American Farmland Trust
SAVING THE LAND THAT SUSTAINS US

A Farmer's Guide to Soil Health Economics

FINDINGS FROM **BUDGET ANALYSES** FOR CORN, SOYBEAN, AND SMALL GRAIN

According to the U.S. Department of Agriculture (USDA), soil science research has shown that practices which improve soil health can lead to benefits such as reduced erosion, maximized water infiltration, improved nutrient cycling, and improved resilience.[10] These "soil health practices" not only have direct benefits for the producers, but they can also have public benefits for the surrounding community.

Although practices such as no-till, cover crops, change in crop rotation or nutrient management have been shown to improve soil health, adoption remains limited: just 21% of cultivated acres are in continuous no-till[4] and only 3.9% are in rotation with cover crops.[11] One barrier to conservation practice adoption is that farmers bear all the costs of practice adoption while sharing the benefits with the public. Soil health practices can allow farmers to reduce input costs, and, in some cases, increase crop yield.

To shed light on the economic impacts of adopting soil health practices, we searched for relevant economic analyses. We organized the results into three factsheets highlighting key findings from surveys, budget analyses, and research trials. Here, we review **BUDGET ANALYSES**. This guide focuses on the production of corn, soybeans, and small grains.

A budget analysis is a common farm economic method to analyze potential changes that producers may experience when adopting new management systems or equipment. Two common budget analyses are partial budget analysis and enterprise budget analysis. Both methods calculate the changes to a farm budget by adding a new practice, either by comparing "before" and "after" results or by comparing the relative change between fields that have and have not adopted the practice. **Partial budget analysis (PBA)** is limited to factors that **change** due to the adoption of a new practice, whereas an **enterprise budget analysis** details **all budget items** for an enterprise whether they have changed or not.

Three organizations use similar PBA frameworks: (1) American Farmland Trust's (AFT) Soil Health Economics Case Studies[1] (2) Soil Health Institute's (SHI) 100 Farm Soil Health Factsheets[3] and (3) Dr. Plastina and colleagues' journal articles at Iowa State University.[7,8,9] AFT and SHI both interviewed row crop producers growing primarily **corn and soybeans** in various states (AFT: **NY, PA, OH, IL, OK**; SHI: **IA, IL, IN, MI, MN, NE, OH, SD, TN**) about the change in costs and benefits from adopting new practices due to new practices. AFT produced

Corn planted into oats

individual case studies, whereas SHI aggregated results by state and released statewide factsheets. Plastina et al.[7,8,9] used surveys across three articles to estimate the costs and benefits of adopting cover crops for **corn and soybean** producers primarily in three states (**IA, IL, MN**). AFT purposefully selected farmers using soil health practices with positive economic experiences. SHI selected farmers with a minimum of 5 years of soil health practice experience, implying successful implementation. Plastina et al.[7,8,9] sampled farmers based on experience and farming management.

Both AFT and SHI highlight similar positive findings from their PBA analyses with farmers that have successfully adopted soil health practices:

- Across AFT's 10 row crop case studies and SHI's 100-farm series, AFT found an **increase in net income** after adopting cover crops ranging from **$4/ac to $59/ac**, and SHI found an **average income increase of $52/ac for corn production and $45/ac for soybean production.**
- **Yield improvements helped drive these positive results.** Eight of the 10 producers reported to AFT that they observed a yield revenue improvement of **$14/ac to $151/ac.** Producers in SHI's study reported average increases in yield revenue of **$31/ac for corn production and $29/ac for soybeans production.** SHI also notes that producers saw **an increase in yield stability.**

For a more in-depth view of one of AFT's soil health economic case studies, please see Box 1.

Plastina et al. published three journal articles using partial budget analysis and found mixed net income results for cover crop adoption.[7,8,9] Each study used a similar survey to analyze the costs and benefits of 15,[7] 79,[8] and 233[9] Midwestern row-crop farmers who have adopted cover crops by comparing their fields with cover crops to their fields without cover crops.

- Across all three studies, farmers saw negative net returns for cover crop adoption except when incentive payments or

Box 1. B&R Farms, Pennsylvania, AFT Soil Health Economic Case Study[1]

B&R Farms is a multi-generational farm in Schuylkill County, Pennsylvania. AFT analyzed the adoption of soil health practices on the 360 acres allocated to a corn-soy rotation. By switching to no-till and adding a rye cover crop, the family estimated their **corn and soybean yields increased by 10%.** Adopting no-till saved **$32/ac** in reduced machinery and labor costs. The increase in net income from no-till and cover crops outweighed their increased net costs, leading to an estimated **increase in total net income of $20/ac.**

B&R Farms became the first farm in Schuylkill County to permanently protect their farmland under an easement supported in part by funds from the **Farm and Ranch Lands Protection Program (FRPP).** The family said the reason they put the farm under an easement and adopted soil health practices is one and the same. The easement ensures that the land will be farmed, and the soil health practices ensure that the land can provide for the next generation.

additional grazing revenue were included.[7, 8, 9] In one study, the addition of cost share (ranging from $25 to 44/ac) led to positive net income results for soybeans after herbicide terminated cover crops as well as for corn and soybeans after winterkilled cover crops.[8] In another study, grazing revenue led to positive results for the mean net income for the cumulative average of all crops.[9]

- In pre-survey focus groups, producers associated poor yield effects with herbicide failure or pest outbreaks. Despite the mixed net income results in the study, there was strong farmer consensus that cover crops provide soil erosion control benefits.[7]

A final set of case studies using PBA analysis comes from the National Association of Conservation Districts and DATU Research[5] (2017), which tracked **three corn and soybean producers** from (**IL, IA, MO**) every year as they adopted cover crops for 3 to 5 years.

- Overall, two farms exhibited positive net income changes. Willis Farms experienced a positive return in year one thanks to yield revenue increasing by $25/ac because the rye cover crops prevented field washouts during heavy rains. While Diaz Farm experienced two initial years of negative returns, eventually yields increased, and net income grew from -$83/ac in the first year to $110/ac in the fourth year.
- Though Moore Farm did not experience positive returns, they remained convinced by cover crops and expect a reduction in input and learning costs as they become more familiar with the practice.

Outside of PBA analyses, Monast et al.[6] and Bowman et al.[2] used **enterprise budgets** to highlight changes that **Midwestern row crop producers** attributed to adopting soil health practices.

In summary:

- Across the three farms (**OH, KS, IA**), Monast et al.[6] found net income grew after soil health practices adoption by $9–$47/ac for corn, $10–$20/ac for sorghum, and $12–$50/ac for soybeans. Results for wheat ranged between -$5 and $5/ac.
- Bowman et al.[2] separated seven producers (**WI, IA, MO, MN, IN**) into categories based on their experience with no-till and cover crops. For both corn and soybean, producers that just adopted no-till had higher net returns than conventional tillage farmers ($377/ac vs $324/ac for corn and $251/ac vs $216/ac for soybean). Producers that adopted both no-till and cover crops had the lowest net returns ($307/ac for corn and $173/ac for soybean).

Key Takeaways

1. **Soil health practices can provide economic gains.** Producers in the AFT,[1] SHI,[3] and Monast et al.[6] reports and two producers in the NACD[5] study experienced positive results from the use of soil health practices driven by increased yields and reductions in some input costs. However, Plastina et al.[7, 8, 9] and one producer in NACD's analysis showed negative results from adopting cover crops driven by increases in cover crop costs. No-till producers in Bowman et al.[2] experienced positive net returns compared to conventional till producers but combining no-till with cover crops resulted in a lower net return than conventional tillage.
2. **Soil health is a long-term investment.** Farmers in both the AFT case studies and focus groups from Plastina et al.[7] commented on the need to see soil health as a long-term investment. These comments are supported by the NACD[5] multiyear analyses.

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FINDINGS FROM **NATIONAL SURVEYS** FOR CORN, SOYBEAN, AND SMALL GRAIN

According to the U.S. Department of Agriculture (USDA), soil science research has shown that practices which improve soil health can lead to benefits such as reduced erosion, maximized water infiltration, improved nutrient cycling, and improved resilience.[5] These "soil health practices" not only have direct benefits for the producers, but they can also have public benefits for the surrounding community.

Although practices such as no-till, cover crops, change in crop rotation or nutrient management have been shown to improve soil health, adoption remains limited: just 21% of cultivated acres are in continuous no-till[1] and only 3.9% are in rotation with cover crops.[6] One barrier to conservation practice adoption is that farmers bear all the costs of practice adoption while sharing the benefits with the public. Soil health practices can allow farmers to reduce input costs, and, in some cases, increase crop yield.

To shed light on the economic impacts of adopting soil health practices, we searched for relevant economic analyses. We organized the results into three factsheets highlighting key findings from surveys, budget analyses, and research trials. In this factsheet, we share findings from **TWO NATIONAL SURVEYS.** This guide focuses on the production of corn, soybeans, and small grains.

Tillage radish planted with triticale and oats

EDWIN REMSBERG AND USDA-SARE

Surveys provide excellent insight into a large sample of producer decisions and the economic effects of those decisions. If large enough and generalizable, surveys can examine national trends in conservation practices. Whereas a case study or research trial tells detailed stories about one or a group of producers, surveys can provide a more overarching view. In this section, we will focus on two large national surveys, USDA's Agricultural Resource Management Survey (ARMS)[4] and the Sustainable Agricultural Research and Education (SARE) National Cover Crop Survey.[3]

The SARE National Cover Crop Survey is a biannual survey specifically targeting producers using cover crops across the country. It asks in-depth questions about cover crop adoption and the effects they have on a producer's operation. The yearly ARM Survey provides information on producers' production practices, resource use, and economic well-being. Within ARMS, there are a few sections that provide insights into soil health practices. It is important to note that each survey has limitations. The SARE survey is limited to current cover crop users and does not include producers for whom cover crops did not work, potentially biasing the results. The ARM Survey, although very large, only has a limited proportion of data from respondents using cover crops.

The SARE Cover Crop Survey showed two important yield-related findings.

- **Producers self-report that their corn and soybean yields improved by 2% and 5% on average,** respectively, over time with the addition of cover crops.[3]
- In an earlier version of the SARE survey (2015–2016), researchers found **gradual increases in yield and input savings over the five years for both corn and soybeans** after the adoption of cover crops, which led to an increase in net income.[2] Corn and soy producers both saw negative returns in their first year of adoption (-$31/ac and -$23/ac, respectively). By the third year, producers of both crops broke even ($1/ac and $0/ac, respectively). Ultimately, producers in the fifth year experienced positive net results of $18/ac for corn and $10/ac for soybeans, showing the importance of a long-term approach (see Table 1).

One key trend highlighted in both national surveys is that farmers are adopting cover crops with and without financial incentives. Although there are different incentives potentially available, such as federal financial assistance, a large number of producers are adopting these practices without monetary support. According to the USDA ARM Survey, only one-third of cover crop acres in the U.S. were planted with an incentive program,[4] thus two-thirds were planted without financial support. The SARE National Cover Crop Survey found that nearly 50% of the 1,172 farmers that responded did not receive incentive payments

TABLE 1. SARE COVER CROP SURVEY CHANGE IN NET INCOME FROM ADOPTING COVER CROPS

	ONE YEAR	THREE YEARS	FIVE YEARS
Corn Net Income ($/ac)	-$31	$1	$18
Soybean Net Income ($/ac)	-$23	$0	$10

Source: Myers et al. 2019[2]

(SARE, 2020). Incentives still remain important in providing transitionary support to farmers who need assistance as they start adopting cover crops.[2]

Another key trend mirrored in both national surveys is that combining no-till and cover crops is common and potentially beneficial. According to the ARM Survey, farmers were two to three times more likely to use no-till on fields with cover crops.[4] Within the SARE survey, 48% of cover crop producers also used no-till.[3] Farmers can use the savings from no-till, e.g., fuel, and labor savings from the reduction in the number of passes across a field, to offset the costs of cover crops and then continue both practices to maintain the numerous soil health benefits they observe in their fields.[2]

Key Takeaways

1. **Yield benefits might not start right away.** Evidence from the SARE Cover Crop Survey suggests that yield improvements are possible with cover crops but may take a few years to materialize.[2]
2. **Incentives are important, but potentially not a limitation.** Both the ARM and SARE Cover Crop surveys show that many producers using cover crops are finding a way to be successful without financial incentives.
3. **No-till and cover crops are being used in combination.** According to both ARM and SARE Cover Crop surveys, producers are using both cover crops and no-till in their operations.

Planting green into a six-way cover crop with a 40-ft, 16-row corn planter

KEVIN KEENAN

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FINDINGS FROM **RESEARCH TRIALS** FOR CORN, SOYBEAN, AND SMALL GRAIN

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Although practices such as no-till, cover crops, change in crop rotation or nutrient management have been shown to improve soil health, adoption remains limited: just 21% of cultivated acres are in continuous no-till[9] and only 3.9% are in rotation with cover crops.[25] One barrier to conservation practice adoption is that farmers bear all the costs of practice adoption while sharing the benefits with the public. Soil health practices can allow farmers to reduce input costs, and, in some cases, increase crop yield.

To shed light on the economic effects of adopting soil health practices, we searched for relevant economic analyses. We organized the results into three factsheets highlighting key findings from surveys, budget analyses, and research trials. Here we share findings from **20 RESEARCH TRIALS**. This guide focuses on the production of corn, soybeans, and small grains.

Research trials measure the in-field impacts of different field operations. We've summarized the results from 20 studies that compare row crops with and without soil health practices and that include an analysis of changes in economic costs and benefits. The trials vary in design, but most commonly they are either: (1) **experimental plots** that an organization designed, monitored, and managed that involve at least one control and one treatment plot to analyze the new practice (14 studies);[1, 2, 4, 5, 7, 12, 13, 15, 16, 17, 19, 20, 21, 24] or (2) **on-farm demonstration trials** managed by a farmer but designed and monitored by a partnering organization involving at least a portion of a field under a new practice (6 studies).[3, 6, 8, 11, 14, 18]

Further, these trials vary in time, location, number of locations across multiple states or within a state, and number and type of treatments. Of note, 13 trials were short-term (less than 5 years). Each study tested multiple practices leading to multi-faceted results from an individual study. Below we give a broad summary of these studies. For more detailed information, please visit our website.

An earthworm surfaces amid cover crop residue after intense rainfall

USDA-NRCS

Within the trials we reviewed:

- **13 studies identified slightly higher average net income or no significant difference in net income <u>for at least one soil health treatment</u>** compared to conventional management over the short-term (6 studies)[7, 8, 11, 12, 18, 24] and long-term (7 studies).[2, 4, 5, 13, 14, 15, 16] These study results have a variety of nuances such as net income results varying with different fertilizer rates, cover crop types, and tillage depths within the trials.[2, 8, 12, 13, 14]
- **2 studies did not analyze net income but identified higher cost-effectiveness** with reduced input costs (by up to 43%), reduced soil loss, and improved drainage with the adoption of no-till and cover crops in the short-term.[17, 20]
- **1 study did not analyze net income but estimated a median cover crop (CC) cost of $40/acre** from CC management data from 112 farms in the Soil Health Partnership network (2015–2021); yield data collected in 2019 from 58 of the strip trials showed that average corn and soybean yields were lower by 0.67 bu/ac and 0.9 bu/ac (respectively); the results were not statistically significant.[6]
- **10 studies identified lower net income <u>for at least one soil health treatment</u>** compared to conventional management over the short-term (8 studies)[1, 3, 7, 8, 11, 12, 19, 21] and long-term (2 studies).[1, 14] Of the 10 research trials with lower net income for at least one treatment within a study, 7 studies found positive though lower net return compared to the control[1, 2, 7, 8, 11, 12, 19] and 5 studies identified negative net income results, meaning that the treatment was not profitable.[3, 7, 14, 19, 21] Of note, for one of the

two on-farm trials that found a negative net income result, interestingly, the negative net income improved from -$119/ac to -$48/ac between years 1 and 2, which the authors attribute to improved soil health management experience.[3]

Key Takeaways

1. **Length of time matters.** All 7 of the long-term trials (5 or more years) found a positive net income result with at least one soil health practice treatment due to either or both increased mean yield or reduced input costs.[2, 4, 5, 13, 14, 15, 16] Two of these trials also identified lower net income for other treatments compared to the control.[2,14]
2. **Location matters.** Even within a trial, location effects, including soil type/texture, weather, and crop type, have an impact on results.[1, 7, 10, 11, 12, 19, 24] For example, studies have identified no-till performs better in coarse, well-drained soils and when there is not too much or too little crop residue.[2, 5, 22]
3. **Farm size matters.** Economies of scale apply to the adoption of soil health practices. Purchasing equipment such as a no-till drill, hiring custom cover crops planting, or investing in grid sampling for advanced nutrient management is disproportionately more costly for smaller farms than larger ones.[11, 24]
4. **Experience matters.** The on-farm demonstration trials show farmers' experience with soil health practice implementation has a large impact on success.[3, 6, 8, 10, 11, 18] Badon et al. (2021)[3] directly attribute the large negative net income findings associated with reduced till and cover crops to a lack of soil health management experience.
5. **Environmental benefits matter.** It is important to consider the on-farm environmental benefits of these practices, such as reduced soil erosion, improved biological activity, and greater nutrient retention, as these benefits have the potential to reduce input costs, such as herbicide or fertilizer, in the future.[1, 4, 5, 13, 15, 18, 20] Roth et al. (2018) found 61% of cover crop costs could be recovered by incorporating the value of the benefits of soil erosion (57% of the recovered value), reduced nitrogen loading (34%), and cover crop residue nitrogen mineralization (9%).[20]

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