Cover Crops and Soil Health in the Southeastern US

Carlene A. Chase, Julia Gaskin, Kip Balkcom, Sindhu Jagadamma, Chris Reberg-Horton, and Mark Rieter

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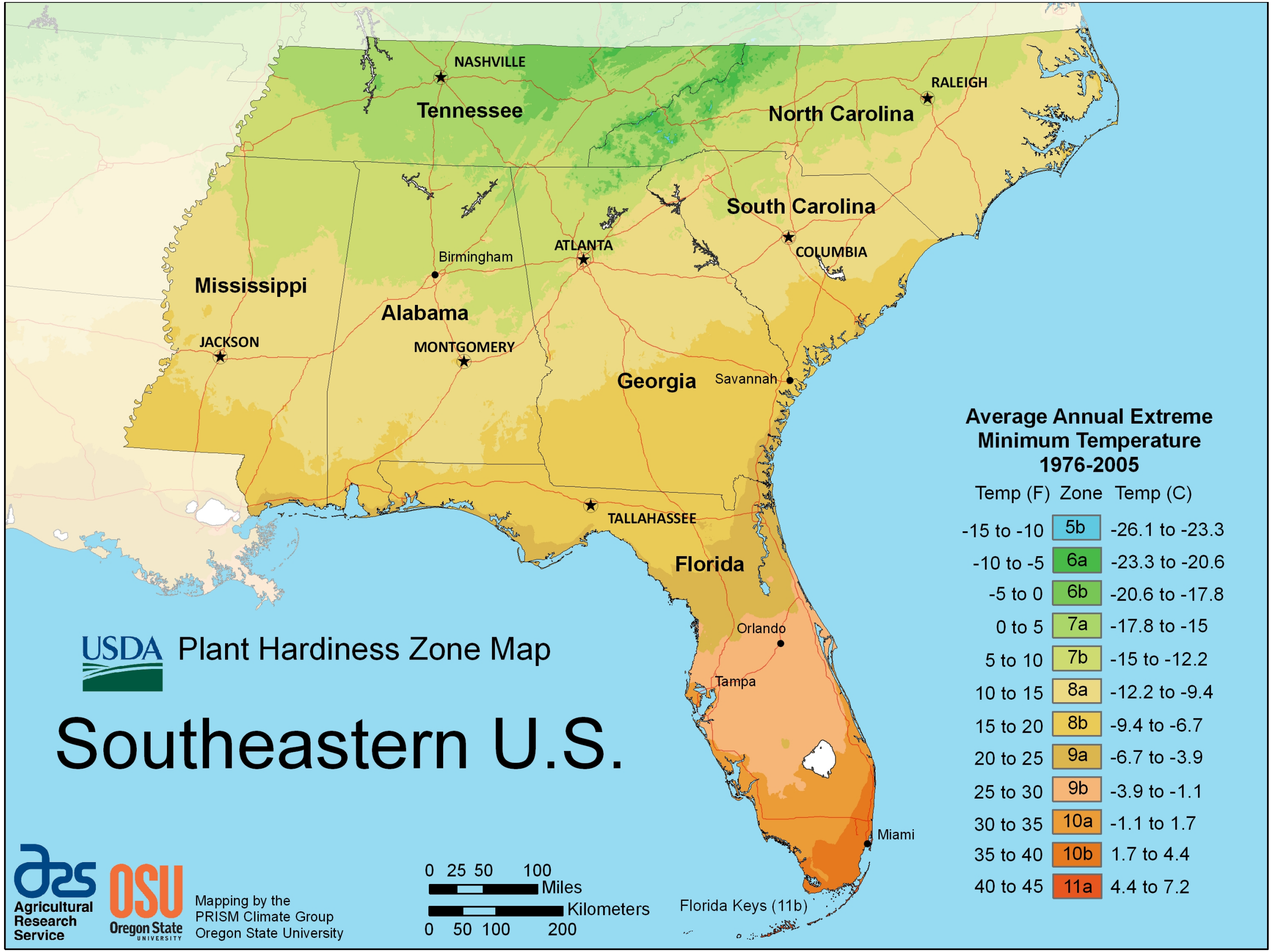
Outline

- Reasons for regional diversity
- Florida
- Georgia
- Alabama
- Tennessee
- North Carolina
- Virginia
- The Future

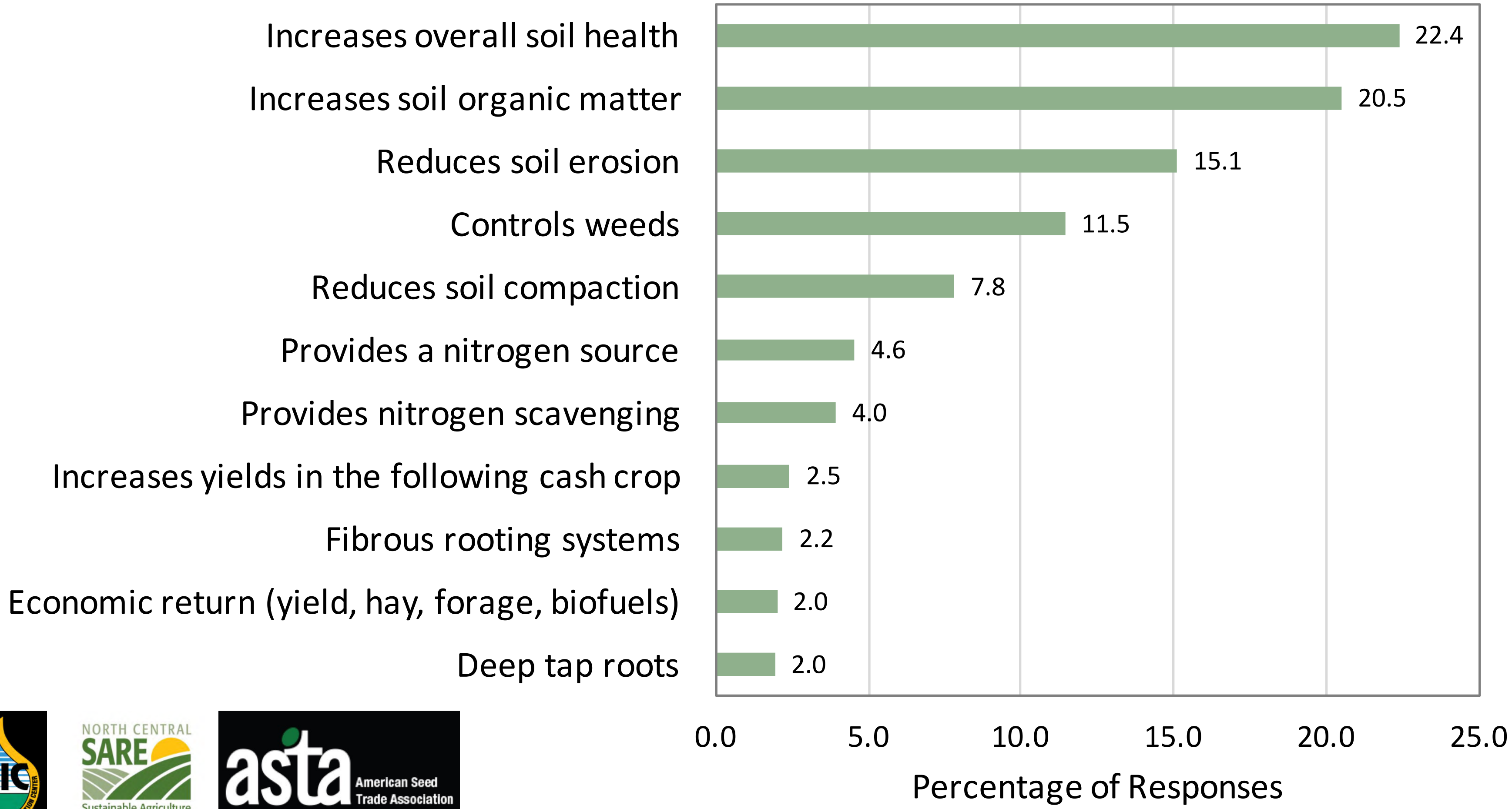
The USDA Plant Hardiness Zone Map for the Southeast



Disciplines Involved in Cover Crop Research

- Agronomy/Crop Science
- Horticultural Science
- Microbiology
- Soil Science
- Weed Science

Top cover crop benefits desired by users



Off-season cover crops for weed and sting nematode suppression for organic strawberry production in Florida

Sunn hemp

Hairy indigo

American jointvetch

Short-flower rattlebox

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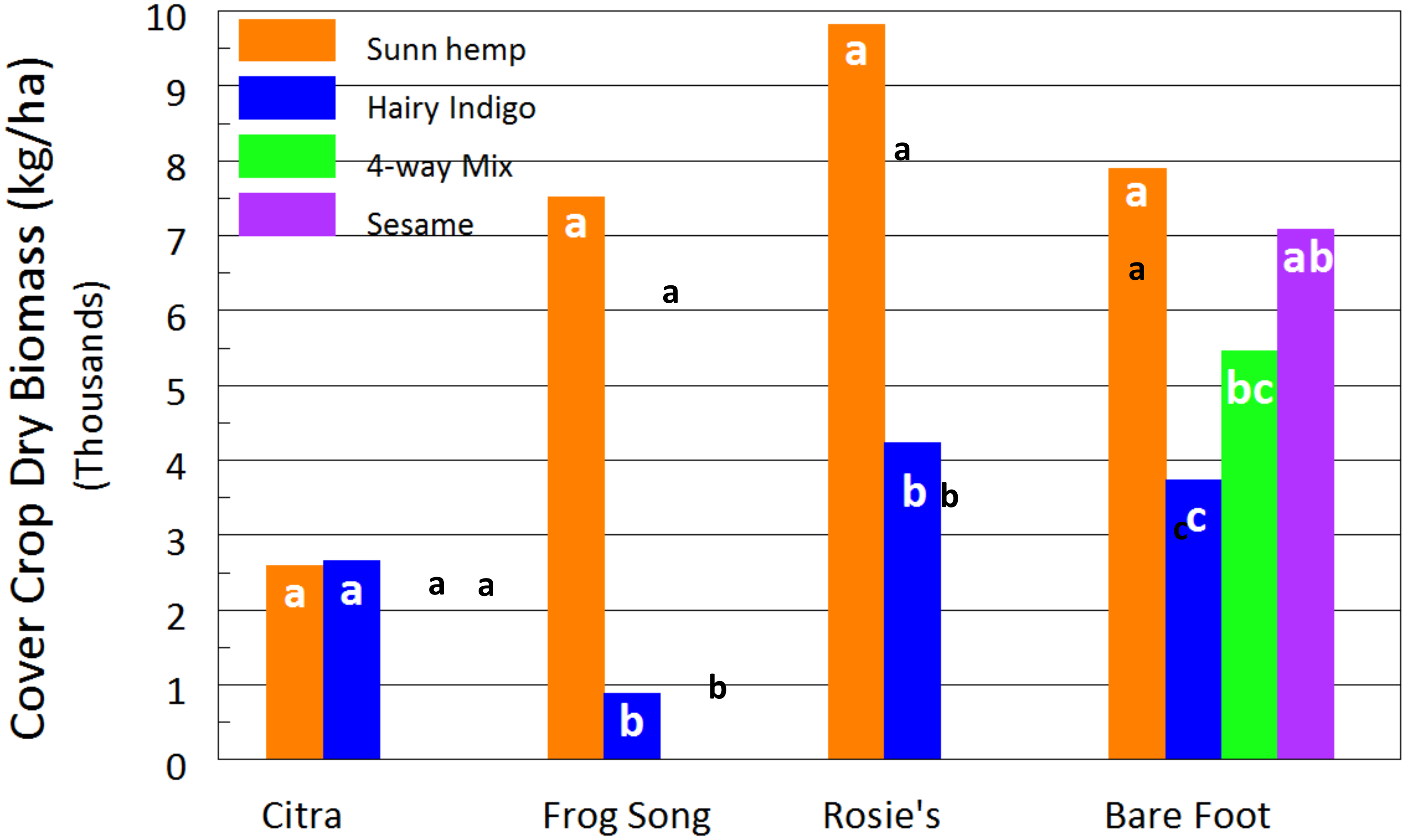
Cover crop dry biomass at 9 WAP by farm (2014)



Weed biomass suppression with cover crops by farm

Farm	Cover Crop	Broadleaf	Grasses	Sedges	Total
		(kg/ha)			
Citra	Weedy	20	186	94	301
	Sunn hemp	25	92	139	256
	H. indigo	5	97	111	213

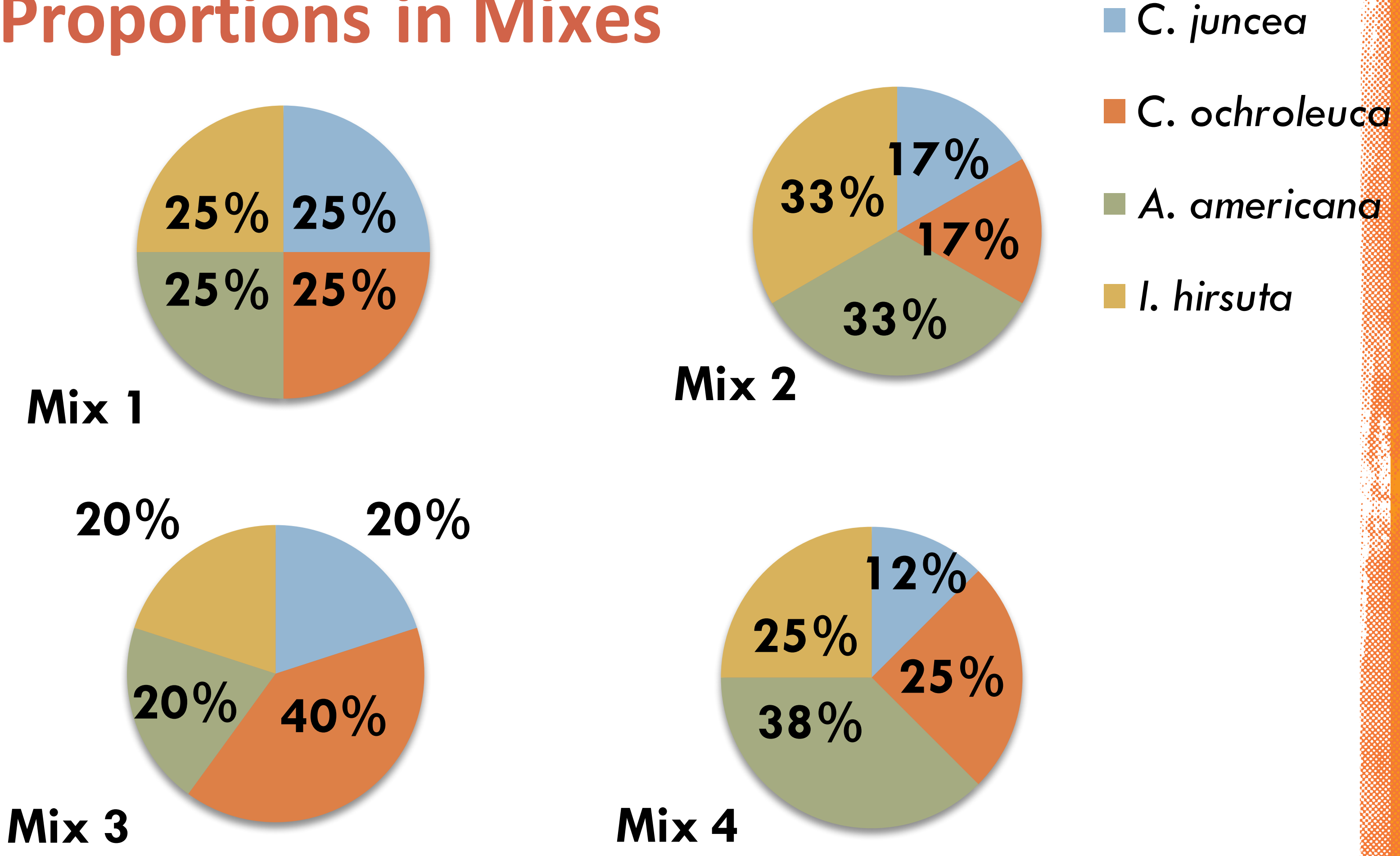
Weed biomass suppression with cover crops by farm

Farm	Cover Crop	Broadleaf	Grasses	Sedges	Total
		(kg/ha)			
Frog Song	Weedy	6237 a	217	273 a	6727 a
	Sunn hemp	473 b	0	8 b	481 b
	Hairy indigo	2709 b	0	0 b	2709 b
Rosie's	Weedy	200	3796 a	214 a	4267 a
	Sunn hemp	1	42 b	46 b	89 b
	Hairy indigo	0	182 b	18 b	200 b

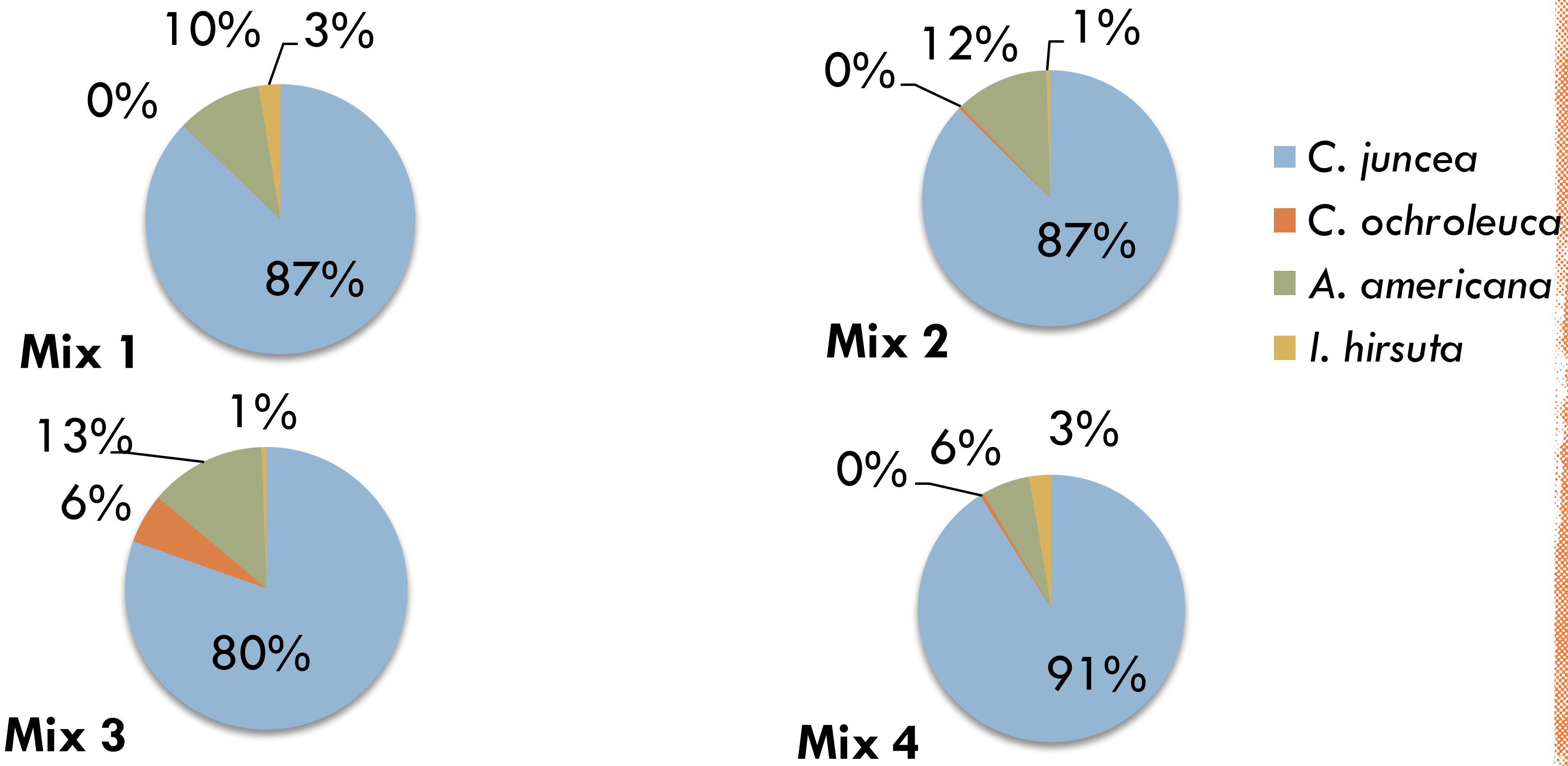
Weed suppression at Bare Foot Farm

Cover Crop	Broadleaf	Grasses	Sedges	Total
	(kg/ha)			
Weedy	1387 a	1322 a	40 a	2749 a
Sunn hemp	39 b	22 b	11 b	73 b
Hairy indigo	268 b	330 b	2 b	600 b
4-way mix	86 b	500 ab	2 b	588 b
Sesame	78 b	243 b	13 b	334 b

Seed Proportions in Mixes



Cover crop species proportion in mixes by biomass



Differing sunn hemp susceptibility to sting nematodes

Accession	Origin	Nematodes/100 cm^3 soil
PI 207657	Sri Lanka	4.0 bc
PI 219717	Myanmar	0.0 c
PI 250485	India	3.4 bc
PI 250486	India	3.8 bc
PI 250487	India	0.0 c
PI 314239	Fmr USSR	0.0 c
PI 322377	Brazil	12.8 b
PI 337080	Brazil	7.8 bc
PI 391567	South Africa	0.0 c
PI 426626	Pakistan	0.0 c
PI 468956	US	0.0 c
Corn	US	60.0 a

Summer Cover Crops Make Me Feel Fine: Optimizing Cool Season Crop Production

George Boyhan, Horticulture
Julia Gaskin, Crop & Soil Science
Elizabeth Little, Plant Pathology
Sam Kaninda, Ag & Applied Economics
Greg Fonsah, Ag & Applied Economics
Suzzanne Tate, Horticulture

SARE Sustainable Agriculture Research & Education

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Why Cool Season Focus?

- Interest in local, organic in groceries, schools, institutions
- Less disease and insect pressure
- Focus on mid-scale farm and wholesale production
- Compost is expensive!

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Two main questions

- Can we maintain soil quality using cover crops?
- Would cool season rotations using cover crops be profitable?

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Positive Key Findings

- Sunn hemp+soil provided 75% of nitrogen for onions
- No differences between rotations for fertility
- Rotations with only cover crops (no compost/manure) may **maintain** soil organic matter

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Negative Key Findings

- Do not appear to ***build*** soil organic matter
- Reliance on only cover crops at this frequency may deplete labile soil N

Questions about Cover Crop Mixtures

Kip Balkcom

United States Department of Agriculture
Agricultural Research Service
National Soil Dynamics Laboratory
Conservation Systems Research

Questions about Cover Crop Mixtures

- Establishment – Segregation of different size seeds.
- Correct/Practical Ratios – Don’t overload with cereals.
- Benefits – Yield, Carbon, and Microbial increase.
- Costs vs Benefits.

3-Way Mixture Test

Number of Species			
Trt #	**1**	**2**	**3**
1	Fallow		
2	Cereal rye (90)		
3	Crimson clover (20)		
4	Radish (8)		
5	Cereal rye (45)	Crimson clover (20)	
6	Cereal rye (30)	Crimson clover (20)	
7	Cereal rye (45)	Radish (8)	
8	Cereal rye (30)	Radish (8)	
9	Crimson clover (20)	Radish (8)	
10	Crimson clover (10)	Radish (8)	
11	Cereal rye (45)	Crimson clover (10)	Radish (4)
12	Cereal rye (30)	Crimson clover (10)	Radish (4)

Cover Crop/Mixture	Seeding Rate	2016	2017	2 year Average
	lb/ac	----------------Biomass (lb/ac)----------------		
Rye/Clover	30/20	4536	6983	5759
Clover/Radish	10/8	4483	6661	5572
Rye	90	4079	6384	5232
Rye/Clover/Radish	45/10/4	3642	6491	5067
Rye/Radish	45/8	3507	5325	4416
Rye/Clover	45/20	3794	4899	4346
Clover/Radish	20/8	4022	4542	4282
Rye/Clover/Radish	30/10/4	3725	4638	4181
Clover	20	3648	4424	4036
Rye/Radish	30/8	3073	4971	4022
Radish	8	3390	3086	3238
Fallow		498	2104	1301
Total		3533	5042	4288

Cover Crop/Mixture	Seeding Rate	Seed Cost	Total Cost	2 year Biomass	Avg Biomass Cost
	lb/ac	-----US $/ac-----		lb/ac	US $/100 lb
Radish	8	12.80	30.64	3238	0.95
Rye	90	22.50	56.92	5232	1.09
Clover	20	40.00	57.84	4036	1.43
Clover/Radish	10/8	32.80	50.64	5572	0.91
Rye/Radish	30/8	20.30	38.14	4022	0.95
Rye/Radish	45/8	24.05	41.89	4416	0.95
Rye/Clover	30/20	47.50	65.34	5759	1.13
Rye/Clover	45/20	51.25	69.09	4346	1.59
Clover/Radish	20/8	52.80	70.64	4282	1.65
Rye/Clover/Radish	45/10/4	37.65	55.49	5067	1.10
Rye/Clover/Radish	30/10/4	33.90	51.74	4181	1.24

Multi-species Cover Cropping and Soil Properties

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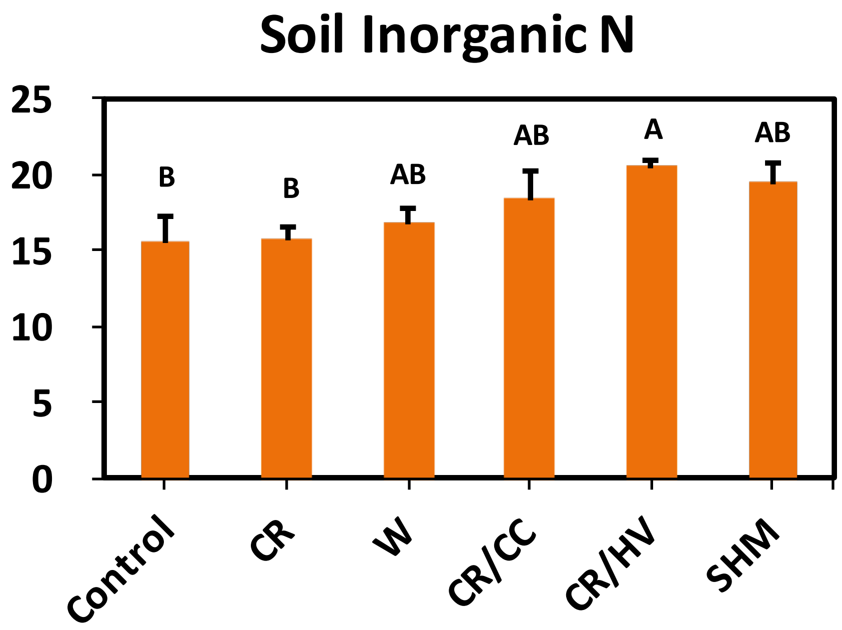
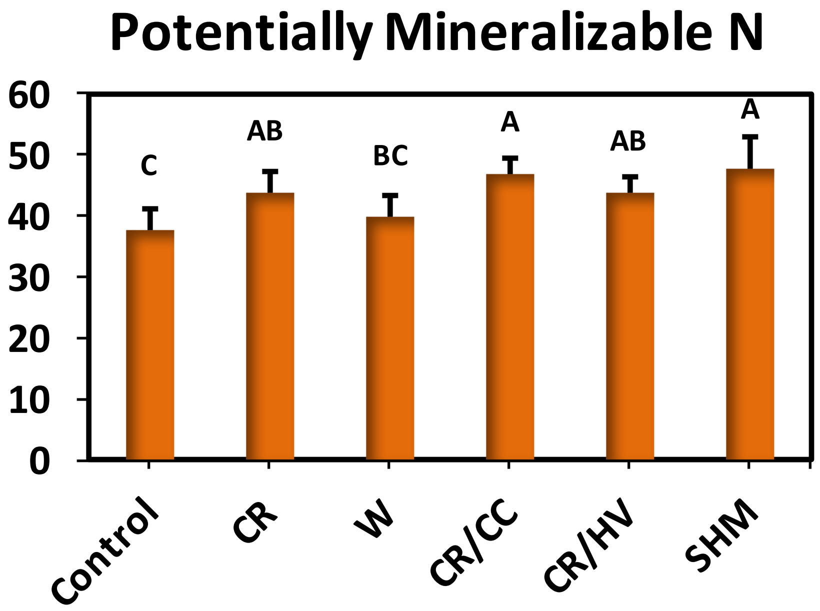
Cover Crop Field Experiment in Tennessee

- Started in 2013
- Corn-soybean system
- No-tillage

Treatments	Cover crop species	# of species
Control	No cover crop	0
CR	Cereal Rye	1
W	Wheat	1
CR/CC	Cereal Rye + Crimson Clover	2
CR/HV	Cereal Rye + Hairy Vetch	2
Soil Health Mix (SHM)	Cereal Rye, Oats, Daikon Radish, Purple Top Turnips, Crimson Clover, Hairy Vetch	6

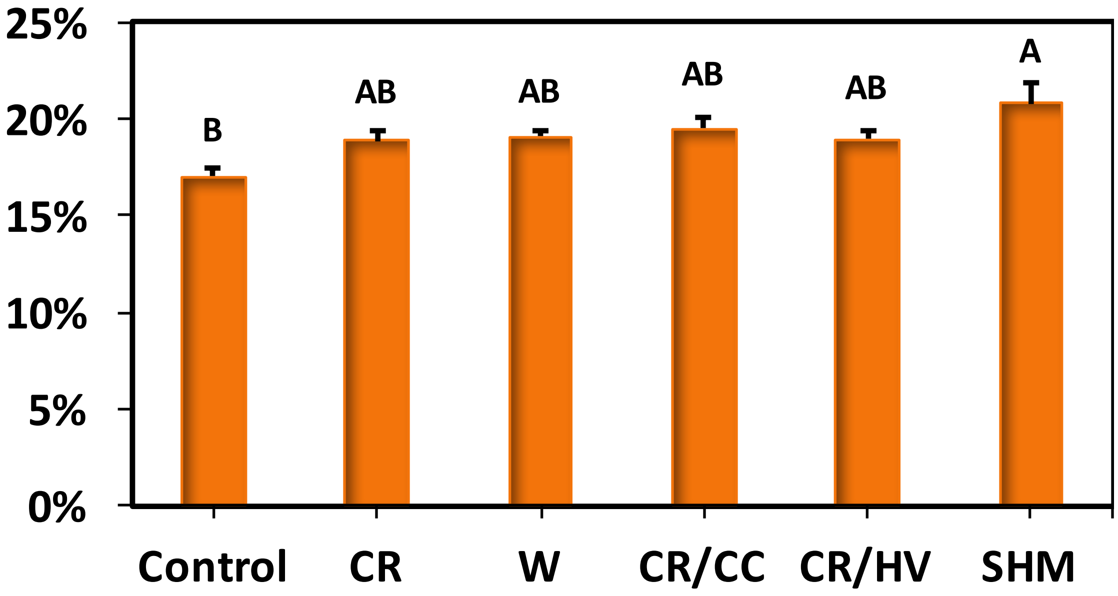
Nitrogen availability in Oct. 2016 directly after soybean harvest





Control	No cover crop
CR	Cereal Rye
W	Wheat
CR/CC	Cereal Rye + Crimson Clover
CR/HV	Cereal Rye + Hairy Vetch
SHM	NRCS's Soil Health Mix

Effect of Cover Crops on Gravimetric Soil Moisture Content



Control	No cover crop
CR	Cereal Rye
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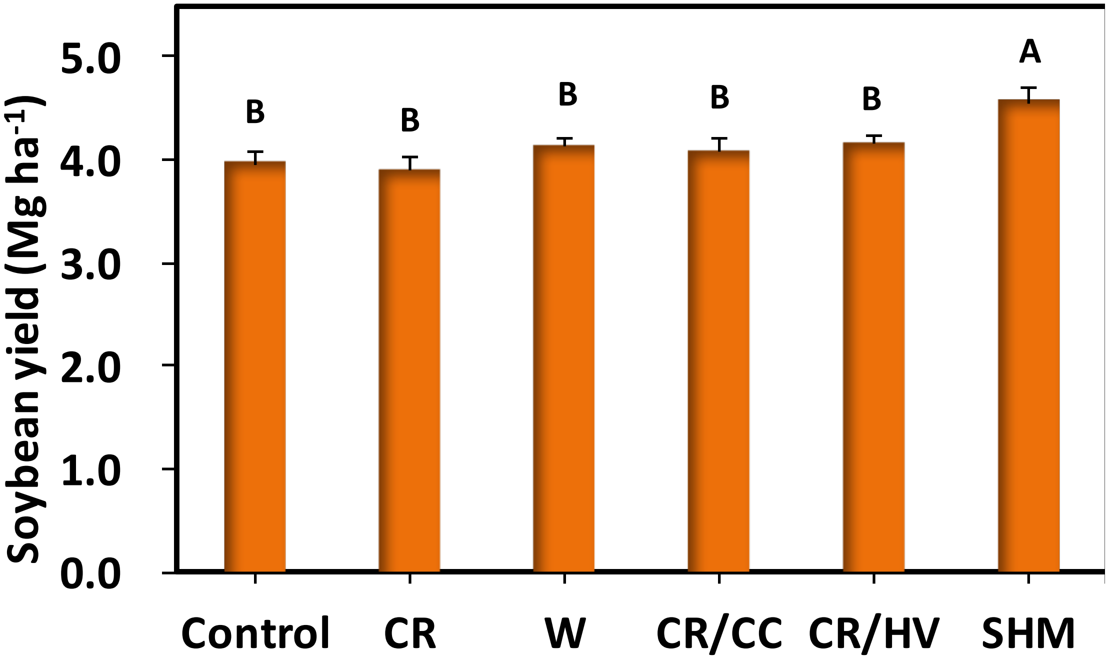
CR/CC	Cereal Rye + Crimson Clover
CR/HV	Cereal Rye + Hairy Vetch
SHM	NRCS's Soil Health Mix

Cover Crop Effects on Soybean Yield (2016)



Control	No cover crop
CR	Cereal Rye
W	Wheat
CR/CC	Cereal Rye + Crimson Clover
CR/HV	Cereal Rye + Hairy Vetch
SHM	NRCS's Soil Health Mix

Conclusions

- After three years, multi-species cover cropping increased:
  - ⇨ Crop yield
  - ⇨ Soil inorganic and potentially mineralizable N
  - ⇨ Gravimetric soil moisture
- No change in total and labile fractions of organic C with cover cropping
- Plan to collect multiple years of data from multiple soil depths and time points

Cover crops for weed suppression

Chris Reberg-Horton

NC STATE UNIVERSITY

- Decrease cultivation for organic systems
- Manage herbicide-resistant weeds in conventional systems.


Weed control can be excellent


Weed control can be poor

Biomass production and residue persistence are key for weed control!

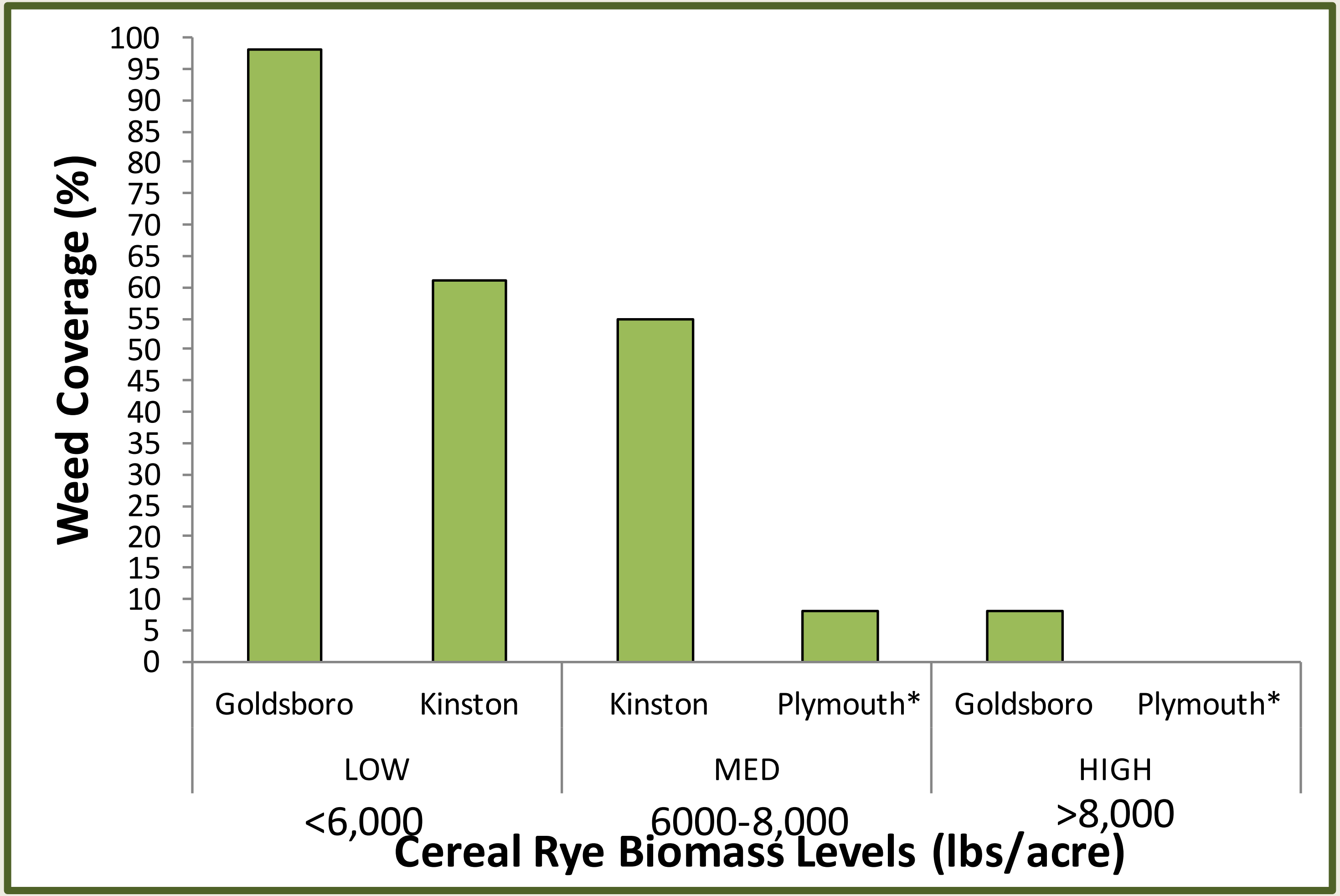
Small Grains

- Can produce substantial biomass, especially cereal rye!
- Residues decompose slowly

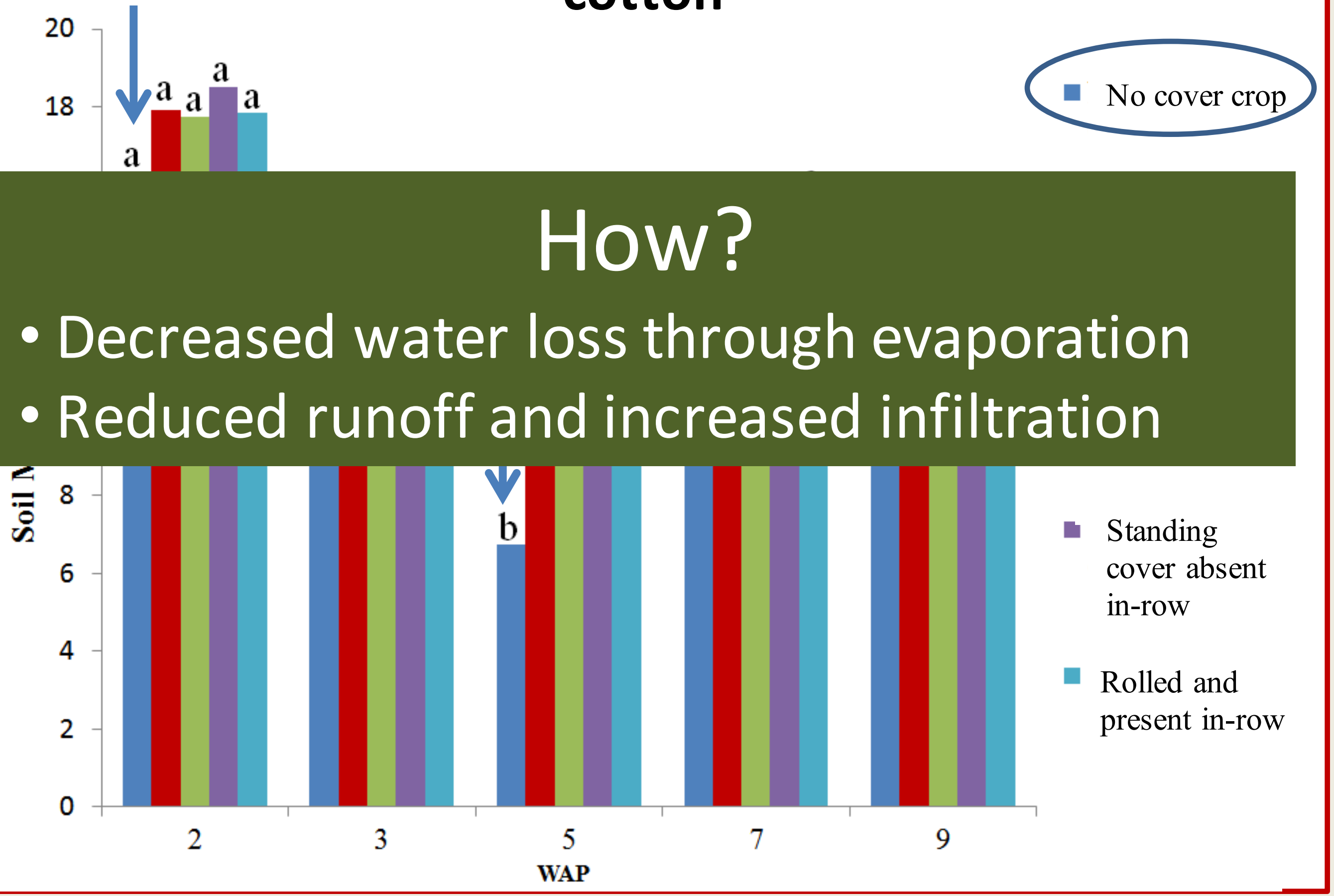
Legumes

- Biomass production is moderate
- Residues decompose rapidly, especially when wet and hot

Weed coverage in soybean as affected by cereal rye biomass



Soil moisture response to cover crop treatments in cotton



How?

- Decreased water loss through evaporation
- Reduced runoff and increased infiltration

Legume cover crops as green manure

Crimson clover

Winter pea

Winter legume cover crops

Hairy vetch

Legume cover crop breeding

Legume cover crop breeding goals

Crimson Clover Goals

- Fall vigor
- Winter hardiness
- Spring biomass production
- Soft & hard seeded varieties
- Early & late maturating cultivars

Hairy Vetch Goals

- Fall vigor
- Winter hardiness
- Spring biomass production
- Remove hard-seededness
- Early & late maturating cultivars

Enhancing Disease Resistance in Winter Pea

Virginia Cover Crops: Successes and Constraints

Eastern Shore Agricultural Research & Extension Center

USDA United States Department of Agriculture
Natural Resources Conservation Service

Virginia Cooperative Extension
Virginia Tech • Virginia State University

VirginiaTech 1872
Invent the Future

VirginiaTech 1872
Virginia Agricultural Experiment Station

Mark S. Reiter, Ph.D.
Soils and Nutrient Management Specialist

Where we want to go:
Soils separated by a 20-ft. dirt road.

3-Year Rotation

Rotation	1 CT Control	2 NT Control	3 Rye	4 Vetch	5 Kitchen Sink Mix	6 NT Control	7 Vetch/ Rye	8 NT Control	9 Diverse Mix 1	10 Diverse Mix 2	11 Diverse Mix 3	12 Perennial
Winter 1/4			Rye	Vetch	Kitchen Sink		Vetch		Residue Maker	N Fixer	Wheat	
Summer 1/4	Corn	Corn	Corn	Corn	Corn	Corn	Corn	Corn	Soybean	Sumer Mix	Summer Mix	
Winter 2/5			Rye	Vetch	Kitchen Sink		Rye	Wheat	Wheat	Residue Maker	N Fixer	Perennial Mix
Summer 2/5	Corn	Corn	Corn	Corn	Corn	Soybean	Soy bean	Soybean	Sumer Mix	Soybean	Summer Mix	
Winter 3/6			Rye	Vetch	Kitchen Sink		Vetch		N Cyclone	Late Bloomers	N Fixer Upper	
Summer 3/6	Corn	Corn	Corn	Corn	Corn	Corn	Corn	Corn	Corn	Corn	Corn	Corn

Successes

- Can provide ample biomass if desiccation is delayed and still have good corn yield (3,000 to 8,000 lbs aerial dry matter/acre plus, depending on species and mixes).
- Increased soil moisture for corn planting if desiccation is delayed.
- Reduced penetrometer pressure readings.
- After 3 years, legumes within the system can provide significant fertility, N cycling, & sulfur mining.

Problems

- Difficult to get many species planted timely in the fall. Brassicas are especially hard.
- Difficult to plant anything behind soybean and soybean is one of the greatest acreage crops.
- While many species winter kill (spring oat, tillage radish), we cannot count on consistent killing for management.

Problems (cont.)

- Planting mixes can be difficult due to seed size variation. Seeds can be too deep or too shallow.
- Planting in high-residue is really difficult even for experienced no-till farmers
- Insect damage to corn can quickly result (i.e. stinkbugs with flowering cover crops - brassicas).

Southern Cover Crops Council

1. Identify a common set of biological & economic measures to be applied across crop and cover crop combinations to generate a region-wide database.

2. Select/evaluate summer & winter cover crop germplasm for regional adaptability and determine the appropriate planting time, seeding rates, cover crop goods, and termination time to optimize benefits without adversely affecting cash crop cycles.

Southern Cover Crops Council

3. Assess the influence of cover crops on soil moisture, nutrient cycling, and soil microbiology.
4. Characterize cover crop efficacy for enhancing cropping system resilience to weeds, pests, and plant pathogens.
5. Generate an economic database that researchers, technical advisors, and farmers can use to assess short & long-term economic outcomes of cover crop use.

Thank you! Questions?

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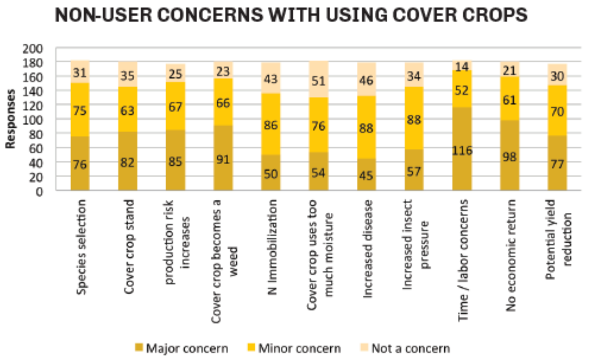
Challenges with cover crop use

- Timing (establishment and termination)
- Seeding costs
- Equipment investments
- Lack of regionally adapted cultivars



SARE, 2017