ECONOMICS OF SOIL HEALTH SYSTEMS ON 100 FARMS

A Comprehensive Evaluation Across Nine States

SOIL HEALTH INSTITUTE

Cargill

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 100 farmers interviewed grew crops on an average of 1940 acres, using no-till on 85% and cover crops on 53% of those acres.
- Those farmers using no-till had been doing so for an average of 19 years, and those who grew cover crops had been doing so for an average of nine years.
- Sixty-seven percent of the farmers interviewed reported increased yield from using a soil health management system. Two farmers reported decreased corn yield.
- Based on the information provided by these farmers, it cost an average of $24.00/acre less to grow corn and $16.57/acre less to grow soybean using a soil health management system.
- Across all 100 farms, soil health management systems increased net income for 85% of farmers growing corn and 88% growing soybean.
- Based on standardized prices, the soil health management system increased net income for these 100 farmers by an average of $51.60/acre for corn and $44.89/acre for soybean.
- Farmers also reported additional benefits of their soil health management system, such as increased resilience to extreme weather and increased access to their fields.
- The current adoption rates of no-till (37%) and cover crops (5%) in the U.S. indicate that many other farmers may improve their profitability by adopting soil health management systems.

Introduction

Improving soil health can help farmers build drought resilience, increase nutrient availability, suppress diseases, and reduce erosion and 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 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/.

Farm Characteristics

A total of 100 farmers were interviewed representing 194,003 acres of cropland across Illinois, Indiana, Iowa, Michigan, Minnesota, Nebraska, Ohio, South Dakota, and Tennessee (Table 1). These nine states collectively contribute 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).

Table 1. ***Locations and crops for 100 farms used for assessing economics of soil health management systems.***

		Average Crop Acres						
State	# Farms	Corn	Soybean	Winter or Spring Wheat	Double Crop Wheat	Cotton	Other	Per Farm
Illinois	11	459	459	16	18	0	0	934
Indiana	16	1628	1630	110	6	0	105	3473
Iowa	10	1202	923	0	0	0	0	2125
Michigan	10	366	494	184	0	0	234	1278
Minnesota	10	959	703	20	0	0	248	1930
Nebraska	12	840	557	41	8	0	47	1485
Ohio	11	426	473	87	14	0	108	1095
S. Dakota	10	776	746	100	0	0	68	1690
Tennessee	10	1043	1083	0	548	655	43	2824
		Total Crop Acres						
Total	100	89,324	82,499	6435	6028	6548	9098	194,003

The 100 farms assessed in this project raised crops on an average of 1940 acres, with 893 acres of corn, 825 acres of soybean, 64 acres of wheat (60 acres double crop wheat), and 156 acres of other crops such as cotton, dry edible beans, and sugar beets (Table 2). The growing conditions under which these farmers successfully adopted a soil health system ranged from 20-55 inches of average annual precipitation, 43-61 °F average annual temperature, and 2400-4000 growing degree days for corn (Table 2).

Table 2. ***Growing conditions and crops for farmers interviewed in the nine states.***

Characteristic	Value
Range in Average Annual Precipitation (inches)[1]	20 - 55
Range in Mean Annual Temperature (°F)[1]	43 - 61
Range in Average Annual Growing Degree Days for Corn[2]	2400 - 4000
Average Acres in Corn	893
Average Acres in Soybean	825
Average Acres in Winter/Spring Wheat	64
Average Acres in Double Crop Wheat	60
Average Acres in Other Crops[3]	156
Average Total Crop Acres	1940

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

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

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

The 100 farmers interviewed reported they have adopted no-till on an average of 85% of their planted land. This is considerably greater than the 37% cropland adoption of no-till for the U.S. (Fig. 1). Reduced tillage of 15% composed the balance of planted acreage (Fig. 1). The 100 farmers interviewed also reported using cover crops on 53% of their cropland, as compared to 5% for the nation (Fig. 1).

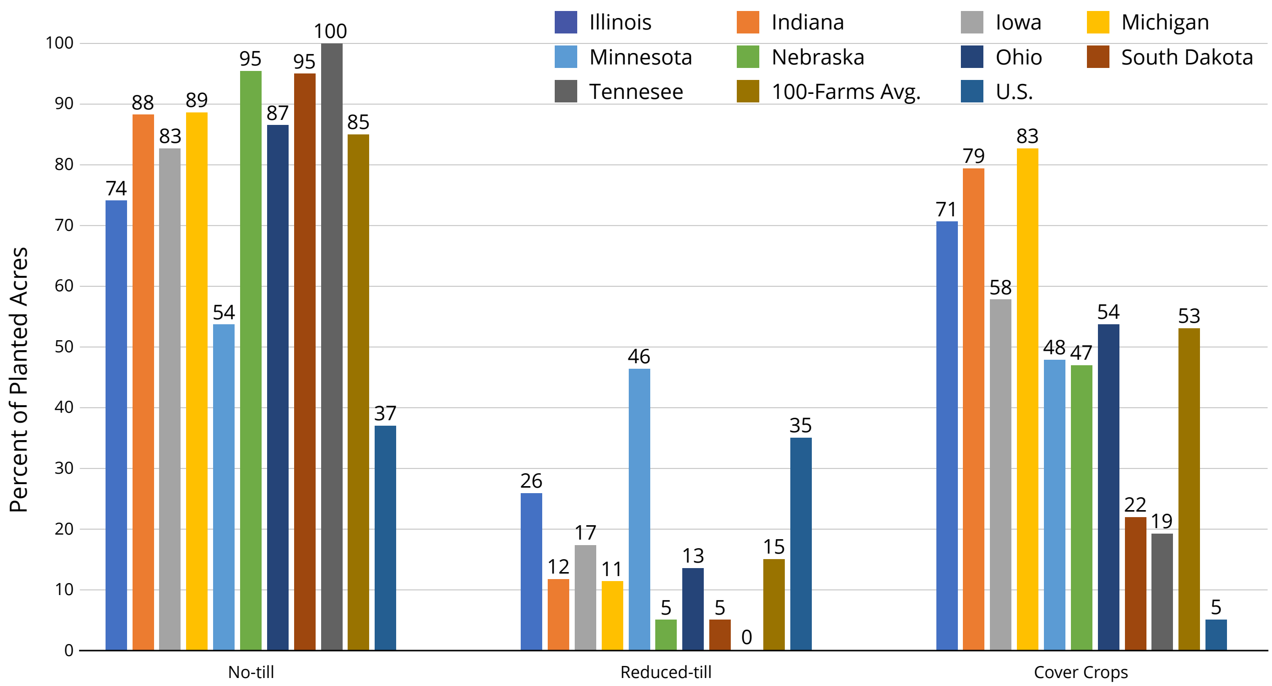

Figure 1. ***Percentage of planted acres in no-tillage, reduced tillage, and cover crops for 100 farms evaluated in nine states, as compared to the U.S.***

USDA-NASS (2017)

The farmers we interviewed who have been practicing no-till have been doing so for about 19 years, and those growing cover crops have been doing so for approximately nine 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 the nine-state region (Table 2).

Partial Budget Analysis

Partial budgets were calculated to assess changes in expenses and revenue associated with adopting a soil health management system. Government payments were excluded from the analysis. Results were averaged across all 100 farms and are presented in Table 3.

Table 3. ***Partial budget analysis[1] of adopting a soil health management system for 100 farms in the nine-state region. 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	4.08	12.62	2.79	10.02
Fertilizer & Amendments	22.36	1.14	9.20	0.25
Pesticides	9.22	7.90	10.00	8.07
Fuel & Electricity	3.91	1.90	4.33	1.80
Labor & Services	11.13	8.24	10.94	8.24
Post-harvest Expenses	0.18	3.48	0.00	0.93
Equipment Ownership	16.18	11.08	18.41	10.72
Total Expense Change	67.06	46.36	55.67	40.03
	Additional Revenue	Reduced Revenue	Additional Revenue	Reduced Revenue
Yield, bu./acre	7.73	0.39	2.91	0.00
Price Received[2], $/bu.	4.21	4.20	10.05	10.00
Revenue Change	32.54	1.64	29.25	0.00
	Total Benefits	Total Costs	Total Benefits	Total Costs
Total Change	99.60	48.00	84.92	40.03
Change in Net Farm Income	51.60		44.89	

[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.

As previously stated, cover crops were planted on 53% of the cropland on these 100 farms (Fig. 2). Cover crops were planted before corn by 63 farmers and before soybean by 64 farmers. Upon averaging across all 100 farms, the additional cost for seed averaged $12.62/acre for corn and $10.02/acre for soybean (Table 3).

Fertilizer and amendment expenses were reduced by an average of $22.36/acre for corn and $9.20/acre for soybean, with a majority of farmers implementing nutrient management practices such as grid soil sampling (86%), variable rate fertilizer application (82%), and split application of nitrogen (89%) as part of their soil health management system.

Overall, 67% of farmers reported a yield increase due to adopting a soil health management system, averaging 7.73 bu./acre for corn and 2.91 bu./acre for soybean (Table 3). However, two farmers reported yield decreases for corn, amounting to a 0.39 bu./acre decrease when averaged across all 100 farms.

Although yield differences are the most obvious driver of changes in income, we also wanted to evaluate other changes attributable to the soil health system not related to yield. To do this, we subtracted the average post-harvest expenses associated with check-off fees and hauling/drying the lower yielding corn ($0.18/acre) from the "Reduced Expenses," as well as similar post-harvest expenses associated with the higher yielding corn ($3.48/acre) and soybean ($0.93/acre) from the "Additional Expenses." This allowed us to compare expenses that were not associated with a change in yield (e.g., ($67.06 - $0.18) – ($46.36 - $3.48) = $24.00 for corn in Table 3). That analysis showed it cost an average of $24.00/acre less to grow corn and $16.57/acre less to grow soybean using a soil health management system. This means that even if yield did not change, the soil health management system was still more profitable on these farms due to the reduced expense of growing a crop with a soil health system. Decreases in production expense with a soil health system ranged from an average of $13/acre to $35/acre for corn and from $8/acre to $23/acre for soybean (Fig. 2).

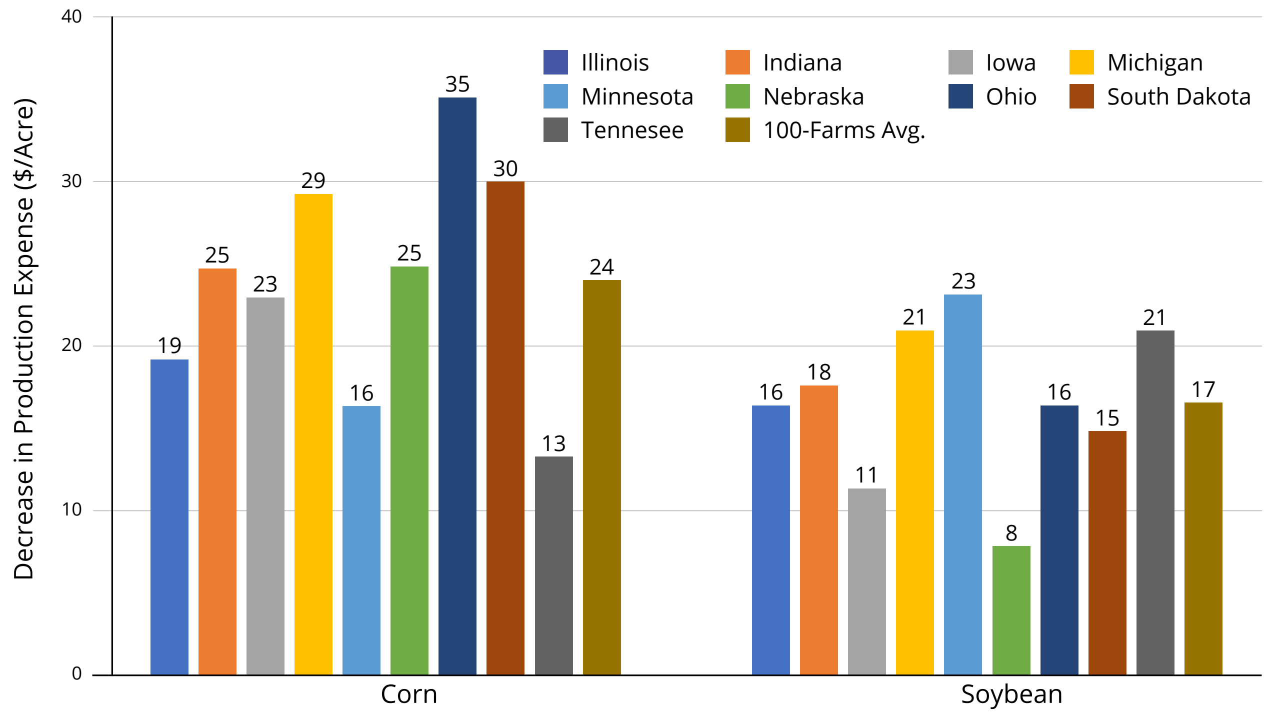

Figure 2. ***Average decrease in production expense with a soil health management system for corn and soybean, by state and for all 100 farms.***

Recognizing that market prices fluctuate, we calculated revenue by using a standardized set of long-term average prices (corn=$4.20/bu., soybean=$10.00/bu.), as shown in the footnote to Table 3. Some farmers planted non-GMO corn or soybean after adopting a soil health management system that provided a price premium. This increased the additional revenue price once averaged across all farms to $4.21/bu. for corn and $10.05/bu. for soybean (Table 3). Using those standardized prices, additional revenue with a soil health management system increased by an average of $30.90/acre for corn ($32.54 - $1.64 = $30.90), and by $29.25/acre for soybean (Table 3).

Combining the changes in expenses and revenue showed that the soil health management system increased net income for these 100 farms by an average of $51.60/acre for corn and $44.89/acre for soybean (Table 3). Average increase in net farm income for corn ranged from $25/acre in Michigan to $68/acre in Nebraska (Fig. 3). Average increase in net farm income for soybean ranged from $37/acre in Iowa and Ohio to $69/acre in Tennessee (Fig. 3). Additionally, net farm income increased with a soil health system by an average of $19.08/acre for the 12 farmers growing wheat, $61.21/acre for the seven farmers growing cotton, $54.28/acre for the four farmers growing dry edible beans, and $47.35/acre for the one farmer growing sugar beets.

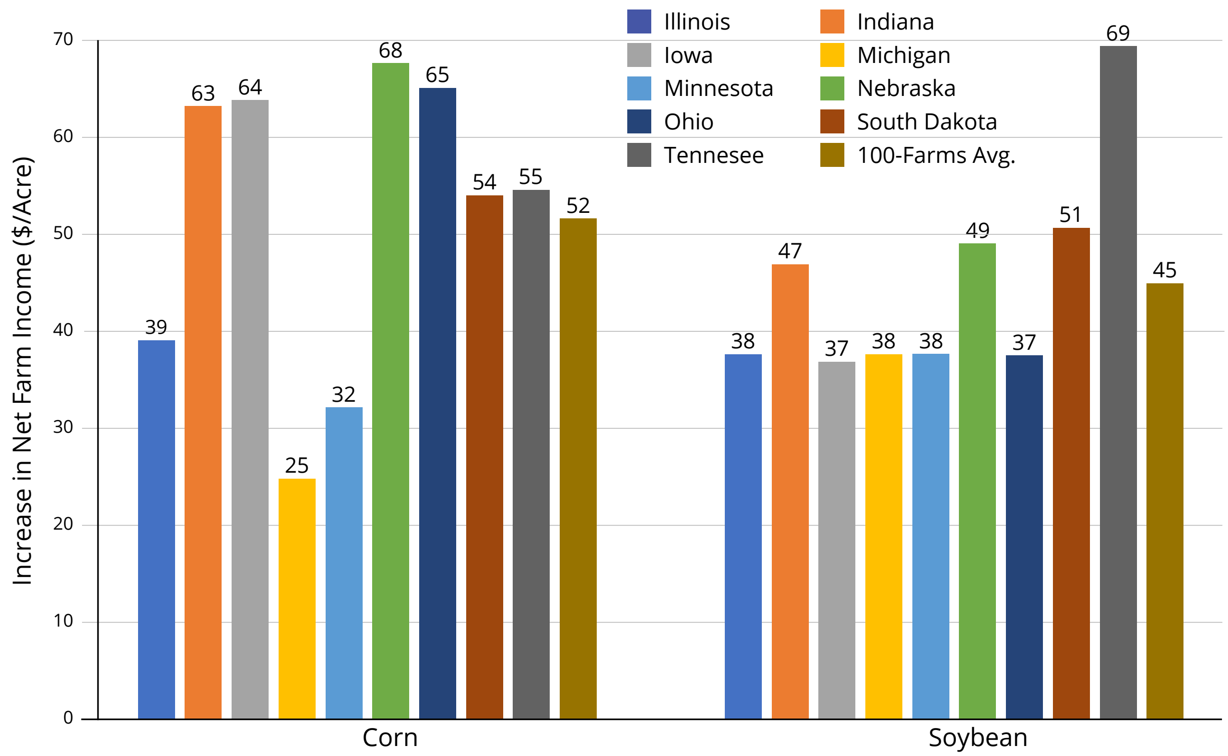

Figure 3. ***Average increase in net farm income for corn and soybean using a soil health management system, by state and for all 100 farms.***

Additional revenue associated with cover crop grazing and forage value was reported by nine farmers. Using cover crops for grazing or forage has significant potential for increasing profitability. However, because only nine of the 100 farmers interviewed used cover crops for this purpose (additional revenue reported ranged from $1.50/acre to $570.00/acre), this source of revenue was not included in the partial budget estimates.

Using a soil health management system, 85% of farms increased net income for corn, and 88% increased net income for soybean. However, a wide range of impact on net income was observed (Figs. 4 and 5). It appeared that some of the highest increases in net income were related to selling/marketing non-GMO crops. This data exemplifies the well-established notion that no two farms are identical, which is one of the main reasons why this project was conducted on 100 farms across nine states.

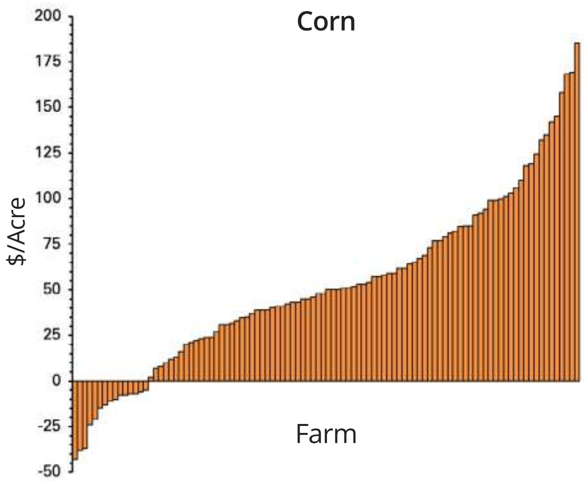

Figure 4. ***Change in net farm income from corn for 100 farms after adopting a soil health management system compared to a conventional system.***

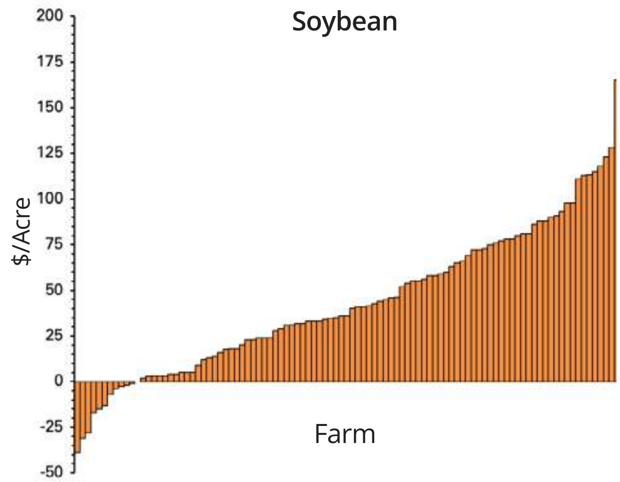

Figure 5. ***Change in net farm income from soybean for 100 farms after adopting a soil health management system compared to a conventional system.***

Additional Benefits

As previously stated, 67% of farmers interviewed reported a yield increase associated with adopting a soil health management system (Table 4). Also, 83% reported that they reduced fertilizer inputs while implementing nutrient management as part of their overall soil health management system. Notably, 97% reported increased resilience to extreme weather such as drought and heavy rain, and 93% reported the soil health system to increase access to their fields. While a few farmers were engaged in water quality monitoring on their farms, most reported this benefit of improved water quality based on observing clearer water on or leaving their fields with a soil health management system.

Table 4. ***Summary of soil health management system benefits reported by 100 farmers.***

Benefits Reported	% Responding Yes
Increased Yield	67
Reduced Applied Fertilizer	83
Increased Crop Resilience	97
Increased Field Access	93
Improved Loan, Land, or Insurance Terms	41
Improved Water Quality	100
Protects License to Operate	98
Increased Soil Organic Matter	54

Interestingly, these farmers were monitoring changes in their soil organic matter levels, and 54% reported those levels to increase by an average of 1.2% 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 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 100 farmers interviewed in a nine-state region grew crops on an average of 1940 acres, using no-till on 85% and cover crops on 53% of those acres. Those farmers using no-till had been doing so for an average of 19 years, and those who grew cover crops had been doing so for an average of nine years. Sixty-seven percent of farmers interviewed reported increased yield from using a soil health management system. Two farmers reported decreased corn yield with a soil health system. Based on the information provided by these farmers, it cost an average of $24.00/acre less to grow corn and $16.57/acre less to grow soybean using a soil health management system. Across all 100 farms, soil health systems increased net income for 85% of farmers growing corn and 88% growing soybean. Based on standardized prices, the soil health management system increased net income for these 100 farmers by an average of $51.60/acre for corn and $44.89/acre for soybean. Additionally, for 12 of the farmers growing winter wheat, seven growing cotton, four growing dry edible beans, and one farmer growing sugar beets, net income increased by an average of $19.08/acre, $61.21/acre, $54.28/acre, and $47.35/acre, respectively, when adopting a soil health management system. Farmers also reported additional benefits of their soil health system, such as increased resilience to extreme weather and increased access to their fields. The current adoption rates of no-till (37%) and cover crops (5%) in the U.S. indicate that many other farmers may improve their profitability by adopting soil health management systems.

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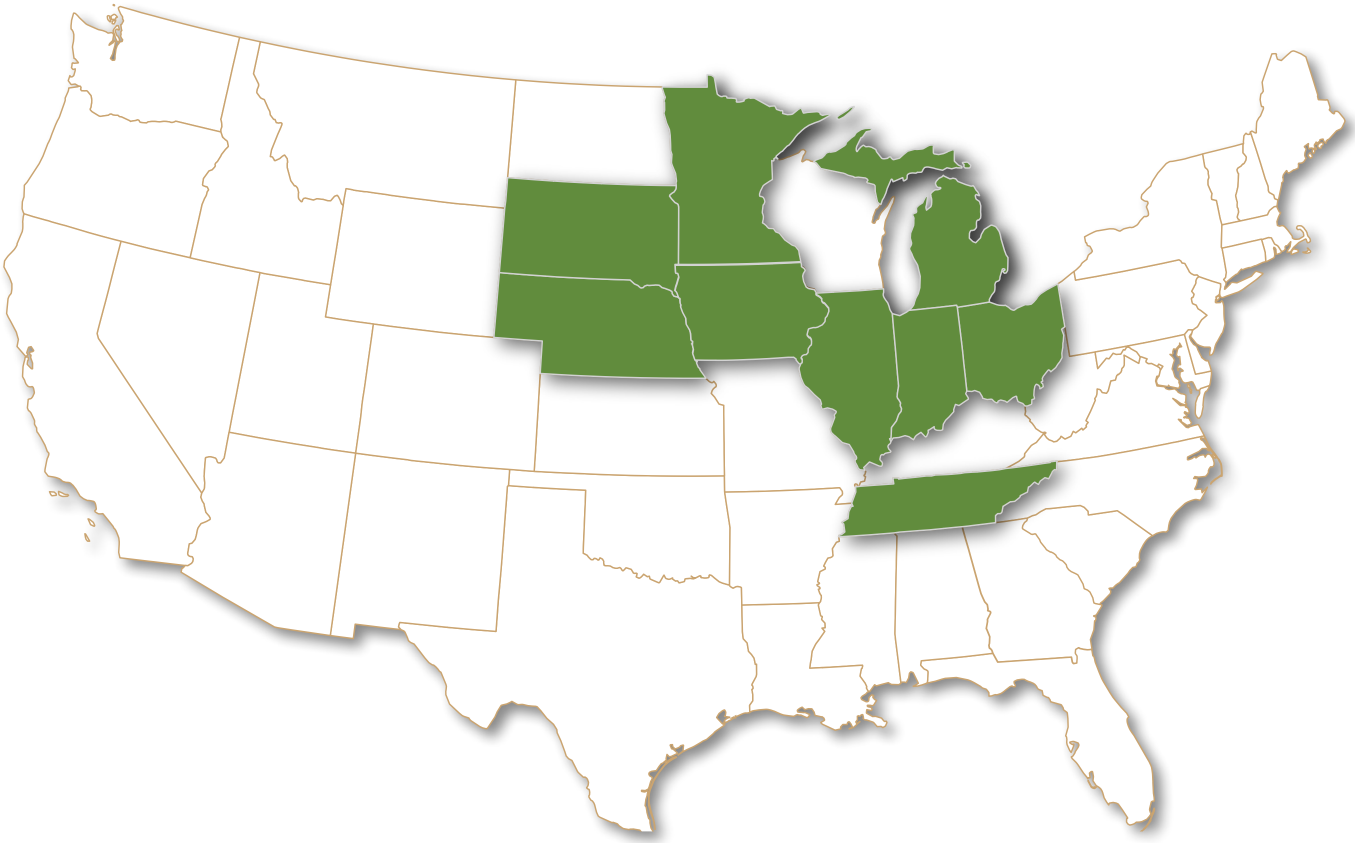

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