ECONOMICS OF SOIL HEALTH SYSTEMS ON 10 WHEAT FARMS IN KANSAS AND NORTH DAKOTA

SOIL HEALTH INSTITUTE

General Mills

Highlights

- The Soil Health Institute and General Mills, conducted partial budget analyses to provide Kansas and North Dakota farmers with the economic information they need when deciding whether to adopt soil health practices and systems.
- The 10 farmers interviewed grew crops on an average of 1,600 acres, using no-till on 100% and cover crops on 45% of those acres.
- Based on the information provided by these farmers, it cost an average of $15/acre less to grow wheat using a soil health management system.
- Based on standardized prices, soil health management systems increased net farm income for these ten farmers by an average of $19/acre for wheat.
- Farmers adopting soil health management systems for other crops also increased net income by an average of $14/acre for grain sorghum, $27/acre for soybean, $73/acre for corn, $47/acre for oats, and $46/acre for canola.
- Six farmers realized additional revenue for grazing cover crops that averaged $87/acre.
- Farmers reported additional benefits of their soil health management system, such as increased resilience to extreme weather, more timely access to fields, and improved water quality.
- Current adoption rates of no-till (48% in Kansas and 35% in North Dakota) and cover crops (2% in both states) indicate that other Kansas and North Dakota wheat farmers may improve their profitability by adopting soil health management systems.

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Introduction

Improving soil health can build drought resilience, reduce erosion, increase nutrient availability, reduce nutrient losses, and enhance management of some plant diseases. Many soil health management systems (SHMS - i.e., 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. This project was conducted in Kansas and North Dakota by the Soil Health Institute (SHI) to provide wheat growers with the economic information when making that decision (Fig. 1).

SHI interviewed 10 farmers (Fig. 1) who have adopted soil health systems in Kansas and North Dakota to acquire production information for evaluating their economics based on partial budget analysis. In using this approach, 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/

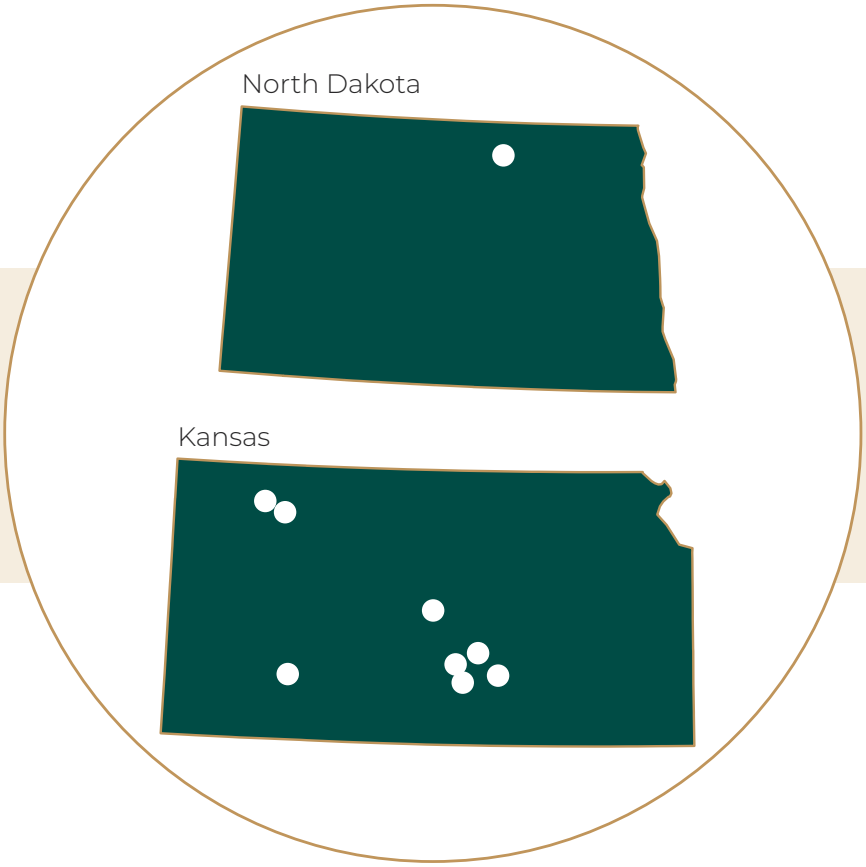

Figure 1. *Geographic distribution of the 10 farms used for economic analysis of soil health management systems.*

Farm Characteristics

The 10 farms in this project produced crops on an average of 1,600 acres, cropping wheat, grain sorghum, corn, soybean, oats, canola, and various other crops. Annual fallow averaged 50 acres with an average of 85 acres double cropped each year (Table 1).

Table 1. *Average annual precipitation,[1] temperature,[1] and crop acres reported for the 10 wheat farms.*

Crop	Value
Mean Annual Precipitation (inches)[1]	16 to 36
Mean Annual Temperature (°F)[1]	36 to 57
Total Farm (acres)	1,600
Wheat (acres)	508
Grain Sorghum (acres)	402
Corn (acres)	333
Soybean (acres)	276
Oat (acres)	27
Canola (acres)	19
Other Crops[2] (acres)	70
Fallow (acres)	50
Double Crop (acres)	85
Total Planted (acres)	1,685

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

[2] *Other crops include alfalfa, barley, field pea, flax, sunflower, triticale, and winter/cereal rye.*

The 10 farmers interviewed reported adopting no-till on all of their planted acres. This is considerably greater than the 48% adoption of no-till in Kansas, 35% in North Dakota, and 37% adoption for the U.S. (Fig. 2). The 10 farms used cover crops on 45% of their cropland, as compared to an average of 2% in both Kansas and North Dakota, and 5% for the nation (Fig. 2).

The farmers have been practicing no-till for an average of 15 years. Farmers planting cover crops have been doing so for an average of 12 years. Such levels of sustained implementation indicate effectiveness of no tillage practices and cover crops for others to consider when evaluating the business case for adopting soil health systems.

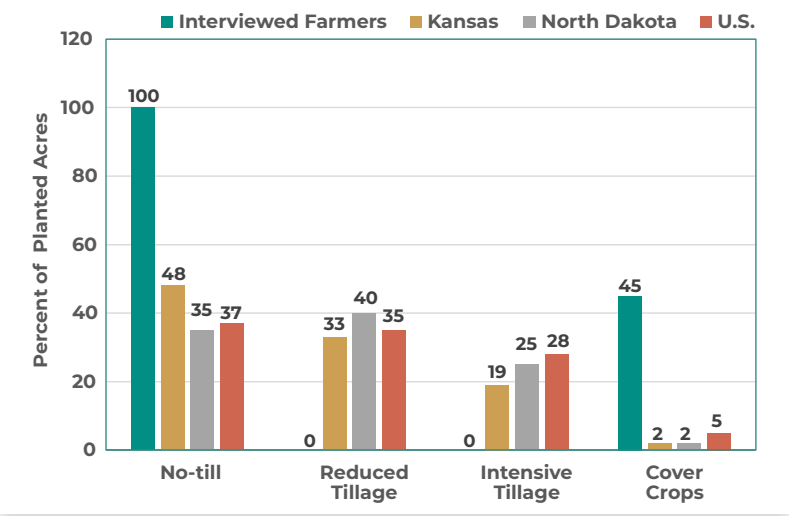

Figure 2. *Percentage of acres planted with no-till, reduced tillage, intensive tillage, and cover crops for the 10 interviewed farmers as compared to adoption of those practices in Kansas, North Dakota, and the U.S. (2017 U.S. Census of Agriculture, Chapter 1, Table 47).*

Partial Budget Analysis

Partial budgets were calculated to assess changes in expense and revenue associated with adopting SHMS for wheat. Average results for the ten farms are presented in Table 2.

Table 2. *Partial budget analysis[1] of adopting a soil health management system for wheat production on ten farms. Expense, revenue, and net farm income units are $/acre (2020 dollars).*

	Wheat	
	Benefits	**Costs**
Expense Category	**Reduced Expense**	**Additional Expense**
Seed	0.00	7.05
Fertilizer & Amendments	6.43	0.00
Pesticides	1.26	3.12
Fuel & Electricity	4.58	1.69
Labor & Services	9.63	4.93
Post-harvest Expenses	0.00	0.22
Equipment Ownership	18.91	9.22
Total Expense Change	**40.81**	**26.23**
	Additional Revenue	**Reduced Revenue**
Yield, bu./acre	0.80	0.00
Price Received[2], $/lb.	5.50	5.50
Revenue Change	**4.40**	**0.00**
	Total Benefits	**Total Costs**
Total Change	45.21	26.23
Change in Net Farm Income	**18.98**	

[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.*

All farmers reported using cover crops on at least a portion of their crop acreage with three planting them before wheat production. Cover crop seed expenses with wheat production ranged from $18.00/acre to $30.00/acre with an average of $23.50/acre. The least expensive cover crop was an oat, pea, canola, and flax seed mix. The greatest cover crop seed expense was a mix of millet, cowpea, radish, sunflower, mung bean, and sun hemp. Additional seed expense averaged $7.05/acre for all farms (Table 2).

Adopting SHMS can reduce some expenses and increase others. For example, SHMS may add nitrogen to the system with legume cover crops. Three farmers reported reducing their fertilizer and amendment expenses when using a SHMS, amounting to an average of $6.43/acre (Table 2).

Reducing tillage and planting cover crops may enhance weed suppression and lead to changing or eliminating some herbicide applications. Reduced pesticide expenses averaged $1.26/acre (Table 2). In other circumstances, additional herbicide is used for weed management or cover crop termination. Such additional pesticide expenses averaged $3.12/acre (Table 2).

Adopting no-till decreased costs for equipment ownership, fuel, labor, and other expenses totaling $33.12/acre (Table 2). Some additional expenses were associated with more pesticide applications and planting cover crops.

No farmers reported lower wheat yield due to adopting a SHMS. One farmer reported increased yield from adopting a SHMS, resulting in a 0.80 bu./acre increase when averaged across all 10 farms (Table 2).

Market prices for crops fluctuate, so revenue due to changing yield was calculated based on a long-term average price for wheat (Table 2 footnote). Using that price, net revenue from growing wheat in a SHMS increased $4.40/acre due to increased yield (Table 2).

Overall, a SHMS increased net income for these 10 farms by an average of $18.98/acre for wheat (Table 2). The higher net income was primarily due to lower costs of producing wheat in a SHMS ($14.58/acre less; $40.81 minus $26.23 = $14.58/acre in Table 2). This means that even if yield did not increase, the SHMS was still more profitable on these 10 farms due to the reduced expense of growing wheat.

Farms in this study were assigned identification numbers based on order of interview, and net farm income change is presented for each farm in Fig. 3. The range in net farm income for all farmers in Fig. 3 shows that economic benefits varied for each farmer with seven farmers reporting a positive benefit for wheat ranging from $3 to $56/acre, and two farmers reporting decreases in net farm income. The farm with the greatest income increase ($56/acre) had the only yield increase (8 bu./acre) coupled with an expense decrease of $12/acre. The lower net incomes for two farms were attributed to greater expenses and no yield increase. These were two of the three farms that planted cover crops before wheat, and reduced expenses did not offset costs associated with planting cover crops.

Figure 3. *Change in net income from wheat for 10 farms after adopting a soil health management system compared to a conventional system.*

Generally, financial benefits for growing other crops with SHMS were also reported by these farmers. Nine farmers growing grain sorghum with a SHMS reported net farm income to increase by an average of $13.93/acre (ranged from -$60.96 to $127.60/acre). Five farmers growing soybean with a SHMS increased net income by an average of $26.64/acre (ranged from -$13.30 to $135.80/acre). Four farmers growing corn with a SHMS increased net income by an average of $167.86/acre (ranged from -$32.91 to $167.86/acre). One farmer growing oats with a SHMS increased net farm income by $47.35/acre, and one farmer growing canola increased net farm income by $45.52/acre. Notably, six farmers included grazing of cover crops as a component of their SHMS and realized additional net income that averaged $86.67 for each acre grazed. Upon incorporating the effects of adopting a SHMS on all of these crops, including the grazing value of cover crops, net farm income increased by an average of $55/acre (ranging from $7 to $143/acre, Fig. 4).

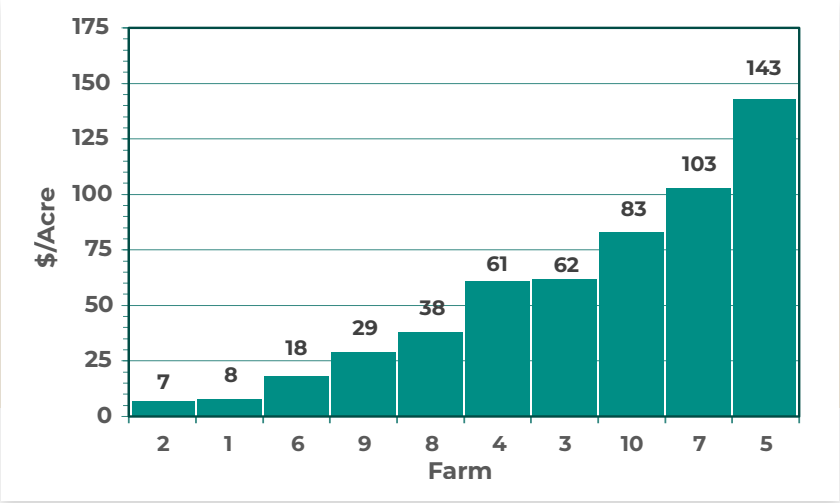

Figure 4. *Change in net farm income from 10 farms after adopting a soil health management system across many crops, including grazing cover crops. The average increase in net farm income is $55/acre.*

Additional Benefits

In addition to equipment ownership expenses being reduced in a SHMS (Table 2), a SHMS can also reduce the total value of equipment owned. Long-term capital debt on high-value equipment exposes a farm to financial risk, especially during periods of lower commodity prices. All farmers interviewed reported decreased value of owned equipment reducing exposure to financial risk (Table 3).

In addition to benefits that directly impact profitability, these farmers also reported other benefits from their SHMS such as increased crop resilience (100%), more timely access to their fields (80%), and improved water quality (80%) (Table 3). Changes in water quality were based on visual differences in water clarity observed by the farmers. Eighty percent of the farmers stated that adoption of SHMS improved public perception of agricultural production.

Research has shown that higher soil organic matter increases nutrient availability and available water holding capacity. This is consistent with the experiences reported by farmers in this project, where adopting a SHMS allowed for reduced fertilizer applications (Table 2), increased crop resilience, and improved field access (Table 3). Most of these farmers were monitoring changes in their soil organic matter levels, and 90% reported that those levels increased due to the SHMS (Table 3). Measured changes in soil organic matter generally increase by 0.1% per year attributable to soil health practices.

Table 3. *Summary of additional soil health management system benefits reported by ten wheat farmers.*

Benefit	% Responding Yes
Decreased Value of Equipment Owned	100
Increased Crop Resilience	100
Increased Field Access	80
Improved Water Quality	80
Improved Public Perception for Agriculture	80
Increased Soil Organic Matter	90

Summary

The Soil Health Institute conducted this project to provide farmers with the economic information when deciding whether to adopt soil health systems. The 10 farmers interviewed grew crops on an average of 1,600 acres, using no-till on 100% and cover crops on 45% of those acres. None of the farmers interviewed reported decreased wheat yield from using a SHMS. It cost an average of $14.58/acre less to grow wheat using a SHMS. Based on standardized prices the SHMS increased net farm income by an average of $18.98/acre for wheat. Adopting a SHMS also increased net farm income by $13.93/acre for grain sorghum, $26.64/acre for soybean, and $72.90/acre for corn. One farmer growing oats with a SHMS increased net farm income by $47.35/acre, and one farmer growing canola increased net farm income by $45.52/acre. Six farmers grazed cover crops as a component of their SHMS. Upon including the effect of adopting a SHMS on all of these crops and grazing the cover crops, net income increased by an average of $55.00/acre. Farmers also reported additional benefits of their SHMS, such as increased resilience to extreme weather, increased access to fields, and improved water quality. The current adoption rates of no till (48% in Kansas and 35% in North Dakota) and cover crops (2% in both states) indicate that other wheat farmers in Kansas and North Dakota may improve their profitability by adopting soil health management systems.

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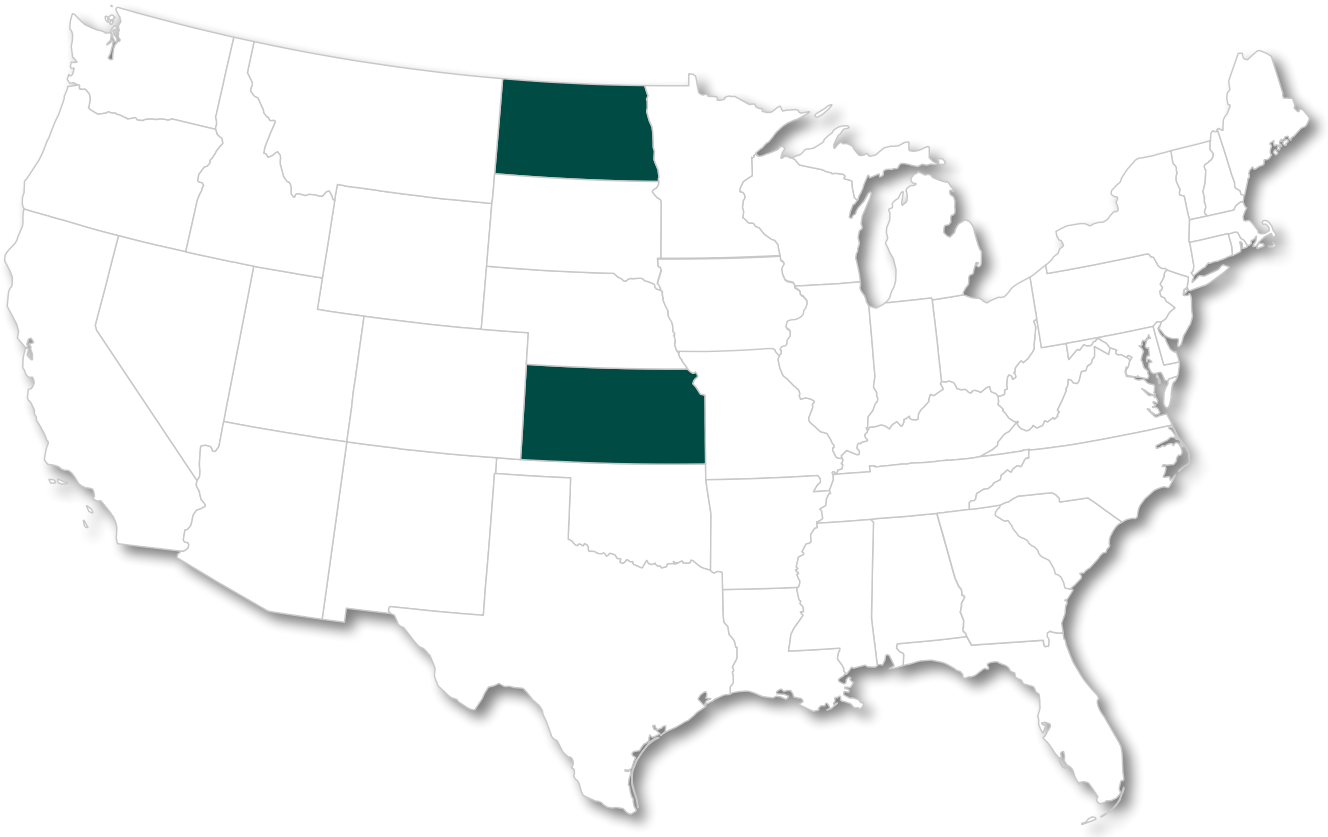

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