Do Cover Crop Mixes Impact Soil Health More than Single Species?

Sabrina Ruis
Research Assistant Professor
Department of Agronomy and Horticulture

Original Landscape of Nebraska: Native Prairie

Often used as a comparison for a "healthy" ecosystem

Delivers many ecosystem services:

- **Food for animals**
- **Habitat for animals, insects**
- **Improved air and water quality**
- **Aesthetic beauty**
- **Recreational opportunities: hiking, hunting…**
- **"Healthy" soil**
- **And many more…**

Original Landscape of Nebraska: Native Prairie

Current Intensive Agriculture: Corn or soybean

Delivers ecosystem services of:

Food and fiber

Air and water quality?? – Nitrate leaching and runoff of soil and nutrients a problem

Habitat?? – reductions in pollinator habitat

Biodiversity?? - reduced

Others…

Original Landscape of Nebraska: Native Prairie

Current Intensive Agriculture: Corn or soybean

How can intensive agriculture mimic the prairie?

Nebraska Crop Management Conference

Original Landscape of Nebraska: Native Prairie

Current Intensive Agriculture: Corn or soybean

How can intensive agriculture mimic the prairie?

Photo by: K. Koehler-Cole

Possible Answer: Cover crop mixes?

But do they really improve soil health parameters over single species?

Are Cover Crop Mixes Better than Single Species Cover Crops For:

1. producing more biomass?
2. reducing soil erosion and N leaching more?
3. improving C, soil health, and resistance to compaction more?
4. using less water?

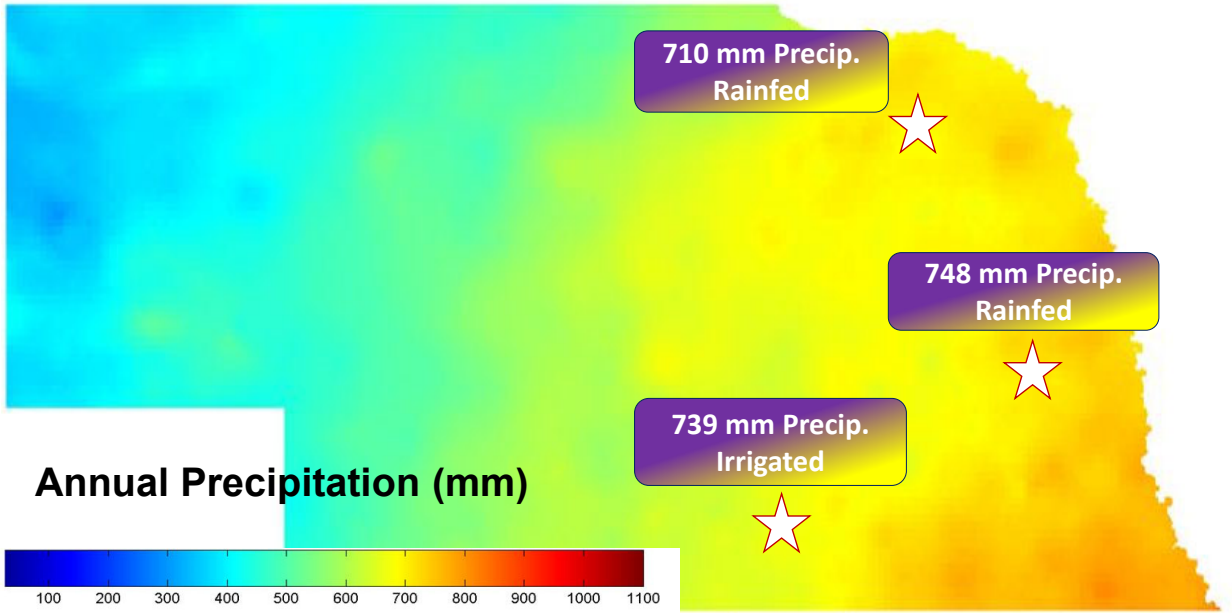
What Does Research on Multispecies CC Mixes Show?

- Case study in Nebraska
- Review of published data

Cover Crop Mix vs Single Species at 3 Sites in Nebraska for 4 years

Assessed:

1) **Biomass production**
2) **Soil C**
3) **Soil properties (health parameters)**



Nebraska Crop Management Conference

- Duration: 2015-2018 (4 yr) under no-till continuous corn, corn-soybean
- Treatments: no CC, rye, mix CC (rye-hairy vetch-winter pea-radish).
- Planting: preharvest (broadcast) in Sep and postharvest (drill) in late Oct or Nov.
- Chemically terminated in late Apr to early May.

	Seeding Rates (kg ha^{-1})		
	Single Species	Mix 2015-2016	Mix 2017-2018
Rye	59	30	30
Hairy vetch		4	8
Radish		4	29
Austrian winter Pea		9	18
Total	59	47	85

Nebraska Crop Management Conference

CC mixes (rye, radish, hairy vetch and winter pea), about 4 weeks (early Oct) after broadcast into standing corn.

Mix before termination (mid spring). Mostly rye, some vetch.

Rye and winter pea (mid spring) at Clay Center.

Photos by: K. Koehler-Cole

	Rainfed Site 1		Rainfed Site 2		Irrigated Site	
	Continuous Corn	Corn-Soybean	Continuous Corn	Corn-Soybean	Continuous Corn	Corn-Soybean
	CC Biomass Production (ton ac^{-1})					
No Cover Crop						
Rye	0.24	0.57	0.29a	0.52	0.14a	0.46
Mix	0.18	0.41	0.16b	0.35	0.07b	0.34
	Soil Organic C (%)					
No Cover Crop	3.01ns	2.94ns	2.00ns	2.11ns	2.46ns	2.10ns
Rye	3.00	2.95	1.98	2.17	2.23	2.23
Mix	3.08	2.99	1.97	2.23	2.35	1.93

	Rainfed Site 1		Rainfed Site 2		Irrigated Site	
	Continuous Corn	Corn-Soybean	Continuous Corn	Corn-Soybean	Continuous Corn	Corn-Soybean
			Bulk Density (g cm^{-3})			
No Cover Crop					1.20a	
Rye	ns	ns	ns	ns	1.16ab	ns
Mix					1.12b	
			Penetration Resistance (psi)			
No Cover Crop	189a	174a			377b	406b
Rye	174a	174a	ns	ns	290b	479ab
Mix	160b	160b			551a	595a

	Rainfed Site 1		Rainfed Site 2		Irrigated Site	
	Continuous Corn	Corn-Soybean	Continuous Corn	Corn-Soybean	Continuous Corn	Corn-Soybean
			Wet-Aggregate Size (in)			
No Cover Crop	ns	0.06b	ns	ns	ns	ns
Rye		0.07a				
Mix		0.08a				
			Water Infiltration (in $s^{-1/2}$)			
No Cover Crop	ns	ns	ns	ns	ns	ns
Rye						
Mix						

- Data from three sites in Nebraska may not tell the whole story.
- What about other studies?

Carbon Sequestration

Parameter	Total Studies	Effect of Mixes Compared to Single Species			Difference in Compaction Between No CC vs CC
		No	Yes	Variable	
Carbon Concentration	24	20	1	3	SS: 0.042±0.15% n=62 Mix: 0.032±0.12% n=45
Carbon Stocks	8	4	0	4	SS: 0.056±0.27 t ac^{-1} n=22 Mix: 0.100±0.38 t ac^{-1} n=21

Average % Change in Carbon Stocks Between SS and Mix:
-0.22±6.46

Summary:
Minimal effects of mixes on carbon stocks

Compaction

Parameter	Total Studies	Effect of Mixes Compared to Single Species			Difference in Compaction Between No CC vs CC
		No	Yes	Variable	
Bulk Density	21	19	0	2	SS: -0.007±0.033 g cm^{-3} n=45 Mix: -0.009±0.056 g cm^{-3} n=28
Penetration Resistance	15	11	2	2	SS: 5.5±32 psi n=17 Mix: 24.7±68.2 psi n=17

Average % Change in Compaction Between SS and Mix: 0.57±15.1

Summary: Minimal changes in compaction

Water Erosion Potential

Parameter	Total Studies	Effect of Mixes Compared to Single Species			Difference in Water Erosion Potential Between No CC vs CC
		No	Yes	Variable	
Wet-aggregate Stability	24	23	0	1	WAS: SS: 0.19±0.29% n=42 Mix: 0.34±0.40% n=27 MWD: SS: 0.08±0.25 in n=18 Mix: 0.11±0.28 in n=18
Water Infiltration	6	5	0	1	SS: 0.35±0.84 in hr^{-1} n=18 Mix: 0.44±0.84 in hr^{-1} n=12

Average % Change in Aggregation Between SS and Mix: 2.47±6.73

Summary:
Mixes tend to increase wet-aggregate stability over single species

Water Content

Parameter	Total Studies	Effect of Mixes Compared to Single Species			Difference No CC vs CC
		No	Yes	Variable	
Water Content	40	29	1	10	SS: -1.32±1.55 in n=34 Mix: -1.10±1.61 in n=60

Average % Change in Water Content Between SS and Mix: 3.69±14.3

Summary:
Mixes tended to increase water content more than single species

Nitrate Leaching Potential

Parameter	Total Studies	Effect of Mixes Compared to Single Species			Difference No CC vs CC
		No	Yes	Variable	
Nitrate Leaching Potential	52	39	3	10	Concentration: SS: 2.52±5.53 ppm n=35 Mix: 4.02±7.37 ppm n=35 Stocks: SS: -19.7±32.4 lb ac^{-1} n=36 Mix: -36.0±42.8 n=29

Average % Change in Nitrate Between SS and Mix:
-10.9±43.7

Summary:
Mixes tended to decrease nitrate more than single species

Soil Biology

Parameter	Total Studies	Effect of Mixes Compared to Single Species			Difference No CC vs CC
		No	Yes	Variable	
Microbial Biomass	6	3	0	3	SS: 28.2±28.7 nmol g^{-1} soil n=22 Mix: 50.2±52.4 nmol g^{-1} soil n=21

Average % Change in Biology Between SS and Mix:
17.6±32.7

Summary:
Mixes tended to increase soil biology more than single species

CC Biomass Production

Parameter	Total Studies	Effect of Mixes Compared to Single Species		
		No	Yes	Variable
Biomass Production	117	38	10	69

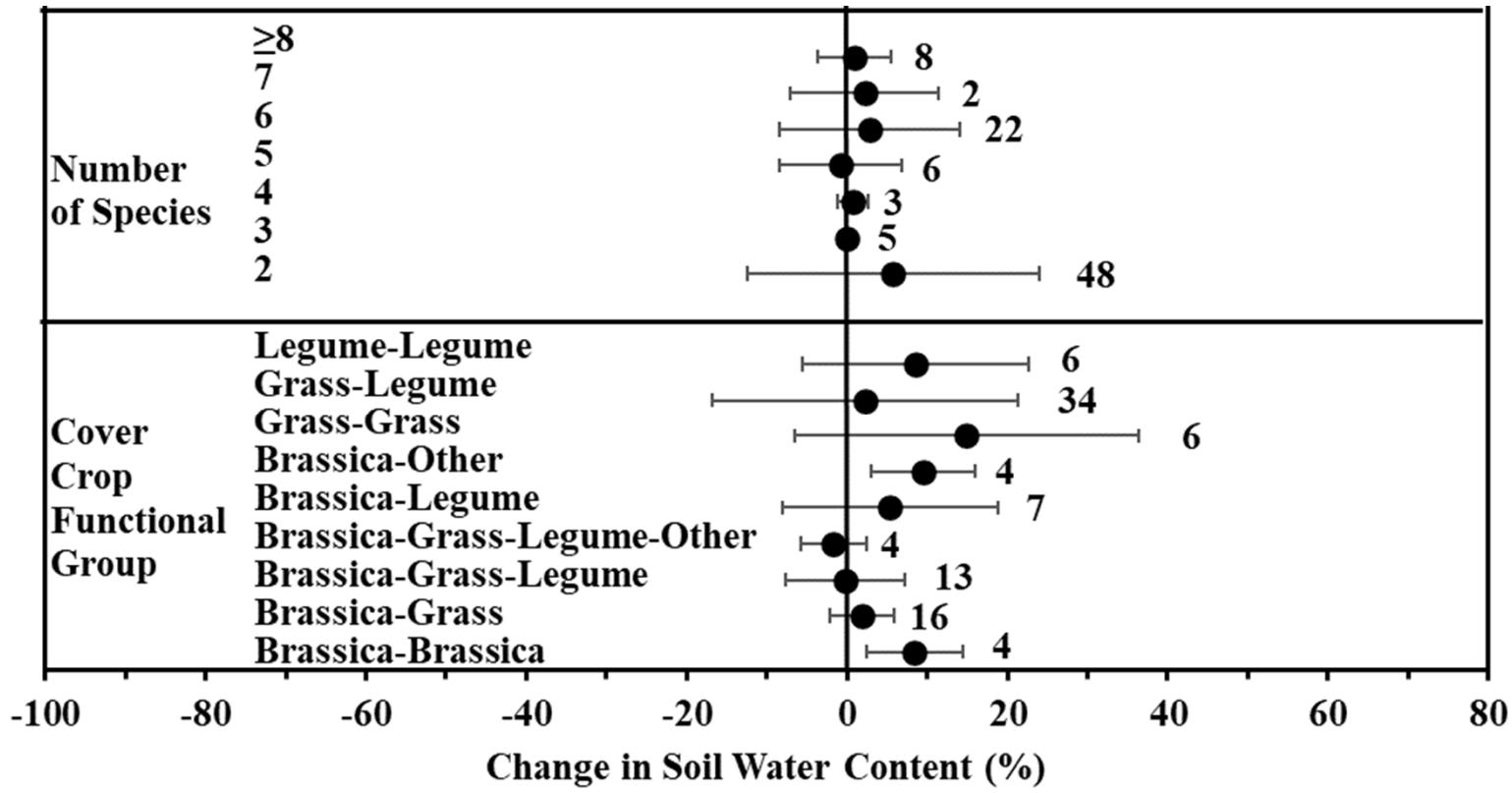
Average % Change in Biomass Between SS and Mix:
28.3±46.2%

Summary:
Mixes tended to increase CC biomass more than single species

Are Cover Crop Mixes Better than Single Species Cover Crops For:

1. producing more biomass? Tend to
2. reducing soil erosion and N leaching more? Tend to
3. improving C, soil health, and resistance to compaction more? Tend to improve soil biology but variable effects on compaction and soil C
4. using less water? Tend to

Does CC functional group or number of species matter?



Take Home Points

- Cover crop mixes tend to improve resistance to water erosion, increase soil biology, reduce water use, and increase CC biomass production
- Cover crop mixes do not seem to improve soil C and compaction
- The composition of the mix (legume, grass, brassica) or the number of species in the mix seems to have little effect on soil health impacts, rather biomass production is the key factor.

Questions

Sabrina Ruis
Research Assistant Professor
Email: sruis2@unl.edu