ECONOMICS OF SOIL HEALTH SYSTEMS IN MINNESOTA

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

SOIL HEALTH INSTITUTE

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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 Minnesota grew crops on an average of 1930 acres, using no-till on 54% and cover crops on 48% of those acres.
- Fifty 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 $16.38/acre less to grow corn and $23.11/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 Minnesota farmers by an average of $32.13/acre for corn and $37.63/acre for soybean.
- The current adoption rates of no-till (6%) and cover crops (4%) in Minnesota indicate that many other 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 is also a business decision. This project was conducted by the Soil Health Institute (SHI) and Cargill to provide farmers with the economics 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 Minnesota (Fig. 1).

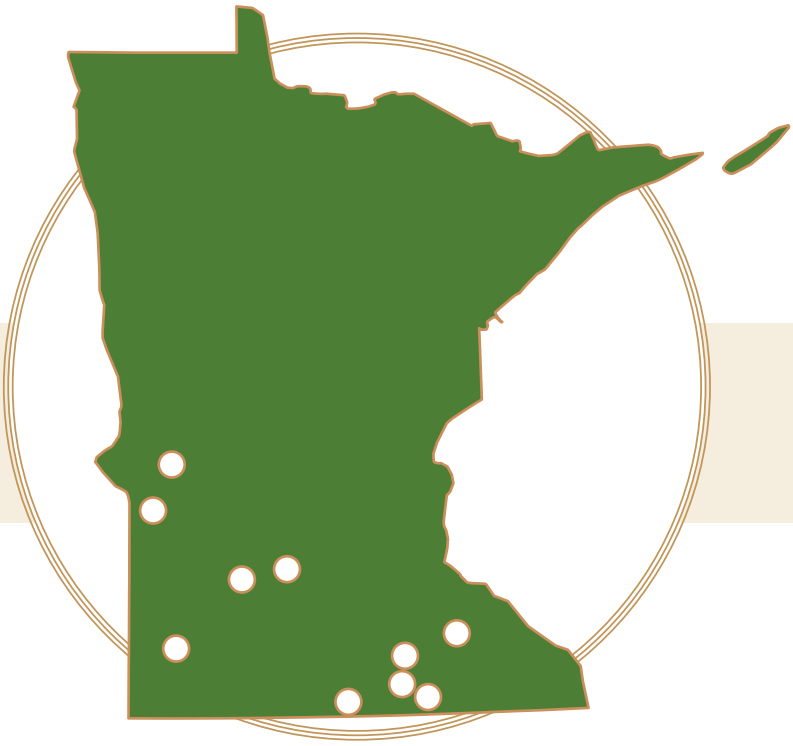

Figure 1. ***Geographic distribution of the 10 farms in Minnesota used for economic analysis of soil health management systems.***

Farm Characteristics

The 10 Minnesota farms assessed in this project raised crops on an average of 1930 acres, with 959 acres of corn, 703 acres of soybean, 20 acres of wheat, and 238 acres of other crops such as dry edible beans and sugar beets (Table 1). The growing conditions under which these farmers successfully adopted a soil health system ranged from 24-36 inches of annual precipitation, 43-46°F average annual temperature, and 2400-2700 growing degree days for corn (Table 1).

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

Characteristic	Value
Range in Average Annual Precipitation (inches)[1]	24 - 36
Range in Mean Annual Temperature (°F)[1]	43 - 46
Range in Average Annual Growing Degree Days for Corn[2]	2400 - 2700
Average Acres in Corn	959
Average Acres in Soybean	703
Average Acres in Spring Wheat	20
Average Acres in other Crops[3]	238
Average Total Crop Acres	1930

[1] *PRISM Climate Group 30 Year Normals (1981-2010) (https://prism.oregonstate.edu/normals/).*

[2] *Purdue Extension Publication NCH-40.*

[3] *Other crops included dry edible beans and sugar beets.*

The 10 farmers interviewed reported that they have adopted no-till on an average of 54% of their planted land. This is considerably greater than the 6% cropland adoption of no-till in Minnesota and 37% cropland adoption of no-till for the U.S. (Fig. 2). Some farmers reported using reduced-till on 46% of cropland instead of no-till, which is also used on about 44% of Minnesota cropland. A frequent reason was that they felt reduced-till (includes strip-till) helped them establish consistent corn stands under wet and cool spring conditions. The 10 farmers interviewed also reported using cover crops on 48% of their cropland, as compared to 4% for the state and 5% for the nation (Fig. 2).

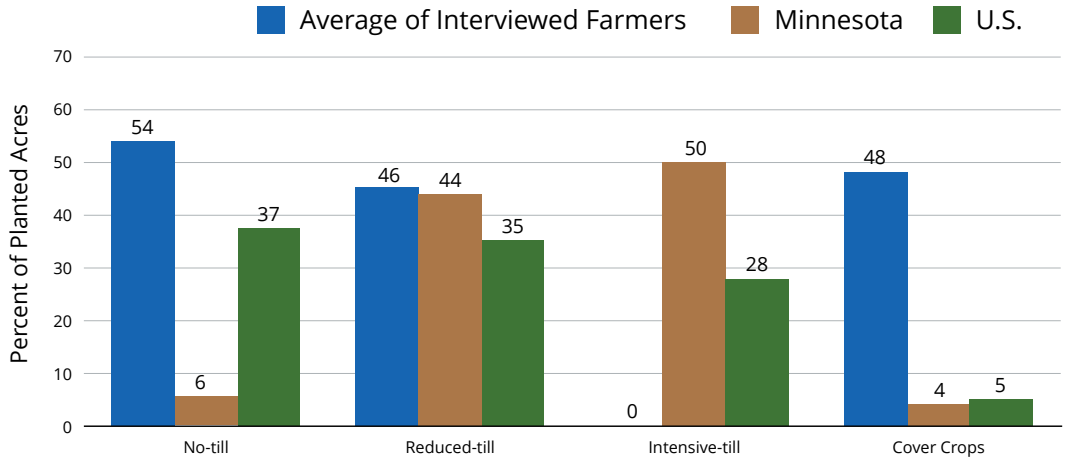

Figure 2. ***Percentage of planted acres in no-tillage, reduced tillage, intensive tillage, and cover crop practices for the 10 Minnesota farmers as compared to cropland adoption of those practices in Minnesota and the U.S.***

USDA-NASS (2017)

The farmers we interviewed who have been practicing no-till have been doing so for about 12 years, and those growing cover crops have been doing so for approximately six years. Such levels of experience, along with the above comparisons with state and national adoption levels, show that the farmers interviewed for this project are clearly leading the way and therefore offer substantial opportunity for others to learn from their experiences in adopting soil health systems. It is also clear that these farmers have been successful at implementing soil health systems across a range of climates in Minnesota (Table 1).

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 Minnesota farms, as presented in Table 2.

Table 2. ***Partial budget analysis[1] of adopting a soil health management system for 10 Minnesota farms. Unless shown otherwise, the units are $/acre (2019 dollars).***

	CORN		SOYBEAN	
	Benefits	**Costs**	**Benefits**	**Costs**
Expense Category	**Reduced Expense**	**Additional Expense**	**Reduced Expense**	**Additional Expense**
Seed	6.50	13.20	4.00	11.65
Fertilizer & Amendments	23.10	0.00	13.44	0.00
Pesticides	9.98	12.45	17.33	11.84
Fuel & Electricity	3.11	2.18	4.44	2.38
Labor & Services	9.87	9.73	12.25	8.84
Post-harvest Expenses	0.00	1.89	0.00	0.48
Equipment Ownership	12.80	11.42	20.24	13.88
Total Expense Change	**65.36**	**50.87**	**71.70**	**49.07**
	Additional Revenue	**Reduced Revenue**	**Additional Revenue**	**Reduced Revenue**
Yield, bu.	4.20	0.00	1.50	0.00
Price Received[2], $/bu.	4.20	4.20	10.00	10.00
Revenue Change	**17.64**	**0.00**	**15.00**	**0.00**
	Total Benefits	**Total Costs**	**Total Benefits**	**Total Costs**
Total Change	83.00	50.87	86.70	49.07
Change in Net Farm Income	**32.13**		**37.63**	

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

[2]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 $23.10/acre for corn and $13.44/acre for soybean, with a majority of farmers implementing nutrient management practices such as grid soil sampling (90%), variable rate fertilizer application (90%), and split application of nitrogen (100%) as part of their overall soil health management system.

None of the 10 Minnesota farms reported a yield decline from adopting a soil health management system. In fact, 50% reported increased yield, averaging 4.20 bu./acre for corn and 1.50 bu./acre for soybean (Table 2).

While these yield increases are notable, 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 ($1.89/acre) and soybean ($0.48/acre) from the "Additional Expenses." This allowed us to compare expenses that were not associated with a change in yield (e.g., $65.36 – ($50.87 - $1.89) = $16.38 for corn in Table 2). That comparison showed it cost an average of $16.38/acre less to grow corn and $23.11/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 $17.64/acre, and for soybean increased by $15.00/acre.

Combining the changes in expenses and revenue showed that the soil health management system increased net income for these 10 Minnesota farms by an average of $32.13/acre for corn and $37.63/acre for soybean (Table 2). The range in net farm income for all farmers interviewed shows that eight of 10 farmers reported a higher net income for both corn (Fig. 3) and soybean (Fig. 4) with a soil health management system. For one of the farmers growing spring wheat, net income increased by an average of $15.80/acre for wheat production when adopting a soil health management system.

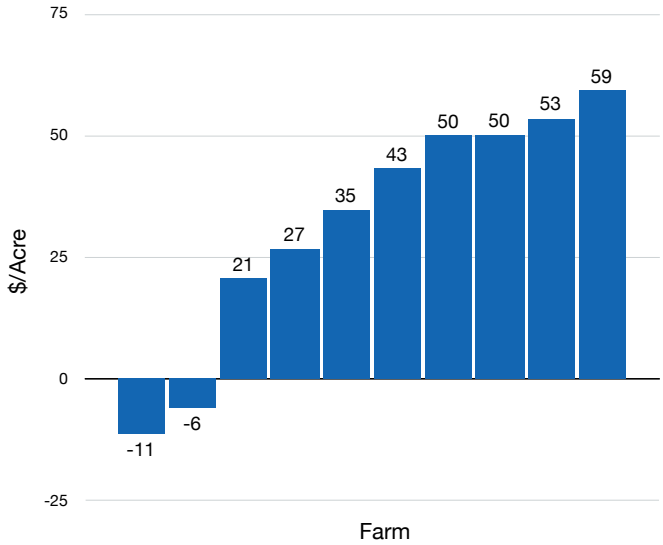

Figure 3. ***Change in net farm income for 10 farms after adopting a soil health management system compared to a conventional system, corn, $/Acre.***

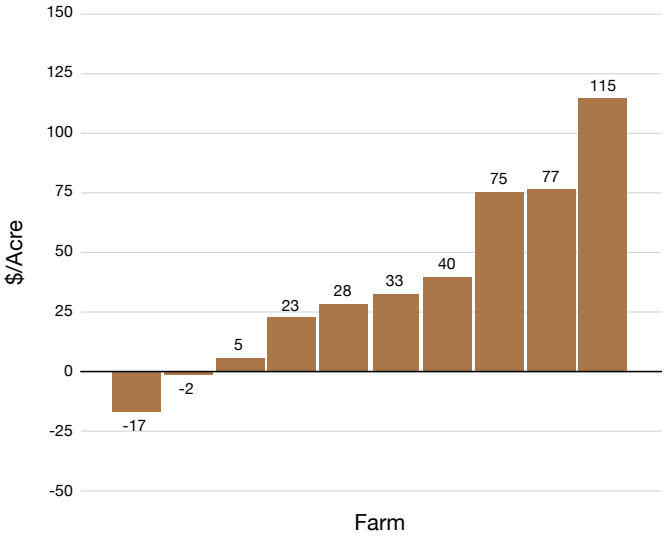

Figure 4. ***Change in net farm income for 10 farms after adopting a soil health management system compared to a conventional system, soybean, $/Acre.***

Additional Benefits

As previously stated, 50% of the farmers interviewed reported a yield increase associated with adopting a soil health management system (Table 3). One hundred 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 resilience to extreme weather such as drought and heavy rain.

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

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

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 loan, land, or insurance terms. Several farmers also indicated that adopting a soil health management system contributed to certification by the Minnesota Agricultural Water Quality Program, thereby protecting their license to operate for 10 years even if new state water quality rules or laws are enacted (Table 3).

Some farmers were monitoring changes in their soil organic matter levels, and 30% reported that those levels increased by an average of 1.0% 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 Minnesota farmers.

Additional revenue associated with cover crop grazing and forage value was reported by one Minnesota farmer. Using cover crops for grazing or forage has significant potential for increasing profitability. However, because only one of the 10 farmers interviewed used cover crops for this purpose (additional revenue reported of $67.50/acre), this source of revenue was not included in the partial budget estimates averaged across all 10 farms.

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 Minnesota grew crops on an average of 1930 acres, using no-till on 54% and cover crops on 48% of those acres. Fifty 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 $16.38/acre less to grow corn and $23.11/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 Minnesota farmers by an average of $32.13/acre for corn and $37.63/acre for soybean. One farmer who grew wheat increased net income by an average of $15.80/acre when adopting a soil health management system. The current adoption rates of no-till (6%) and cover crops (4%) in Minnesota indicate that other Minnesota 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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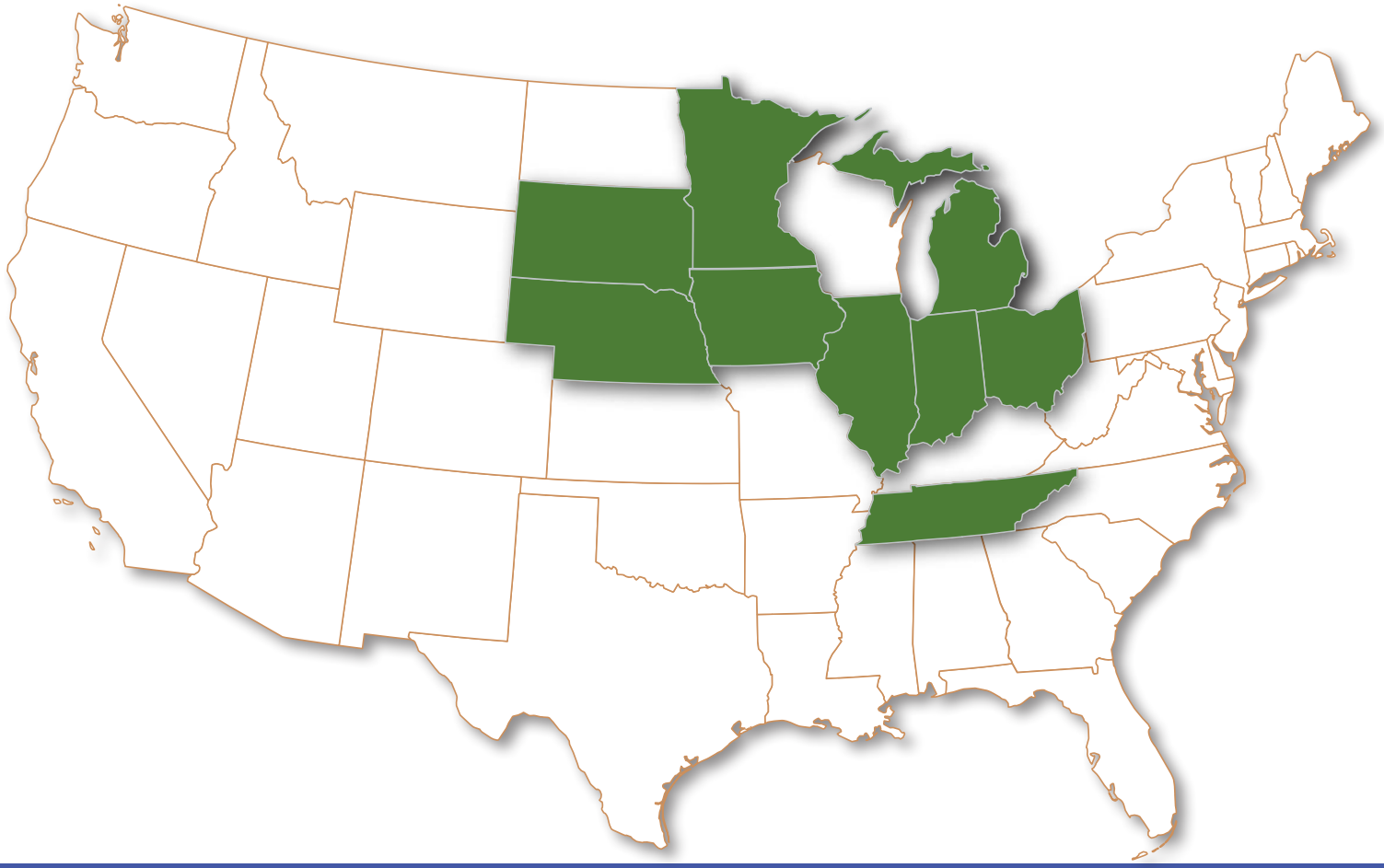

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