Crop Rotation and Cover Cropping Impacts on Soil Health

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Outline of Talk

- Recent cover crop survey data
- Data from long-term trials
- Integrating cover crops into the system

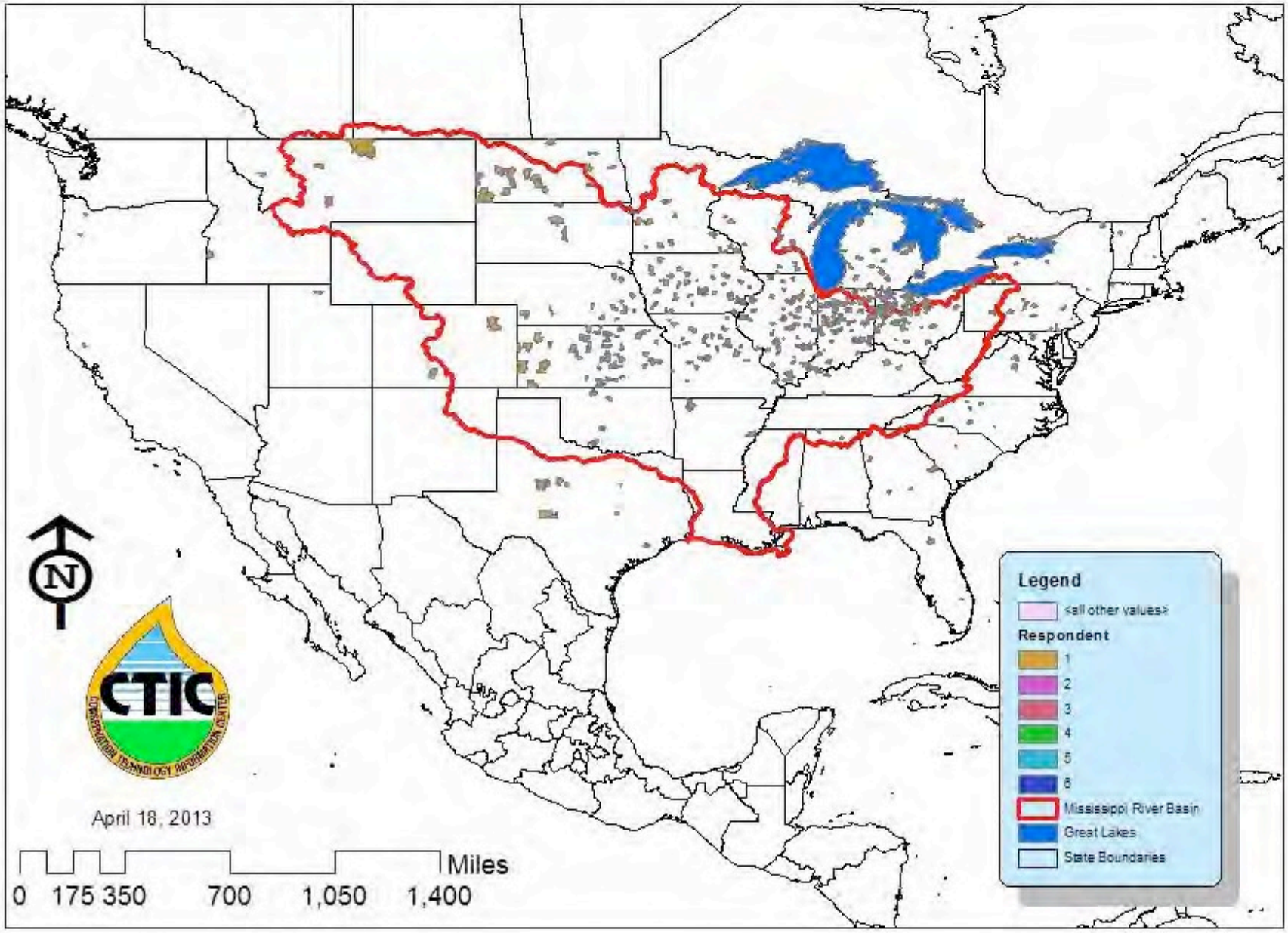
Recent Cover Crop Survey

- Conservation Technology Information Center (CTIC) and the USDA North Central Region Sustainable Agriculture Research and Education (SARE) program
- Looked at cover cropping practices across the Midwest
- Farmer-generated data

Survey Details

- Conducted over the winter of 2012 – 2013 and concluded in the spring of 2013
- Online and using paper copies distributed at meetings where cover crop users would be present
- 718 respondents completed survey
  - May not have answered every question

2012-2013 Cover Crop User Survey Respondents



CITC Survey, 2013

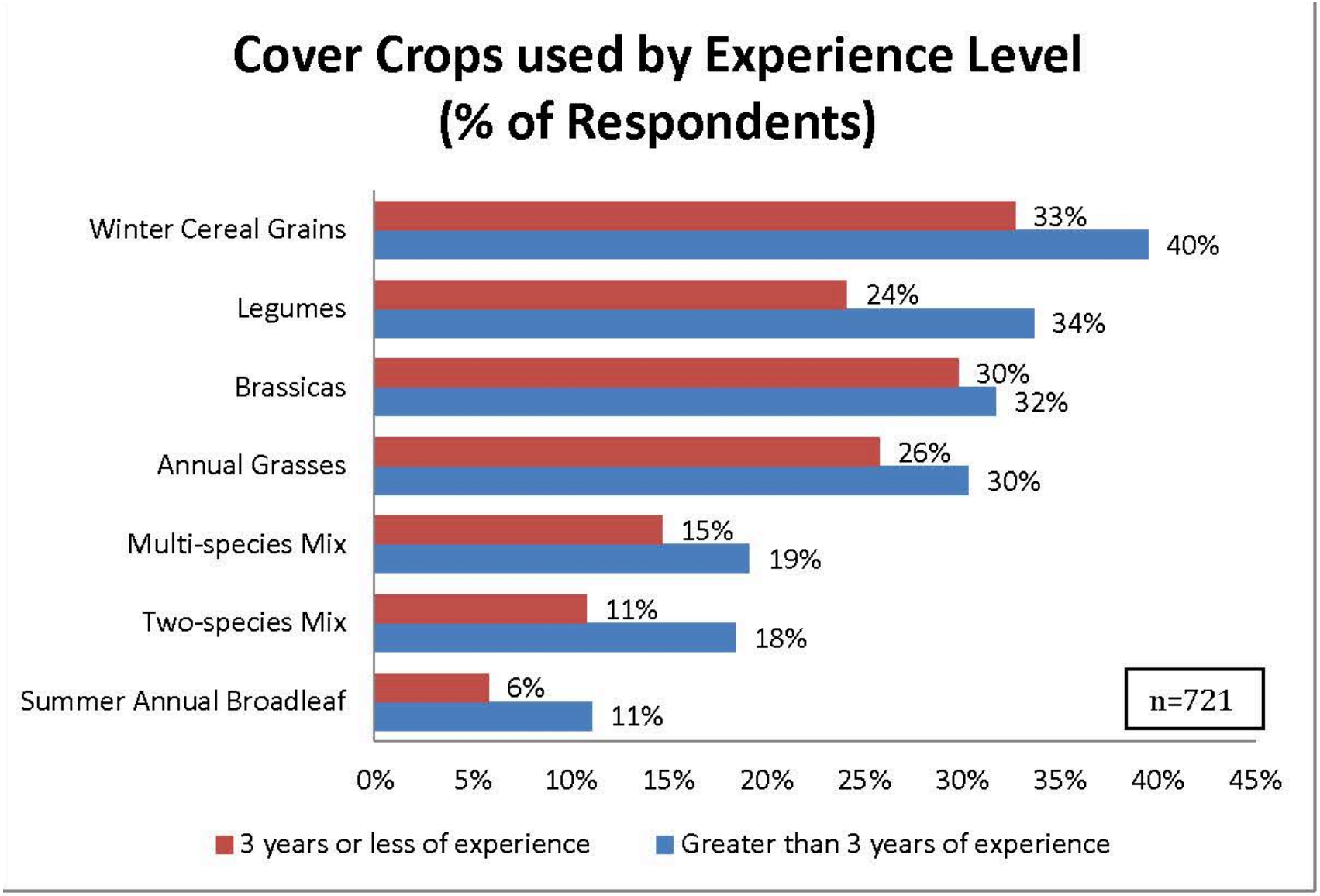


Figure 9. Survey respondents' cover crop choices broken down by experience level (percentage of respondents).

CITC Survey, 2013

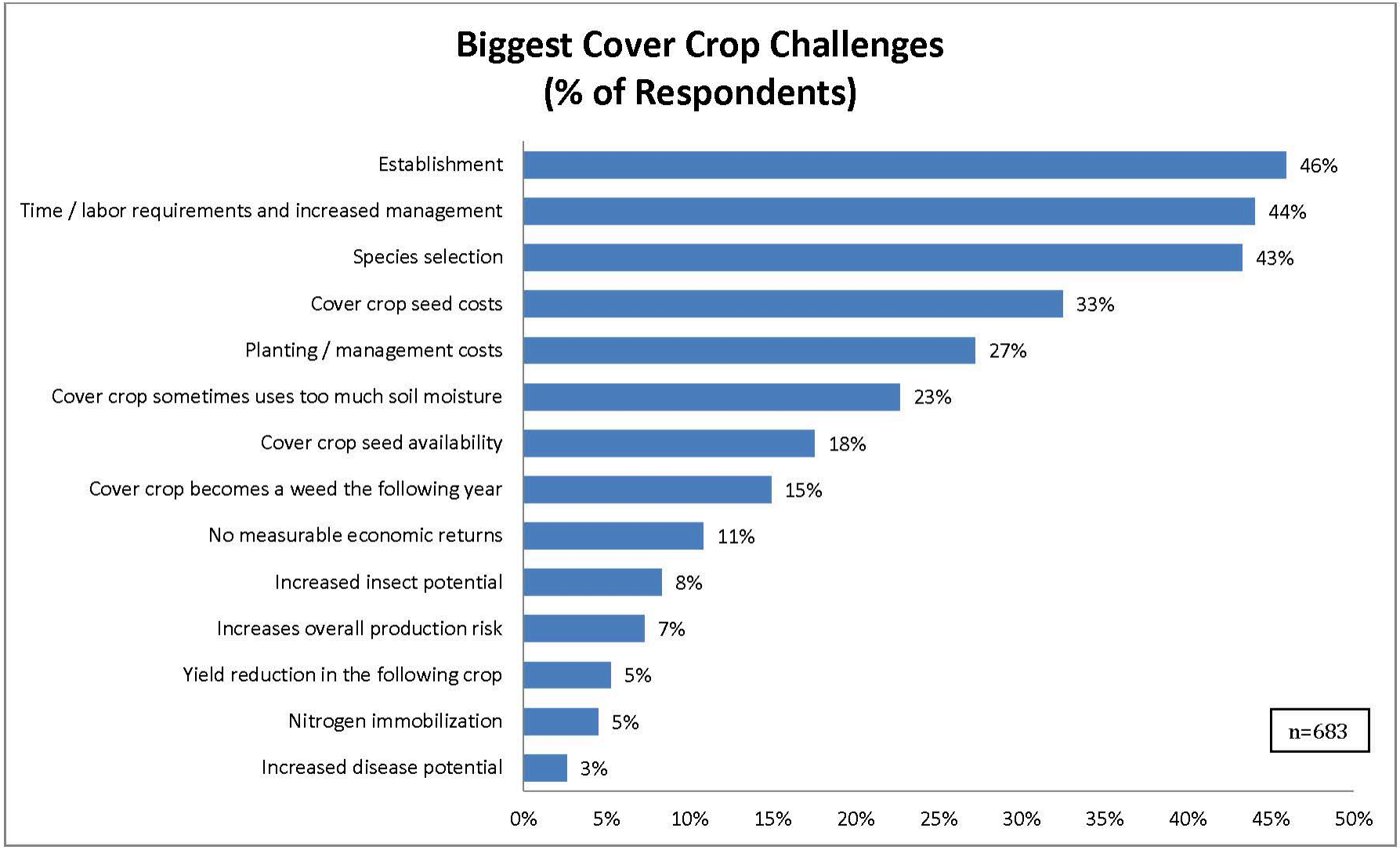


Figure 15. Challenges faced using cover crops by survey respondents (percentage of respondents).

CITC Survey, 2013

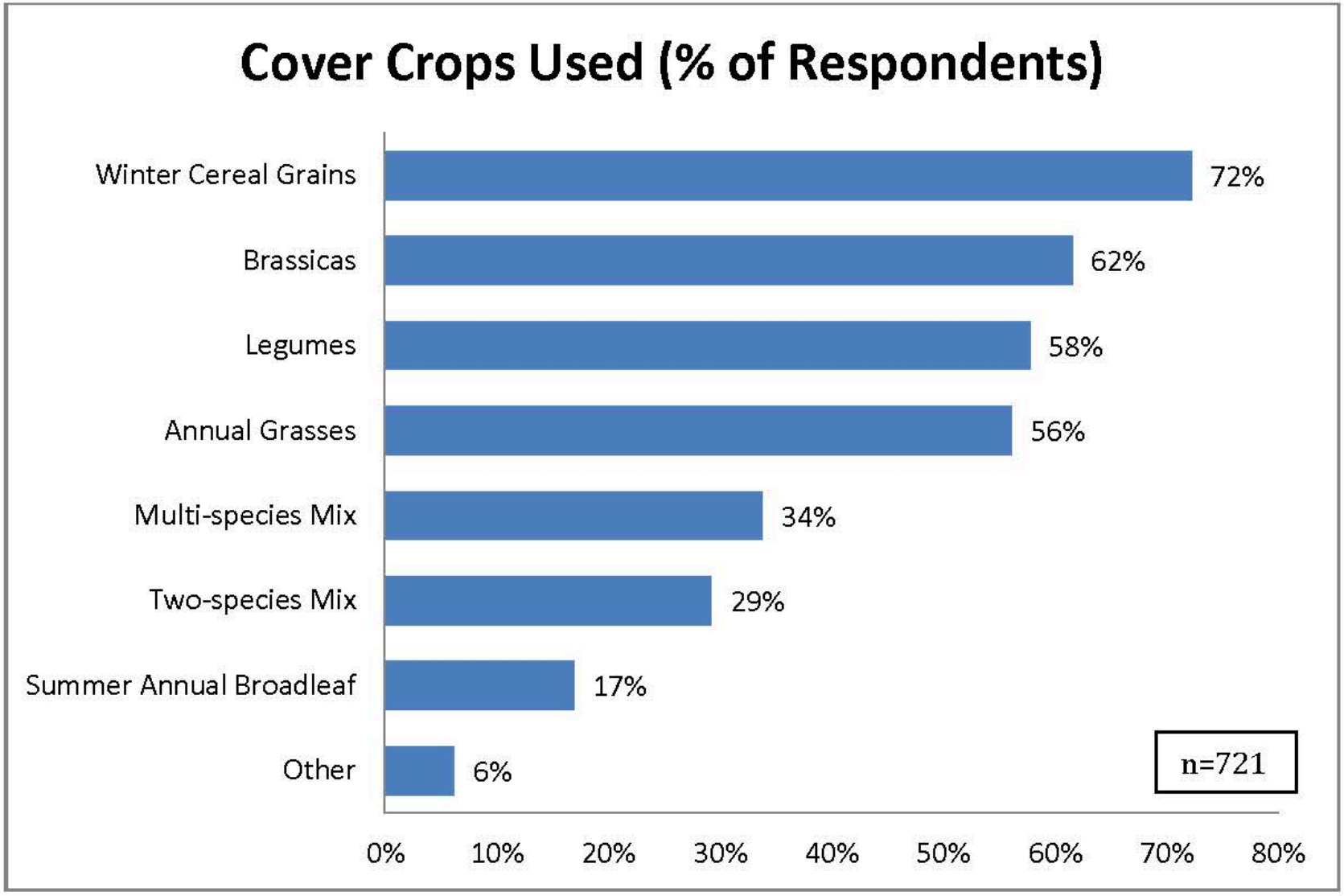


Figure 8. Cover crop species used by survey - percentage of respondents

CITC Survey, 2013

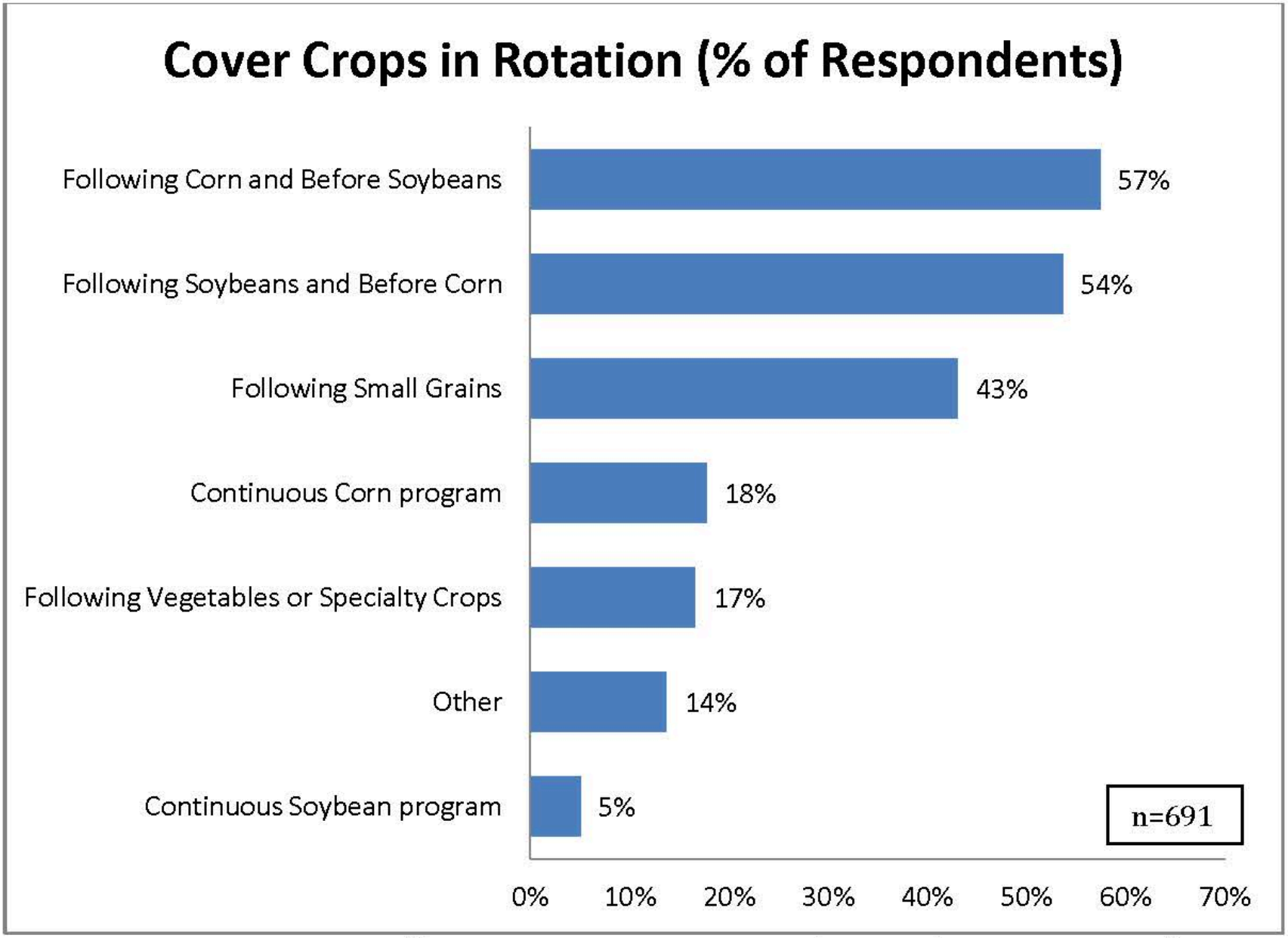


Figure 11. Crop rotations used by cover crop survey respondents with cover crops in their rotations (percentage of respondents).

CITC Survey, 2013

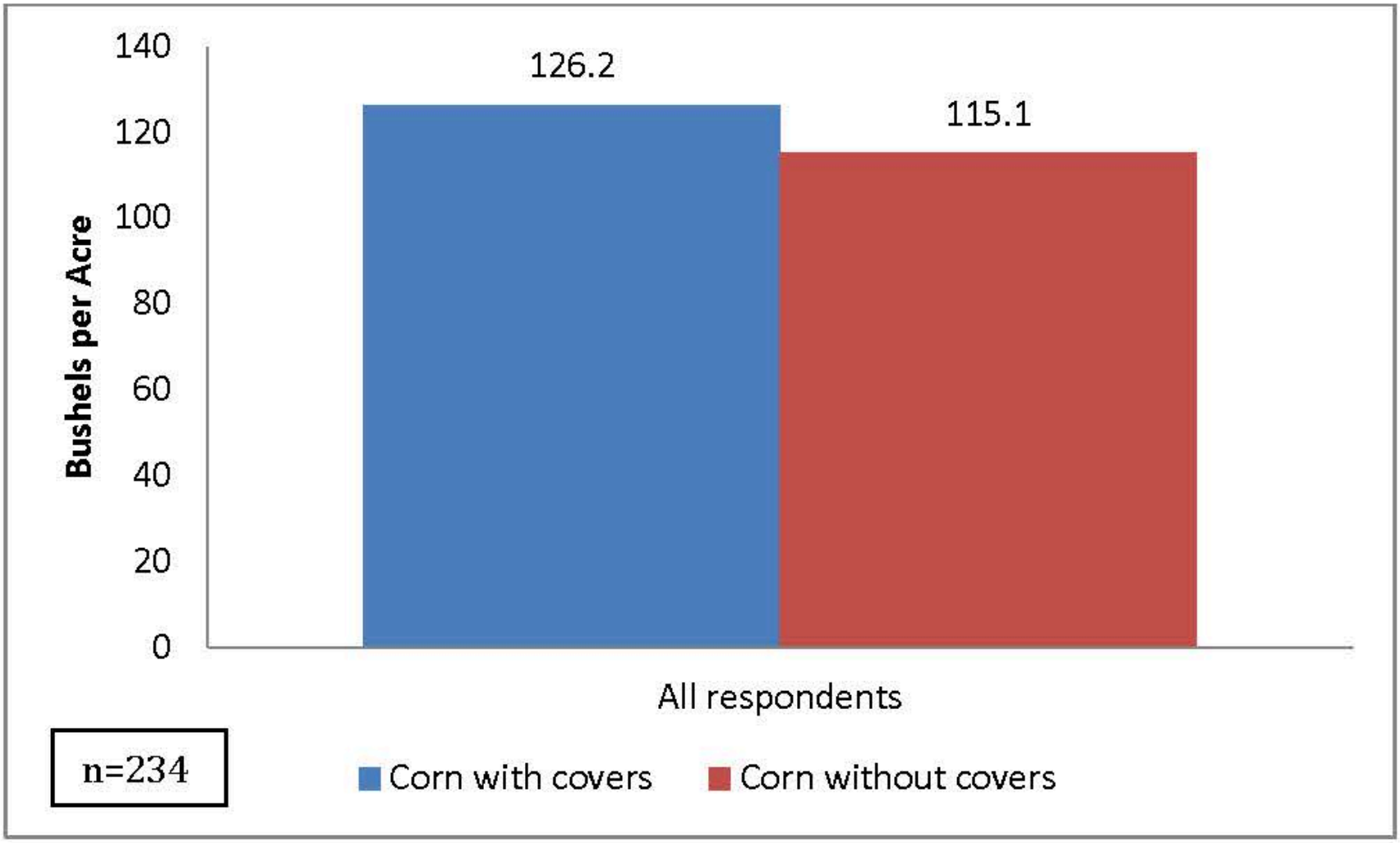


Figure 21. Average corn yields from cover crop survey respondents.

CITC Survey, 2013

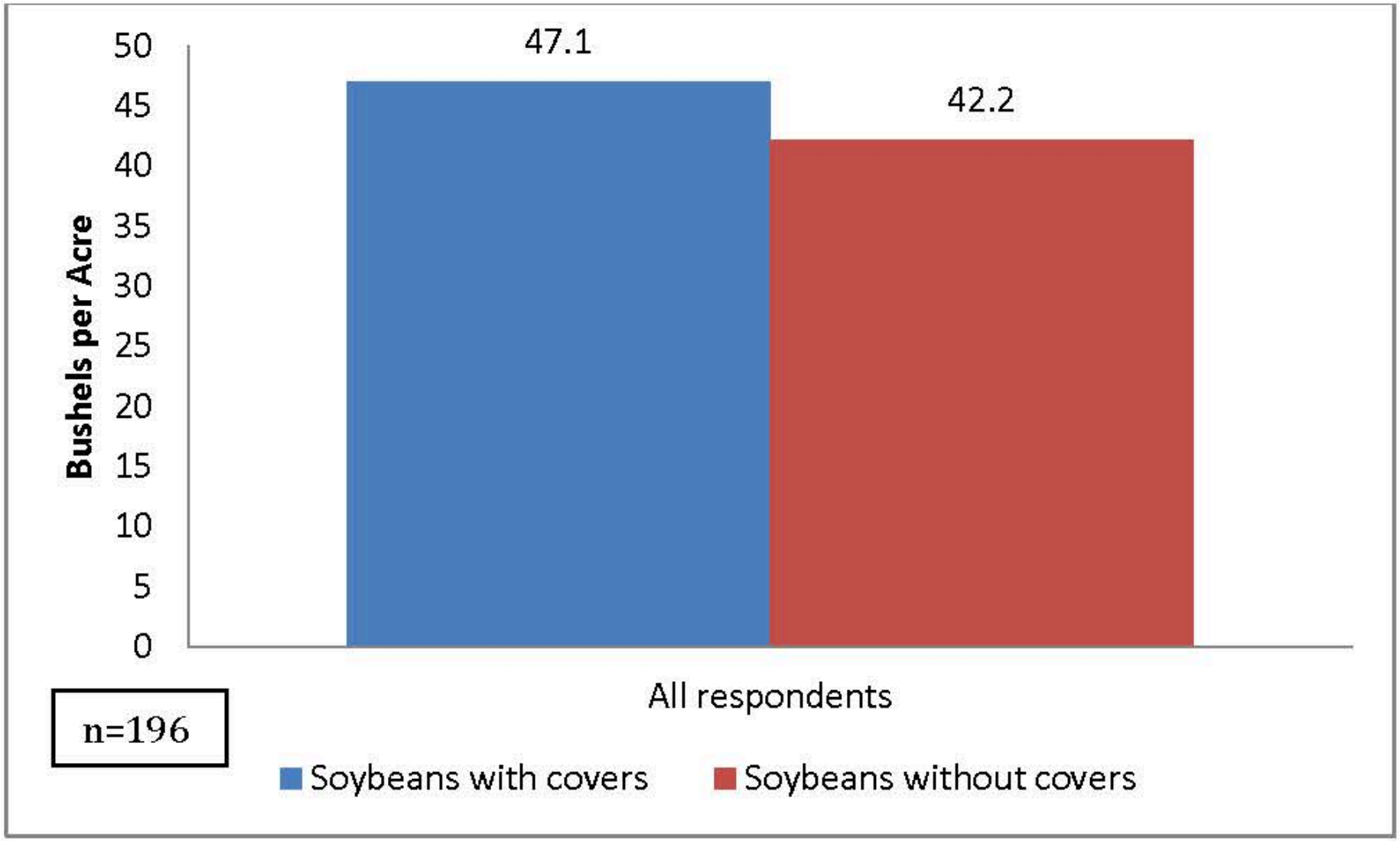


Figure 22. Average soybean yields from cover crop survey respondents.

CITC Survey, 2013

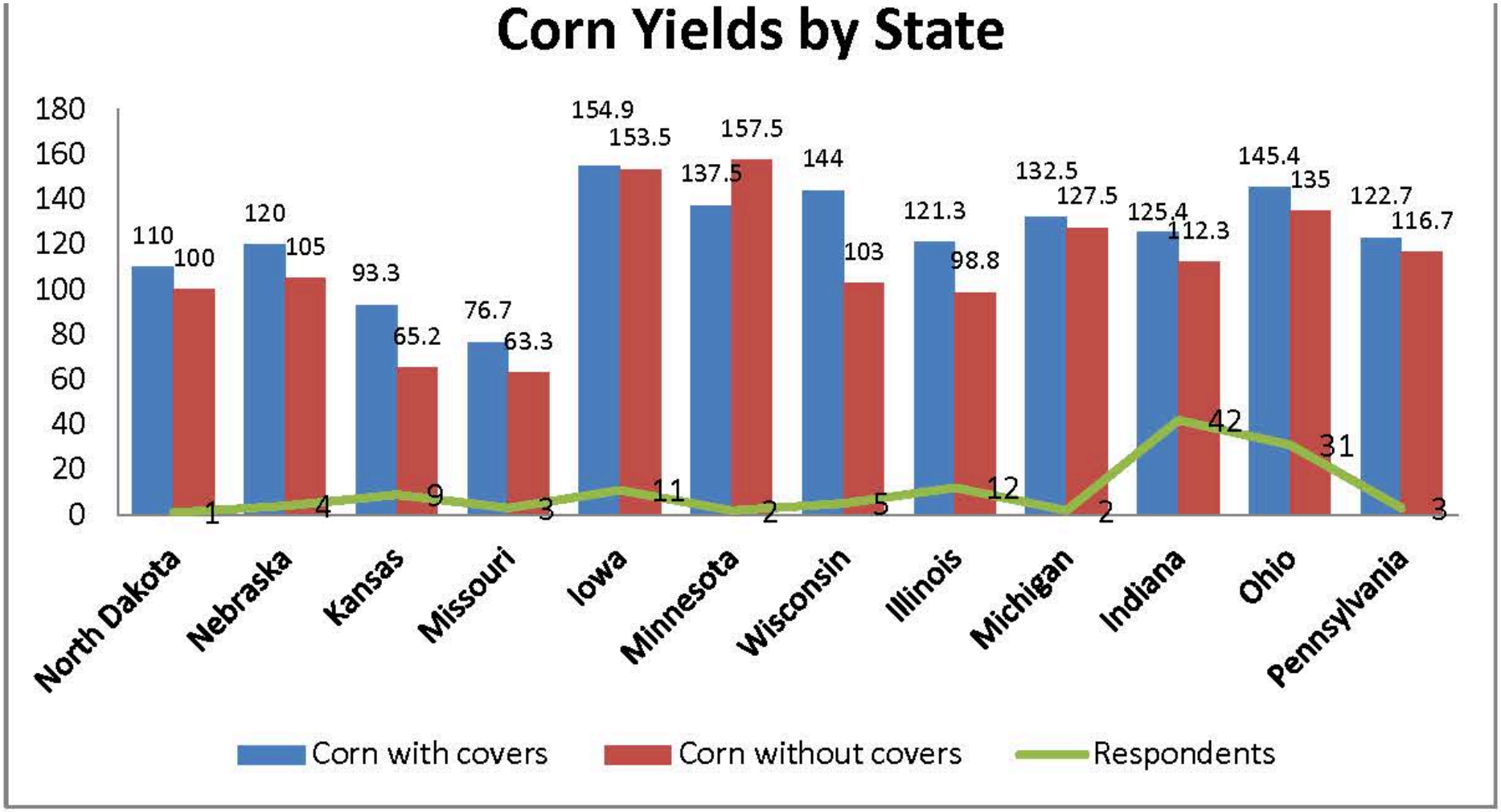


Figure 26. Average corn yields by state with and without cover crops.

CITC Survey, 2013

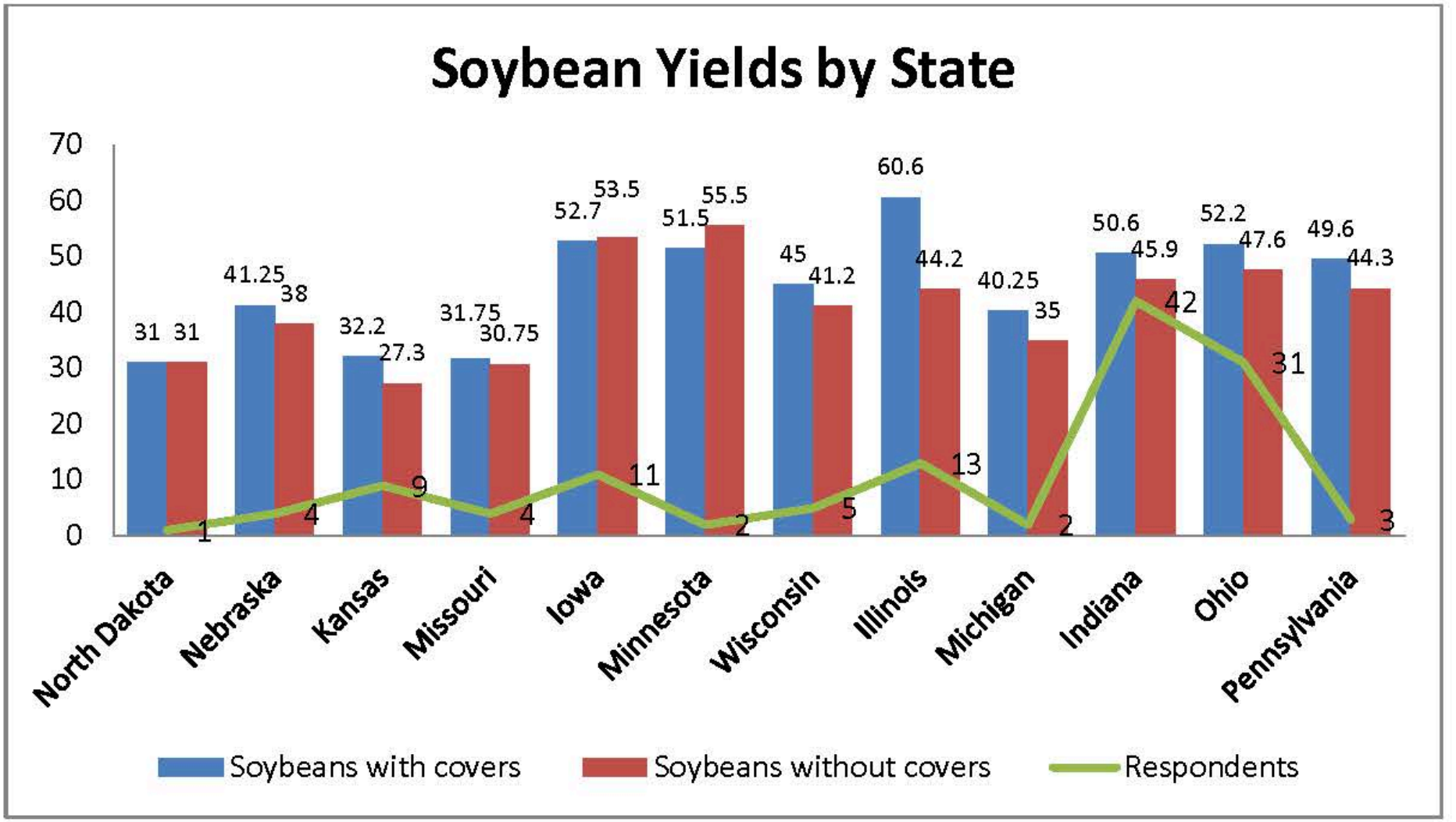


Figure 27. Average soybean yields by state with and without cover crops.

CITC Survey, 2013

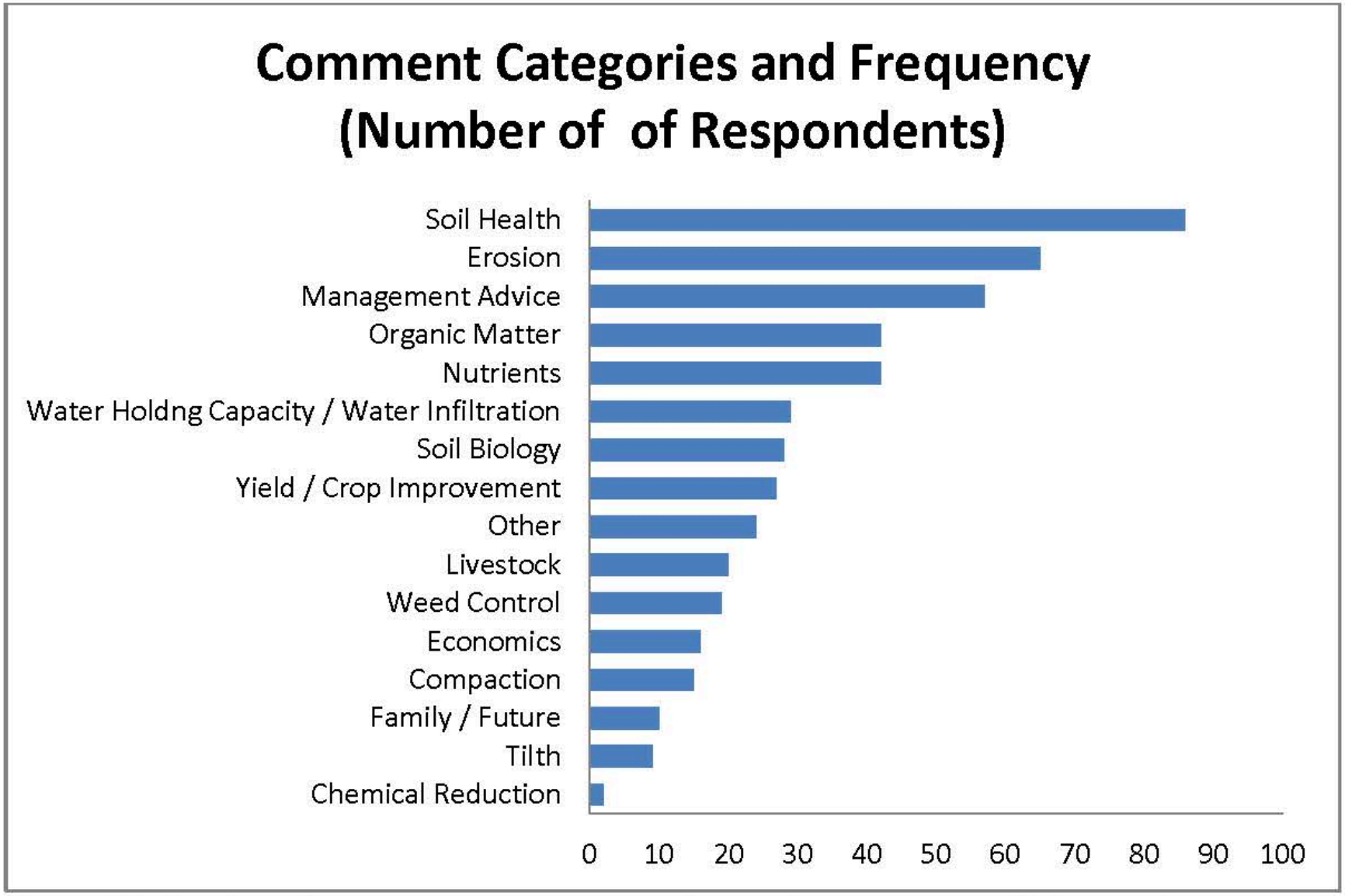


Figure 28. Number of cover crop survey respondents whose responses fit into each category.

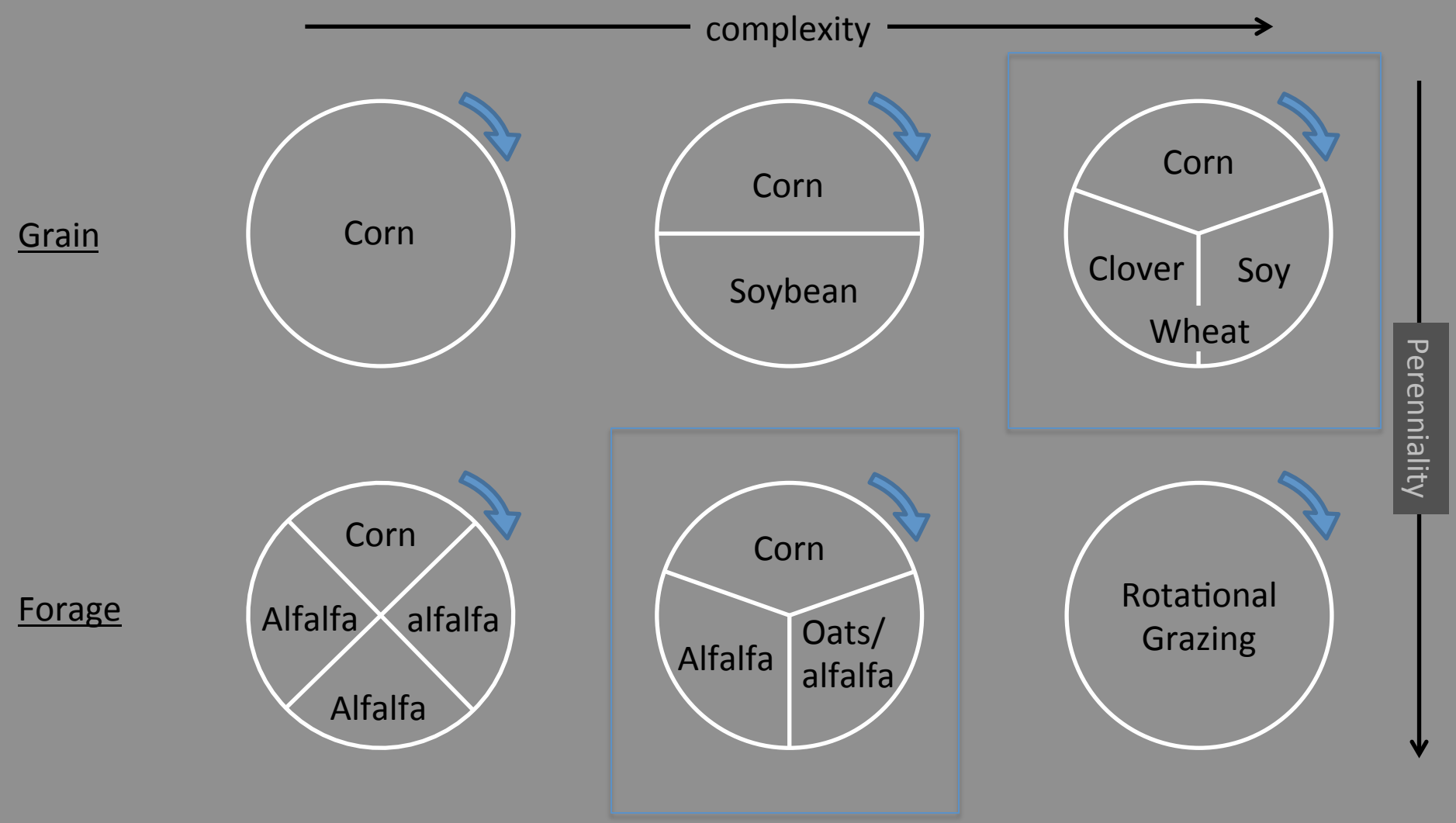
CITC Survey, 2013

The Wisconsin Integrated Cropping Systems Trial

The Wisconsin Integrated Cropping Systems Trial (WICST)

- UW Ag. Research Station
  - Arlington, WI
  - Lakeland, WI
- One-acre plots – field scale equipment
- Silt loams
  - LAC – poorly drained Pella and Griswold, mottled subsoil variant
  - ARL – Plano silt loam
- In dairy rotation
  1850 - 1989
- WICST established
  1989 - 1990
- RCB with 4 blocks

WICST Cropping Systems



SOC trends at WICST

Historic loss of SOC

c. 1850 - present

Wisconsin

Grace et al. 2006

- 14 % SOC lost
- Sampled 0 - 10 cm

Arlington, WI

Collins et al. 1999

- 18% SOC lost
- Sampled 0 - 20 cm

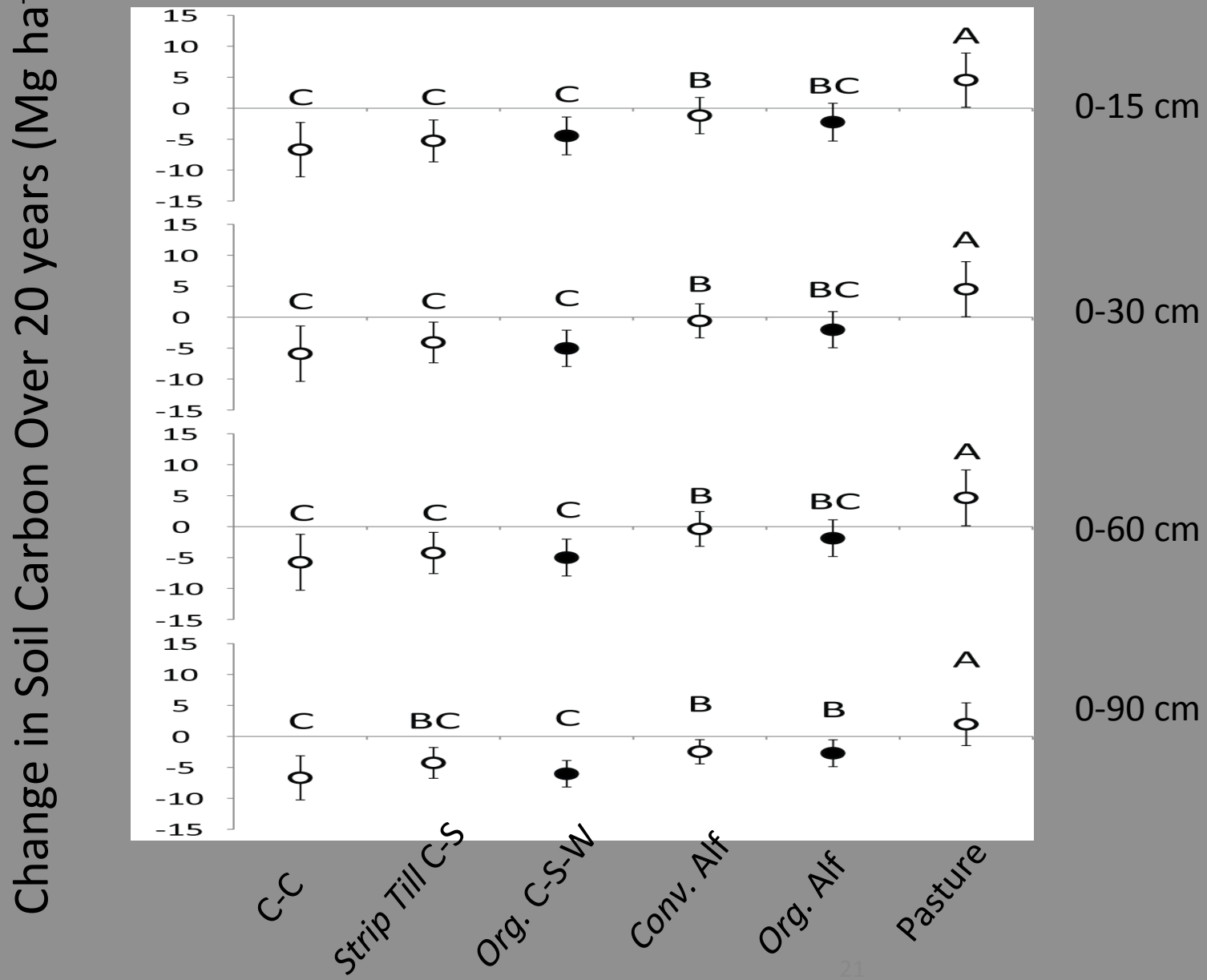
Globally: 30 - 50% of SOC lost (Lal 2008; Ogel et al. 2005)

http://www.kansasmemory.org/item/7878

NCSU photo: http://iowahomestead.wordpress.com/


http://ngm.typepad.com/photos/uncategorized/2008/01/02/0103_os.jpg

WICST SOC trends



Bars represent ±1 standard error; Pr>|t| , † p<0.1, * p<0.05, ** p<0.01

Soil C inputs on WICST

Group	System	Description	Estimated Annual C Input		
			Above Ground	Below Ground	Root / Shoot
			---------- (kg ha^{-1}) ----------		
Grain	CS1	continuous corn	3800	2240	0.58
	CS2	corn-soybean	2940	1670	0.56
	CS3	organic grain	2240	1200	0.54
Forage	CS4	conventional forage	3050	3840	1.25
	CS5	organic forage	3220	4010	1.24
	CS6	pasture	1590	4570	2.87

WICST SOC trends

General SOC (g kg^{-1}) trends

	Δ g kg^{-1}	Sign.
NT vs. Tilled	**2.8**	**†**
Forage vs. Grain	**3.2**	*****

SOC (g kg^{-1}) correlations

			------ Estimated C inputs------	
	Tillage	Manure	Aboveground	Belowground
	----------	----------	r ----------	----------
-	**0.10***	**0.13****	-0.05	**0.11****

Pr>|t|, ns=not significant, † p<0.1, * p<0.05, ** p<0.01

Conclusions & Implications

- NT, manure, forage crops – beneficial
- Perennial grasses in crop rotations
  - Grass ley
- Perennial functionality
  - Cover crops, intercropping
- Pasture systems – important part of agricultural landscape

Data from Long-term Study at Kellogg Biological Station in MI

- High residue crops and perennials (sod) increase SOM.
- High residue crops and perennials (sod) reduce soil erosion.
- Diversity in crop rotations increases biological activity in the soil and diversity of soil biota.
- Many perennial species and some annuals have deep extensive root systems that reduce soil compaction and improve soil condition.

Bhardwaj et al., 2011

How do we integrate cover crops into the system?

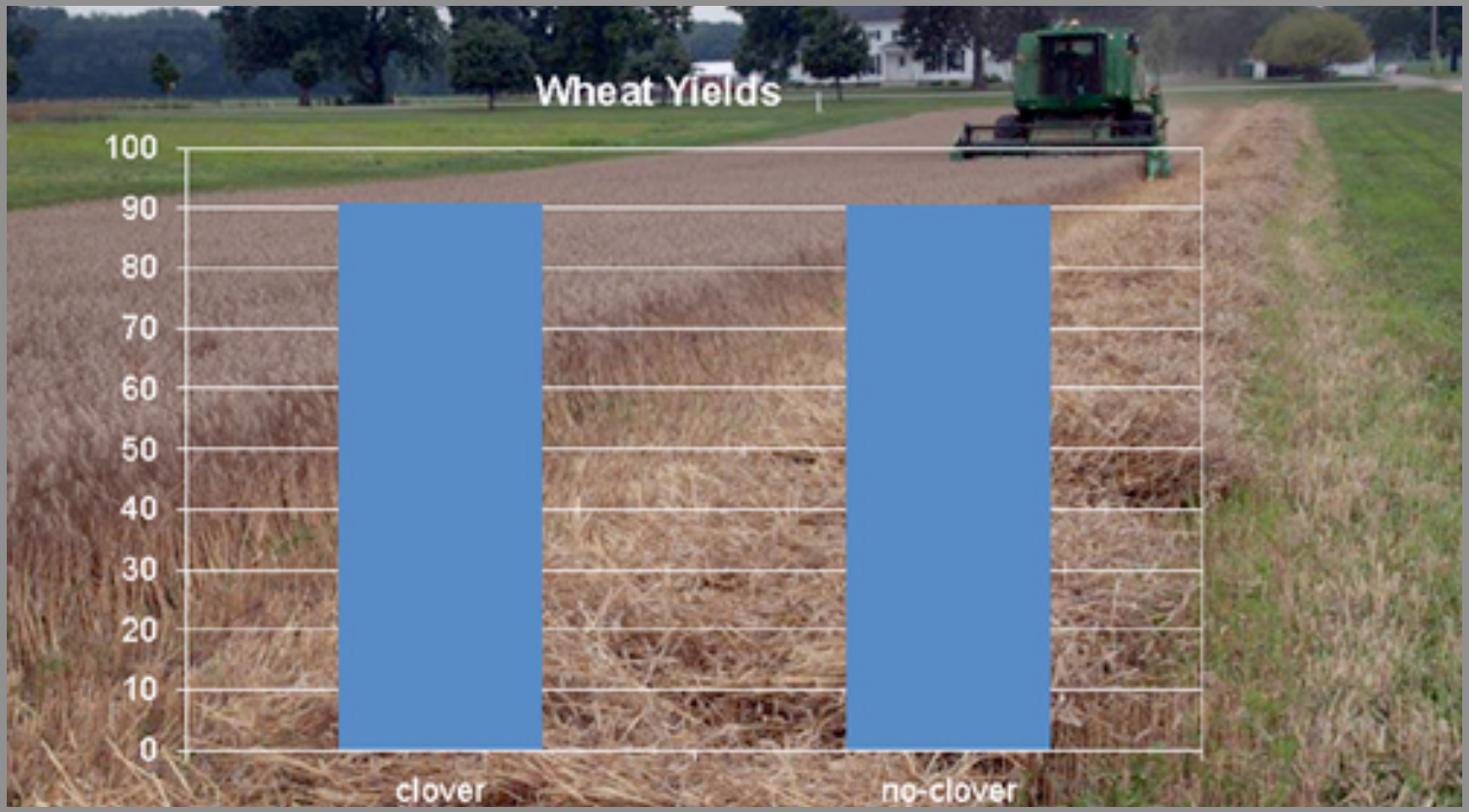
- Fall planting after a cash crop
- Frost seeding with small grain
- Aerial seeding into standing corn
- Cover crop-based no-till

Frost-seeded clover in wheat

Frost Seeding into Winter Wheat

- “Cracked soil surface” seeding.
- Seed falling into the cracks is placed at an ideal depth, resulting in stands similar to those produced by drilling
- Usually, ideal conditions for frost seeding occur in mid to late March
  - Low overnight temperatures cause the surface to freeze and crack
  - Warm daytime temperatures thaw the surface, sealing the cracks
- Daily “window” for seeding lasts only a few hours, beginning at dawn
- Seed can be broadcast until mid-April if cracks are present and the traditional frost-seeding window is missed
  - beyond mid-April more risky
- Ideal frost seeding conditions may only occur a few days each year so preparation and close monitoring of field conditions are essential for success
- Seed should not be broadcast before mid-March even if conditions are ideal because extreme cold temperatures can still occur and may kill seedlings

Wheat Yields in MI after Frost-Seeding with Red Clover



Mutch, 2011

Aerial Seeding

(Ruark, 2013)

- Aerial apply cover crops when the corn plant is dried approximately to the ear
- Aerial apply cover crops when approximately 50% of the sunlight can reach the ground between the rows (Walk in the field a few rows to determine this)
- When seeding into soybean, aerial application should occur between 50% yellowing and 50% leaf drop
- The seeding rate for aerial application should be increased by 20 to 50% over recommended rates for drill-seeded cover crops

Photo of Aerial Seeded Cereal Rye – SE Iowa

http://talk.newagtalk.com/forums/thread-view.asp?tid=202051&DisplayType=flat&setCookie=1

Phases of Cover-Crop Based No-Till

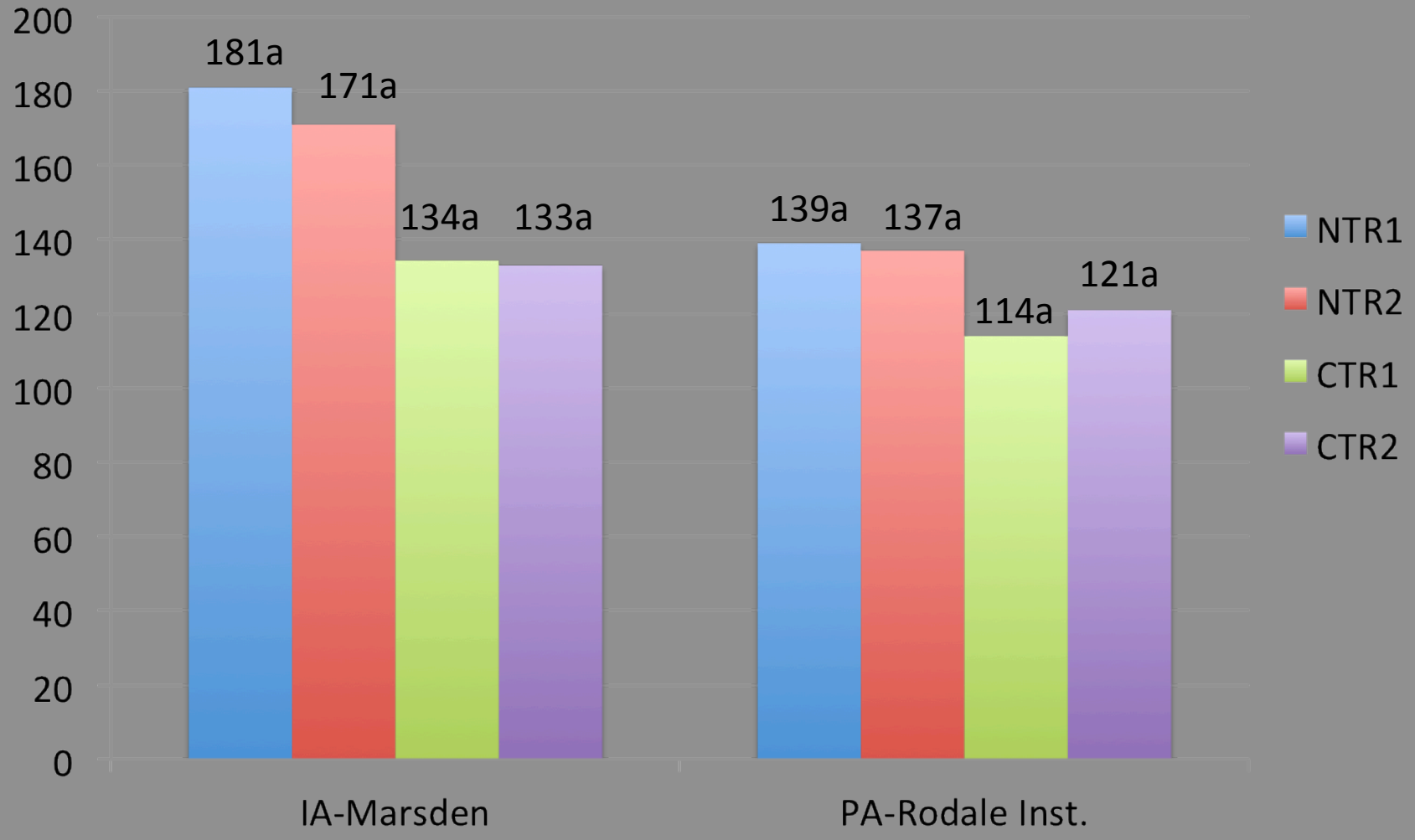
Images courtesy of Kathleen Delate at Iowa State Univ., and Dale Mutch at Michigan State Univ.

Soybean – end of July

Examples of Soybean Yields across Experiments

	Till (bu/ac)	Cover-Crop No-Till (bu/ac)
2009 (Silva)	47	30
2008/2009 (Bernstein)	54	43
2011 (Silva)	52	53

Microbial biomass C-Fall 2011



Take-Home Messages

- High residue crops and perennials increase SOM and reduce soil erosion
- Diversity in crop rotations increases biological activity in the soil and diversity of soil biota
- Integration of cover crops into the system is one way to achieve these results