2025 CONSERVATION WEBINAR SERIES

ADOPTION AND DISADOPTION OF SOIL AND WATER MANAGEMENT PRACTICES IN THE U.S.

Alejandro Plastina

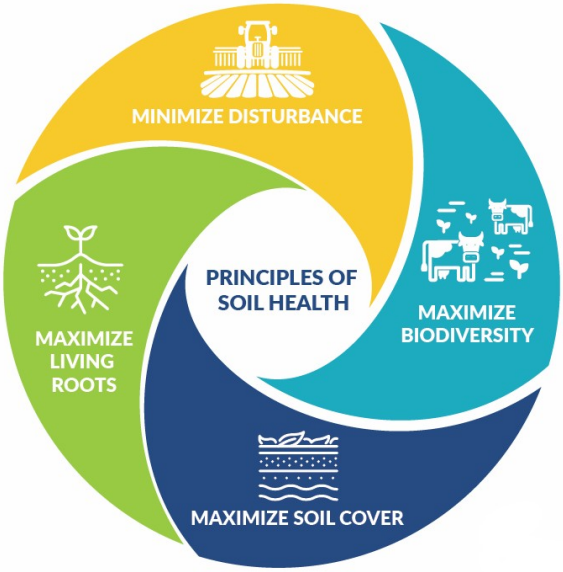
Center Director, Rural and Farm Finance Policy Analysis Center

University of Missouri-Columbia

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Soil Health Management

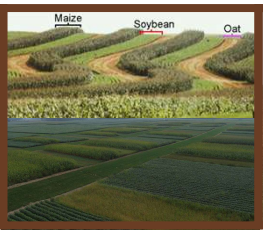
Research has determined how to manage soil in a way that improves soil function:



https://www.nrcs.usda.gov/conservation-basics/natural-resource-concerns/soils/soil-health

Principles of Soil Health

USDA Natural Resource Conservation Service

Soil Armor	Minimize Disturbance	Plant Diversity	Continual Live Plant/Root (Perenniality)	Livestock Integration
				
• Cover crops • Residue	• Reduced tillage • Lower compaction (controlled traffic)	• Cover crop mixtures • Crop rotations • Intercropping • Prairie strips	• Cover crops • Perennial crops • Prairie strips • Relay cropping	• Grazing cover crops • Seed pastures in rotation • Adding manure

Slide courtesy of Dr. Marshall McDaniel

Examples of <u>private</u> costs and benefits of soil health management practice decisions^

Potential Private Benefits (Revenue increasing or cost decreasing)	Potential Private Costs (Revenue decreasing or cost increasing)
• Increased average yield or decreased yield variability (e.g., more resilient to drought and/or moisture during the growing season) • Decreased input costs (e.g., less fertilizer with legume cover crop or fuel with conservation tillage) • Grazing or harvested forage benefits from cover crops • Reduced soil erosion/decreased soil compaction • Improved nutrient use efficiency and/or reduced nutrient loss	• Decreased average yield or increased yield variability from cover crops (e.g., competition for moisture or nutrients with cash crop) • Fixed costs (e.g., equipment purchases or capital investments to implement new practices or systems) • Increased input costs (e.g., cover crop seed, herbicide costs for no-till, or cover crop termination) • Opportunity costs (e.g., planting a cover crop instead of a cash crop where double cropping is feasible) • Cover crop may attract unwanted wildlife or pests • Adding field operations (e.g., planting, spraying) may affect field work scheduling and increase labor costs

^Bowman, M., Ferraro, P. J., Binzen Fuller, K., Gramig, B., Mosheim, R., Njuki, E., Pratt, B., Rejesus, R., & Rosenberg, A. (2025). *Economic outcomes of soil health and conservation practices on U.S. cropland* (Report No. ERR-353). U.S. Department of Agriculture, Economic Research Service.

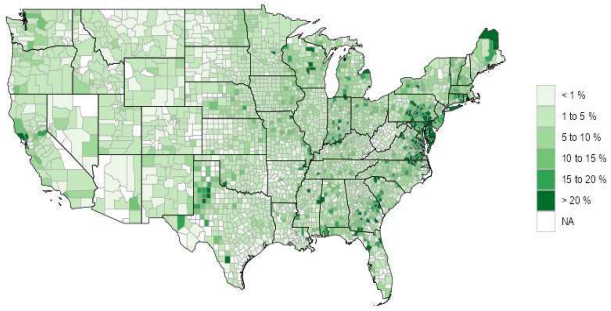
Examples of public costs and benefits of soil health management practice decisions^

Potential Public Benefits (Revenue increasing or cost decreasing)	Potential Public Costs (Revenue decreasing or cost increasing)
• Reduced pest and disease outbreak incidence (e.g., due to beneficial insects or reduction in herbicide-resistant weeds) • Reduced soil erosion improves air and water quality • Carbon sequestration • Reduced nutrient loss or improved pesticide management improves water quality • Increased soil infiltration or water holding capacity could mitigate effects of extreme precipitation events • Increased biodiversity	• Decreased yield or increased yield variability could have public costs in terms of federal program expenditures or land use change tradeoffs • Increased pest or disease incidence for neighbors due to cover crops being a possible host • Practices and management systems must be evaluated for environmental tradeoffs

^Bowman, M., Ferraro, P. J., Binzen Fuller, K., Gramig, B., Mosheim, R., Njuki, E., Pratt, B., Rejesus, R., & Rosenberg, A. (2025). *Economic outcomes of soil health and conservation practices on U.S. cropland* (Report No. ERR-353). U.S. Department of Agriculture, Economic Research Service.

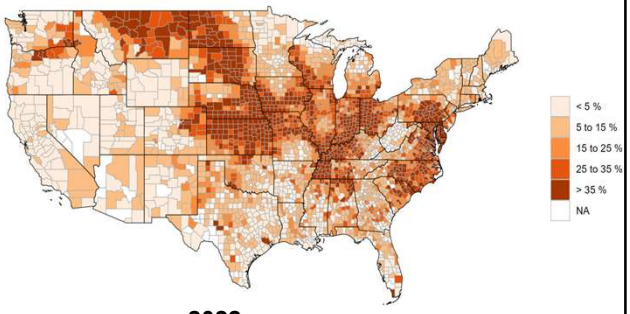
Adoption of Cover Crops and No-Till as percent of Cropland Area in 2022 (Census of Agriculture)*

Figure 1. Cover Crop Area by County



2022
US: 4.7%
Iowa: 5.0%

Figure 2. No-Till Area by County



2022
US: 27.5%
Iowa: 32.7%

*Plastina, Sawadgo & Okonkwo. 2024. "Pervasive Disadoption Substantially Offsets New Adoption of Cover Crops and No-Till." *Choices.*

Adoption of Soil Health Practices by Crop (Survey Data, Various Years)^

Summary of adoption rates for key soil health practices by crop (percent of acreage), 2019–23

	Barley (2019)	Corn (2021)	Cotton (2019)	Oats (2023)	Sorghum (2019)	Soybeans (2023)	Wheat (2022)	
							Durum and other spring wheat	Winter wheat
	Percent							
Conventional tillage	20.9	24.5	57.1	23.7	24.4	19.3	20.8	34.4
Reduced tillage	35.0	39.9	23.5	39.8	16.8	35.9	21.7	25.6
No-till	44.1	35.6	19.4	36.5	58.9	44.8	57.5	40.1
Cover crops	2.1	8.4	18.8	3.4	1.1	11.1	0.8	0.0
Conservation crop rotation	27.3	23.9	9.7	34.3	14.0	22.2	18.5	25.8
Conventionally tilled acres with cover crops	1.6	4.3	5.4	5.5	0.0	4.7	0.0	0.0
Reduced tillage acres with cover crops	3.6	3.7	43.1	3.2	0.0	6.9	*	0.0
No-till acres with cover crops	1.3	14.3	29.0	2.4	2.0	17.0	*	0.0

Source: USDA, Economic Research Service (ERS) using USDA, ERS and USDA, National Agricultural Statistics Service ARMS Phase 2 (field-level) data.

Definitions

No-till: Growing crops without tilling or plowing the soil.

Strip tillage: Tilling the soil using equipment that tills only a narrow strip where the crop will be planted, leaving the area between the rows undisturbed.

Reduced tillage: Tilling the soil in ways that minimize disturbance to the soil or maintain more residue cover than conventional tillage.

Cover cropping: Growing a crop primarily for conservation purposes, often over the winter. A cover crop is typically left in place as residue or harvested for forage or other on-farm use.

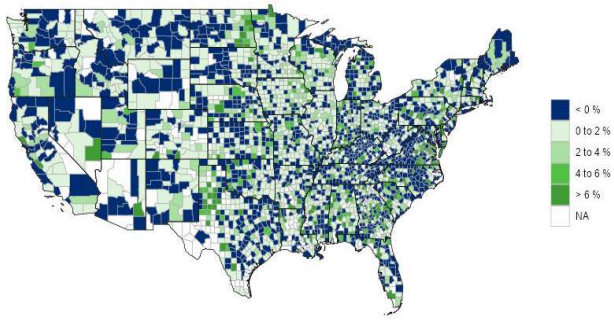
Conservation crop rotation: Choosing crop rotations to maximize crop diversity, build organic matter, and improve soil biodiversity.

^Bowman, M., Ferraro, P. J., Binzen Fuller, K., Gramig, B., Mosheim, R., Njuki, E., Pratt, B., Rejesus, R., & Rosenberg, A. (2025). *Economic outcomes of soil health and conservation practices on U.S. cropland* (Report No. ERR-353). U.S. Department of Agriculture, Economic Research Service.

Are Soil & Water Management Practices Expanding?

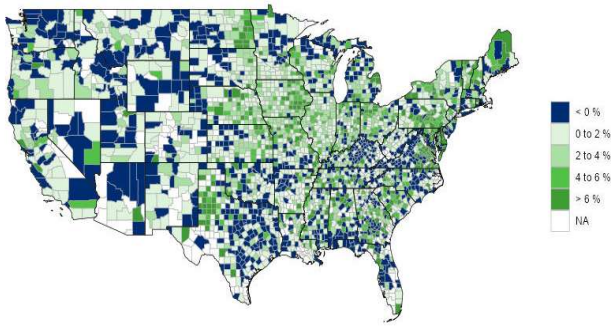
% Change in Cropland Area by County, 2022 vs. 2017

Cover Crops



	2017	2022
US:	3.9%	4.7%
Iowa:	3.7%	5.0%

No-Till

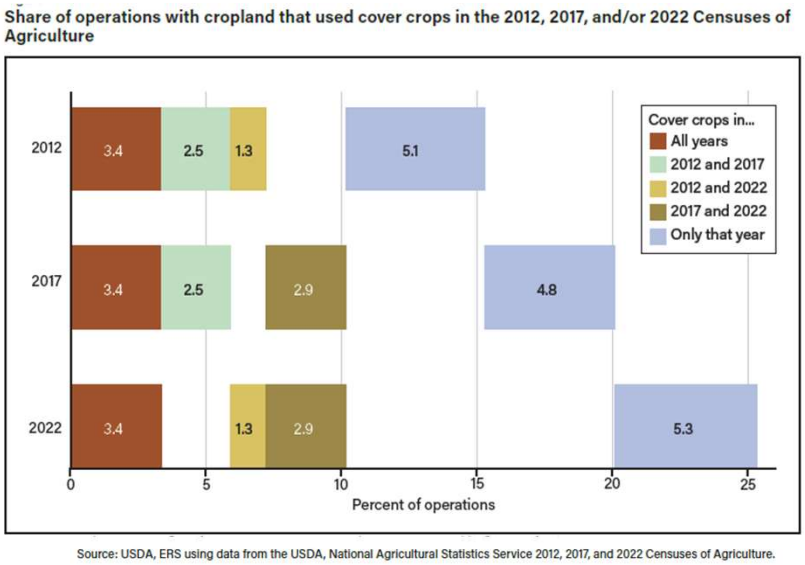


	2017	2022
US:	26.4%	27.5%
Iowa:	30.9%	32.7%

Source: Plastina, Sawadgo & Okonkwo. 2024. "Pervasive Disadoption Substantially Offsets New Adoption of Cover Crops and No-Till." *Choices.*

Cover Crop Adoption is Increasing, but Many Producers Do Not Continue Cover Cropping^

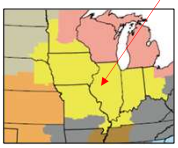
% of U.S. Operations (not acreage)

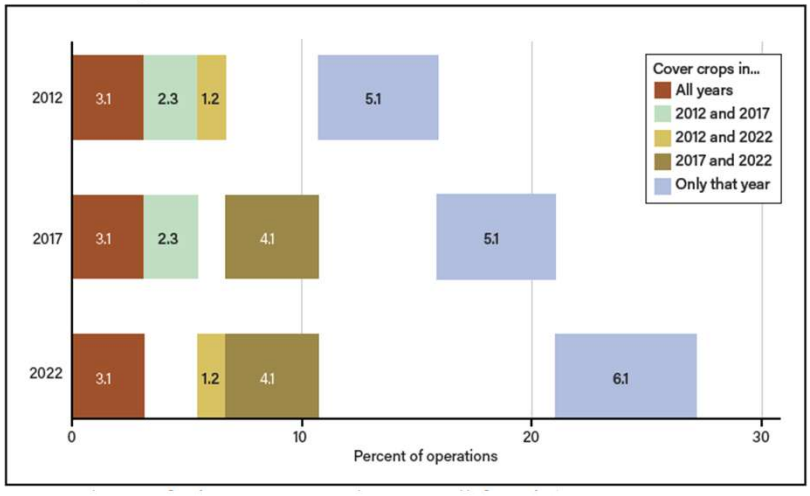


^Bowman et al. (2025). *Economic outcomes of soil health and conservation practices on U.S. cropland* (ERR-353). USDA-ERS

Cover Crop Adoption is Increasing, but Many Producers Do Not Continue Cover Cropping^

% of Heartland Region Operations (not acreage)





^Bowman et al. (2025). *Economic outcomes of soil health and conservation practices on U.S. cropland* (ERR-353). USDA-ERS

Key themes surrounding the profitability of soil health practices

Theme	Key studies	Major ideas within key themes
Reducing tillage intensity can reduce input costs, but net profitability varies.	Al-Kaisi et al., 2016; Cusser et al., 2020; Liu and Duffy, 1996; Singh et al., 2021; Trlica et al., 2017	▪ Lower tillage intensity can lead to reduced input costs in labor, machinery, and fuel. ▪ Estimated yield effects of no-till and reduced-tillage are variable.
The short-term return to adopting cover crops is often negative.	Bowman et al., 2022; Deines et al., 2022; Myers et al. 2019; Plastina et al., 2018b; Wallander et al., 2021	▪ Cover cropping increases input costs, specifically for seed, planting, and terminating the crop. ▪ Cover crops may lead to yield losses in the short-run. ▪ Profit effects are more likely to be positive if cover crops are used for grazing livestock or forage or for addressing in-field resource concerns, such as soil compaction.
The economic outcomes of soil health practices are dynamic.	Bergtold et al., 2019; Boyer et al., 2018; Myers et al., 2019; Snapp et al., 2005; Wood and Bowman, 2021	▪ Profitability of practices such as cover crops may increase over time. ▪ The literature is mixed about the long-term profitability of cover cropping. ▪ Long-term profits depend largely on assumptions about the discounting of future benefits. Estimates of producer discounting range widely.

Source: Bowman et al. (2025). *Economic outcomes of soil health and conservation practices on U.S. cropland* (ERR-353). USDA-ERS.

Key themes surrounding the profitability of soil health practices (continued)

Theme	Key studies	Major ideas within key themes
Risk and uncertainty impact producer adoption of new soil health practices like cover crops.	Arbuckle and Roesch-McNally, 2015; Bowman et al., 2022; Connor et al., 2021; Plastina et al., 2020; Stanger et al., 2008; Thompson et al., 2021	▪ Producers are typically risk and ambiguity averse; they avoid practices when they lead to more variability in yields or in the absence of information about outcomes. ▪ More research on the effects of cover crops on yields and yield risk is needed to improve decision making for producers.
The profitability of individual practices is impacted by the management system as a whole.	Canales et al., 2020; Gong et al., 2021	▪ Use of other practices might make a certain practice more profitable if adopted. Several studies have found complementarities between no-till, cover crops, and other practices.

Source: USDA, Economic Research Service using the published literature listed in the Key studies column.

Source: Bowman et al. (2025). *Economic outcomes of soil health and conservation practices on U.S. cropland* (ERR-353). USDA-ERS.

Correlation between conservation tillage adoption and crop yields and costs of production in the Agricultural Resource Management Survey data, 2010–18

	Field-level outcome	Corn (2010, 2016)	Soybeans (2012, 2018)
Correlation between conservation tillage adoption and…	…crop yield	Positive; correlated with increased crop yield	No significant effect
	…production cost	Negative; correlated with decreased production costs	Negative; correlated with decreased production costs

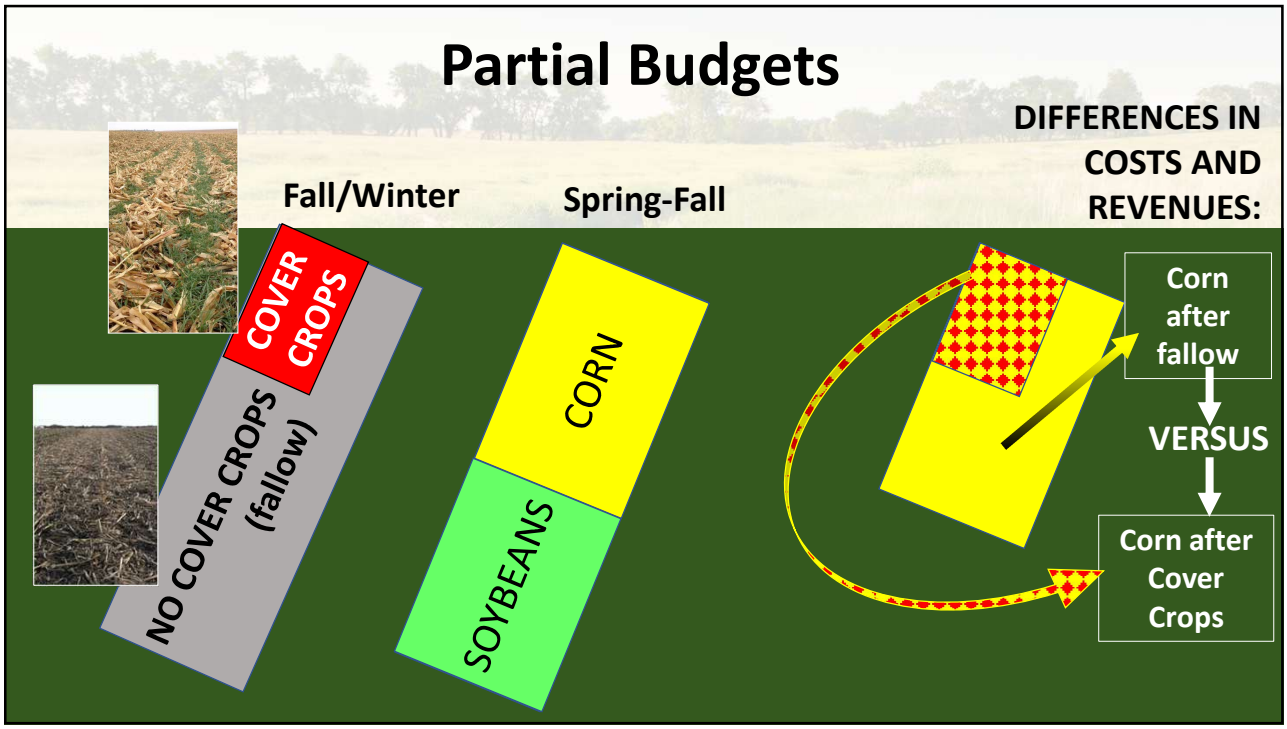
Note: Estimates generated using a matching analysis that compares yield and total production costs per acre in fields that adopt and do not adopt each practice. All reported directional correlations are significantly different from 0, with 95-percent confidence.

Source: USDA, Economic Research Service using data from the USDA, Economic Research Service and USDA, National Agricultural Statistics Service, Agricultural Resource Management Survey (ARMS) for corn (2010 and 2016) and soybeans (2012 and 2018).

Source: Bowman et al. (2025). *Economic outcomes of soil health and conservation practices on U.S. cropland* (ERR-353). USDA-ERS.

My Research on Net Returns to Cover Crops at Iowa State University

1. In crop-only Midwestern production systems, cover crops are not profitable for most farmers without cost-share payments
2. Cost-share payments make net returns less negative among program participants, but not all experience positive profits
3. In mixed production systems with cows, cover crops can be profitable under the "right" conditions



Private Net Returns to Cover Crops tend to be negative in Iowa ($/acre)

Source	Focus groups IA IL MN (n=14) 2016	Regional Survey (n=79) Corn 2017	Regional Survey (n=79) Soy 2017	Statewide IA Survey (n=440) Corn 2017	Statewide IA Survey (n=440) Soy 2017	Experimental Plots in IA (n=24 treatments x 6 replications) Corn 2018-19
Value of Yield Change	9	-9	32	0	0	-16
Planting CC	-41	-32	-31	-32	-32	-28
Extra Termination Cost	-2	-5	-4	-3	-2	-9
Net Returns	**-34**	**-46**	**-3**	**-35**	**-34**	**-53**
NR + Cost Share	**-23**	**-21**	**+25**	**-15**	**-19**	**n/a**
NR+ Grazing Livestock	**-34**	**n/a**	**n/a**	**-13**	**-14**	**-35**
NR + CS + Grazing L.	**-22**	**n/a**	**n/a**	**+7**	**+1**	**n/a**

Plastina, Acharya, Marcos, Parvej, Licht, and Robertson. 2023. "Does grazing winter cereal rye in Iowa, USA, make it profitable?" *Renewable Agriculture and Food Systems*. doi:10.1017/S1742170523000388.

Table 4. Descriptive statistics of net returns to grazed cereal rye.

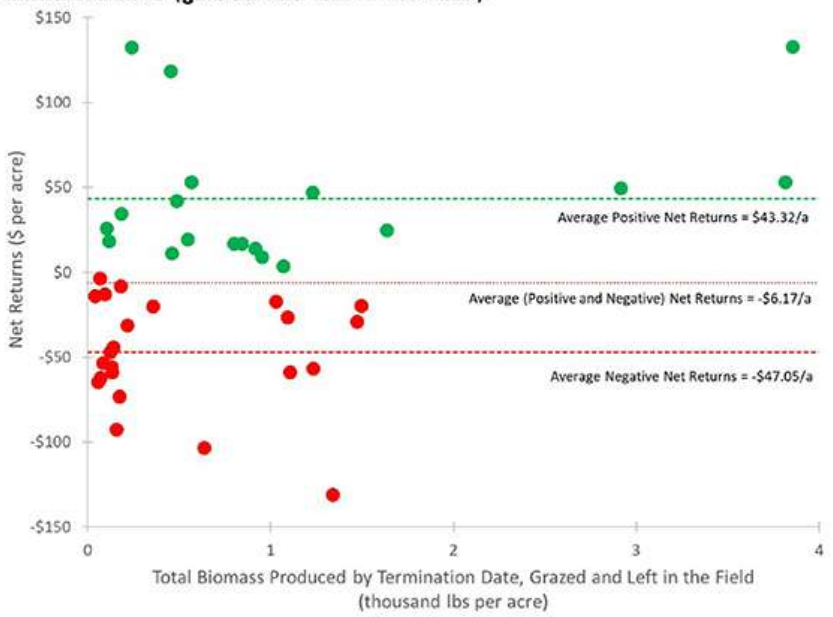
	All Observations					Negative Net Returns		Positive Net Returns	
Treatment	N	Mean ($/a)	StDev ($/a)	Min ($/a)	Max ($/a)	% of N	Mean ($/a)	% of N	Mean ($/a)
All	42	-$6.17	$57.95	-$130.79	$133.00	54.8%	-$47.05	45.2%	$43.32
Planting Date-Method									
B	21	-$3.22	$57.29	-$130.79	$133.00	47.6%	-$50.45	52.4%	$39.72
D	21	-$9.12	$59.88	-$103.19	$132.37	61.9%	-$44.44	38.1%	$48.28
Seeding Rate									
L	14	$7.30	$48.51	-$55.39	$133.00	50.0%	-$27.86	50.0%	$42.47
M	14	-$11.64	$55.51	-$92.45	$118.36	57.1%	-$49.44	42.9%	$38.76
H	14	-$14.17	$69.72	-$130.79	$132.37	57.1%	-$61.46	42.9%	$48.88
Termination Date									
14	30	-$11.17	$51.24	-$130.79	$132.37	56.7%	-$45.15	43.3%	$33.26
3	12	$6.34	$73.19	-$103.19	$133.00	50.0%	-$52.44	50.0%	$65.13

Notes: B: early-broadcast; D: late-drill; L: low seeding rate; M: medium seeding rate; H: high seeding rate; 3 = target termination date 3 days before planting; 14 = target termination date 14 days before planting.

Plastina et al. (2023)
Feed cost savings from grazing cereal rye depend on:

1) the availability of biomass in the spring
2) quality of the biomass (use of supplements, hay saved)

Figure 1. Net returns to grazed cover crops versus total biomass produced by termination date (grazed and left in the field).



Criticisms to these findings:

"Economic studies fail to capture changes in SOM over the long-run and the associated improvement in soil health, water quality, and land value"

- **Soil health**: private benefit → higher yields, less soil erosion (both accounted for in econ. studies)
- **Water quality**: societal benefit, does NOT change profitability analysis for farmer (no fines to polluters)

Do soil and water management practices affect land values?

Monetizing Soil Health*

- Land is traded on potential productivity indexes (CSR2), developed for tax purposes (land surveys from the '80s)
- Certified General Appraisers must follow USPAP or risk losing their Certification
- Current USPAP practices **do not allow** for adjustments in appraised land values based on soil health or soil fertility
- **Not possible to monetize Soil Health without a database of soil health indicators attached to Comparable Sales**

*Iowa Nutrient Research Center Grant # 2018-06

Concluding Remarks

- Soil and water management practices provide multiple public benefits (justification for government support)
- Public Benefits > Private Benefits
- Private net returns not always positive (even with gov't. support)
- Overall use of soil and water management practices is increasing, but there is substantial temporary or permanent dis-adoption
- Hard barriers to monetizing soil health (Appraisal process)

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SCAN ME

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HIDDEN CARBON CREDITS: REDUCING SOIL ORGANIC CARBON EROSION WITH COVER CROPS

Wenjuan Huang
Assistant Professor, EEOB Department
Iowa State University

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