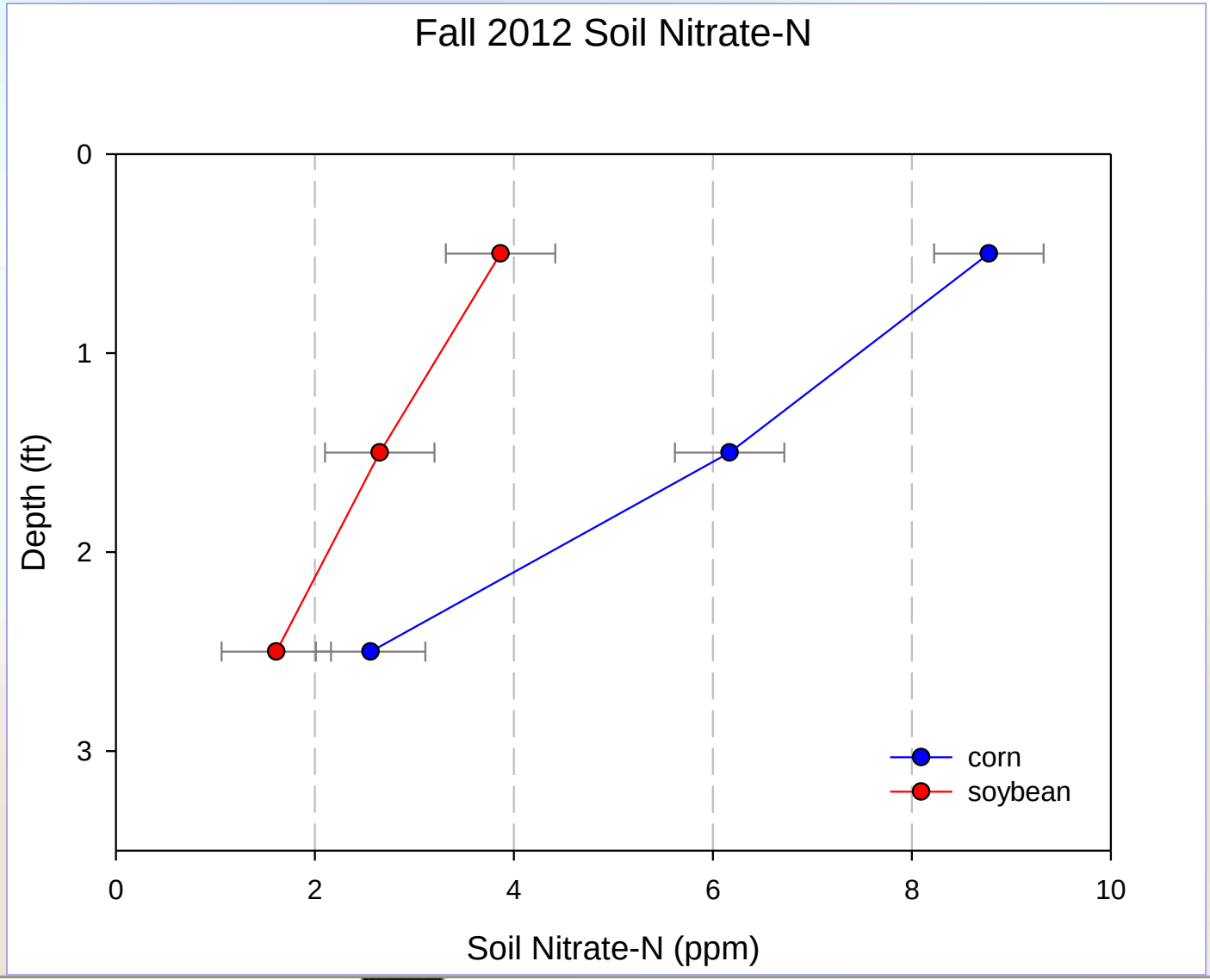
Fall 2012 Characterization of sites



Results

Effect	DF	DF	F	Value
crop	1	28.6	63.17	<.0001
till(crop)	2	360	0.18	0.8335
D(crop)	4	641	36.21	<.0001
till*D(crop	4	641	0.94	0.4401

Fall 2012 Characterization of sites



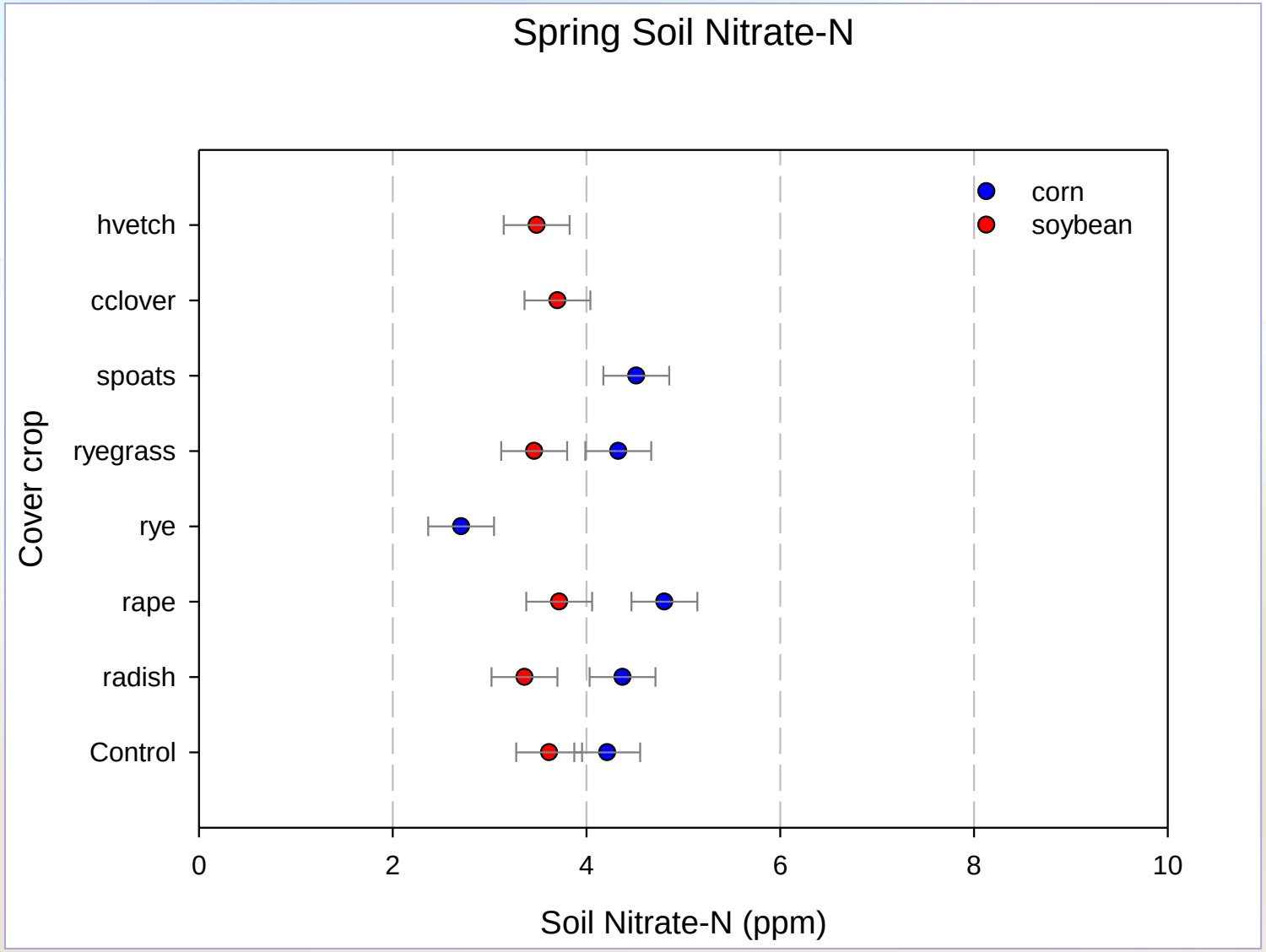
Results

Crop 2012	Cover crop	n	Biomass (gr/m2)		
			Mean	SE	CV
soybean	cclover	2	8	0	0
	hvetch	13	87	18	75
	ryegrass	14	77	12	60
corn	rape	6	32	10	75
	rye	23	145	31	102
	ryegrass	9	59	12	62

Results

Effect	DF	DF	F	Value
crop	1	20.3	2.66	0.1186
till(crop)	2	262	0.18	0.8321
cover(crop)	10	262	4.76	<.0001
till*cover(crop)	10	262	0.91	0.5281
D(crop)	4	420	68.93	<.0001
till*D(crop)	4	426	2.12	0.0771
cover*D(crop)	20	481	0.99	0.4727
till*cover*D(crop)	20	481	0.52	0.9583

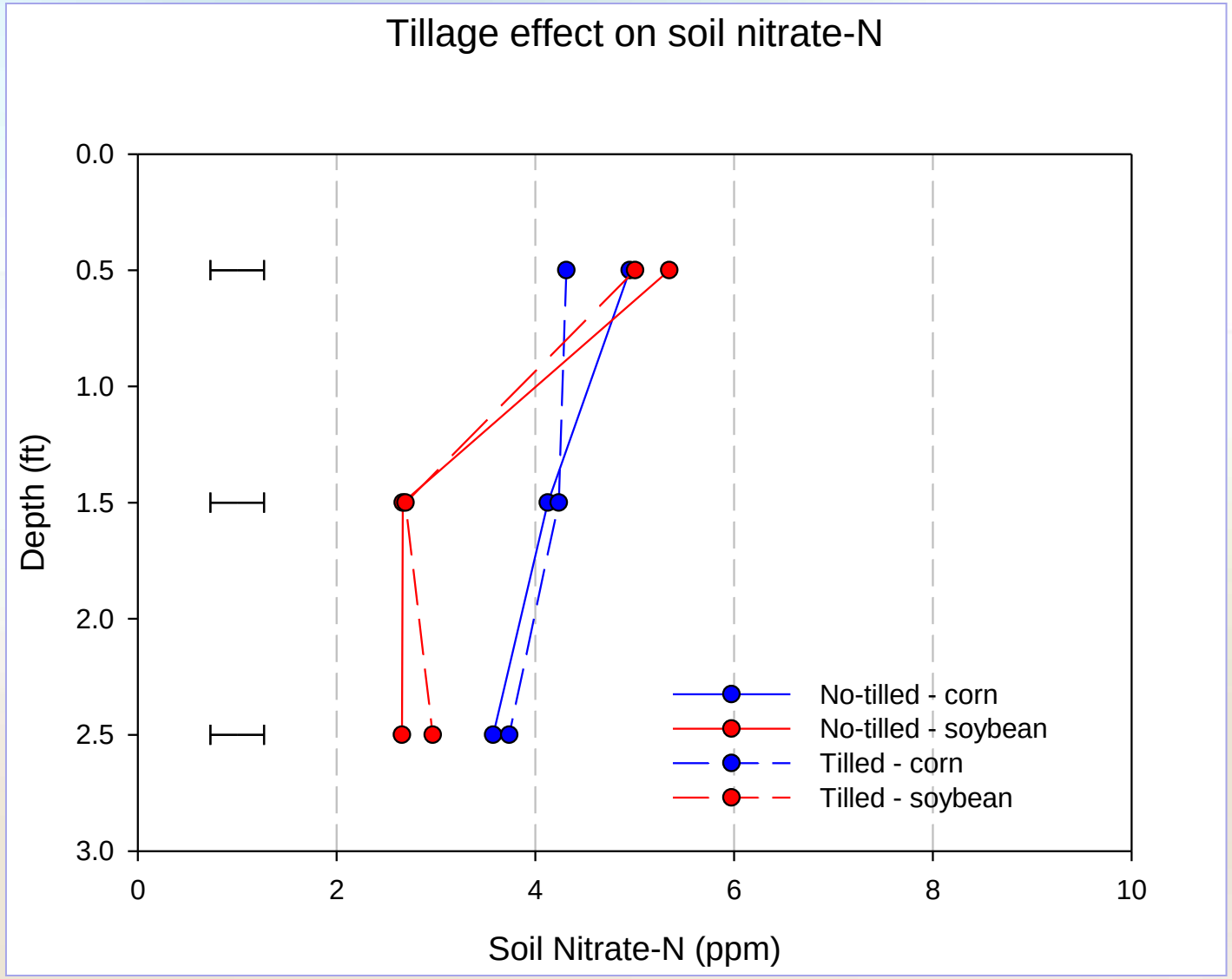
Spring 2013 Characterization of sites



Results

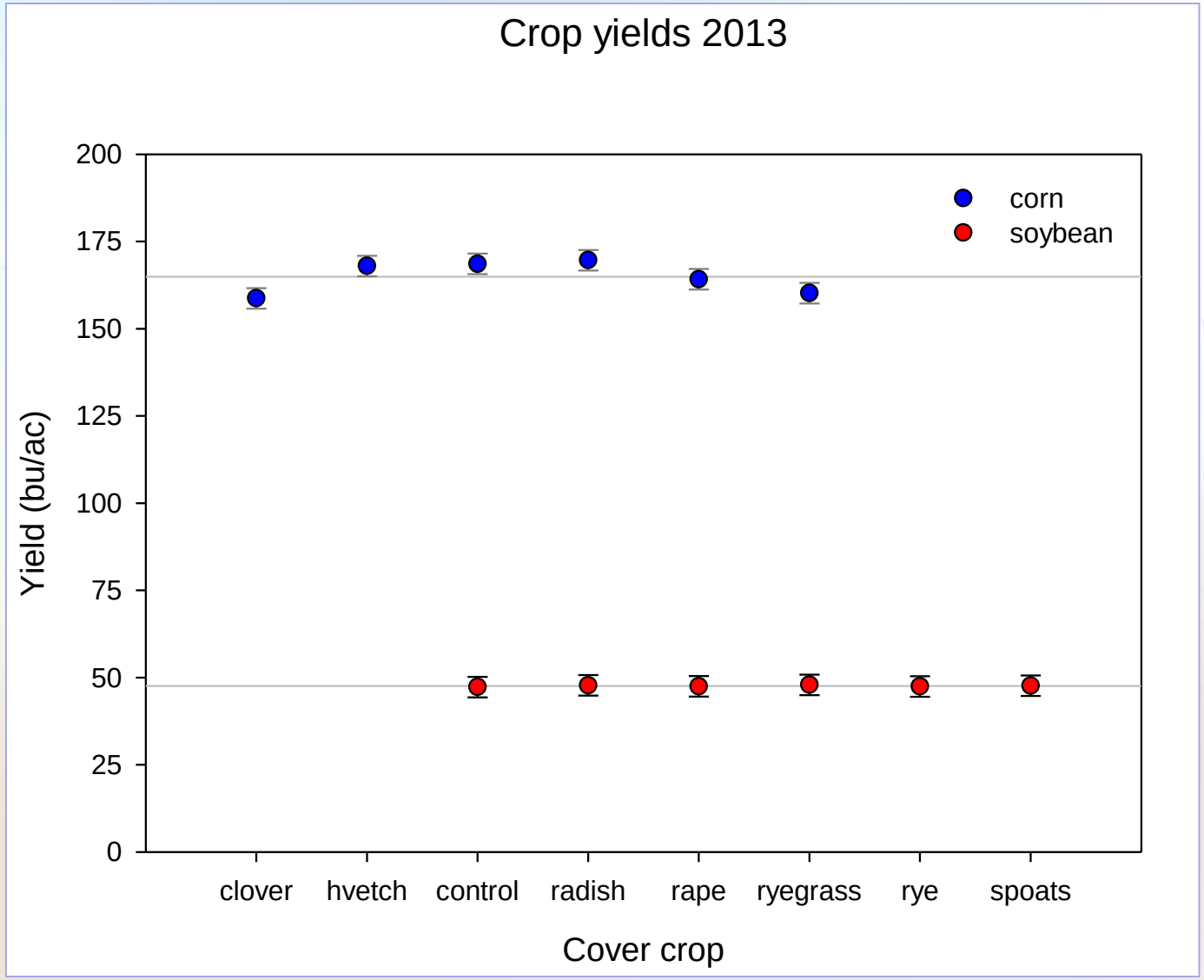
Effect	DF	DF	F	Value
crop	1	20.3	2.66	0.1186
till(crop)	2	262	0.18	0.8321
cover(crop)	10	262	4.76	<.0001
till*cover(crop)	10	262	0.91	0.5281
D(crop)	4	420	68.93	<.0001
till*D(crop)	4	426	2.12	0.0771
cover*D(crop)	20	481	0.99	0.4727
till*cover*D(crop)	20	481	0.52	0.9583

Spring 2013 Characterization of sites



Results

Effect	DF	DF	F	Value
crop	1	27	536.23	<.0001
till(crop)	2	30	1.6	0.2196
cover(crop)	10	149	2.46	0.0095
till*cover(crop)	10	149	0.83	0.5983



Summary

- Preliminary findings
- Challenging seasons 2012 – 2013
  - ✓ cover crop establishment and growth
  - ✓ measure soil available N
- Experiments are in place at 6 RCs and 10 farm sites
  - ✓ more years and locations will allow a realistic assessment of the potential of cover crops to affect yields and scavenge N

Next steps

- Spring 2014: 6 RCs and 10 farm sites
  - ✓ Biomass sampling
  - ✓ Soil sampling
    - available N
  - ✓ Corn and soybean planting
  - ✓ Recruitment of farm collaborators to start late summer/ early fall

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QUESTIONS?