ABSTRACT

This study uses partial budgets to assess the annual net private economic returns to cover crop use in Midwest row crop farms. Data were compiled through an online survey to farm operators that manage production systems with and without cover crops. The average net returns to cover crops terminated with herbicides followed by corn was negative, but the average net return to cover crops terminated with herbicides followed by soybeans was positive. Cost-share payments tend to be insufficient to cover all private costs associated with cover crop use, but are a critical incentive to support this practice.

Partial Budgets for Cover Crops in Midwest Row Crop Farming

By Alejandro Plastina, Fangge Liu, Wendiam Sawadgo, Fernando Miguez, and Sarah Carlson

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Row crop farming in the Midwest has been increasingly singled out as a major non-point source of nitrate pollution in waterways, putting pressure on farmers to adopt conservation practices. One of the promising conservation practices is the use of cover crops, which is known to promote many aspects of soil and water sustainability (Kaspar & Singer, 2011; Chatterjee, 2013). For instance, preliminary results from simulations based on a long-term cover crop study in Iowa suggest that nitrate concentration in tile drainage can be reduced by 54 percent when a winter rye cover crop is added to corn-soybean acres (Miguez, Basche, and Archontoulis, 2013). Moreover, the Iowa Nutrient Reduction Strategy (2014), Illinois Nutrient Loss Reduction Strategy (2015), and Minnesota Nutrient Reduction Strategy (2014) all list cover crops as one of the practices with the greatest potential for nitrate-N reduction. However, despite the considerable benefits the cropping systems can accrue, adoption of cover crops is very low in the Midwest. Singer, Nusser, and Alf (2007) found that in 2006, only 11 percent of farmers surveyed in Illinois, Iowa, Minnesota, and Indiana had grown a cover crop within the previous five years. An analysis by the National Wildlife Federation of seed dealer data calculated that in 2011, less than two percent of the total cropland acreage in the Mississippi River Basin was planted to cover crops (Bryant, Stockwell, and White, 2013). Rundquist and Carlson (2017), using satellite imagery, report that in 2015 cover crops were incorporated into corn and soybean rotations in 2.3 percent of Illinois cropland, 7.1 percent of Indiana cropland, and 2.65 percent of Iowa cropland.

It has long been recognized that lack of familiarity with novel approaches in agriculture can inhibit adoption of conservation practices (Nassauer, et al. 2011). The top cover crop challenges farmers reported across four annual cover crop surveys (Watts & Myers 2013, 2014, 2015, and 2016) were establishment, time or labor required and increased management, and species selection. Farmers' perceptions that cover crops are costly is also found to be a major barrier to their adoption: 74 percent of the respondents to the Iowa farm and Rural Life Poll (Arbuckle, 2015) report that potential economic impacts have moderate to very strong influence on changes in their management practices, and 57 percent agree with the statement that "pressure to make profit margins makes it difficult to invest in conservation practices". During the 2014 National Conference on Cover Crops and Soil Health, participants highlighted the need for economic analyses to document short- and long-term impacts of cover crops (Sustainable Agriculture Research and Education, 2014). Roesch-McNally, et al. (2017) found that despite having successfully planted cover crops, farmers tended to believe that greater economic incentives would be needed to spur more widespread adoption of the practice. The U.S Department of Agriculture Natural Resource Conservation Service (2017) estimated that Iowa farmers planted more than 353,000 acres of cover crops with financial assistance from the Iowa Department of Agriculture and Land Stewardship (through the Iowa Water Quality Initiative, state cost-share, and local watershed project) and federal conservation programs (through the Environmental Quality Incentives Program (EQIP), Conservation Stewardship Program (CSP), and Regional Conservation Partnership Program (RCPP)) in the fall of 2016 – nearly 18 percent more than the previous year.

Science-based information on the potential return on investment at the farm-level associated with the use of cover crops by Midwest farmers is very limited. A

handful of papers evaluate the economic impact of cover crops on different cash crops, including Reddy (2009) with soybeans in Mississippi; Mahama, et al. (2016) with corn in Kansas; and Roberts, et al. (1998) with no-till corn in Tennessee. However, those studies are based on field experiments set up to evaluate agronomic factors, and the resulting estimates of economic returns might not apply to real farms where management practices do not follow an experimental design. Roberts and Swinton (1995), using actual data from 15 farms growing corn in Michigan in 1994 to explore the relationship between operating costs and crop diversity, concluded that cover crops reduce non-point source pollution without significantly reducing net returns. However, the small sample size limits the robustness of the results. Snapp, et al. (2005) provided a summary of the potential benefits and costs from the cover crops, both external and internal to the farm, and report qualitative findings from focus group discussions with eight Michigan potato farmers.

There is a gap in the literature on the actual changes in economic costs and revenues faced by farmers who choose to use cover crops in their corn-soybean rotations in the Midwest. This paper aims to bridge that gap by providing partial budgets for cover crops based on a regional online survey of farm operators. Partial budgets capture the net annual private economic benefit or loss associated with the use of cover crops by identifying and monetizing the differences in management practices across production systems with and without cover crops. The next section discusses the methods used to develop and implement the survey instrument, and to analyze the data. Partial budgets are presented in the following section, with detailed analysis of the drivers of net economic benefits or losses associated with cover crop use. The concluding section briefly discusses the implications of the findings for farm operators and policy makers.

Online Survey

Survey Questionnaire

The survey instrument was designed based on extensive interaction with farmers with at least three years of experience with cover crops. To cover a wide range of different management practices and soil and weather conditions, 16 farmers were recruited from Iowa, Minnesota, and Illinois by Practical Farmers of Iowa (PFI) based on their years of experience with cover crops, species of cover crop used, type of crop rotation used, interest in better understanding cover crop return on investment, and availability. The focus group sessions were conducted in December 2015.

Figure 1 summarizes the potential linkages between changes in practices associated with the use of cover crops and changes in revenues and costs identified during the focus group sessions (Plastina & Liu 2016). Note that while for some farmers cover crop use is associated with lower input costs for the following cash crop or higher yields, for some other farmers the effect is the exact opposite.

A pilot survey based on the main topics highlighted in Figure 1 was implemented in March 2016 among the same focus group participants. After completing the survey, respondents were interviewed via teleconference to obtain feedback on the pilot survey questionnaire. After several rounds of revision, the final survey questionnaire consisted of 192 questions, organized in seven sections: basic farm information, cover crop planting, cover crop termination, revenues and costs, tillage, previous rotation, and perceptions about cover crops.

The strategy to identify differences across production systems with and without cover crops was to ask respondents to characterize the production practices implemented in their production system with cover crops first, and then to ask them whether such characteristics also applied to their production system without cover crops. Such strategy is deemed better than the traditional way of asking farmers about the dollar values of their perceived changes in costs and revenues associated with cover crops, because (1) all respondents are exposed to the same exhaustive list of possible changes in practices (instead of just a few broad categories that can be interpreted by different respondents to include fewer or more concepts), and (2) their attention is directed toward both practices that generate changes in cash flows and opportunity costs (instead of only the former).

Cash costs (including seed costs, fertilizer costs, herbicide costs, and custom hired work) and revenues (cost-share payment received through local, state, or federal programs such as EQIP, CSP, or RCPP) were directly identified through questions that asked producers to enter dollar values. To identify own machinery costs, the survey asked about the type of machinery used, and associated costs were derived from a budgeting tool developed specifically for cover crops by Cartwright and Kirwan (2014).

To estimate the opportunity costs of added management due to the use of cover crops, the survey asked for an estimate of additional management hours, assigned an hourly rate of $15 (Plastina, 2017) and divided that total by the total cover crop acres planted in 2015. To estimate changes in revenue due to yield differences across fields with and without cover crops for the same farmer, prices of $3.35 per bushel of corn and $9.55 per bushel of soybeans were used in the calculations.

Farmers' experience with cover crops was measured by the number of years planting cover crops and the cumulative cover crop acreage until 2016.

Survey Results

The survey was implemented online with Qualtrics®, and the display of questions was designed to be conditional upon previous answers where possible, minimizing the total number of questions asked. On average, respondents spent about half an hour to complete the online survey.

Electronic invitations to participate in the survey were sent to more than 20,000 farmers, including members of PFI, the Midwest Cover Crops Council, National Wildlife Federations' Cover Crops Champions Program, and the American Society of Agronomy, among other regional associations. More than 300 responses were received, but only 79 responses were used in the budgets presented in this paper, after excluding responses from: (1) farmers who were interested in cover crops but had no hands-on experience; (2) farmers that did not plant cover crops in 2015; (3) farmers that planted cover crops in 2015 on all their acres; (4) farmers that in 2016 planted a different cash crop on acres following cover crops than on acres left fallow during winter; and (5) incomplete responses. This selection process reduces the sample size, but improves the validity of the results by focusing on the changes in costs and revenues associated with cover crop use controlling for the farm manager effect and the macroeconomic conditions prevalent in 2015-2016.

This study suffers from several limitations related to the self-selection bias of survey respondents, the potential unrepresentativeness of the sample, and the limited number of responses included in the partial budgets. However, it is the first study to attempt to generate partial budgets using field data (instead of experimental plots) from farmers that manage row crop production on acres with cover crops and on acres with no cover crops. The partial budgets presented below are the best available estimates of net returns to cover crop users, because the data were collected following a scientific method across the largest number of farms included in any cover crop study available to date.

More than two-thirds of the respondents operated farms in Minnesota, Iowa, or Illinois, and nearly 80 percent of the farms were larger than 500 acres in size (Table 1). The single most frequently used cover crop species among survey respondents was cereal rye, but nearly half of the respondents used cover crop mixes composed of three or more cover crop seeds. The most commonly used planting method was drilling, followed by aerial seeding.

The average number of farmers' years of experience with cover crops was 3.94 years, and the range of responses went from 0.2 to 15 years, with a median of 4 years (Table 2). The average cumulative cover crop acreage per farmer was 1,483 acres, but the median was 540 acres, indicating that the distribution of responses was skewed.

Partial Budgets

Results are organized into four partial budgets: (1) for cover crops terminated with herbicides followed by corn for grain; (2) for cover crops terminated with herbicides followed by soybeans; (3) an annual average for cover crops terminated with herbicides in a corn-soybean rotation; and (4) a partial budget for winter-kill cover crops.

In order to obtain robust estimates of each of the items included in the partial budgets, all valid responses were used in the calculation of the reported summary statistics: mean, first quartile, median, and third quartile. The downside to this approach is that the summary statistics do not reflect the actual net returns for any particular producer, but instead reflect the probabilities that a producer would obtain the reported net returns. The probability of farmers obtaining a net return lower than the first quartile and median are, respectively, 25 and 50 percent. The probability of farmers obtaining a net return higher than the median and third quartile are, respectively, 50 and 25 percent.

A quick comparison of the mean changes in revenues, costs and profits per acre across the four partial budgets (Table 3) suggests that cover crops induce net losses in the absence of cost-share programs; and only cover crops winterkilled, or terminated with herbicides before planting soybeans tend to break even after accounting for cost-share payments.

Cover crops followed by corn

The partial budget for cover crops terminated with herbicides followed by corn for grain indicates that, on average, the use of cover crops generated a net economic loss of $20.76 per acre (Table 4). However, there is great variability around that average loss. There is a 25 percent chance that farmers derive net economic losses from cover crop use of at least $65.15 per acre (first quartile). There is a 50 percent chance that farmers derive net economic losses of at least $5.90 per acre (median).

Finally, there is a 25 percent chance that farmers obtain net economic profits of at least $19.59 per acre (third quartile).

The largest cost drivers are cover crop seeds and planting costs. It is important to note that the median additional herbicide costs on top of the regular weed control program due to cover crop use was null, suggesting that at least half the respondents applied the same weed control program to corn fields with and without cover crops.

The cost-share program was used by 6 out of 21 farmers, and cost-share payments accounted for the largest increase in revenue associated with cover crops followed by corn. Without the cost share program, the average and median net economic losses amounted to $46.09 and $30.90 per acre, respectively.

Corn yields in acres with cover crops were, on average, 2.7 bushels per acre lower than corn yields in acres without cover crops, resulting in an average reduction in crop revenues of $9.18 per acre. However, half of the respondents indicated differences in corn yields ranging from minus 10 bushels per acre to plus 5.5 bushels per acre, with a median of zero.

Cover crops followed by soybeans

The partial budget for cover crops terminated with herbicides followed by soybeans indicates that, on average, the use of cover crops generated a net economic profit of $25.13 per acre (Table 5). However, there is great variability around that average loss. There is a 25 percent chance that farmers derive net economic losses from cover crop use of at least $22.86 per acre (first quartile). There is a 50 percent chance that farmers derive net economic losses of at least $4.31 per acre (median). Finally, there is a 25 percent chance that farmers obtain net economic profits of at least $60.15 per acre (third quartile).

As is the case with corn, the largest cost drivers for cover crops followed by soybeans are cover crop seeds and planting costs. For most respondents, the additional herbicide costs on top of the regular weed control program due to cover crops were null, indicating that the same weed control program was typically applied to soybean fields with and without cover crops.

The cost-share program was used by 14 out of 34 farmers, and cost-share payments averaged $28.07 per acre. Without the cost share program, the average and the median net economic losses amounted to $46.09 and $30.90 per acre, respectively.

Soybean yields on acres with cover crops were, on average, 3.32 bushels per acre higher than soybean yields on acres without cover crops, resulting in an average increase in crop revenues of $31.74 per acre. Half of the respondents indicated differences in soybean yields ranging from zero to 6 extra bushels per acre, with a median of 0.50 bushels per acre.

Cover crops on a corn-soybean rotation

The annual average partial budget for cover crops terminated with herbicides on a 50-50 corn-soybean rotation (Table 6) was created by weighting operators' responses so that each line of the partial budget considers an equal number of corn and soybean producers. Since more operators in the sample planted soybeans than corn, corn producers' responses are given a higher weight than are soybean producers' in calculating the descriptive statistics.

Table 6 indicates that the use of cover crops on a corn-soybean rotation generated an average net economic loss of $11.78 per acre. There is a 25 percent chance that farmers derive net economic losses from cover crop use of at least $56.19 per acre (first quartile). There is a 50 percent chance that farmers derive net economic losses of at least $6.81 per acre (median). Finally, there is a 25 percent chance that farmers obtain net economic profits of at least $25.33 per acre (third quartile).

Winter-kill cover crops

Since only 11 corn producers and 13 soybean producers among the respondents planted a winter-kill cover crop, Table 7 reports a combined partial budget for cover crops across soybean and corn producers (not in rotation similar to Table 6). The use of winter-kill cover crops generated an average net economic profit of $6.43 per acre. There is a 25 percent chance that farmers derive net economic losses from cover crop use of at least $21.39 per acre (first quartile). There is a 50 percent chance that farmers derive net economic profits of at least $17.05 per acre (median). Finally, there is a 25 percent chance that farmers obtain net economic profits of at least $28.31 per acre (third quartile).

Concluding remarks

The partial budgets presented in this article serve as an assessment of the annual net private economic return to cover crop use in Midwest row crop farms. The average net returns to cover crops terminated with herbicides followed by corn was negative, but the average net return to cover crops terminated with herbicides followed by soybeans was positive. There is substantial variability in the net returns to cover crops, driven by the difference in yields obtained in fields with and without cover crops, planting costs, and cost-share program payments. For the most farmers, cost-share payments are insufficient to cover all private costs associated with cover crop use, but are a critical incentive to support this practice.

The present findings are expected to serve as regional benchmarks, inform the policy debate on how to implement nutrient reduction strategies, and spur further research on the long-term private and social benefits of cover crops.

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Figure 1. Potential changes in revenues and costs associated with cover crops

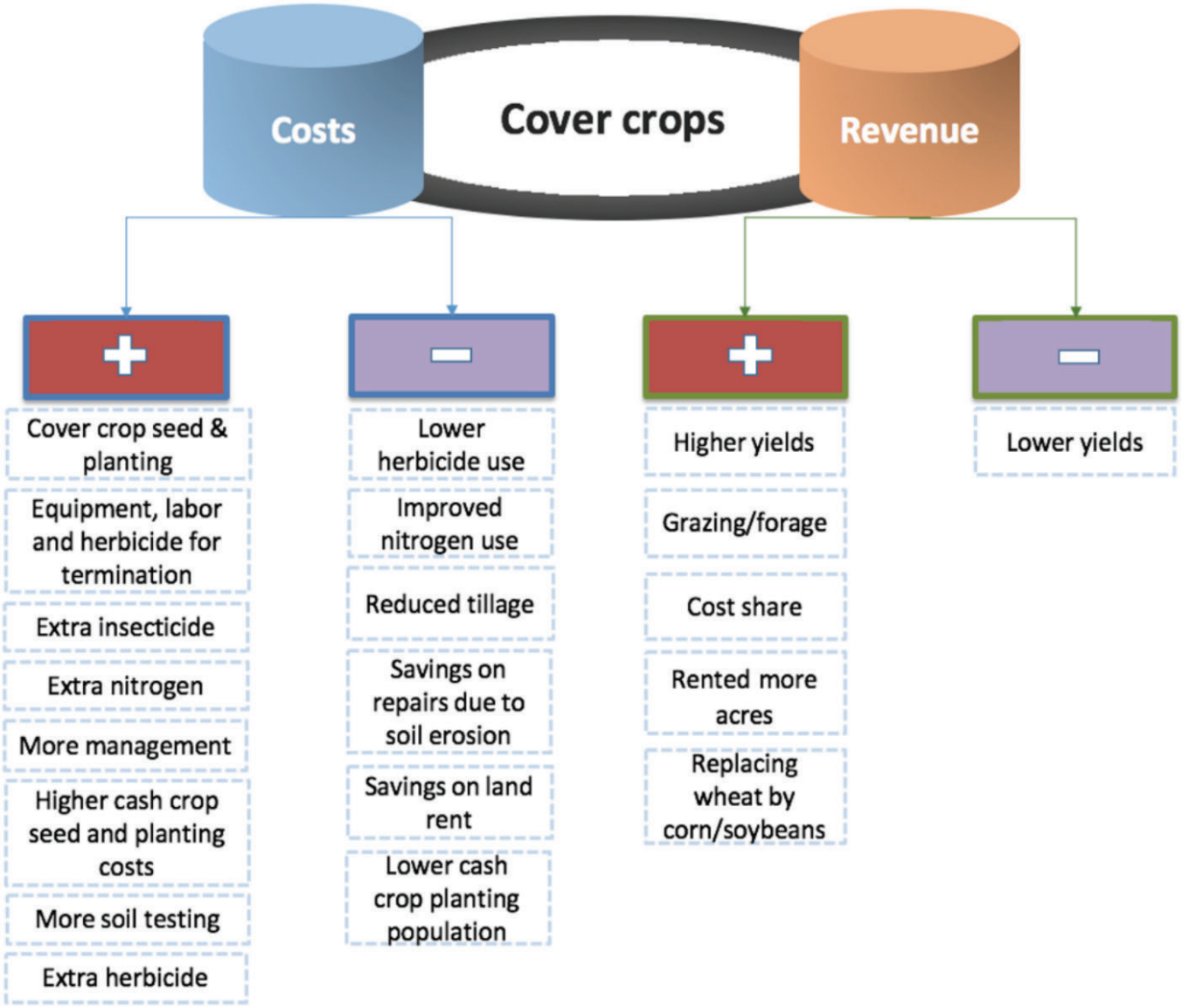

Table 1. Farm characteristics

Factors	Factor levels	Count of farms	Percent in sample
Cover crop mix	Cereal rye	34	43.04
	Annual Ryegrass	4	5.06
	Cereal Rye + Oats	2	2.53
	Annual ryegrass + crimson clover + oilseed radish	5	6.33
	Annual ryegrass + crimson clover + oilseed radish + rapeseed	2	2.53
	Oats + oilseed radish + buckwheat	1	1.27
	Crimson clover + oilseed radish	3	3.80
	Oats + oilseed radish + turnip	1	1.27
	Other	27	34.18
	Subtotal	79	100
Size of farms (acres)	50-99	1	1.27
	100-199	5	6.33
	200-499	11	13.92
	500-999	19	24.05
	1000-1999	20	25.32
	2000+	23	29.11
	Subtotal	79	100
Farm location	Illinois	12	15.19
	Iowa	21	26.58
	Minnesota	24	30.38
	Other states^	22	27.84
	Subtotal	79	100
Planting method	Drilling	50	56.82
	Aerial	20	22.73
	Broadcast	5	5.68
	Other	13	14.77
	Subtotal	88	100

^Other states: North Dakota (11 farms), Indiana (3 farms), Nebraska (2 farms), Ohio (2 farms), Michigan (1 farm), Missouri (1 farm), South Dakota (1 farm), and Wisconsin (1 farm)

Table 2. Farmers' experience with cover crops

Variable	Mean	Standard deviation	Median	Min	Max
Number of years planting cover crops	3.94	2.64	4	1	15
Cumulative cover crop acreage	1483	3783	540	5	30000

Table 3. Summary of Results: Mean changes in revenues, costs and profits

Sources of changes in net profits	**Cover crops terminated with herbicides followed by corn for grain ($/acre)**	**Cover crops terminated with herbicides followed by soybeans ($/acre)**	**Cover crops terminated with herbicides in corn-soybean rotation ($/acre)**	**Cover crops winterkilled followed by corn or soybeans($/acre)**
A. Changes in revenue:				
1. Cash Crop Yield	-9.18	31.74	-1.80	-8.25
2. Cost-share program	25.33	28.07	31.14	43.83
Subtotal	*16.16*	*59.81*	*29.34*	*35.58*
B. Changes in costs:				
1. Cover crop planting	31.84	31.14	33.60	32.06
2. Herbicide expenses	4.05	3.82	6.94	-0.33
3. Other Costs	1.02	-0.27	0.57	-2.57
Subtotal	*36.91*	*34.69*	*41.12*	*29.16*
Net change in profit (A-B):	*-20.76*	*25.13*	*-11.78*	*6.43*
Net change in profit without Cost-Share	*-46.09*	*-2.95*	*-42.92*	*-37.41*

Table 4. Partial budget for cover crops terminated with herbicides followed by corn for grain

Sources of changes in net profits	Mean ($/acre)	1st Quartile ($/acre)	Median ($/acre)	3rd Quartile ($/acre)	N
A. Changes in revenue:					
3. Corn Yield (valued @ $3.35/bushel)	-9.18	-33.50	0.00	18.36	21
4. Cost-share program	25.33	17.00	25.00	25.00	6
Subtotal	*16.16*	*-16.50*	*25.00*	*43.36*	
B. Changes in costs:					
4. Cover crop planting	31.84	39.86	29.88	23.05	
a. Seeds	16.33	21.00	14.00	12.00	21
b. Planting (excluding seeds) (weighted average of i-ii)	15.51	18.86	15.88	11.05	
i. Custom work	17.50	19.00	16.00	15.00	8
ii. Non-Custom	14.44	18.78	15.82	8.95	15
5. Herbicide expenses (weighted average of a-b)	4.05	7.38	0.72	0.72	
a. For farmers that did not apply herbicides before planting corn in baseline	15.06	15.06	15.06	15.06	1
i. Herbicide cost to terminate cover crops	9.00	9.00	9.00	9.00	1
ii. Application (Non-custom)	6.06	6.06	6.06	6.06	1
b. For farmers that applied herbicides before planting corn in baseline	3.50	7.00	0.00	0.00	20
i. Additional herbicide costs on top of regular weed control program*	3.50	7.00	0.00	0.00	20
ii. Labor costs to apply herbicides on top of regular weed control program*					0
6. Other Costs (sum of a-k)	1.02	1.41	0.30	0.00	
a. Corn seed costs	0.00	0.00	0.00	0.00	21
b. Corn planting costs (excluding seeds)	0.71	0.00	0.00	0.00	21
c. Nitrogen costs	0.26	0.00	0.00	0.00	21
d. P & K costs	0.00	0.00	0.00	0.00	21
e. Manure costs	0.00	0.00	0.00	0.00	21
f. Insecticide costs	0.90	0.00	0.00	0.00	21
g. Fungicide costs	0.00	0.00	0.00	0.00	21
h. Soil testing costs	0.00	0.00	0.00	0.00	21
i. Management ($15 per hour)	1.24	1.41	0.30	0.00	15
j. Cash rent	-1.43	0.00	0.00	0.00	14
k. Soil erosion repairs	-0.67	0.00	0.00	0.00	21
Subtotal	*36.91*	*48.65*	*30.90*	*23.77*	
Net change in profit (A-B):	*-20.76*	*-65.15*	*-5.90*	*19.59*	
Net change in profit without Cost-Share	*-46.09*	*-82.15*	*-30.90*	*-5.41*	

N = number of responses per row; *values for farmers who used herbicide on both cover crop and non-cover acres

Table 5. Partial budget for cover crops terminated with herbicides followed by soybeans

Sources of changes in net profits	Mean ($/acre)	1st Quartile ($/acre)	Median ($/acre)	3rd Quartile ($/acre)	N
A. Changes in revenue:					
1. Soybean Yield (valued @ $9.95/bushel)	31.74	0.00	4.78	57.30	34
2. Cost-share program	28.07	20.00	25.00	30.00	14
Subtotal	*59.81*	*20.00*	*29.78*	*87.30*	
B. Changes in costs:					
1. Cover crop planting	31.14	35.95	29.77	24.82	
a. Seeds	15.11	17.00	13.50	11.00	34
b. Planting (excluding seeds) (weighted average of i-ii)	16.02	18.95	16.27	13.82	
i. Custom work	13.61	15.00	14.50	11.50	14
ii. Non-Custom	17.44	21.25	17.31	15.17	24
2. Herbicide expenses (weighted average of a-b)	3.82	5.50	4.05	2.33	
a. For farmers that did not apply herbicides before planting soybeans in baseline	16.85	23.38	17.23	9.91	8
i. Herbicide cost to terminate cover crops	11.25	16.50	11.00	6.00	8
ii. Application (weighted average a-b)	5.60	6.88	6.23	3.91	8
(a) Custom work	6.17	7.00	6.50	5.00	3
(b) Non-Custom	5.26	6.81	6.06	3.25	5
b. For farmers that applied herbicides before planting soybeans in baseline	-0.19	0.00	0.00	0.00	26
i. Additional herbicide costs on top of regular weed control program*	-0.19	0.00	0.00	0.00	26
ii. Labor costs to apply herbicides on top of regular weed control program*					0
3. Other Costs (sum of a-k)	-0.27	1.41	0.27	0.00	
a. Soybean seed costs	0.21	0.00	0.00	0.00	34
b. Soybean planting costs (excluding seeds)	1.18	0.00	0.00	0.00	34
c. Nitrogen costs	0.00	0.00	0.00	0.00	34
d. P & K costs	0.00	0.00	0.00	0.00	34
e. Manure costs	0.53	0.00	0.00	0.00	34
f. Insecticide costs	-0.21	0.00	0.00	0.00	34
g. Fungicide costs	-0.38	0.00	0.00	0.00	34
h. Soil testing costs	0.00	0.00	0.00	0.00	34
i. Management ($15 per hour)	0.97	1.41	0.27	0.00	24
j. Cash rent	-2.50	0.00	0.00	0.00	20
k. Soil erosion repairs	-0.06	0.00	0.00	0.00	34
Subtotal	*34.69*	*42.86*	*34.09*	*27.15*	
Net change in profit (A-B):	*25.13*	*-22.86*	*-4.31*	*60.15*	
Net change in profit without Cost-Share	*-2.95*	*-42.86*	*-29.31*	*30.15*	

N = number of responses; *values for farmers who used herbicide on both cover crop and non-cover acres

Table 6. Annual average partial budget for cover crops terminated with herbicides in corn-soybean rotation

Sources of changes in net profits	Mean ($/acre)	1st Quartile ($/acre)	Median ($/acre)	3rd Quartile ($/acre)	N
A. Changes in revenue:					
1. Cash crop yield (corn @ $3.35/bu; soy @ $9.95/bu)	-1.80	-26.19	0.81	24.06	55
2. Cost-share program	31.14	21.31	29.76	31.55	55
Subtotal	*29.34*	*-4.88*	*30.57*	*55.61*	
B. Changes in costs:					
1. Cover crop planting	33.60	40.79	31.72	25.31	
a. Seeds	16.81	20.63	14.63	12.31	55
b. Planting (excluding seeds) (weighted average of i-ii)	16.80	20.16	17.09	13.01	
i. Custom work	17.38	18.96	16.70	14.83	22
ii. Non-Custom	16.47	20.84	17.31	11.98	39
2. Herbicide expenses (weighted average of a-b)	6.94	9.04	5.36	4.96	
a. For farmers that did not apply herbicides before planting cash crop in baseline	32.58	34.65	32.78	30.31	9
i. Herbicide cost to terminate cover crops	23.41	24.89	23.34	21.94	9
ii. Application (weighted average a-b)	9.17	9.76	9.44	8.38	8
(a) Custom work	6.17	7.00	6.50	5.00	3
(b) Non-Custom	10.67	11.13	10.91	10.07	6
b. For farmers that applied herbicides before planting cash crop in baseline	1.93	4.03	0.00	0.00	46
i. Additional herbicide costs on top of regular weed control program*	1.93	4.03	0.00	0.00	46
ii. Labor costs to apply herbicides on top of regular weed control program*					0
3. Other Costs (sum of a-k)	0.57	1.49	0.30	0.00	
a. Cash crop seed costs	0.08	0.00	0.00	0.00	55
b. Cash crop planting costs (excluding seeds)	0.94	0.00	0.00	0.00	55
c. Nitrogen costs	0.17	0.00	0.00	0.00	55
d. P & K costs	0.00	0.00	0.00	0.00	55
e. Manure costs	0.21	0.00	0.00	0.00	55
f. Insecticide costs	0.51	0.00	0.00	0.00	55
g. Fungicide costs	-0.15	0.00	0.00	0.00	55
h. Soil testing costs	0.00	0.00	0.00	0.00	55
i. Management ($15 per hour)	1.20	1.49	0.30	0.00	39
j. Cash rent	-1.93	0.00	0.00	0.00	34
k. Soil erosion repairs	-0.46	0.00	0.00	0.00	55
Subtotal	*41.12*	*51.31*	*37.38*	*30.27*	
Net change in profit (A-B):	*-11.78*	*-56.19*	*-6.81*	*25.33*	
Net change in profit without Cost-Share	*-42.92*	*-77.50*	*-36.58*	*-6.22*	

N = number of responses; *values for farmers who used herbicide on both cover crop and non-cover acres

Table 7. Partial budget for cover crops winterkilled followed by corn or soybeans

Sources of changes in net profits	Mean ($/acre)	1st Quartile ($/acre)	Median ($/acre)	3rd Quartile ($/acre)	N
A. Changes in revenue:					
1. Cash crop yield (corn @ $3.35/bu; soy @ $9.95/bu)	-8.25	-18.00	0.00	0.00	24
2. Cost-share program	43.83	40.00	46.50	48.00	6
Subtotal	*35.58*	*22.00*	*46.50*	*48.00*	
B. Changes in costs:					
1. Cover crop planting	32.06	42.43	29.15	19.69	
a. Seeds	18.23	23.50	15.50	10.00	24
b. Planting (excluding seeds) (weighted average of i-ii)	13.83	18.93	13.65	9.69	
i. Custom work	9.50	11.50	10.00	7.50	8
ii. Non-Custom	16.31	23.17	15.73	10.94	14
2. Herbicide expenses	-0.33	0.00	0.00	0.00	
a. Additional herbicide costs on top of regular weed control program*	-0.33	0.00	0.00	0.00	24
b. Labor costs to apply herbicides on top of regular weed control program*					0
3. Other Costs (sum of a-k)	-2.57	0.97	0.30	0.00	
a. Cash crop seed costs	-0.63	0.00	0.00	0.00	24
b. Cash crop planting costs (excluding seeds)	0.00	0.00	0.00	0.00	24
c. Nitrogen costs	-2.54	0.00	0.00	0.00	24
d. P & K costs	-0.25	0.00	0.00	0.00	24
e. Manure costs	1.25	0.00	0.00	0.00	24
f. Insecticide costs	0.00	0.00	0.00	0.00	24
g. Fungicide costs	0.00	0.00	0.00	0.00	24
h. Soil testing costs	0.00	0.00	0.00	0.00	24
i. Management ($15 per hour)	0.70	0.97	0.30	0.00	21
j. Cash rent	-1.11	0.00	0.00	0.00	9
k. Soil erosion repairs	0.00	0.00	0.00	0.00	24
Subtotal	*29.16*	*43.39*	*29.45*	*19.69*	
Net change in profit (A-B):	*6.43*	*-21.39*	*17.05*	*28.31*	
Net change in profit without Cost-Share	*-37.41*	*-61.39*	*-29.45*	*-19.69*	

N = number of responses; *values for farmers who used herbicide on both cover crop and non-cover acres; responses from 11 farms that planted corn, and 13 farms that planted soybean in 2016.