Long-term Soil Health Pays in Southwestern Nebraska



Improving soil health can build drought resilience, reduce wind and water erosion, increase nutrient availability, reduce nutrient losses, and enhance management of some plant diseases. Many soil health management systems (SHMS – a suite of soil health practices) also benefit the environment by storing soil organic carbon, reducing greenhouse gas emissions, and improving water quality. However, investing in SHMS is a business decision that must be economically viable.

Understanding this, the Nebraska Soil Health Coalition partnered with the Soil Health Institute to provide farmers with the economic information they need when making that decision. The Nebraska Soil Health Coalition promotes adoption of soil health systems, leveraging collaborative efforts to increase sustainable agricultural production and foster thriving rural communities. Addressing the economic case for soil health is a key part of this producer-focused education and outreach.

The Soil Health Institute interviewed 15 Nebraska farmers in one regional cohort in Southwestern Nebraska who have adopted SHMS to evaluate their economics based on partial budget analysis.

In using this approach, the costs and benefits of a SHMS are compared before and after adoption of that system.

The bottom-line benefits farmers saw include:

- Reduced production costs by an average of $34/acre for irrigated corn and $6/acre for irrigated soybean using soil health management systems.
- Improved water infiltration reduced irrigation water applied for both corn and soybean.
- Improved yields from soil health management systems increased crop revenue for irrigated corn and soybean production.
- In irrigated systems with grazed stover after corn harvest, soil health management systems increased farm income $19/acre.
- In non-irrigated systems, soil health management systems increased farm income $52/acre for corn and $73/acre for winter wheat.
- On nine farms, pastures managed with soil health management systems increased farm income $71/acre.

Before we break down the cost and revenue changes due to managing for soil health, let's take a look at the farms in the study.

ABOUT THE
Farms

The farmers interviewed for this study were primarily located in the Central High Tableland of southwest Nebraska. The soils in this region are moderately to very deep, with drainage ranging from well to excessively drained. Soils range widely in texture with sandy, loamy, silty, and clayey soils all present. Due to low and erratic rainfall in the region, water resources are a concern. Agricultural production is split between dryland systems utilizing non-irrigated row crops or native range and irrigated systems relying on irrigated row-crops. While some irrigation water is available from surface bodies like the North Platte, South Platte Rivers, the majority comes from ground water sources. The High Plains aquifer supplies much of the ground water for irrigation and quantity and quality of irrigation water are chief resource concerns in the region.

The 15 farms had an average size of 5,828 acres. On average, farms had pasture on 3,366 acres and row crops on 2,462 acres. Fourteen farms had row crops with eight of these having pasture acreage, and one farm had pasture acreage with no row crop acreage. Row crop acres were led by corn, popcorn, wheat, and millet. Other crops included grain sorghum, soybean, sunflower, oat, and dry bean/pea. Seven farms included forage and feed crops for an average of 419 acres in rotation systems that included row crops.

Town Name	Number of Farms
Arnold	1
Benkelman	1
Champion	1
Culbertson	1
Imperial	2
Indianola	1
Lamar	1
Lyman	1
Madrid	1
Ogallala	1
Stratton	2
Sutherland	1
Venago	1



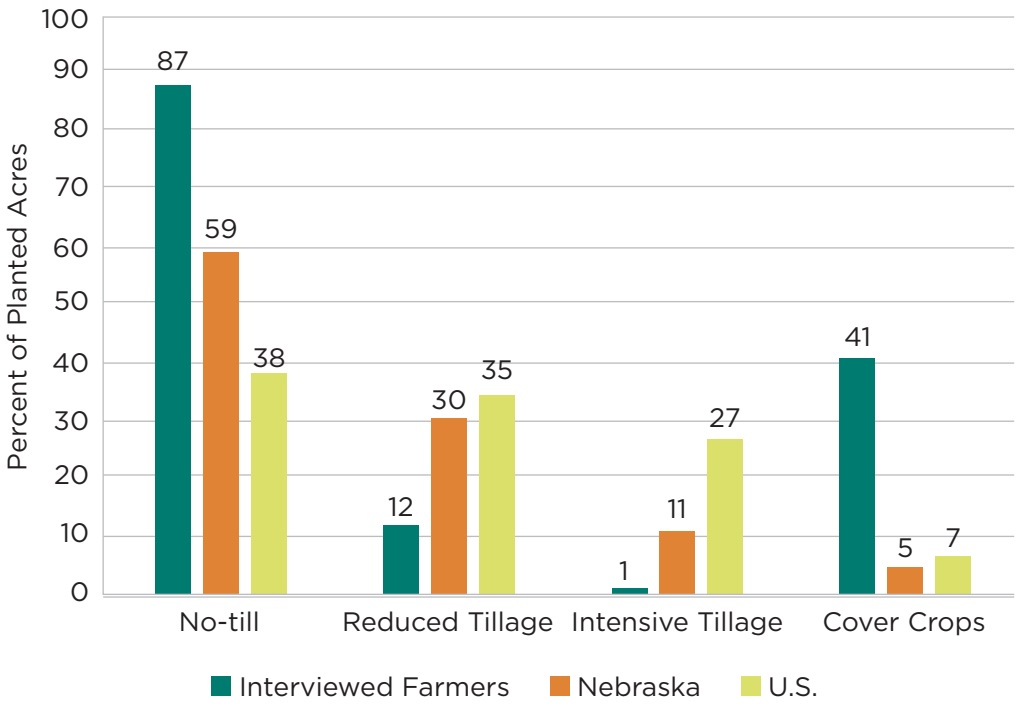
LAND USE	ACRES
Pasture	3,366
Corn	531
Wheat	438
Millet	200
Popcorn	186
Grain Sorghum	175
Soybean	129
Sunflower	126

LAND USE	ACRES
Oat	80
Dry Bean/Pea	62
Other Crop	74
Forage & Feed Crop	419
Fallow	56
Double Crop	14
Crop Acres	**2,462**
Average Farm Size	**5,828**

Mean annual precipitation was 15 to 22 inches, while mean temperature was 48 to 56 degrees F. Cropland production consisted of 31% irrigated acreage which was with center pivot systems. One farm was entirely irrigated, and three farms were entirely non-irrigated, with the balance having combinations of irrigated and non-irrigated production.

Ten farms produced corn with six planting cover crops before corn, and six farms produced soybean with four planting cover crops before soybean. The farmers using no-till have been doing so for an average of 21 years, while those practicing reduced tillage have been doing so for an average of 16 years. Farmers planting cover crops had an average of 10 years of experience. The farmers interviewed primarily practiced no-till and reduced tillage. Farms with reduced tillage systems mostly used strip tillage. The farmers also reported using cover crops considerably more than the state average for Nebraska.

Partial budgets were calculated to assess changes in expenses and revenue associated with adopting a SHMS. Results were averaged across seven farms with irrigated corn and six farms with irrigated soybean, as well as six farms with non-irrigated corn and eight farms with non-irrigated winter wheat. No farms produced non-irrigated soybean.



VISIT US AT

https://soilhealthinstitute.org/economics
for a detailed description of our partial budget methodology

BOTTOM-LINE BENEFITS

for irrigated corn and soybean production

Management for soil health increased per-acre expenses for irrigated corn and soybean, however, those costs were offset by greater reductions in fertilizer, pesticide, and tillage expenses, as well as revenue from increased crop yields and grazing value. On average, net income rose by $67 per acre for corn and $9 per acre for soybean.

Partial budget analysis for irrigated corn on seven farms and irrigated soybean on six farms, $/acre.

	CORN		SOYBEAN	
Expense Category	**Reduced Expense**	**Additional Expense**	**Reduced Expense**	**Additional Expense**
Seed	3.57	6.93	2.33	6.25
Fertilizer & Amendments	62.60	49.05	30.00	42.33
Pesticides	28.32	14.83	14.99	9.45
Fuel & Electricity	9.00	3.12	6.23	3.02
Labor & Services	15.75	11.15	19.53	11.64
Equipment Ownership	19.98	19.95	25.12	19.96
Post-harvest Expenses[2]	0.00	1.59	0.00	0.11
Total Expense Change	**139.22**	**106.62**	**98.20**	**92.76**
	Additional Revenue	**Reduced Revenue**	**Additional Revenue**	**Reduced Revenue**
Yield, bu.	3.57	0.00	0.33	0.00
Price Received,[3] $/bu	4.50	4.50	10.50	10.50
Other Revenue[4]	18.52	0.00	0.00	0.00
Total Revenue Change	**34.59**	**0.00**	**3.47**	**0.00**
	Total Benefits	**Total Costs**	**Total Benefits**	**Total Costs**
Total Change	173.81	106.62	101.67	92.76
Change in Farm Income	**67.19**		**8.91**	

[1] Expenses and expected yields based on farmer reported production practices. https://soilhealthinstitute.org/economics/

[2] Check-off fees and hauling for corn and soybean with drying expense for corn applied to yield change.

[3] Commodity prices applied to yields based on long-term average prices. S. Irwin, "IFES 2018: The New, New Era of Grain Prices?" Department of Agricultural and Consumer Economics, University of Illinois at Urbana-Champaign, January 11, 2019.

[4] Other revenue includes revenue from grazing in row-crop systems.

Expenses

Seed, Fertilizer, and Amendments

Additional seed expense for corn of $6.93/acre included planting cover crops prior to corn production. Cover crop seeds for six corn farms averaged $15/acre and ranged from $7.50/acre for winter/cereal rye to $25/acre for a multi-seed mix that included sorghum, millet, sunflower, and radish. Additional seed expenses for soybean of $6.25/acre included planting cover crops prior to soybean production. Cover crop seed expenses on four soybean farms averaged $9/acre for soybean and ranged from $7.50/acre for winter/cereal rye to $11/acre for an alternative seeding rate of winter/cereal rye. Reduced seed expenses for corn ($3.57/acre) and soybean ($2.33/acre) reflect farmers attributing the capability to produce non-GMO crops and reduce seed treatments.

Reduced fertilizer and amendment expenses were $62.60/acre for corn and $30/acre for soybean. Phosphorous applications were reduced for both corn and soybean, and nitrogen applications were reduced for corn. Nitrogen reductions averaged 52 units/acre for irrigated corn. Average reductions in phosphorus were 40 lb/acre for corn and 51 lb/acre for soybean. Additional fertilizer and amendment expenses were $49.05/acre for corn and $42.33/acre for soybean, reflecting applications of compost, manure, and biological inputs by some farms. Accounting for reduced expenses and additional expenses in the SHMS, net fertilizer and amendment reductions were $14/acre for corn, while net fertilizer and amendment additions were $12/acre for soybean.

Pesticides

Reducing tillage and planting cover crops can suppress weeds and lead to changing or eliminating some herbicides. On the other hand, herbicide use may increase to terminate cover crops or to control weeds previously controlled with tillage. Farmers reported improved biodiversity and soil biology, which included beneficial insects attracted by cover crops that reduced insecticide use and reduced fungicide use due to better crop disease resistance—both attributable to improved soil health systems. Averaged across all farms, reduced net pesticide expenses were $13.49/acre for corn and $5.54/acre for soybean.

Equipment Ownership, Fuel, Labor and Services, and Other Expenses

Adopting no-till and reduced tillage decreases costs for equipment ownership, fuel, labor, and services for expenses associated with conventional tillage practices. Services include custom applications that are substituted for farm owned equipment operations. Reduced equipment expenses were $19.98/acre for corn and $25.12/acre for soybean. Additional expenses included planting cover crops, spraying biological inputs, and strip tillage. Additional equipment expenses were approximately $19.95/acre for corn and $19.96/acre for soybean.

Fuel and electricity expenses are associated with powering equipment and irrigation. Net reduced expenses were $5.88/acre for corn and $3.21/acre for soybean. Irrigation was reduced by 1.9 acre-inches for corn (15% reduction) and 0.6 acre-inches for soybean (6% reduction). Net reduced expenses for labor and services were $4.60/acre for corn and $7.89/acre for soybean. Net reductions in equipment and associated expenses were $10.51/acre for corn and $16.26/acre for soybean.

Corn reduced production expenses totaled $139.22/acre, with $105.03/acre in additional production expenses. Soybean reduced production expenses totaled $98.20/acre, with $92.65/acre in additional production expenses. Reduced production expenses contributed $34.19/acre for corn and $5.55/acre for soybean to increased farm income.





Revenue

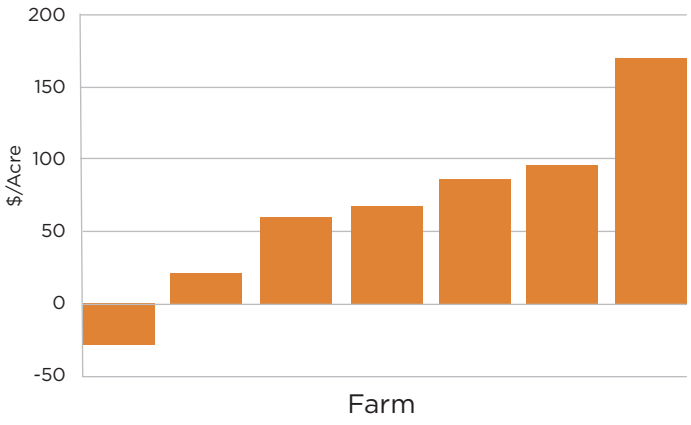
Yield increases averaged 3.57 bu/acre for two corn farms and 0.33 bu/acre for one soybean farm having yield increases. Because market prices for crops fluctuate, revenue for increased yield was calculated by applying long-term average corn and soybean prices. Average crop revenue increases were $16.07/acre for corn and $3.47/acre for soybean.

All farms grazed corn stover, with farmers valuing grazing as either feed costs saved or as a payment rate received from others. Other revenue from grazing averaged $18.52/acre for corn with no grazing reported for soybean.

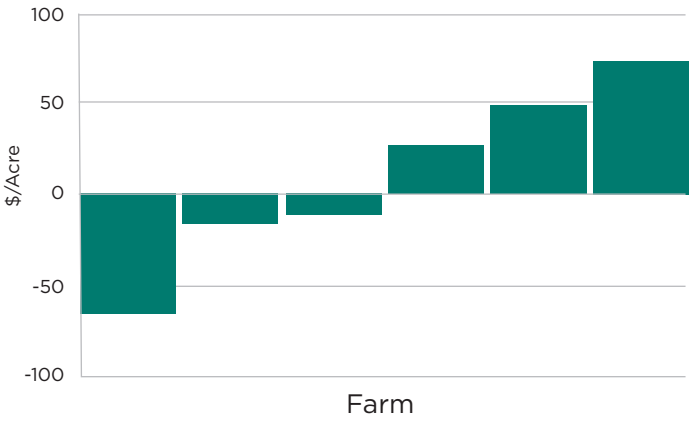
Combining yield increases and grazing value resulted in increased revenue of $34.59/acre for corn and $3.47/acre for soybean. With reduced expenses, farm income increased $67.19/acre for corn and $8.91/acre for soybean. Results for these farmers with irrigated production indicate that even when yield does not increase and value of grazing cattle is not considered, profitability increased because of the reduced expense of growing corn and soybean.

Economic benefits for irrigated corn ranged from -$29 to $168 per acre with one farm reporting increased expenses that were not offset by either increased yield or sufficient revenue from grazing. One farm reported increased expenses that were offset by revenue from increased corn yield and grazing value. Five farms reported decreased expenses with one having revenue contributions from increased corn yield and grazing value. Economic benefits for irrigated soybean increased farm income for three farms having reduced expenses. Three farms had increased production expenses that were not offset by revenue from increased yield or grazing value. Economic benefits for irrigated soybean ranged from -$67 to $73 per acre.

Change in farm income, irrigated corn



Change in farm income, irrigated soybean



BOTTOM-LINE BENEFITS

for non-irrigated corn and winter wheat production

Management for soil health increased per-acre expenses for non-irrigated corn and winter wheat, however, those costs were offset by greater reductions in fertilizer, pesticide, and tillage expenses, as well as revenue from increased crop yields and grazing value. On average, net income rose by $52 per acre for corn and $73 per acre for wheat.

Partial budget analysis for non-irrigated corn on six farms and non-irrigated winter wheat on eight farms.

	CORN		WINTER WHEAT	
Expense Category	**Reduced Expense**	**Additional Expense**	**Reduced Expense**	**Additional Expense**
Seed	0.00	0.00	0.00	6.88
Fertilizer & Amendments	22.26	11.08	37.60	11.12
Pesticides	21.72	23.01	24.19	0.52
Fuel & Electricity	3.62	1.37	2.57	1.71
Labor & Services	15.10	5.65	21.93	5.26
Equipment Ownership	22.66	10.21	15.75	10.03
Post-harvest Expenses	0.00	1.12	0.93	0.08
Total Expense Change	**85.36**	**52.44**	**102.97**	**36.60**
	Additional Revenue	**Reduced Revenue**	**Additional Revenue**	**Reduced Revenue**
Yield, bu.	2.50	0.00	0.25	3.13
Price Received, $/bu	4.50	4.50	5.50	5.50
Other Revenue[1]	7.70	0.00	21.25	0.00
Total Revenue Change	**18.95**	**0.00**	**22.63**	**17.22**
	Total Benefits	**Total Costs**	**Total Benefits**	**Total Costs**
Total Change	104.31	52.44	125.60	52.82
Change in Farm Income	**51.87**		**72.78**	

[1] Other revenue includes revenue from grazing in row-crop systems.



Expenses

Seed, Fertilizer, and Amendments

Additional seed expense for wheat of $6.88/acre includes two farmers planting summer cover crops prior to wheat production. Cover crop seed expenses for wheat ranged from $25/acre to $30/acre for two alternative multi-seed mixes. One seed mix was terminated with herbicide before planting wheat, and the other was grazed without termination before planting wheat.

Reduced fertilizer and amendment expenses were $22.26/acre for corn and $37.60/acre for wheat. Nitrogen and phosphorous applications were reduced for both crops. Farmers reported reduced nitrogen that averaged 27 units/acre for corn and 35 units/acre for wheat. Average reductions in phosphorous were 8 lb/acre for corn and 13 lb/acre for wheat. Additional fertilizer and amendment expenses were $11.08/acre for corn and $11.12/acre for wheat, reflecting applications of compost, manure, and biological inputs by some farms.

Pesticides

Farms reporting reduced pesticide expenses entailed herbicides, insecticides, and fungicides for both corn and wheat, while additional pesticide expenses included herbicides to manage weeds previously controlled by tillage. Averaged across all farms, additional net pesticide expenses were $1.29/acre for corn which mostly entailed herbicides added to replace weed management with tillage, as well as substituting herbicides in conventional production with alternative herbicides in the SHMS. Reduced net expenses were $23.67/acre for wheat.

Equipment Ownership, Fuel, Labor and Services, and Other Expenses

Reduced equipment expenses decreased as farmers reduced tillage operations. Additional expenses included planting cover crops and spraying biological inputs. Net reduced equipment expenses were $12.45/acre for corn and $5.72/acre for wheat.

Fuel expense, labor (operating hours), and services (repairs and maintenance) are associated with equipment ownership expenses. Services include custom applications that are substituted for farm owned equipment operations. Corn net reduced expenses associated were $2.25/acre for fuel and $9.45/acre for labor and services. Wheat net reduced expenses were $0.86/acre for fuel and $16.67/acre for labor and services. Net reductions in equipment and associated expenses were $24.15/acre for corn and $23.25/acre for wheat.

Corn reduced production expenses totaled $85.36/acre, with $51.32/acre in additional production expenses. Wheat reduced production expenses totaled $102.04/acre, with $35.52/acre in additional production expenses. Reduced production expenses contributed $34.04/acre for corn and $66.52/acre for wheat to increased farm income.



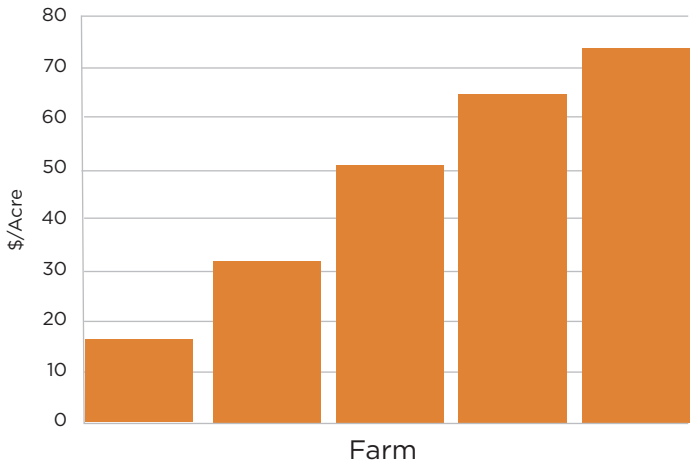
Revenue

The average yield increase for wheat was 0.25 bu/acre with one of eight farms reporting an increase, and the average yield decrease was 3.13 bu/acre with two farms reporting decreases. Average crop revenue changes were an $11.25/acre increase for corn and a net decrease of $15.84/acre for wheat. Four farms grazed corn stover for an average non-irrigated farm value of $7.70/acre. One farm grazed summer cover crops before planting wheat which was followed by grazing wheat during early development before the crop finished production for harvest. This management practice for wheat led to a 5 bu/acre yield decrease, but total revenue for grazing summer crops and grazing wheat during early development was valued at $170/acre.

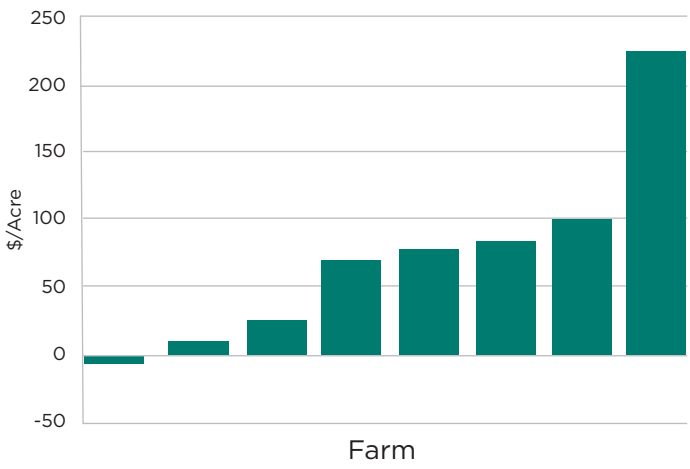
Combining yield increases and grazing value resulted in increased revenue of $18.95/acre for corn and $5.41/acre for wheat. With reduced production expenses, farm income increased $51.87/acre for corn and $72.78/acre for wheat. Results indicate that even when yield does not increase and value of grazing cattle is not considered, profitability increased because of the reduced expense of growing corn and soybean.

Economic benefits increased income for all but one farm growing wheat with a range for non-irrigated corn from $17 to $75 per acre. Economic benefits for non-irrigated wheat ranged from -$4 to $223 per acre.

Change in farm income for six farms, non-irrigated corn



Change in farm income for eight farms, non-irrigated winter wheat



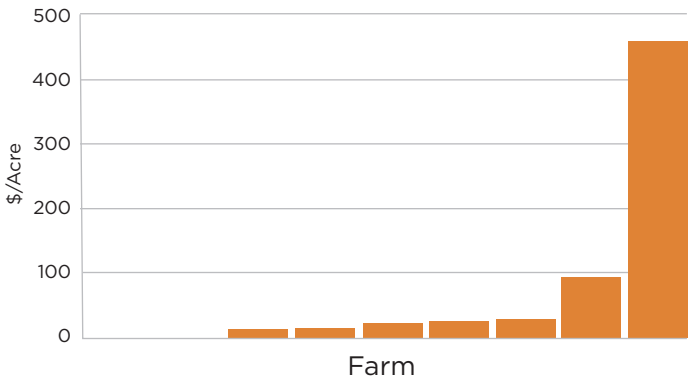
BOTTOM-LINE BENEFITS

for pasture and forage production

Nine farmers reported adopting rotational grazing for pasture and forage acreage. Average farm income increase of $71/acre included combinations of reduced production expenses, increased quantity of grass produced, increased stocking rates, and increased marketing value due to improved animal health.

Two farms reported no income change but stated that rotational grazing resulted in healthier pastures and was a risk management practice so that stocking rates were not reduced during drought periods. One farm with rotational grazing reduced four months of hay purchases that was valued at $32/acre and increased stocking rate for selling 15 additional calves that was valued at $430/acre for a total income increase of $462/acre. Six other farms reported income increases ranging from $9/acre to $92/acre due to either reduced hay purchased (one farm at $9/acre), improved animal health that realized price premiums (one farm at $11/acre), or increased calves sold due to increased stocking rate (four farms for a $39/acre average).

Change in farm income for nine farms, pasture and forage



Additional benefits

In addition to benefits that directly impact profitability, all farmers reported that soil health practices reduced erosion, improved water infiltration, improved soil structure, and improved soil biology or farm biodiversity. Improved soil structure was associated with greater field access with equipment after rainfall events that would otherwise cause ruts or delay planting and harvest, as well as eliminating cattle tracks in pastures. Improved soil biology or biological diversity was reported as farmers observed more earthworms and increased numbers of birds, beneficial insects, or other wildlife. Ninety-three percent of farmers reported increased crop resilience to stressful conditions such as drought. Improved water quality was reported by 67% of farmers based on observations of clear runoff from fields while many reported that water quality was not a problem before adopting the practices.

Decreased fertilizer applications were reported by 73% of farmers. Sixty percent of farmers used soil fertility testing, with most monitoring nutrients using grid or zone sampling. Other soil testing included the Haney test, tissue sampling, and Brix testing.

These farmers visually monitored changes in soil organic matter, and 87% reported that soil organic matter appeared to have increased. Those who measured soil organic matter found absolute increases ranging from 0.5% to 3.0%, averaging 1.8%. Greater soil organic matter increases available nutrients, available water holding capacity, and improved soil structure — all consistent with reduced fertilizer applications, increased crop resilience, and improved field access reported by the farmers. All farmers mentioned the additional benefit of positive public perceptions of agriculture.

The Soil Health Institute's Agricultural Economist, Dr. Archie Flanders, conducted this research and analysis. We thank the farmers who participated, as well as Soil Health Educator Shannon Moeller for her input on the experimental design and for conducting the interviews.



"Everyone I know that has cattle that tried cover crops has made it work. It takes time, but it's an exponential gain. It's not linear. Right when you're frustrated is when you're about to experience exponential growth."

- Logan Pribbeno, Hub 2 Rancher

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Join the soil health movement

Long-term adoption of soil health practices is improving profitability for corn and soybean farmers in Nebraska. These findings underscore the importance of supporting growers who are interested in transitioning to these practices, where 89% of cropland combines no-till/reduced tillage and cover crops use represents just 5% of planted acres.

To learn more about managing for soil health, please visit

https://soilhealthinstitute.org/resources/