

# ECONOMICS OF SOIL HEALTH SYSTEMS IN TENNESSEE



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A project to evaluate profitability of soil health systems on 100 U.S. farms



**SOIL HEALTH**  
— INSTITUTE —



## Highlights

- The Soil Health Institute and Cargill conducted this project to provide farmers with the economics information they need when deciding whether to adopt soil health practices and systems.
- The 10 farmers interviewed in Tennessee grew crops on an average of 2,824 acres, using no-till on 100% and cover crops on 19% of those acres.
- Eighty percent of the farmers interviewed reported increased yield from using a soil health management system, and none reported a yield decline.
- Based on the information provided by these farmers, it cost an average of \$13.32/acre less to grow corn and \$21.08/acre less to grow soybean using a soil health management system.
- Based on standardized prices, the soil health management system increased net income for these 10 Tennessee farmers by an average of \$54.57/acre for corn and \$69.48/acre for soybean. Farmers who grew cotton increased net income by an average of \$61.21/acre, and those who grew wheat increased net income by an average of \$42.22/acre when adopting a soil health management system.
- The current adoption rates of no-till (79%) and cover crops (11%) in Tennessee indicate that other Tennessee farmers may improve their profitability by adopting soil health management systems.
- Farmers also reported additional benefits of their soil health management system, such as increased resilience to extreme weather and increased access to their fields.



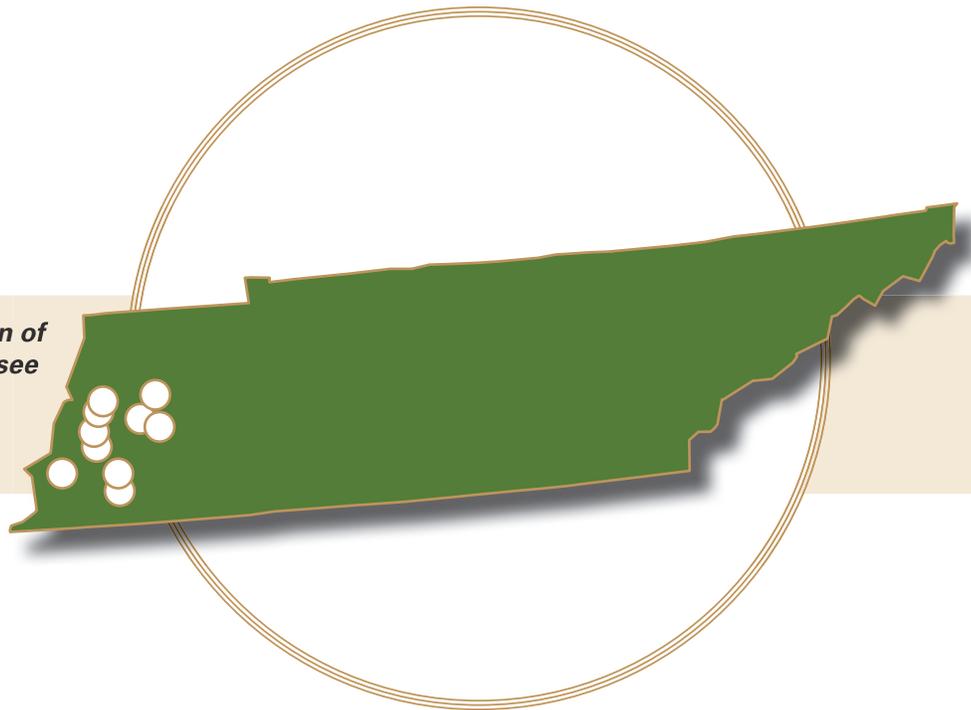
## Introduction

Improving soil health can help farmers build drought resilience, increase nutrient availability, suppress diseases, reduce erosion, and reduce nutrient losses. Many soil health management systems (i.e., a suite of soil health practices) also benefit the environment by storing soil carbon, reducing greenhouse gas emissions, and improving water quality. However, investing in soil health management systems (SHMS) is also a business decision. This project was conducted by the Soil Health Institute (SHI) and Cargill to provide farmers with the economic information they need when making that decision.

SHI interviewed farmers who have adopted soil health systems to acquire production information for evaluating their economics based on partial budget analysis. In using this approach, the costs and benefits of a soil health system are compared before and after adoption of that system. A detailed description of the partial budget methodology can be found on the SHI website: <https://soilhealthinstitute.org/economics/>

A total of 100 farmers were interviewed across nine states (Illinois, Indiana, Iowa, Michigan, Minnesota, Nebraska, Ohio, South Dakota, and Tennessee), which collectively represent approximately 71% of the total amount of corn and 67% of the total amount of soybean produced in the United States (USDA, NASS Crop Production 2019 Summary). The following summarizes the results obtained from 10 farmers interviewed in Tennessee (Fig. 1).

**Figure 1. Geographic distribution of the 10 farms in Tennessee used for economic analysis of soil health management systems.**



## Farm Characteristics

The 10 Tennessee farms assessed in this project raised crops on an average of 2824 acres, with 1043 acres of corn, 1083 acres of soybean, 548 acres of double crop wheat, and 655 acres of cotton (Table 1). The growing conditions under which these farmers successfully adopted a soil health system ranged from 50-55 inches of annual precipitation, 57- 61°F average annual temperature, and 3800-4000 growing degree days for corn (Table 1).

**Table 1. Growing conditions and crops for the 10 Tennessee farmers interviewed.**

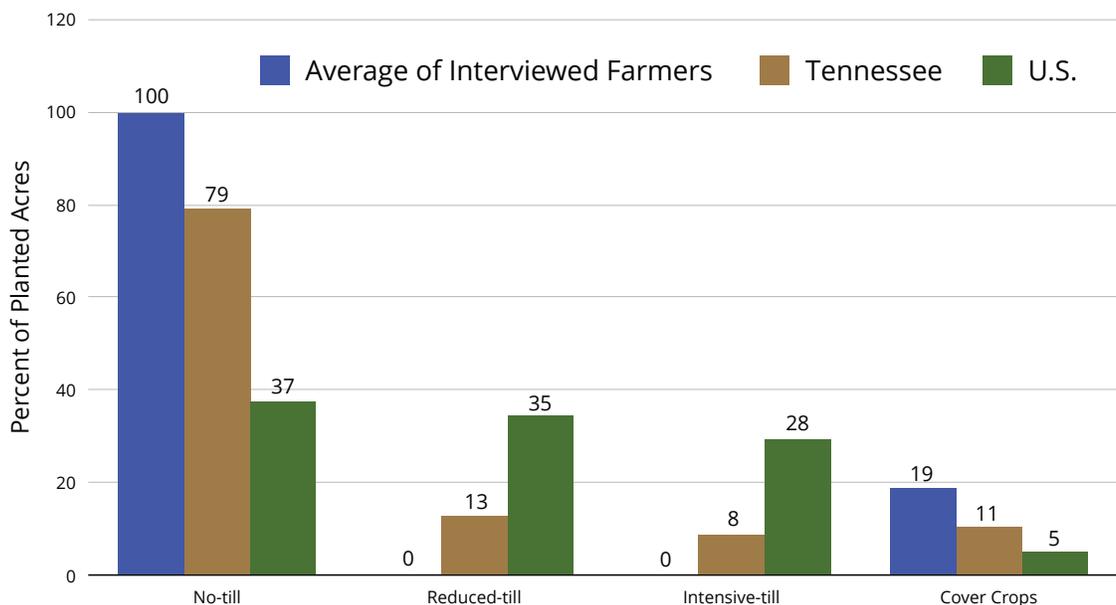
Characteristic	Value
Range in Average Annual Precipitation (inches) <sup>1</sup>	50 - 55
Range in Mean Annual Temperature (°F) <sup>1</sup>	57 - 61
Range in Average Annual Growing Degree Days for Corn <sup>2</sup>	3800 - 4000
Average Acres in Corn	1043
Average Acres in Soybean	1083
Average Acres in Double Crop Wheat <sup>3</sup>	548
Average Acres in Cotton	655
Average Total Crop Acres	2824

<sup>1</sup> PRISM Climate Group 30 Year Normals (1981-2010) (<https://prism.oregonstate.edu/normals/>).

<sup>2</sup> Purdue Extension Publication NCH-40.

<sup>3</sup> Double crop wheat acres were not added to the total crop acres.

The 10 farmers interviewed reported that they have adopted no-till on an average of 100% of their planted land. Tennessee itself has a notably high level of no-till adoption, with 79% of cropland in no-till compared to 37% for the U.S. (Fig. 2). The 10 farmers interviewed also reported using cover crops on 19% of their cropland, as compared to 11% for the state and 5% for the nation (Fig. 2).



**Figure 2. Percentage of planted acres in no-tillage, reduced tillage, intensive tillage, and cover crop practices for the 10 Tennessee farmers as compared to cropland adoption of those practices in Tennessee and the U.S.**

USDA-NASS (2017)

The farmers we interviewed who have been practicing no-till have been doing so for about 17 years, and those growing cover crops have been doing so for approximately 7 years. Such levels of experience indicate substantial opportunity for others to learn from these farmers when considering the business case for adopting soil health systems.

## Partial Budget Analysis

Partial budgets were calculated to assess changes in expenses and revenue associated with adopting a soil health management system. The results were averaged across the 10 Tennessee farms, as presented in Table 2.

**Table 2. Partial budget analysis<sup>1</sup> of adopting a soil health management system averaged for 10 Tennessee farms. Unless shown otherwise, the units are \$/acre (2019 dollars).**

Expense Category	CORN		SOYBEAN	
	Benefits	Costs	Benefits	Costs
	<b>Reduced Expense</b>	<b>Additional Expense</b>	<b>Reduced Expense</b>	<b>Additional Expense</b>
Seed	0.00	6.65	0.00	2.80
Fertilizer & Amendments	9.89	0.00	6.07	0.00
Pesticides	4.00	8.81	8.75	6.94
Fuel & Electricity	3.71	1.45	3.31	1.11
Labor & Services	11.83	7.16	10.90	5.16
Post-harvest Expenses	0.00	4.95	0.00	1.60
Equipment Ownership	17.56	9.60	15.51	7.45
<b>Total Expense Change</b>	<b>46.99</b>	<b>38.62</b>	<b>44.54</b>	<b>25.06</b>
	<b>Additional Revenue</b>	<b>Reduced Revenue</b>	<b>Additional Revenue</b>	<b>Reduced Revenue</b>
Yield, bu.	11.00	0.00	5.00	0.00
Price Received <sup>2</sup> , \$/bu.	4.20	4.20	10.00	10.00
<b>Revenue Change</b>	<b>46.20</b>	<b>0.00</b>	<b>50.00</b>	<b>0.00</b>
	<b>Total Benefits</b>	<b>Total Costs</b>	<b>Total Benefits</b>	<b>Total Costs</b>
Total Change	93.19	38.62	94.54	25.06
<b>Change in Net Farm Income</b>	<b>54.57</b>		<b>69.48</b>	

<sup>1</sup>Expenses and expected yields based on farmer reported production practices. (<https://soilhealthinstitute.org/economics/>)

<sup>2</sup>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.

Fertilizer and amendment expenses were reduced by an average of \$9.89/acre for corn and \$6.07/acre for soybean, with a majority of farmers implementing nutrient management practices such as grid soil sampling (80%), variable rate fertilizer application (80%), and split application of nitrogen (100%) as part of their overall soil health management system.

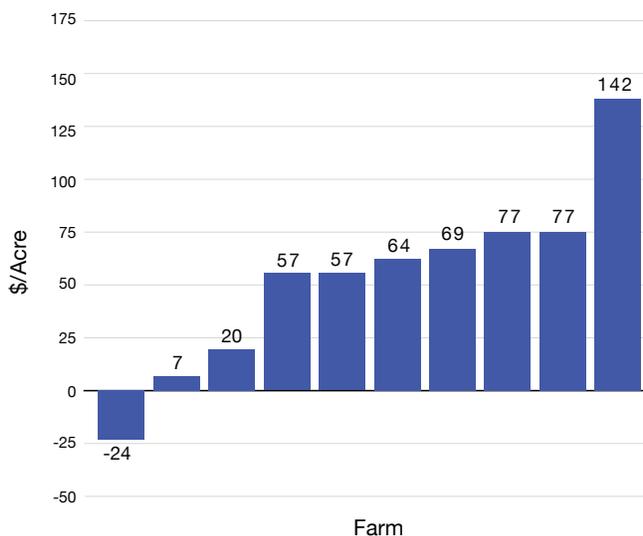
None of the 10 Tennessee farms reported a yield decline from adopting a soil health management system. In fact, 80% reported increased yield, averaging 11 bu/acre for corn and 5 bu/acre for soybean (Table 2).

While these yield increases are substantial, we also wanted to evaluate changes in expenses that are attributed to the soil health system. To do this, we subtracted the average post-harvest expenses associated with check-off fees and hauling/drying the higher yielding corn (\$4.95/acre) and soybean (\$1.60/acre) from the “Additional Expenses.” This allowed us to compare expenses that were not associated with a change in yield (e.g., \$46.99 – (\$38.62 - \$4.95) = \$13.32 for corn in Table 2). That comparison showed it cost an average of \$13.32/acre less to grow corn and \$21.08/acre less to grow soybean using a soil health management system. This means that even if yield did not increase, the soil health management system was still more profitable on these farms due to the reduced expense of growing a crop by using a soil health system.

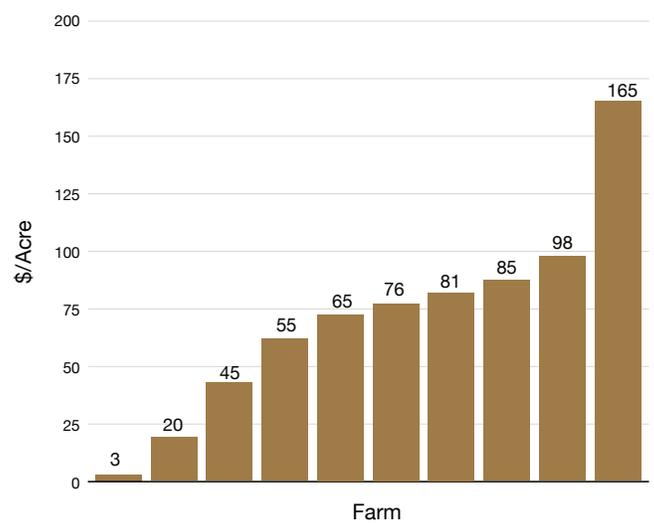
Recognizing that market prices fluctuate, we calculated revenue by using a standardized set of long-term average prices, as shown in the footnote to Table 2. Using those standardized prices, revenue from growing corn in a soil health management system increased by \$46.20/acre, and for soybean increased by \$50.00/acre.

Combining the changes in expenses and revenue showed that the soil health management system increased net income for these 10 Tennessee farms by an average of \$54.57/acre for corn and \$69.48/acre for soybean (Table 2). The range in net farm income for all 10 farmers displayed in Fig. 3 for corn and Fig. 4 for soybean shows that while economic benefits varied for each farmer, nearly all farmers reported a positive benefit for both crops and some were rather significant.

In addition, those farmers growing cotton reported net farm income to increase from \$5.00 to \$116.37/acre (averaging \$61.21/acre) when adopting a soil health management system. Those growing wheat reported net farm income to increase from \$7.85 to \$84.27/acre (averaging \$42.22/acre) when adopting a soil health management system.



**Figure 3.** Change in net farm income for 10 farms after adopting a soil health management system compared to a conventional system, corn, \$/Acre.



**Figure 4.** Change in net farm income for 10 farms after adopting a soil health management system compared to a conventional system, soybean, \$/Acre.

## Additional Benefits

As previously stated, 80% of the farmers interviewed reported a yield increase associated with adopting a soil health management system (Table 3). Fifty percent also reported that they reduced fertilizer inputs while implementing nutrient management as part of their overall soil health management system, and 100% reported increased crop resilience to extreme weather such as drought and heavy rain.

**Table 3. Summary of soil health management system benefits reported by 10 Tennessee farmers.**

Benefits Reported	% Responding Yes
Increased Yield	80
Reduced Applied Fertilizer	50
Increased Crop Resiliency	100
Increased Field Access	100
Improved Loan, Land, or Insurance Terms	30
Improved Water Quality	100
Protects License to Operate	100
Increased Soil Organic Matter	50

In addition to such benefits that directly impact profitability, these farmers also reported several other benefits from adopting a soil health system. These included increased access to the field and improved water quality.

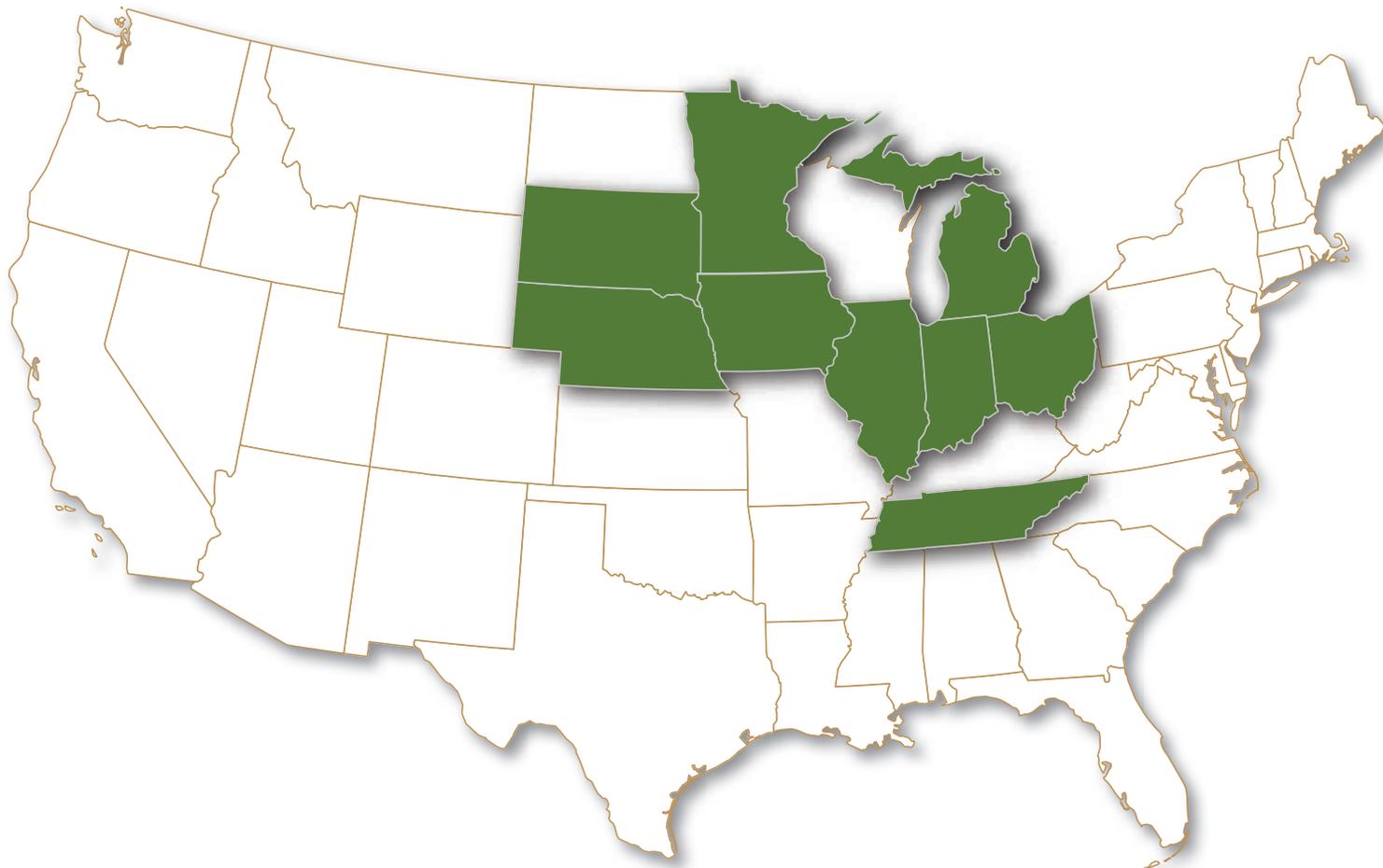
Interestingly, these farmers were monitoring changes in their soil organic matter levels, and 50% reported that those levels increased by an average of 1.3% due to the soil health management system. Research has shown that higher soil organic matter increases a soil's available nutrients and available water holding capacity, which is consistent with reduced fertilizer application, increased crop resilience, and improved field access observed by these Tennessee farmers.

## Summary

The Soil Health Institute and Cargill conducted this project to provide farmers with the economics information they need when deciding whether to adopt soil health practices and systems. The 10 farmers interviewed in Tennessee grew crops on an average of 2,824 acres, using no-till on 100% and cover crops on 19% of those acres. Eighty percent of the farmers interviewed reported increased yield from using a soil health management system, and none reported a yield decline. Based on the information provided by these farmers, it cost an average of \$13.32/acre less to grow corn and \$21.08/acre less to grow soybean using a soil health management system. Based on standardized prices, the soil health management system increased net income for these 10 Tennessee farmers by an average of \$54.57/acre for corn and \$69.48/acre for soybean. Farmers who grew cotton increased net income by an average of \$61.21/acre, and those who grew wheat increased net income by an average of \$42.22/acre when adopting a soil health management system. The current adoption rates of no-till (79%) and cover crops (11%) in Tennessee indicate that other Tennessee farmers may improve their profitability by adopting soil health management systems. Farmers also reported additional benefits of their soil health system, such as increased resilience to extreme weather and increased access to their fields.



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