Regional Strategic, LTD.

Estimation of Financial Implications Resulting from the Implementation of Farm Conservation Practices

Prepared for the Iowa Soybean Association

By

Mark Imerman, Senior Consultant
Eric Imerman, Senior Consultant
Regional Strategic, Ltd.
Des Moines, Iowa

October 4, 2019

Forward

This investigation was developed to generate interview-based estimates of enterprise-level financial implications resulting from the implementation of farm conservation practices in Iowa. The impetus for this analysis is an interest in developing robust information from Iowa farm enterprises to provide a more focused and localized representation of the farm case studies included in 2018's "Farm Finance and Conservation" publication presented by the Environmental Defense Fund and K-COE ISOM.

The goal is to better understand what influences farmers' participation in the implementation and maintenance of conservation practices. At the outset, it was hoped that information generated here would show that there are farm finance and profit incentives for engaging in conservation practices.

The work has been undertaken by Regional Strategic, Ltd with funding from the Iowa Soybean Association and the Walton Family Foundation.

KEY FINDINGS

Primary producers on participant operations tend to be older than Iowa primary producers overall as reported by the 2017 U.S. Census of Agriculture.

Participant farms are generally larger than Iowa farms reported in the 2017 Census of Agriculture. Only one participant operation, at 294 acres, was smaller than the Iowa average farm size of 355 acres. The largest study operation was 5,200 acres. Two, at 2,000 acres each, were of minimum size to get into the largest size category. The final large-category farm was 2,200 acres. Total acreage (row-crop and otherwise) in the study group was 29,056. This is less than one-tenth of one percent of Iowa farmland.

Among the twenty participants:

Eighteen produced 6,889 acres of soybeans after corn with cover crop
Fourteen produced 6,002 acres of soybeans after corn without cover crop
Fourteen produced 6,222 acres of corn after soybeans with cover crop
Fifteen produced 5,420 acres of corn after soybeans without cover crop
Three produced 1,447 acres of corn after corn with cover crop
Six produced 1,225 acres of corn after corn without cover crop

Cover crop acreage and non-covered acreage were compared in three ways

1. Averages across all participants (seventeen) that supplied sufficient information for comparison
2. Averages for participants that produced both covered and non-covered acreage within a particular rotation and could distinguish yields
3. Averages for participants that either covered all acreage within a rotation or covered no acreage within a rotation

Across three rotations

A. Soybeans following corn
B. Corn following soybeans
C. Corn following corn

Cover crop production was disadvantageous for all three comparisons in the corn following corn rotation due to yield shortfalls relative to acreage where no cover crop was produced.

Soybean yields after cover crop production were superior to yields where no cover crop was produced in all three comparisons, but in comparison 1 the yield premium was insufficient to offset higher costs of cover crop production. In comparisons 2 and 3 soybeans following corn and a cover crop showed advantages over soybeans on acreage where no cover crop had been grown.

Corn following soybean and a cover crop outperformed acreage where no cover crop was produced in comparisons 1 and 3.

For rotations A and B, crops following covers showed advantageously in two out of three comparisons for each rotation.

Total pesticide expenditures (herbicide, insecticide, and fungicide) were consistently lower for acreage following a cover crop relative to acreage where no cover crop had been grown. This relationship did not transfer consistently to pesticide application (sprayer) costs.

In nearly all comparisons where cover crop acreage was advantageous relative to acreage where no cover had been grown, total fertilizer expenditures were lower on the covered acreage.

The majority of otherwise eligible participants for comparison 2 could not be utilized because they did not provide differentiable yields for covered and non-covered acreage.

Five participants harvested cover crops from 560 acres in 2018. These harvests generated a net revenue of $78,160 after harvest costs were paid. A sixth participant owns a cover crop seed sales and service business that contracts for 1700 acres of rye and oat seeds from cover crops. Nearly all of these participants indicated an interest in expanding their cover crop harvest operations.

Participants displayed a wide range of record keeping systems. These ranged from nearly one-third demonstrating no visible documentation to one-third utilizing computer-based accounting and agronomic information. The remainder were scattered between.

Better records appear to be correlated with more intense participation in conservation practices, but good records do not appear to be a function of operation scale.

Participants indicate that moving to no-till and strip-till generated savings of $10-88 per acre relative to conventional tillage. These estimates tend to be higher for participants that are better able to account for them through quality record keeping systems. Estimated potential fuel and equipment savings range up to $265 million annually on a statewide basis for Iowa.

Participant average nitrogen applications are significantly higher than the maximum return to nitrogen (MRTN)rates promoted by the Iowa nutrient reduction strategy. On average, reducing participant application rates to MRTN would result in increased returns of approximately $6 per acre according to the online MRTN calculator at Iowa State University.

Five participants are regularly applying nitrogen to acreage going into beans.

Nearly half of manure users indicate they are gifted manure, barter for manure, or receive manure as a by-product from leasing livestock production facilities. Several others note that the price they pay for manure is substantially less than what they would pay for its potassium and phosphorus content. It appears that a lot of manure is being purchased and applied as free nitrogen.

While participants strive to treat rented land as owned land from a conservation perspective, they acknowledge that there is a reduced willingness to invest on the part of landlords. Additionally, as tenants how they manage land depends upon how much is paid in rent.

While it is difficult to nail down the mechanism, it is clear that strong farm transition plans are conducive to maintaining conservation practices as a farm operation changes hands.

Table of Contents

Introduction

Farm conservation is important to the long-term economic viability of all farm operators and farmland owners, all consumers of food and farm products, and all downstream consumers of water resources. The implications of farm conservation practices on production, soil health, food supply, and water quality receive substantial attention. The field-level costs of improving conservation practices at the farm level are also well substantiated. The enterprise-level and statewide savings that can result from significant implementation of conservation practices across an operation receive less attention. This report is the result of an investigation into the levels and significance of such savings through direct interviews and data collection with select Iowa conservation adopters.

The foundation of this investigation is a series of interviews with twenty Iowa farm operators known to have adopted conservation practices. The population of participants was identified – and their participation was arranged by – the Iowa Soybean Association's Environmental Programs and Services team.

Initial interviews were conducted from late February through early April of 2019. Each participant received an interview questionnaire and crop budget worksheets prior to committing to the process. Each participant who committed to the study agreed to and scheduled an initial interview covering

- General farm information
- Specific cropping and conservation practices, costs, and outputs for the most recent available year or rotation
- Farm lifecycle and succession information

Interviews and crop budgets focused on the 2018 cropping year defined as the period following 2017 crop harvest through 2018 crop harvest. Where cover crops were planted, the cover was planted in fall 2017 and terminated in 2018 before or shortly after the 2018 (budgeted) crop was planted. The goal was to provide a snapshot of crop costs and outcomes for corn and soybeans following cover crops relative to crop costs and outcomes for corn and soybeans not following cover crops. The second years of six two-year crop rotations were considered:

Soybeans after corn with cover crop
Soybeans after corn without cover crop
Corn after soybeans with cover crop
Corn after soybeans without cover crop
Corn after corn with cover crop
Corn after corn without cover crop

Following summarization and review of initial results, staff from the Iowa Soybean Association and Regional Strategic, Ltd. selected nine participants for follow-up interviews. Eight of these participants scheduled follow-up interviews. These additional interviews support a series of eight case studies included in this report.

This report provides summaries of participant characteristics and findings from the initial interviews. Additionally, seven topical case studies address the following topics:

1. Records management and information systems
2. Risk management
3. Cover crop valuation and monetization
4. Reduced tillage
5. Nutrient management
6. Ownership impacts
7. Transitions

An eighth case study focuses on Wayne Fredericks' farm operation, record management, and conservation profile.

Participant Summary

In February and March of 2019, the Iowa Soybean Association selected twenty farm operators to be interviewed for this investigation. Selection was not random. Operators selected represent a subset of the farm operator population that maintains high visibility in conservation discussions, events, and organizations related to Iowa agriculture. Figure 1 shows the distribution of participants by county in Iowa (removed to ensure participant anonymity).

Table 1 and Figure 2 show the age distribution of the principal producers[1] involved in participant's operations compared with a distribution of principal producers from the 2017 Census of Agriculture for Iowa. Study participants' principal producers are generally older than Iowa farmers.[2]

Five principal producers (all 65 years or more in age) reported joint decision-making. Two of these reported a partner of the same generation (a wife and a brother). One reported a wife and children. One, sons of the next generation (45-54) and a younger nephew (25). One reported a son (35). In the 3 cases where children were noted, it was a son of the principal producer who participated in the interview.

TABLE 1: Age of Principal Producers

Age of Principal Producer	2017 Census of Agriculture		Study Participants	
	Number	Percent	Number	Percent
Under 25 years	859	0.74	0	0.00
25-34 years	8,093	7.00	0	0.00
35-44 years	12,708	10.99	2	10.00
45-54 years	19,040	16.47	4	20.00
55-64 years	34,387	29.74	3	15.00
65-74 years	25,433	22.00	10	50.00
75 years and over	15,110	13.07	1	5.00

[1] "Principal producer" refers to the active operator controlling the largest share of land, equipment, and production on the participant farm operation.
[2] This table compares principal producers in participant operations in order to get a direct comparison to 2017 Census of Agriculture data. At least one participant interview was with an operator under 35, but he was in partnership with his father.

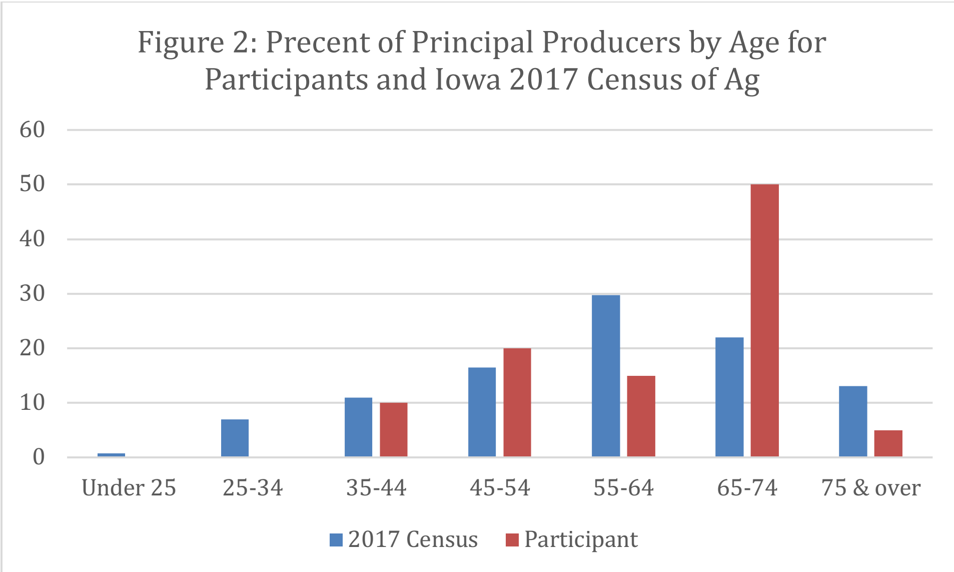
Figure 2: Precent of Principal Producers by Age for
Participants and Iowa 2017 Census of Ag
60
50
40
30
20
10
0
Under 25
25-34
35-44
45-54
55-64
65-74
75 & over
2017 Census
Participant

Given the age distribution of participants' principal producers, it is not surprising that farm operation transition is a concern for several study participants:

- Seven report no transition plan (37% of participant acreage)
- Three report that the current transition is to the current principal producer – meaning the farm is transitioning from non-operating owners (retired operators and/or estates) to the current principal producer (7.9% of participant acreage)
- Nine report a plan to move from the current principal producer to members of a younger generation (48.5% of participant acreage)
- One reports the farm is a corporation owned by the family (6.6% of participant acreage)

TABLE 2: Study Participant Farm Size

Farms by Size (acres)	**2017 Census of Agriculture**		**Study Participants**	
	Number	**Percent**	**Number**	**Percent**
1-9 acres	9,120	10.59	0	0.00
10-49 acres	18,183	21.12	0	0.00
50-179 acres	20,831	24.19	0	0.00
180-499 acres	19,172	22.27	1	5.00
500-999 acres	10,381	12.06	9	45.00
1,000-1,999 acres	6,525	7.58	6	30.00
2,000 acres or more	1,892	2.20	4	20.00

Table 2 shows the distribution of study participants by farm size in acres compared to all farms in the 2017 Census of Agriculture for Iowa. Like the distribution of principal producer age, study operation size distribution is skewed towards larger farms relative to Iowa all farms. Figure 3 provides a visual interpretation of this distribution.

Only one participant, at 294 acres, was smaller than the Iowa average farm size of 355 acres. The largest study operation was 5,200 acres. Two, at 2,000 acres each, were of minimum size to get into the largest size category. The final large-category farm was 2,200 acres. Total acreage in the study group was 29,056. This is less than one-tenth of one percent of Iowa farmland.

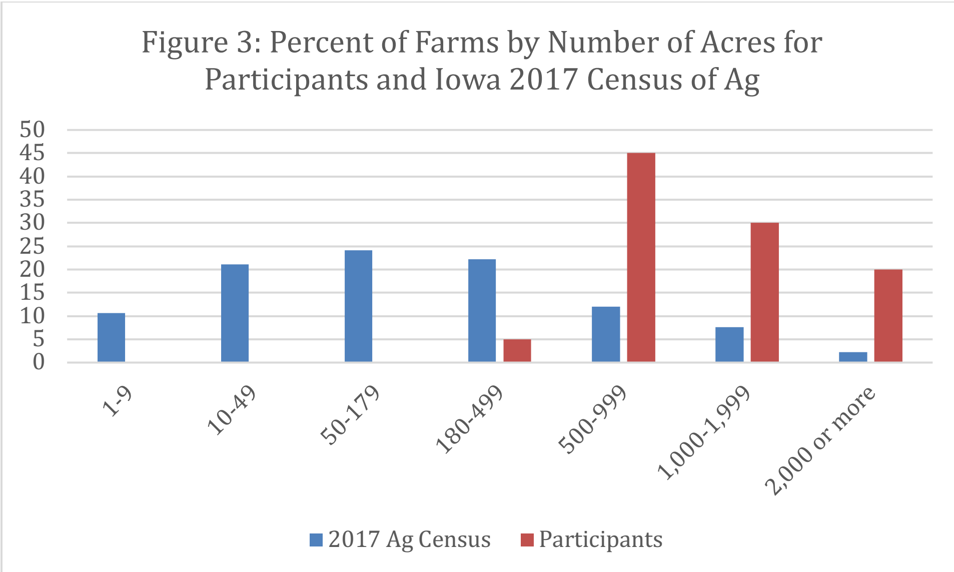
Figure 3: Percent of Farms by Number of Acres for Participants and Iowa 2017 Census of Ag
50
45
40
35
30
25
20
15
10
5
0
1-9
10-49
50-179
180-499
500-999
1,000-1,999
2,000 or more
2017 Ag Census
Participants

Three Compilations of Average Crop Rotation Yields and Costs

Tables 3, 6, and 7 present three compilations of production cost and yield information across the participant population. The three tables were all constructed by calculating average yields and production costs per acre across three subsets of the twenty study participants.

- Table 3 provides averages across seventeen interview participants who provided both production practice activities and out-of-pocket input expenditure information
- Table 6 provides averages only for participants who planted into both covered ground and non-covered ground for any given rotation
- Table 7 provides averages for participants who either covered all their row-crop acreage or covered none of their acreage in any given rotation

Each of the tables was produced by averaging participant reported costs over reported acres. Participants were asked to provide a descriptive narrative of their operations and to provide cropping budgets by crop, rotation, and the cultivation of a cover crop. Wherever necessary, gaps in operator knowledge about specific field-level costs were augmented with benchmark data from Iowa State University's *2018 Iowa Farm Custom Rate Survey*.[3] Every participant relied at least partially on Iowa State University survey estimates for practice costs.

Among the twenty participants:

Eighteen produced 6,889 acres of soybeans after corn with cover crop
Fourteen produced 6,002 acres of soybeans after corn without cover crop
Fourteen produced 6,222 acres of corn after soybeans with cover crop
Fifteen produced 5,420 acres of corn after soybeans without cover crop
Three produced 1,447 acres of corn after corn with cover crop
Six produced 1,225 acres of corn after corn without cover crop

For the purposes of this investigation, the most important data provided was pre-harvest practices[4] (how many activities happened in the field) and cover crop establishment and harvest yield information. Pre-harvest costs include the costs of establishing and terminating cover crops, savings from reduced tillage, savings on fertilizer, herbicides, and pesticides that can be attributable to cropping practices, and increases or decreases in yield (revenue) that may be attributable to cropping practices.

---

[3] Available at https://www.extension.iastate.edu/hancock/sites/www.extension.iastate.edu/files/hancock/2018_CustomRateSurvey.pdf

[4] The 2018 crop year was defined as the period from 2017 harvest through 2018 harvest. Fall tillage, fertilization, and other activities that occurred following 2017 harvest are considered pre-harvest practices for the 2018 crop year. Fall tillage, fertilization, and other practices that occurred following the 2018 harvest are considered as pre-harvest activities for the 2019 crop year.

Other than minimal cost differentials due to yield, primary-crop harvest cost data does not directly reflect the costs or savings from conservation practices. Sales cost information reflects marketing choices rather than production practices. Interest and insurance reflect finance choices and risk allocation. These differences are much less likely to be attributable to cropping practices.

Averages Across All Participants

Table 3 shows rotation averages for pre-harvest operating and cover crop production costs across the acreage of all participants that provided both operational practice and out-of-pocket expense information. The table provides information on a per-acre basis. In most cases, it is assumed that a particular application or treatment was carried out in a single pass across the field. In the cases of spraying (both ground and aerial), the number of passes (spray events) was included as a separate line in addition to average overall practice cost per acre. This reflects the reality that spraying regularly happens multiple times per season. It also reflects an interest in whether cover crop practices consistently affect spraying activity.

It is important to note that the data in Table 3 cannot be interpreted as head-to-head comparisons. There are different practices and management information systems across the seventeen participants in the comparison. It is possible that participants growing cover crops are better managers than those that do not or vice versa. There is no way within the data to determine the allocation of high-quality land to one practice relative to another. Differences in Table 3 may be due to general participant practices or land selection rather than the implementation of a cover crop. There are, however, some interesting observations to be made with respect to Table 3.

Yields and yield expectations (lines 2 and 3) were similar for cover and non-cover crops in beans following corn and corn following beans. Average yields in both situations favored crops following cover crops (0.5 bushel per acre premium on beans following corn and a cover and 2.2 bushels per acre premium on corn following beans and a cover). The yield premium on soybeans following a cover crop would not be sufficient to offset higher costs even after taking reported cover crop subsidies into account (line 26). The 2.2-bushel yield premium on corn following beans with a cover crop would be sufficient to offset increased costs at corn market prices of $3.37 per bushel with average reported cover crop subsidies of $7.85 per acre (line 26).

For corn following corn, however, average participants' yield goal was 6.7 bushel per acre lower when a cover crop was planted. Actual reported yields showed an average 44.9 bushel per acre shortfall where a cover crop was established between corn-on-corn crops relative to the uncovered rotation. While the covered rotation showed a $36.56 input-cost advantage after accounting for the average cover crop subsidy of $15.81, this would not offset the yield shortfall at any sustainable market price.

These findings are for a single crop year and a select group of participants. They do not carry the weight that results of multiple-year randomized strip trials over a larger population would carry. Nevertheless, they are important because risks to regular summer crops are a significant factor in decisions to establish a cover crop.

Table 3: Production practice and cost for all participants providing budget information

		Beans After Corn		Corn after Beans		Corn after Corn	
Row		and Cover	and No Cover	and Cover	and No Cover	and Cover	and No Cover
1	Acres	5638.6	5577.0	5642.2	4370.0	1222.0	525.0
2	Yield goal (bu./acre)	61.0	62.5	212.6	211.8	200.3	207.0
3	Actual yield (bu./acre)	59.1	58.6	209.0	206.8	166.9	211.8
4	Actual yield as percent of goal	96.9	93.7	98.3	97.6	83.3	102.3
5	Chisel plow pass cost ($/acre)	0.00	0.32	0.00	0.00	0.00	13.00
6	Field cultivate pass cost ($/acre)	0.00	0.26	1.57	0.50	0.00	6.86
7	NH3 application cost ($/acre)	0.00	0.00	1.04	0.89	0.00	1.05
8	Strip-till pass cost ($/acre)	0.67	0.00	6.21	5.10	12.28	1.47
9	Side dress pass cost ($/acre)	0.00	0.00	5.26	4.01	1.91	3.89
10	Fertilizer pass Cost ($/acre)	0.00	0.18	1.00	1.41	0.00	4.06
11	Other tillage pass cost ($/acre)	0.93	0.62	0.00	0.75	0.00	9.19
12	Plant cost ($/acre)	18.64	18.14	19.16	18.56	13.24	19.26
13	Number of ground spray passes	2.50	2.49	1.77	1.62	2.95	2.00
14	Ground spray costs ($/acre)	15.65	16.07	10.55	10.02	14.53	13.75
15	Number of aerial spray passes	0.25	0.10	0.31	0.35	0.00	0.25
16	Aerial spray costs ($/acre)	2.86	1.08	3.00	3.70	0.00	3.24
17	Seed ($/acre)	62.86	61.38	96.95	98.91	111.16	114.66
18	Fertilizer: All ($/acre)	40.16	36.13	103.79	109.20	90.34	92.18
19	Herbicide, insecticide & fungicide: All ($/acre)	41.76	44.85	40.33	45.39	42.18	49.79
20	Reported costs prior to cover costs ($/acre)	186.28	181.61	290.92	300.42	288.59	334.65
21	Cover Crop: Seed ($/acre)	11.19	0.00	11.76	0.00	14.52	0.00
22	Cover Crop: Plant ($/acre)	10.85	0.00	10.83	0.00	7.93	0.00
23	Cover Crop: Termination ($/acre)	1.36	0.00	2.15	0.00	2.86	0.00
24	Reported costs with cover costs ($/acre)	209.68	181.61	315.67	300.42	313.90	334.65
25	Reported cover subsidies ($/acre)	10.19		7.85		15.81	
26	Net reported costs ($/acre)	198.96	181.61	307.82	300.42	298.09	334.65

It is also notable that average reported production costs prior to cover crop establishment costs for both corn rotations were notably lower on covered ground (line 20). The bulk of these savings were in average costs for seed, fertilizer, and herbicide, insecticide, and fungicide (lines 17-19).

Average pesticide (total herbicide, insecticide, and fungicide) expenditures were lower for cover crop acreage than for uncovered acreage in all rotations in Table 3. Costs and differences are shown in Table 4.

Although average pesticide material costs were lower on covered acreage for all rotations when averaging all participants, this relationship is not consistently seen when averaging subsets of participants in Tables 6 and 7 below.

Table 4: Total reported herbicide, insecticide, and fungicide material cost ($/acre) comparison for acreage with and without cover crops

	Cover	No cover	Cover savings
Soybean following corn	41.76	44.85	3.09
Corn following soybean	40.33	45.39	5.06
Corn following corn	42.18	49.79	7.60

Consistently lower pesticide costs were not reflected in application (sprayer) costs. Sprayer costs were higher for covered land in the soybeans following corn rotation but lower for both corn following soybeans and corn following corn. Table 5 shows combined pesticide material and sprayer costs by rotation and advantages for acreage with a cover crop.

Table 5: Total reported herbicide, insecticide, and fungicide material and sprayer cost ($/acre) comparison for acreage with and without cover crops

	Cover	No cover	Cover savings
Soybean following corn	60.27	62.00	1.73
Corn following soybean	53.88	59.12	5.23
Corn following corn	56.72	66.78	10.06

Cover crop subsidies (row 25) were substantially less than the cost of producing cover crops (rows 21-23) on average. Participants in this comparison reported cover crop subsidies ranging from $0 to $25.38 per acre. Three participants did not engage in cover cropping for the 2018 crop year. Ten reported average cover crop subsidies of less than $10 per acre, and three of these reported no subsidies at all.

Selective Crop Rotation Comparisons

As noted above, the comparison of overall participant averages does not account for differences that may exist in operation management, land allocation, or other factors. Cover crop producers self-select. Individuals that feel comfortable with the risks and returns available in the presence of cover crops will chose to produce them. Individuals that are uncomfortable with respect to the associated risks and returns will chose not to. Individual comfort levels and selection decisions may reflect past success, management expertise and/or confidence, quality of land available, etc. All these factors affect the choice to produce covers, and those selective choices almost certainly affect the average yield and production cost information presented in Table 3.

To expand on overall averages, two additional comparisons are provided here. Attempting to get beyond operator qualifications, Table 6 provides a comparison between covered and non-covered rotations among participants that had both covered and non-covered crops within any specific rotation. Table 7 compares covered and non-covered rotations between participants that either covered all their row-crop acreage or covered none of their row-crop acreage within a particular crop rotation

The seventeen participants whose averages are compared in Table 3 included:

- Three participants planting cover crops on all their row-crop acreage
- Three participants not planting cover crops at all
- Ten participants with soybeans following corn both with and without cover crops
- Eight participants with corn following soybeans both with and without cover crops
- One participant with corn following corn both with and without cover crops

A total of eleven participants provide situations where we can directly compare a given crop in a given rotation both following and not following a cover crop. Of these, only four participants with six rotations had records that allowed participants to distinguish yields between their cover crop land and their non-cover crop land:

- Two participants with beans following corn
- Three participants with corn following beans
- One participant with corn following corn

Table 6 replicates Table 3 with data from only these four participants. Table 6 eliminates some of the self-selection effects that undoubtedly affect the averages in Table 3. Each participant in the averages presented in Table 6 produce both covered and non-covered crops for each rotation in which they are included. This should substantially reduce the effects of management ability between averages for crops that follow a cover crop and crops that do not.

Table 6: Production practice and cost for participants raising both covered and non-covered crops in any given rotation

Row		Beans After Corn and Cover	Beans After Corn and No Cover	Corn after Beans and Cover	Corn after Beans and No Cover	Corn after Corn and Cover	Corn after Corn and No Cover
1	Acres	694.0	364.0	1174.0	351.0	40.0	245.0
2	Yield goal (bu./acre)	60.0	60.0	197.5	205.8	210.0	210.0
3	Actual yield (bu./acre)	55.8	54.7	167.3	179.5	225.0	233.0
4	Actual yield as percent of goal	93.0	91.2	84.7	87.2	107.1	111.0
5	Chisel plow pass cost ($/acre)	0.00	4.84	0.00	0.00	0.00	20.10
6	Field cultivate pass cost ($/acre)	0.00	4.04	0.00	6.28	0.00	14.70
7	NH3 application cost ($/acre)	0.00	0.00	2.95	5.38	0.00	0.00
8	Strip-till pass cost ($/acre)	0.00	0.00	13.45	5.69	0.00	0.00
9	Side dress pass cost ($/acre)	0.00	0.00	7.35	3.39	0.00	0.00
10	Fertilizer pass Cost ($/acre)	0.00	0.00	0.00	0.00	0.00	5.45
11	Other tillage pass cost ($/acre)	0.00	0.00	0.00	0.00	0.00	0.00
12	Plant cost ($/acre)	12.20	9.61	13.97	13.49	21.65	19.15
13	Number of ground spray passes	3.21	3.45	2.83	2.38	2.00	2.00
14	Ground spray costs ($/acre)	14.89	15.23	14.15	11.50	13.20	13.20
15	Number of aerial spray passes	0.00	0.00	0.00	0.00	0.00	0.00
16	Aerial spray costs ($/acre)	0.00	0.00	0.00	0.00	0.00	0.00
17	Seed ($/acre)	71.64	67.48	90.06	87.56	111.75	111.75
18	Fertilizer: All ($/acre)	30.79	36.99	95.57	107.56	64.84	64.84
19	Herbicide, insecticide & fungicide: All ($/acre)	44.36	61.87	34.84	31.15	33.91	33.91
20	Reported costs prior to cover costs ($/acre)	177.09	203.51	275.17	274.39	247.35	285.10
21	Cover Crop: Seed ($/acre)	12.99	0.00	14.57	0.00	44.00	0.00
22	Cover Crop: Plant ($/acre)	8.17	0.00	9.85	0.00	19.50	0.00
23	Cover Crop: Termination ($/acre)	7.51	0.00	4.91	0.00	0.00	0.00
24	Reported costs with cover costs ($/acre)	205.76	203.51	304.49	274.39	310.85	285.10
25	Reported cover subsidies ($/acre)	15.09		19.27		0.00	
26	Net reported costs ($/acre)	190.66	203.51	285.22	274.39	310.85	285.10

Cover crop subsidies in Table 6 (row 25) are substantially higher for soybeans following corn and for corn following soybeans than they are in Table 3. One of the four participants in Table 6 reported receiving an average of $25/acre cover crop subsidy on both his beans-on-corn rotation and his corn-on-beans rotation. One participant included in the corn-on-bean rotation reported an average of $25.38/acre in cover crop subsidies. That left one participant in each category that was not receiving cover crop subsidies.

In the beans following corn rotations, the two participants averaged in Table 6 show that on cover crop acreage they:

- Benefited from an extra yield of 1.1 bushels of soybeans per acre (row 3)
- Spent $26.42 per acre less in production costs prior to cover crop costs (row 20)
- Spent $2.25 per acre more on production costs including cover crop costs (row 24)
- Received an average of $15.09 per cover crop acre in cover crop subsidies (row 25)

The overall result is that soybeans following corn and a cover crop for Table 6 participants with both covered and non-covered acreage netted $12.85 in cover crop subsidies over costs (row 26) and 1.1 bushel per acre in increase yield (row 3) over soybeans following corn where no cover crop was planted. At market prices over $2.05 per bushel, the yield premium would be sufficient to pay cover crop establishment costs and reported subsidies would be free cash flow.

Cost savings for soybeans after a cover crop in this rotation manifested themselves primarily in reduced expenses for

- Tillage (rows 5-11)
- Total fertilizer (row 18)
- Total herbicide, insecticide, and fungicide (row 19)

It is possible that savings from reduced tillage (which reduces erosion and phosphorus loss) is an important component in offsetting costs for cover crop establishment (which further reduces erosion and sequesters nitrogen). In some combination, the two practices are associated here with reduced fertilizer and chemical pest control (herbicide, insecticide, and fungicide) use in the bean following corn rotation. Reduced fertilizer utilization is also seen on covered acreage for corn following corn in Table 6. This investigation does not have enough information to make claims of causation, but more detailed multi-year field-level practice studies might be of interest in this regard.

The 4 participants engaged in corn-following-beans and corn-following-corn rotations in Table 6 had a different average experience. Both rotations showed an average yield shortfall on covered ground (row 3). Average reported costs prior to cover crop costs were higher for crops following covers for corn following beans but lower for corn following corn (row 20). Adding a cover crop resulted in costs for corn after cover being higher both after beans and after corn. Average cover crop subsidies were insufficient to offset those increased costs. Yield shortfalls in both cases relative to yields in the no-covered corn rotations mean that higher production costs could not be made up for this group of participants in 2018.

The comparisons in Table 6 provide cover-to-no-cover comparisons for farm participants engaged in both practices. This option for direct comparisons at least partially accounts for differences in operator efficiency and management ability, as each operator in each rotation was engaged in both covered and non-covered row crops. There is the possibility, however, that some practices are common to both cover options on any of these operations simply because it is easier managerially or operationally rather than optimal for the existence of a cover crop. This would mute any distinctions that can be drawn.

One way to get around this is to compare operations that cover all acreage in a given rotation with operations that do not cover any acreage in a given rotation. In each of these cases, one would expect the participant to engage in only practices that are optimal for either option rather than blending practices to simplify operations or management. Our participants included twelve operators who met one of these criteria for at least one rotation.

Table 7 provides a comparison of average costs and yields for participants that cover all row-crop acreage within a given rotation or covered none of their row-crop acreage within a given rotation.

Table 7: Production practice and cost for participants raising only covered or non-covered crops in any given rotation

		Beans After Corn		Corn after Beans		Corn after Corn	
Row		and Cover	and No Cover	and Cover	and No Cover	and Cover	and No Cover
1	Acres	1591.6	1489.0	1901.2	2181.0	1182.0	280.0
2	Yield goal (bu./acre)	60.0	60.0	210.3	212.2	200.0	204.3
3	Actual yield (bu./acre)	65.4	58.4	209.6	204.5	164.9	193.2
4	Actual yield as percent of goal	109.1	97.3	99.7	96.4	82.5	94.6
5	Chisel plow pass cost ($/acre)	0.00	0.00	0.00	0.00	0.00	6.80
6	Field cultivate pass cost ($/acre)	0.00	0.00	4.66	0.00	0.00	0.00
7	NH3 application cost ($/acre)	0.00	0.00	0.84	0.20	0.00	1.96
8	Strip-till pass cost ($/acre)	2.39	0.00	4.86	4.94	12.70	2.75
9	Side dress pass cost ($/acre)	0.00	0.00	2.37	3.69	1.97	7.30
10	Fertilizer pass Cost ($/acre)	0.00	0.66	0.00	1.69	0.00	2.84
11	Other tillage pass cost ($/acre)	0.00	2.32	0.00	1.50	0.00	17.24
12	Plant cost ($/acre)	21.21	20.00	19.91	17.92	12.96	19.35
13	Number of ground spray passes	2.00	2.00	2.00	2.21	2.98	2.00
14	Ground spray costs ($/acre)	12.50	13.50	12.61	13.96	14.58	14.24
15	Number of aerial spray passes	0.71	0.00	0.41	0.56	0.00	0.46
16	Aerial spray costs ($/acre)	7.82	0.00	4.44	6.25	0.00	6.07
17	Seed ($/acre)	62.68	62.48	104.53	101.93	111.14	117.21
18	Fertilizer: All ($/acre)	55.11	53.85	85.12	98.29	91.20	116.10
19	Herbicide, insecticide & fungicide: All ($/acre)	40.47	49.08	49.49	55.02	42.46	63.68
20	Reported costs prior to cover costs ($/acre)	204.89	203.88	291.23	308.16	289.99	378.01
21	Cover Crop: Seed ($/acre)	9.26	0.00	12.19	0.00	13.52	0.00
22	Cover Crop: Plant ($/acre)	5.58	0.00	7.14	0.00	7.54	0.00
23	Cover Crop: Termination ($/acre)	0.00	0.00	0.00	0.00	2.95	0.00
24	Reported costs with cover costs ($/acre)	219.73	203.88	310.56	308.16	314.01	378.01
25	Reported cover subsidies ($/acre)	6.57		6.38		16.34	
26	Net reported costs ($/acre)	213.15	203.88	304.18	308.16	297.66	378.01

The comparison in Table 7 shows that costs before cover crop expenditures for covered acres were lower for both corn rotations, and nearly equal for the bean rotation relative to uncovered acreage. Fertilizer expense was lower for the covered portion of both corn rotations. Herbicide, insecticide, and fungicide expense was lower for the covered portions of all three rotations. This echoes results seen in Table 6, and, again, might warrant more detailed multi-year field-level practice analysis.

Table 7 shows that the covered portion of acreage generated a

- 7.0 bushel per acre yield premium over uncovered acreage for soybeans following corn
- 5.1 bushel per acre yield premium over uncovered acreage for corn following soybeans
- 28.3 bushel per acre yield shortfall relative to uncovered corn after corn acreage

For the soybean following corn rotation, participants that cover are better off than their non-covering counterparts (after reported cover crop subsidies) at soybean prices above $1.33 per bushel. At prices over $2.27 participants producing a cover crop would be better off even without cover crop subsidies.

Table 7 shows a similar story for the corn following soybean rotation. After average reported cover crop subsidies of $6.38 per acre, production costs for covered acreage are $3.98 lower than costs for non-covered acreage. Even in the absence of any cover crop subsidies, at any corn market price above $0.48 per bushel, cover crop producers would be better off than non-covered producers in the corn after soybean rotation.

The situation for corn following corn participants producing a cover crop in the Table 7 comparison is not so advantageous. Covered acreage experienced a yield shortfall of 28.3 bushels per acre relative to acreage where a cover crop was not produced. While costs after accounting for cover crop subsidies were $80.35 per acre lower for covered acres, participants producing corn after corn without a cover crop would be better off than cover crop producers at any market price above $2.84 per bushel of corn.

However, in removing participants that might blend practices to simplify operations and management (Table 6) we have potentially reintroduced management bias into Table 7. Participants that completely cover a given rotation are likely to be relatively confident cover croppers. This confidence may come from a history of more intense management. Participants that leave entire rotations uncovered may fall on the other side of the scale. In removing the potential for practice blending from Table 6 to Table 7 we reintroduced the participant bias that we specifically tried to remove with Table 6.

Concluding Thoughts on Three Comparisons

The three comparisons were presented in order to see if different biases among the participants of each group might lead to significantly different conclusive results. There were no hard-and-fast conclusions to be drawn across comparisons, but some general observations can be made.

To a certain extent, comparisons in Table 7 echo results in Tables 3 and 4.

- In no case do cover crop producers out-perform non-cover crop producers in corn after corn rotations
- Cover crop producers show an advantage in corn following bean rotations in Table 3 and Table 7
- Cover crop producers show an advantage in bean following corn rotations in Table 6 and Table 7

In nearly every case where cover crops have the rotational advantage, that advantage is accompanied by lower fertilizer and lower total herbicide, insecticide, and fungicide costs (the single exception is fertilizer applied to beans following corn in Table 7). In some cases, lower tillage costs are also a factor. Tillage costs might be more of a factor if participants were not so heavily engaged in reduced tillage already.

While this investigation is not able to speculate on the direction of causation or the mechanism of the relationships, it does appear that there is a relationship between tillage, fertilizer use, pesticide use, and cover crop advantages in the soybean following corn and the corn following soybean rotational comparisons in each of the three comparisons constructed.

These results appear to indicate that much might be learned from a more intensive study. While there is merit in looking at smaller and more selective participant groups in Tables 4 and 5, it is hard to consistently recognize a general pattern of outcomes across these and the averages of all participants (Table 3) given the small sample group and variations in respondent detail. Developing a study with a larger randomized control population and one or more specifically defined production and management practices could provide more robust insights into cost and yield differentials associated with cover cropping.

Harvesting Cover Crops

Five participants generate substantial returns on grazing, harvesting, and marketing their cover crops in the soybean following corn rotation. All told, about 560 participant acres were monetized in this way. Table 8 shows average harvest revenue per acre and harvest cost per acre for harvested cover crop acreage. Table 8 does not include establishment costs for the cover crop on these acres, as it is assumed the cover crop is produced for conservation purposes and exists regardless of whether it is harvested.

Table 8: Harvested Cover Crop Acres and Revenue

Participant harvested cover crop acres	560
Harvest revenue ($/acre)	165
Harvest cost ($/acre)	25
Net revenue per harvested acre ($/acre)	140
Total net revenue for 560 harvested acres ($)	78,160

On average, participants realized approximately $165 per acre in market revenue and accrued approximately $25 per acre in harvest costs. Given the existence of a cover crop as a conservation practice, participants were able to net an average of approximately $140 per acre by harvesting that cover crop rather than terminating it in the field.

This net return is relatively high compared to participants' expectations regarding their regular summer crops, but establishment costs, land costs, and some percentage of pest control costs are already allocated to the production of summer crops. These costs would be incurred in any event. Subtracting harvest costs, which would not otherwise be incurred, yields an average net revenue per harvested cover crop acre of approximately $140.

In addition, one participant has developed a cover crop seeding and consulting business. This business contracts with other farm operators to harvest, clean, and sell their cover crop production as seed for other farm operators. It also provides custom planting services.

Other Issues

The sections above focused on yield and reported production cost differences for participants cropping land that had either been covered or left bare following the previous crop. In the process of gathering and analyzing this information several other issues presented themselves that may be of further interest or subject to future inquiry. Seven topics were selected for follow-up interviews and case studies that will be presented separately:

1. Record management and information systems
2. Risk management
3. Cover crop valuation and monetization
4. Tillage reduction
5. Nitrogen management
6. Land ownership impacts
7. Farm transitions

An eighth case study focuses on an individual participant.

In addition, there are some issues that were not followed up on for case studies that warrant some discussion. The following sections provide some insight on these and general notes on case study topics where warranted.

Cover Crop Issues and Record Keeping

Evaluating the economic value of producing cover crops is hobbled by record keeping. Looking at Table 3, a comparison across all participants that provided cost information, three participants had to be omitted for lack of out-of-pocket costs. These three participants represented nearly 17% of all participant row-crop land. Two of them cover all their row-crop acreage. One represents the second largest operation among participants. These three were omitted from all three comparisons represented in Tables 3, 6, and 7 because their operating practices could not be matched to input costs.

Looking to Table 6, two participants were included in the comparison of covered acreage to non-covered acreage in the soybean following corn rotation. Eight other participants could not be used for the comparison because they did not differentiate yields between covered and bare acreage. These eight represented over 85% of the acreage in this rotation that could have been directly compared. Adding one otherwise eligible participant that did not provide input cost data pushes the omission rate past 90%.

The inability to differentiate yields between covered and bare ground is not trivial. It is important because one of the regularly stated benefits of cover crop production is increased yields through moisture retention and soil quality. The inability to differentiate yields means that this benefit cannot be evaluated in the investigation or on individual participant's farm operations.

Similarly, for the corn following soybean rotation in Table 6, three participants were available. Five additional participants were omitted because they did not distinguish yields between covered and bare acreage. These five represented 75% of the acreage in the corn after soybean rotation that could have been directly compared.

Another implication this has for Table 6 is there is an enhanced possibility the insights drawn from the table are driven by outliers. The issue cascades back into insights drawn from Table 3, as differences in actual yields with respect to cover status are minimized, limiting the reliability of any calculation of prices where cover crop producers are better off or worse off.

The omission of three participants who did not provide input cost information also affected the population available for Table 7, as two of those participants cover all row-crop acreage and the remaining omission plants no covers in rotations going to corn.

Beyond the inability to distinguish yields with regard to cover crop production, in every case where cover crops had an advantage within a given rotation, this advantage was accompanied be reduced fertilizer costs and reduced total herbicide, insecticide, and fungicide costs. Reduced tillage was also a factor in some cases (although reduced tillage is nearly the norm in all rotation options with the participant population). Very few budgets, however, distinguished fertilizer and pesticide application passes with respect to cover crop production. Application costs savings might reasonably be expected to magnify savings in fertilizer and pesticide material. These savings did not show up in the production budgets.

The insights available from Tables 3-5 suggest that advantages accruing to cover crop production are understated in the crop production budgets provided for this investigation. This would have important implications for continued cover crop adoption.

More important, however, is the possibility that the uncertainty in the budget compilations masks the opposite result. Accurate operating records that distinguish cover crop production within rotations is necessary to quantify cover crop advantages. It is also necessary to assure that those advantages exist. The lack of records sufficiently detailed to draw out these distinctions almost certainly increases the risks faced by individual participants.

Reduced Tillage

Participants almost uniformly stated moving from conventional tillage to strip-till and no-till practices saves them equipment, fuel, and time while improving their soil quality and reducing soil loss. One participant documented equipment costs savings of $44 per acre and labor cost savings of $27 per acre. Another indicated the move cut tractor hours by two-thirds and fuel use by 80%. Participants also documented increased soil organic matter, which leads to increased retention of nutrients and water. None of our participants were moving away from these practices, and all of those that had opportunities to deepen their exposure were in the process of doing so.

In spite of all this, it is difficult to directly compare conventional and reduced tillage practices in this investigation because nearly all participants are so heavily committed to reduced tillage. Much of the conventional tillage identified was practiced by a participant who did not give sufficient information to be included in the comparisons in Tables 3, 6, and 7.

Tillage might be another valuable topic for an in-depth study with a larger population.

Diversification

One of the issues presented for this study that was not pursued was the impact of conservation on farm diversification and vice versa. There are at least two dimensions to this:

1. Diversification of farm operations and income
2. Diversification of farm operator income with off-farm income

Both are of interest but beyond the scope of what could be handled under this project. One of the important issues involved is the direction of causation. Does the adoption of conservation practices lead to more diverse enterprises, or are more diverse enterprises more likely to engage in conservation practices?

While reduced tillage practices do not appear dependent upon farm diversification, it does appear that cover crop monetization is partially dependent upon the presence of unconfined livestock. Much of the cover crop utilization identified in this investigation took the form of grazing or baling hay or straw. Expanding these uses is limited by the local livestock industry in any given area. The other primary cover crop market is cover crop seed. This market is constrained by the rate of growth in cover crop acreage. This rate of growth may be accelerated by the development of niche markets for cover crop products, but that is a development that remains to be seen.

Off-farm income changes the risk profile of the farm operator and should provide freedom to experiment. There was no direct inquiry in the first round of interviews on off-farm income, but some participants had regular off-farm work. In inquiries regarding farm transitions during follow-up interviews participants were explicitly asked how they would cover household expenses during the farm transition period. Every respondent discussed off-farm income. Most had sufficient off-farm income that they could leave farm earnings entirely to finance transition debt and expenditures. Untethering farm operations earnings from family income requirements should have substantial implications for farm management.

While the relationship between diversification and conservation practices is an important topic, it is beyond the scope of the investigation and interviews here. It does, however, provide an interesting topic for future study.

Combining or Stacking Conservation Practices

To a certain extent, our participants are combining or stacking conservation practices. Much of the cover cropped acreage in the comparisons above is also either no-tilled or strip-tilled. This accounts for a portion of the cost differentials between covered and non-covered land where covered land shows an advantage. Participants who are successful cover crop producers are earning that success at least partially on reduced tillage. Savings from a practice that primarily controls erosion and phosphorus loss are being utilized to fund a practice that further reduces erosion and sequesters nitrogen. Better records would provide a better picture of how this works.

Another characteristic of comparisons favoring cover crop production is reduced expenditures for fertilizer and pesticides. These reductions are a direct conservation practice that is either partially funding or is made possible by successful cover crop production. There are almost certainly some stacking benefits from these practices in terms of cost reduction, soil health, and environmental sustainability. The interviews in this study, however, are not sufficiently detailed and do not have a deep enough of a historical series to tease out how the practices augment or are detrimental to one another. The coexistence of these practices has substantial risk-management and sustainability implications that would also benefit from enhanced record keeping.

It would be useful to have field-level practice, crop, yield, and soil quality information over a longer time series. This would allow for statistical analysis into how rotations, tillage, nutrients, and cover status interact over time. Such a time series will have to be a project going into the future, as most farm operators will not be able to regenerate accurate field-level practices and costs from the past.

Many of this investigation's participants have the technological ability to develop and maintain field level data series (utilizing tractor and implement mounted data collection systems) and integrating it with computer-based accounting systems. Developing this capacity would be a critical next step in understanding the value of stacking conservation practices as well as in monetizing soil quality. Variable production costs are largely driven by field-level practices. Returns on those costs are driven by field-level results. Fixed production costs are largely a function of field-level practices and production scale. Generating robust estimates of cost savings and/or yield premiums that accrue to individual conservation practices or conservation practices that are stacked requires robust field-level data.

Summary

This report is based upon interviews with twenty Iowa farm operators who were chosen by the Iowa Soybean Association on the basis of their perceived focus on conservation and land stewardship.

Participant farms are larger than Iowa farms in general as reported by the 2017 Census of Agriculture. Primary producers among participant operations are somewhat older than primary producers for Iowa, but this is mitigated by the number of participant primary producers who are actively involved in transitioning operations to younger partners.

Participant-supplied production cost and yield information was utilized to generate three comparisons of average costs and yields for crops following a cover crop and crops not following a cover crop for three crop rotations. The comparisons averaged information from:

1. Seventeen participants who provided both production practice budgets and out-of-pocket input expenses
2. Participants who produced crops on both covered acreage and non-covered acreage in any rotation and could distinguish yields between covered and non-covered production
3. Participants who either covered all acreage in a given rotation or covered none of their row-crop acreage in a given rotation

Conclusions on the financial viability of cover crop establishment were not completely consistent among comparisons, but some trends were identifiable

- In comparison 3 (Table 7) yield premiums and cover crop subsidies on crops following a cover crop were sufficient to more than offset cover crop establishment costs for soybeans following corn and for corn following soybeans
- This was also true for soybeans following corn in comparison 2 (Table 6)
- Both soybeans following corn and corn following soybeans in comparison 1 (Table 3) generated yield premiums on crops following a cover. For soybeans following corn, however, this premium is not sufficient to cover the cost of establishing the cover crop – even after reported cover crop subsidies are taken into account. For corn following soybeans, the yield premium on crops following a cover crop would pay establishment costs at corn prices of $3.37 per bushel or more
- Acreage in corn following corn and a cover crop underperformed its uncovered counterparts in all three comparisons
- Covered soybean following corn acreage and covered corn following soybean acreage had advantages over uncovered acreage in two out of three comparisons for each rotation
- In nearly all cases where covered acreage showed a rotational advantage, it was accompanied by lower total fertilizer and total pesticide (herbicide, insecticide, and fungicide) expenditures

By rotation:

- For soybeans following corn, all three comparisons generated an average yield premium for covered acres relative to uncovered acres
    - In comparison 1 (Table 3) this yield premium was insufficient to pay cover crop establishment costs – even after reported cover crop subsidies are accounted for
    - In comparisons 2 and 3 (Tables 6 and 7) this yield premium is sufficient to pay for cover crop establishment costs after accounting for reported cover crop subsidies.

- For corn following soybeans, comparisons 1 and 3 (Tables 3 and 7) generated yield premiums for crops following cover crops, and this premium plus reported cover crop subsidies was sufficient to offset cover crop establishment costs

- Corn following corn and a cover crop generated lower yields than corn following corn without a cover crop in all comparisons

It appears that the ability of yield premiums and reported cover crop subsidies to offset expenses is at least partially dependent upon the implementation of other conservation practices. In nearly all cases where cover crop production was associated with a rotational advantage, cover crop production was associated with lower average total costs for fertilizers and pesticides. Often, cover crop advantages were also associated with reduced tillage expenses.

Five participants are grazing or harvesting 560 acres of cover crop. This activity is taking place on covers following corn in a corn-soybean rotation. Harvesting into the soybean plant allows a little extra time before planting the summer crop. Average cover crop revenue for these 560 acres is $165 per acre. Average cover crop harvest costs are $25 per acre, giving a net revenue over harvest costs of $140 per acre. Grazing and harvesting hay or straw is somewhat dependent upon local populations of unconfined livestock. On the flipside, cover crop production might encourage the expansion of diversification into livestock. The other major harvest market is cover crop seed. This market is dependent upon the rate of growth in cover crop acreage.

We were not able to do in-depth evaluations of no-till and strip-till relative to intensive tillage because participants were almost entirely engaged in reduced tillage practices. It is clear, however, that our participants universally see significant savings. Some can access specific records to document those savings and all who still have tillage reductions to make are heading that direction. Also, where there are cost advantages in our comparisons of crop rotations with and without cover crops, those cost advantages are often partially tied to tillage costs. Soybeans following a cover crop, in particular, are closely tied to no-till practices.

Finally, we have been heartened to connect with a number of young farmers who are on the ball with respect to records, transition management, and conservation. Similarly, we visited with several established farmers who are objectively managing their operations with the help of detailed records, randomized production trials, and a wealth of experience.