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U.S. DEPARTMENT OF AGRICULTURE

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February 2021

Cover Crop Trends, Programs, and Practices in the United States

Steven Wallander, David Smith, Maria Bowman,
and Roger Claassen





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Abstract

On U.S. cropland, the use of cover crops increased by 50 percent between 2012 and 2017. During this same period, Federal and State conservation programs increased efforts to promote cover crops through financial and technical assistance. When farmers introduce cover crops into a crop rotation, there can be important onfarm benefits for the farmers as well as benefits to society. These benefits depend upon how the farmers manage the cover crop, such as the type of cover crop, the method used to terminate its growth, and other soil health and residue-management practices employed. Based on a series of farm- and field-level surveys, this report details how cover crops are managed on corn, cotton, soybean, and wheat fields. These surveys reveal that there are many different approaches to using cover crops. This includes considerable variation in the other soil-health-related practices farmers use with cover cropping, such as no-till farming, conservation cropping, and soil testing.

Keywords: Cover crop, conservation practice, soil health, conservation program, financial assistance, erosion, tillage.

Acknowledgments

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Cover Crop Trends, Programs, and Practices in the United States

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What Is the Issue?

Farmers grow cover crops for a variety of production and soil health benefits that do not include the sale or direct use of the crop. This distinguishes cover crops from both cash crops, which are harvested and sold, and forage crops, which are grazed by livestock or harvested for hay or silage. Well-managed cover crops provide a living, seasonal coverage of soil between commodity or forage crops. Depending upon the field, soil, climate, and weather, cover crops can result in a variety of onfarm benefits: reduced soil erosion and compaction, improved water infiltration and storage within the soil profile, greater weed and pest suppression, and better nutrient cycling and soil stability to support machine operations. Cover crops can also provide public environmental benefits: less runoff of sediments and nutrients into waterways, reduced flooding in watersheds, and greater soil carbon sequestration. As the understanding of links between soil health and these environmental benefits has grown, USDA and many States have increased financial assistance for cover crops through working lands conservation programs. This report summarizes unique, nationally representative data available on cover crop adoption rates, crop type, and management choices, and the links between cover crop use and other conservation practices.

What Did the Study Find?

U.S. farmers are rapidly expanding the adoption of cover crops.

- In 2017, farmers reported planting 15.4 million acres of cover crops, a 50-percent increase compared to the 10.3 million acres reported in 2012.
- Field-level surveys of corn, cotton, soybean, and wheat fields reveal the use of cover crops; and rates of expanded adoption are highest on fields that include corn silage in the rotation and lowest on fields that include wheat.

Financial incentives provided by Federal, State, and private organizations to encourage cover crops are one driver of increased cover crop adoption.

- In 2018, about one-third of the acreage planted with a cover crop received a financial assistance payment from either Federal, State, or other programs that support cover crop adoption.
- In fiscal year 2018, USDA's Environmental Quality Incentives Program (EQIP) obligated \$155 million in planned payments toward cover crops on about 2 million acres.

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This is about 20 times the level of financial support for cover crops through EQIP in 2005, driven primarily by an increase in acres enrolled in a cover crop practice.

- Between 2011 and 2015, the total acreage enrolled in USDA's Conservation Stewardship Program (CSP) through contracts, including cover crop practices and enhancement, increased from about 350,000 acres to more than 2 million acres.
- A variety of incentive programs administered by at least 22 States supported more than 1 million acres of cover crops in 2018.
- In 2018, financial assistance for cover crops across a variety of Federal and State programs, excluding CSP, ranged from \$12 per acre to \$92 per acre.

Farmers use a variety of cover crops and diverse strategies to manage them.

- Fields in cotton and corn silage are much more likely to use cover crops compared to fields in corn-for-grain or soybeans.
- The most common cover crops are rye (cereal rye or annual ryegrass) and winter wheat. (Note Summary figure).
- To prepare for the planting of cash crops, most cover crops are terminated with herbicide or tillage.

Cover crops are often part of a suite of conservation practices that comprise a farmer's soil health management system. Other conservation practices, such as no-till farming and a written nutrient management plan, are more common on fields with cover crops than on fields without cover crops.

- No-till planting is two to three times more likely on fields with cover crops.
- Testing for nutrients and soil organic matter and the use of written nutrient management plans are all more likely on fields with a cover crop.

How Was the Study Conducted?

We estimate cover crop adoption rates using data from the 2012 and 2017 Census of Agriculture and the Agricultural Resource Management Survey (ARMS), a national survey of farming operations and production practices conducted by USDA's National Agricultural Statistics Service (NASS) and Economic Research Service (ERS). The field-level data are based on the Production Practice and Cost Report (Phase 2) ARMS that is conducted periodically for corn (2010 and 2016), cotton (2015), wheat (2017), and soybeans (2018). Field-level data on cover crop adoption and management are obtained from a series of questions that ask farmers about what crops they grew during the 4 years prior to the survey, whether the crop was a cover crop, and what tillage and termination practices were used. To capture potential relationships between cover cropping and other management practices, we also use field-level survey data to estimate the extent to which different tillage practices, conservation cropping, soil testing, and other practices are associated with the use of cover crops on surveyed fields.

We use data obtained from the USDA, Natural Resources Conservation Service (NRCS) ProTracts database and other online NRCS resources to estimate the magnitude of Federal financial incentives for cover crops and trends in these incentives provided through EQIP and CSP. Information on State-level programs and financial incentives for cover crops was compiled from various sources, including publicly available documents and conservation program reporting, and personal communication with State departments of agriculture and conservation districts.

Cover Crop Trends, Programs, and Practices in the United States

Background

Maintaining, supporting, and enhancing soil health is a cornerstone of an agroecosystem that sustains productive agricultural land. Soil health management follows four basic principles: (1) minimize soil disturbance; (2) maximize soil cover; (3) maximize biodiversity; and (4) maximize the presence of living roots in the soil (USDA-NRCS, 2018f). Cover crops, a soil-health-related conservation practice, have received increased attention from Federal and State conservation programs, farmers, and nongovernmental organizations. This single conservation practice meets three of the four basic principles for improving soil health (principles 2-4).

The soil health improvements that can come with the use of cover crops are associated with a variety of potential on-field benefits for the farmer. Cover crops can enhance soil properties such as aggregate stability, beneficial microbial activity, and the amount of organic matter in the soil (Snapps et al., 2005). Depending upon the local soil and climate, these changes can help suppress and control weeds, reduce nutrient and pesticide losses, increase infiltration, and increase the volume of water retained in the soil profile, which may lead to greater drought resilience (Myers et al., 2019). The types of soil health improvements and onfarm benefits are variable, complex, and context-specific (Tonitto et al., 2006). Many of these benefits are also associated with public benefits, such as improved downstream water quality (Dabney et al., 2001).

Cover crops can also have costs—both monetary and non-monetary—that limit the willingness of many farmers to plant them (Plastina et al., 2018). Establishing a cover crop involves seed, machinery, and time. Managing a cover crop to achieve the desired benefits can require significant learning and adjustments in other aspects of the farming system. Terminating a cover crop to prepare for the following cash crop also involves machinery, time, and sometimes additional herbicide. In some situations, there can be unintended or undesired negative consequences from cover crops, such as allelopathy or an increase in certain crop pests (Lu et al., 2000; Bakker et al., 2016).

This report relies on survey data in which farmers self-report whether they are growing cover crops on their operation or on a given field. For any management practice, such data collection relies upon survey respondents defining the practice in the same way as the analysts interpreting the survey data. What is a cover crop? In general, a cover crop can be a single species or a mix of grasses, legumes, or forbs grown primarily to provide seasonal cover and related benefits. For example, cereal rye is often planted as a cover crop in the fall to provide winter cover between the planting of cash crops such as corn and soybeans.

USDA defines a cover crop based on the primary intended use for the crop (see box “How does USDA define a cover crop?”). This definition separates cover cropping from double cropping, a practice in which farmers plant and harvest a second cash crop within a year (Borchers and Wallander, 2014). Sometimes this distinction is simplified to define cover crops as crops that are not harvested; though as the data below show, many farmers use harvesting as a method to terminate the cover crop. In

some cases, farmers even harvest a cover crop for grain. While such cover crop management is not allowed in USDA financial assistance programs (NRCS, 2014b), some State programs have allowed for such management of cover crops in return for reduced payments. For example, between 2007 and 2017, roughly 20 to 40 percent of the cover crop acres planted in Maryland as part of the State's Agricultural Water Quality Cost Share Program were "commodity cover crops" that could be harvested for sale (Bowman and Lynch, 2019). Since there are conflicting rules around cover crops in these conservation programs, statistics on cover crop adoption inherently capture a certain amount of acreage that would not qualify as having cover crops under some program definitions. This challenge of consistently defining cover crops reflects the inherent complexity of managing cover crops.

How does USDA define a cover crop?

In 2014, USDA agencies revised their definition of a cover crop for consistency across agencies, as follows:

"Crops, including grasses, legumes, and forbs, for seasonal cover and other conservation purposes. Cover crops are primarily used for erosion control, soil health improvement, and water quality improvement. A cover crop managed and terminated according to these guidelines is not considered a 'crop' for crop insurance purposes. The cover crop may be terminated by natural causes such as frost, or intentionally terminated through chemical application, crimping, rolling, tillage, or cutting" (USDA-NRCS, 2014c; USDA-NRCS 2014e).

Further, USDA's definition allows for grazing and harvesting under specific conditions, as follows:

"Cover crops may be grazed or harvested as hay or silage, unless prohibited by RMA (Risk Management Agency) crop insurance policy provisions. Cover crops cannot be harvested for grain or seed" (USDA-NRCS, 2014c; USDA-NRCS, 2014e).

Adoption of Cover Crops

In 2017, U.S. farmers reported planting 15.4 million acres of cover crops. The adoption of cover crops increased 50 percent from 2012 when farmers reported planting 10.3 million acres of cover crops (USDA-NASS, 2019, table 47). Various conservation groups and experts have suggested long-run targets for cover crop adoption that range from 20 million acres by 2020 to 100 million acres by 2025 (Hamilton et al., 2017). Currently, though, there is no official USDA goal or target for the extent of cover crop adoption.

Looking at adoption rates, rather than total acreage, allows for comparison across regions. Previous research has suggested that total cropland is not the correct denominator for calculating adoption rates (Hamilton et al., 2017). For this study, we calculate adoption rates using a denominator of harvested cropland minus harvested alfalfa acreage.¹ Harvested cropland excludes fallow land, failed crops, and the long-term, perennial cover on land enrolled in the Conservation Reserve Program (CRP). As a share of harvested cropland, excluding alfalfa, cover crop adoption increased from 3.4 percent in 2012 to 5.1 percent in 2017.

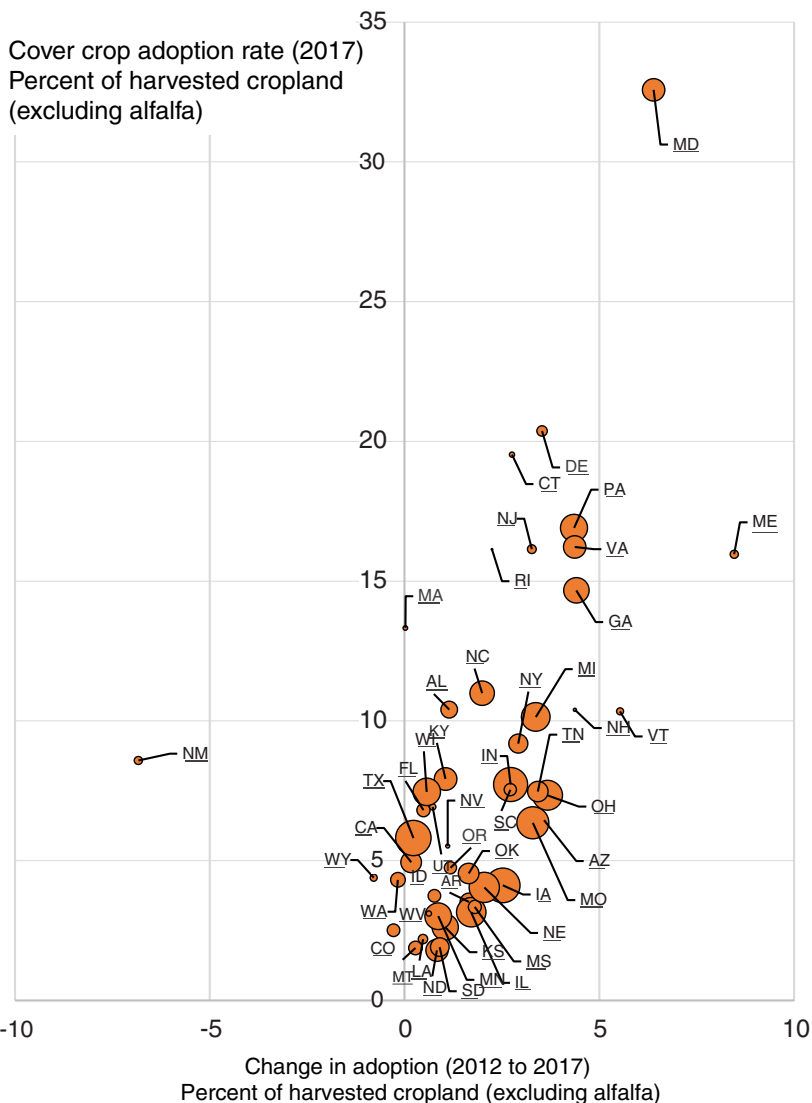
Cover crop adoption rates in 2017 and the change from 2012 to 2017 vary a great deal across the United States (figure 1). Maryland, which has been heavily promoting cover crops for well over a decade, has both a high adoption rate (about 33 percent in 2017) and a high growth rate (more than 6 percentage points from 2012 to 2017). States with both high adoption and high growth rates are often in the eastern United States (e.g., Pennsylvania, Virginia, and Georgia). Several States in the Midwest and Great Lakes regions had moderate adoption and growth rates (e.g., Missouri, Indiana, Michigan, and Ohio). There was a slight decline in cover crop adoption in Colorado, Washington, and Wyoming, and a much larger decline in New Mexico.

Adoption levels can also vary considerably within States, reflecting the combined effects of different soils, primary crops, livestock density, outreach and training availability, and conservation technical assistance and financial incentive programs (figure 2). For example, within Texas, some of the highest adoption rates are in the panhandle, where a larger share of acreage is planted to cotton. As shown later in this report, cotton fields have higher adoption rates than corn for grain or soybeans. In Pennsylvania, cover crop adoption is more common in counties within the Chesapeake Bay watershed, which could reflect greater conservation program- or regulation-related incentives in those counties. In Iowa, cover crop adoption is more common in the southeastern portion of the State, where soils have lower organic matter and higher erodibility compared to the rest of the State. These potential drivers of variation in adoption suggest a complex mix of both the benefits and costs of using cover crops, which include variation in cover crop incentive programs.

As noted above, cover crop adoption was high in 2017 compared to where it was in 2012 but is still relatively rare at a 5.1-percent adoption rate. Given the extensive interest in cover crops and calls for expanded adoption, comparing cover crop acreage to the acreage of other crops, conservation practices, and land uses can provide useful perspective even though these other practices and land uses generally provide different economic, agronomic, and environmental benefits (figure 3).

¹We do not exclude orchards, as suggested by Hamilton et al., (2017), because it is possible to plant cover crops within an orchard. We do not exclude non-alfalfa hay and haylage because an examination of county-level data makes clear that in some areas, particularly the northeastern United States, a large share of cover crops is reported as hay or haylage. We do not exclude double-cropped acres, which are similar to perennial rotations in lacking the ability to include crops, because the Census of Agriculture data do not capture double-cropped acreage.

Figure 1
State comparisons of 2017 cover crop adoption rates and 2012-17 trends



Notes: Alaska and Hawaii are not included in the chart. Share of acreage is calculated as harvested cropland acreage (which excludes Conservation Reserve Program, fallow, and failed cropland acres) minus harvested hay and forage acreage. The size of circles is proportional to the total cover crop acreage in 2017; States with more total acreage in cover crops have larger circles.

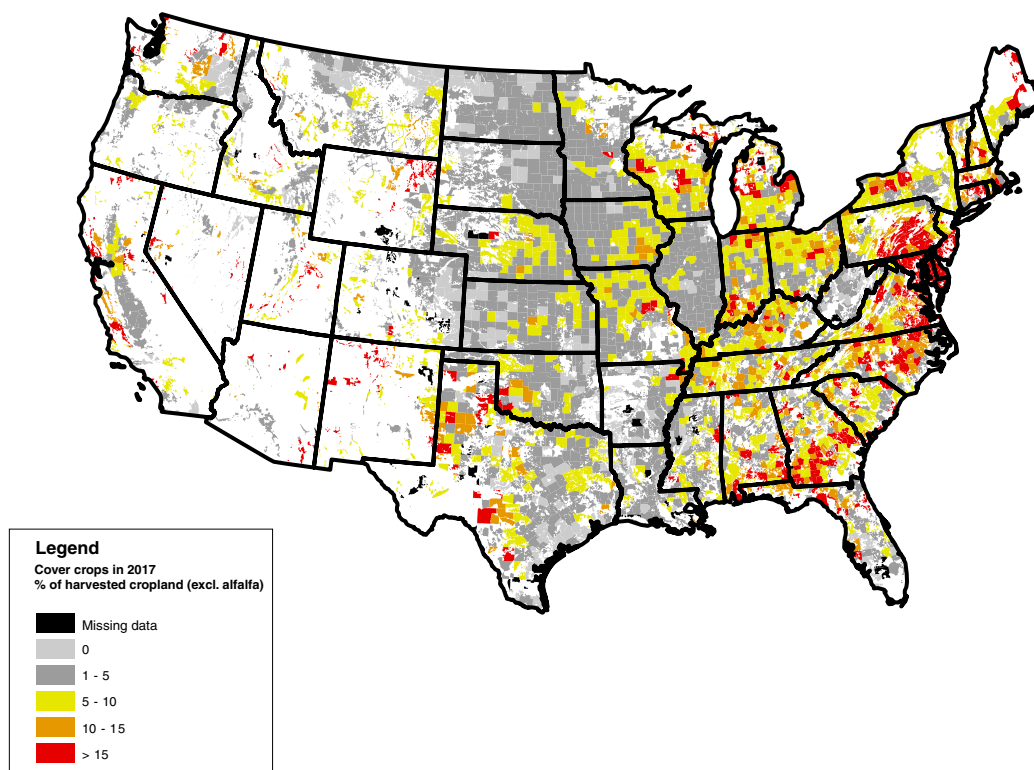
Source: USDA, Economic Research Service using data from USDA, National Agricultural Statistics Service.

As a conservation practice focused on both increasing organic matter and reducing erosion, cover crops are often considered alongside tillage practices. Both no-till (104 million acres) and conservation tillage (97 million acres, excluding no-till) are much more widely adopted than cover crops, which suggests there is still potential for cover crop adoption to increase.² However, no-till and conservation tillage generally involve reduced onfarm costs because of fewer field operations and lower input use relative to conventional tillage. In contrast, cover crops can involve increased costs, at least in the short run, due to seed purchases and additional field operations and, often but not always, greater use of inputs such as herbicide.

²According to the NASS Census of Agriculture definition, conservation tillage includes all reduced tillage operations, excluding no-till, that leave at least 30 percent of the soil covered in crop residue at the time of planting.

Figure 2

Cover crop adoption as a share of harvested acreage by county, 2017



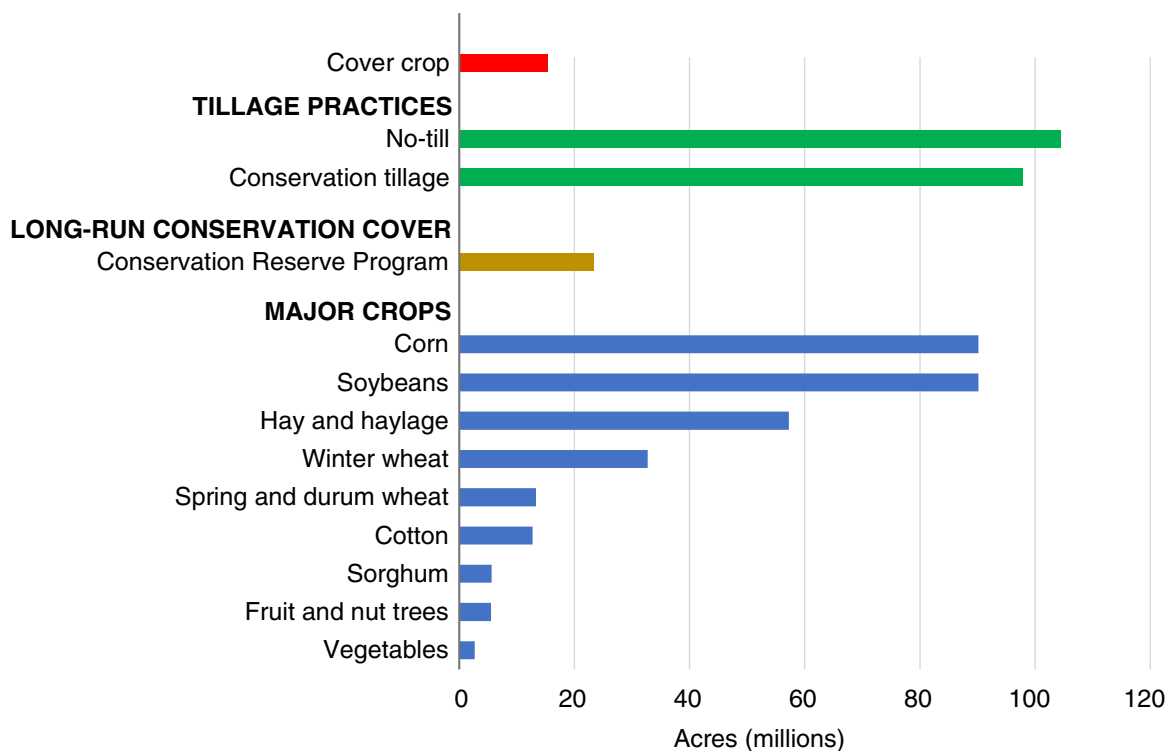
Note: County boundaries are clipped to show only cropland. Non-cropland appears white. Missing data occur when county-level estimates cannot be publicly released due to an insufficient number of observations in a county.

Source: USDA, Economic Research Service estimates using 2017 Agricultural Census, USDA, National Agricultural Statistics Service.

As a crop that is generally not harvested and that can have very high benefits if used on highly erodible land, cover crops may also be compared to the CRP. In 2017, CRP contracts enrolled 24 million acres. However, there are very different costs and benefits involved in the two different land uses since the environmentally sensitive land in CRP is effectively retired from active crop production for at least 10 years.

Given that cover crops are integrated into cash crop rotations, it is also helpful to compare cover crop acreage to cash crop acreage. In 2017, only corn, soybeans, winter wheat, and hay had more total acreage than cover crops. Winter wheat and hay are probably the most relevant comparisons because of the potential use of cover crops for forage in some circumstances. There were more cover crops planted in 2017 than spring wheat (including durum), cotton, sorghum, and many other crops.

Figure 3
Comparing cover crop acreage to other crop and conservation acreage in 2017



Note: Conservation tillage acreage does not include no-till acreage.

Source: Crop acreages are from USDA, National Agricultural Statistics Service annual surveys. Cover crop and tillage acreages are from 2017 Census of Agriculture. Conservation Reserve Program acreage is from September 2017, USDA, Farm Service Agency monthly report.

Conservation Programs for Cover Crops

Federal and State conservation programs reduce the cost of cover crop adoption through financial assistance payments, which encourage greater adoption of cover crops than would occur without the program payments. As detailed in this section, during 2017, these programs provided more than \$180 million in total incentives for the adoption of cover crops on more than 5 million acres of cropland. The per-acre payment rates, the eligibility requirements, and even the types of cover crops and management practices vary significantly across programs as well as between States and regions within Federal programs.

USDA has two major programs that provide such financial assistance: the Environmental Quality Incentives Program (EQIP) and the Conservation Stewardship Program (CSP). In addition to the Federal programs, farmers may be eligible for State programs that provide financial assistance to farmers who plant cover crops. In most cases, farmers cannot simultaneously receive payments from multiple programs for the cover crops on the same field in the same year, although some exceptions do exist.

The Environmental Quality Incentives Program

Under EQIP, farmers may be eligible to receive annual payments for introducing cover crops if the conservation planning process finds their fields have environmental resource concerns that cover crops could address. Farmers are ineligible for payment through EQIP on fields where they are already planting cover crops. In this way, EQIP is meant to encourage trial adoption of cover crops for up to 5 years.

Farmers who receive an EQIP payment cannot harvest their cover crop for grain or seed. In many cases, participants can terminate their cover crop by grazing livestock on the forage or harvesting the cover crop for hay or silage (USDA-NRCS, 2014c), but these requirements can vary by State. Each EQIP contract specifies the type of cover crop to be established, seeding rates and dates, when and how farmers will apply nutrients, and how they will terminate their cover crop (USDA-NRCS, 2014b).

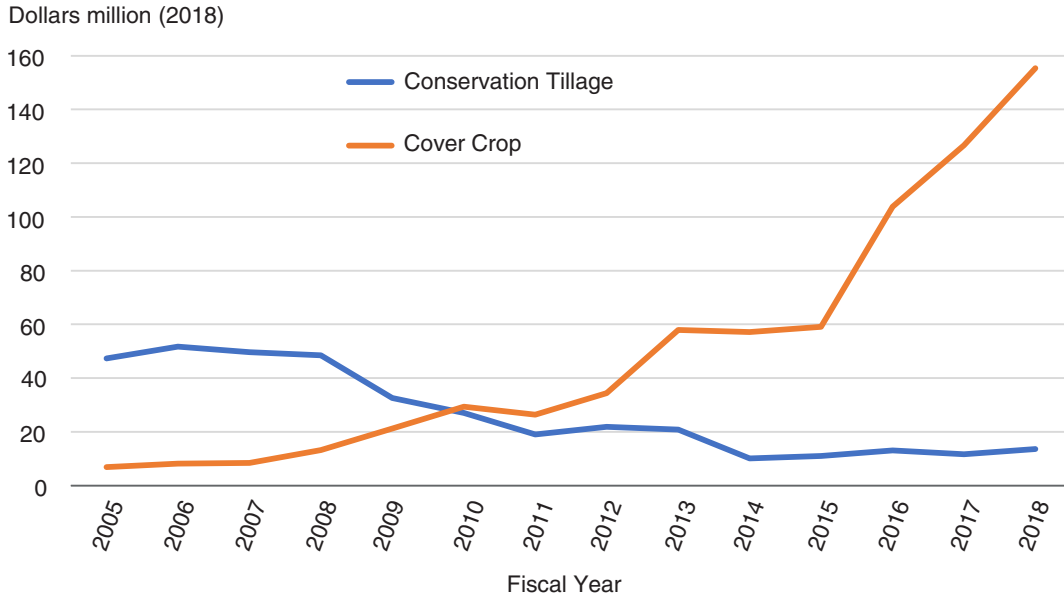
Cover crops are considered an annual practice in EQIP and can be included in an EQIP contract for a maximum of 5 years on the same field (USDA-NRCS, 2017b). Per-acre payment levels for cover crops through EQIP differ by region, in part due to variation in the costs of implementing the practice (USDA-NRCS, 2018a). In FY 2017, the median per-acre payment at the State level for the cover crop practice ranged from \$62.33 (Illinois) to \$92.27 (Delaware). Payment rates for cover crops in EQIP vary according to whether a single crop or multiple crop mix is planted, may differ in organic production systems, and can be higher if the farmer is a member of a historically underserved producer group.³

There is a significant upward trend in total funding going toward cover crops through both EQIP and CSP. During the past 14 years, USDA funding for cover crops through EQIP has increased—both in absolute terms and relative to other practices included in the programs such as no-till. Between 2005 and 2018, funding for cover crops through EQIP increased from about \$7 million to more than \$155 million (in 2018 dollars) (figure 4). During this same period, funding for no-till declined substantially.

³Historically underserved producer groups, as defined by the Agricultural Act of 2014, include Limited Resource Farmers, Socially Disadvantaged Farmers, Beginning Farmers and Ranchers, and Veteran Farmers (NRCS, 2014d).

Figure 4

Spending trends on conservation tillage and cover crops in EQIP



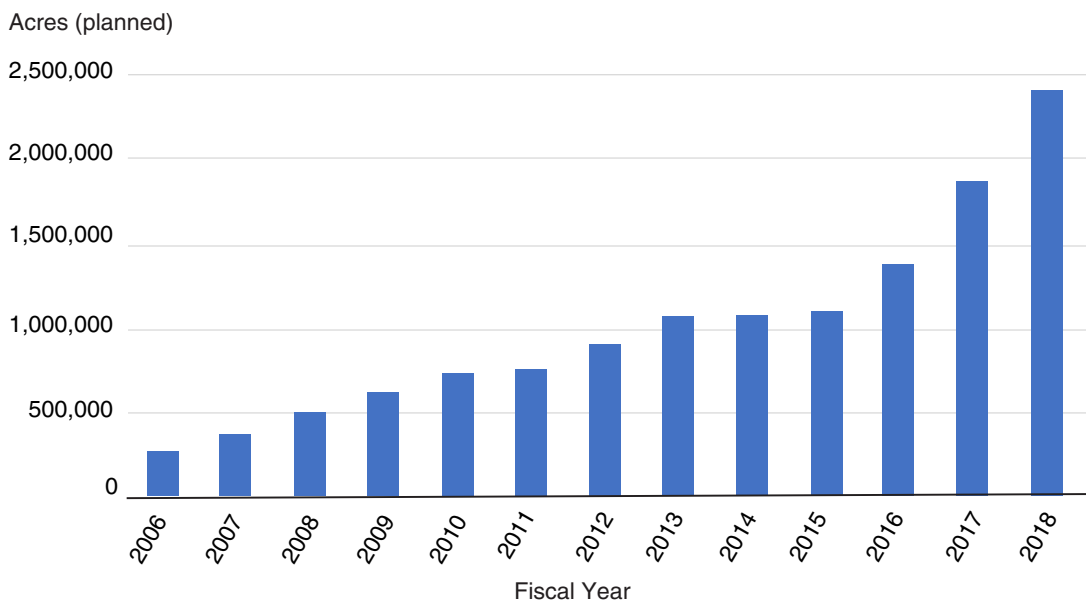
Note: Dollar figure is the total amount of funding obligated for financial assistance (“cost-share”) payments on the cover crop practice within EQIP contracts signed in each fiscal year. Adjustments for inflation are made with the Consumer Price Index.

Source: USDA, Economic Research Service analysis of USDA, Natural Resources Conservation Service ProTracts data on Environmental Quality Incentive Program (EQIP) obligations.

The growth in total financial assistance for cover crops reflects both an increase in the per-acre financial assistance payment for cover crops and the large increase in the total number of acres enrolled in the cover crop practice (figure 5). The analysis here reports total funding by the fiscal years in which

Figure 5

Cover crop acres enrolled in EQIP

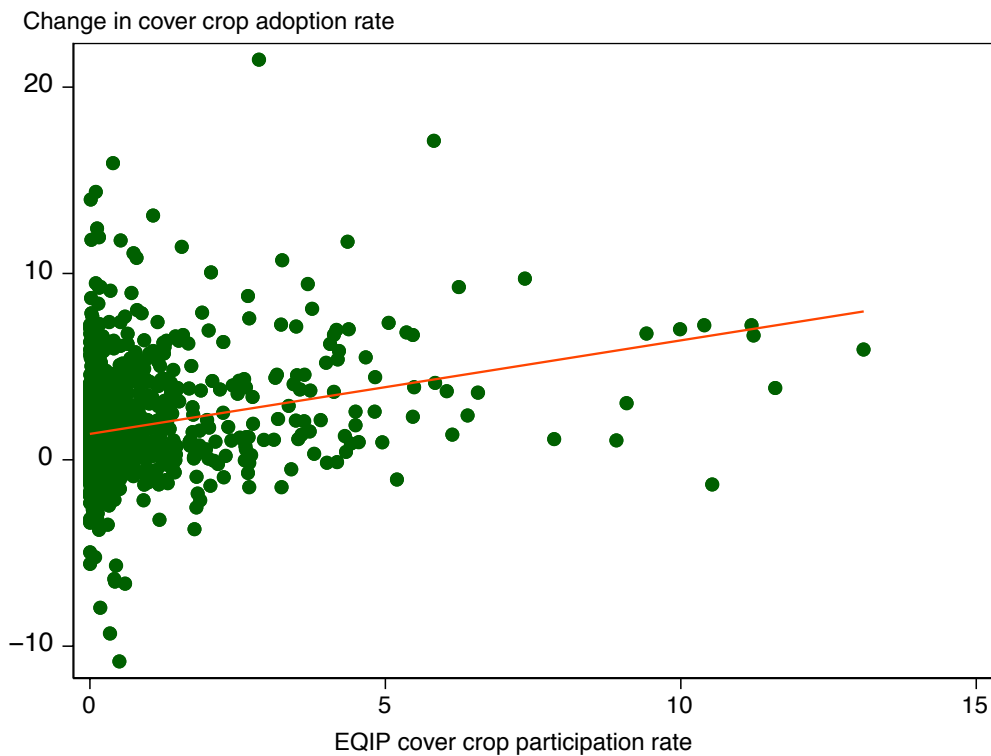


Source: USDA, Economic Research Service analysis of USDA, Natural Resources Conservation Service ProTracts data for the Environmental Quality Incentive Program.

contracts are initiated. However, many practices in a contract are planned to be implemented in subsequent years, at which point payments for the practices will be made. For this reason, the actual increase in cover crop acreage receiving financial assistance through EQIP lags slightly behind the increase in EQIP funding levels for cover crops. For example, total planned acreage for cover crops in 2018, about 2.4 million acres, reflects contracts from the 2018 fiscal year as well as from earlier fiscal years.

To examine how well the increase in EQIP funding explains the increase in cover crop adoption in the Census of Agriculture data, we estimate the correlation between the county-level change in adoption between 2012 and 2017 and the total planned acres of cover crop in EQIP for 2013 to 2017 by county. If EQIP financial assistance were the only driver of changes in cover crop adoption and all contracts resulted in new adoption, then we would expect to see a perfect (1-to-1) correlation between the share of acreage enrolled in EQIP cover crop practices and the change in the cover crop rate of adoption. On average, there is a positive correlation, and a 1-percentage-point enrollment of county-harvested cropland in EQIP is associated with a 0.5- percentage-point increase in cover crop adoption (figure 6). That this correlation is less than 1-to-1 is consistent with both the fact that not all farmers will continue

Figure 6
County-level changes in cover crops and EQIP participation



Note: Change in cover crop adoption is the difference between the share of harvested, non-alfalfa cropland with cover crops in 2017 and 2012. EQIP enrollment in cover crop practices is expressed as the share of harvested, non-alfalfa cropland enrolled for financial assistance on the cover crops (practice code 340) in at least 1 year from 2013. Enrollment acreage is the total number of acres based on planned year in the original contract and divided by 3 since most contracts specify 3 years of cover crops on the same fields. Only counties with at least 100,000 acres of harvested, non-alfalfa cropland are included in the chart because of the noisier adoption rates in the smaller counties. The predicted line is a simple linear fit to the displayed data with no weighting.

Source: USDA, Economic Research Service analysis of USDA, Natural Resources Conservation Service ProTracts data for the Environmental Quality Incentive Program (EQIP) and Census of Agriculture (2012 and 2017), USDA, National Agricultural Statistics Service.

the use of cover crops after an EQIP contract expires, and that some farmers receiving financial assistance would have adopted the cover crops without the payments (Claassen et al., 2018).

In addition, while this correlation is statistically significant, there is a lot of variation in cover crop adoption rates not explained by EQIP funding. This likely reflects the influence of other programs, weather, shifts in cash crop acreage, and perhaps other factors such as cover crop seed availability.

The Conservation Stewardship Program

While EQIP generally focuses on incentivizing new adoption of practices to address resource concerns and deliver environmental benefits, CSP seeks to incentivize enhanced conservation stewardship on farms that have the potential to achieve even higher levels of environmental benefits by implementing enhancements to existing practices (USDA-NRCS, 2016a). This means farmers who are already using cover crops (with or without financial assistance) might be eligible for CSP if they shift to enhanced cover crop systems, such as more diverse cover crop mixes or systems that promote specific ecosystem services or address additional resource concerns. Examples of eligible CSP enhancements involving cover cropping include the use of multi-species cover crops to improve soil health and increase soil organic matter.⁴ Cover crop enhancements can be used to address several resource concerns, including soil erosion, weed and pest pressure, soil health degradation (e.g., aggregate instability, soil organism habitat degradation, compaction, organic matter depletion), and water quality degradation (USDA-NRCS, 2018b).

Farmers enrolled in CSP sign a 5-year contract committing to engage in conservation activities (“practices, enhancements, and bundles of enhancements”) included in a whole-farm stewardship plan. In 2017, CSP shifted to a system with enhancement-based payment rates similar to the structure of EQIP. Under this system, the per-acre payment levels for CSP are generally lower than those for EQIP (table 1). In part, this reflects the fact that CSP payment rates are based only on the enhancement component of the activity—such as moving from a simple cover crop, which typically would be required to meet eligibility for CSP, to a more complex cover crop—and these costs are lower than the costs of adopting cover crops for the first time.

Going further back into the history of the program, CSP payments are not itemized by activity during the timeframe covered by this report, so it is generally not possible to disaggregate CSP funds by specific activity. Therefore, the trends in cover crop funding under CSP cannot be charted in the same way as for EQIP. For CSP, the cover cropped acres are estimated as the total acres under contracts with at least one cover crop practice or enhancement receiving financial assistance. The total cover crop acreage receiving CSP payments increased from just over 350,000 acres in 2010 to more than 2 million acres in 2015. This growth in CSP acreage with cover crop practices or enhancements mirrors the shift toward cover crops in EQIP.

⁴For a full list of 2018 CSP enhancements, including enhancements that incorporate cover cropping, see USDA-NRCS, 2018b.

State Programs

In addition to Federal sources of funding to incentivize the adoption of cover crops, there are many State programs (AGREE, 2019). The seven largest and longest standing State programs enrolled about 1.4 million acres in 2017 (table 2). In combination with the 1.8 million acres planned for 2017 in EQIP (figure 5) and the approximately 2 million acres in CSP (table 1), this means that at least 5 million acres, a third of total cover crop acres, were receiving some form of financial assistance for cover crops in 2017. In addition to the 7 States listed in table 2, at least 17 other States or conservation districts within States have provided a per-acre incentive payment for cover crops.⁵

In terms of both total funded acreage and per-acre payment levels, Maryland has the largest program in the United States: In FY 2017, the Maryland program provided incentives on 639,710 acres and payments of more than \$20 million statewide. After Maryland, the next-largest programs were in Iowa and Virginia. In FY 2017, Iowa spent \$5 million to incentivize the planting of cover crops on 250,000 acres; in FY 2016, Virginia spent \$5.1 million to incentivize cover cropping on approximately 200,000 acres.

The requirements of these State programs vary widely; some substitute for Federal programs, while others are complementary to Federal financial assistance or are designed to make sure the farmer is receiving a 100 percent cost-share for using a cover crop practice. Some programs limit the total acreage a farm can enroll or the length of time a field can enroll. Others limit their programs to farmers who have never previously used cover crops. In Missouri, the Department of Natural Resources requires farmers participating in the cover crop cost-share program to provide initial soil samples to the University of Missouri Soil Health Assessment Center, and they are encouraged to complete a follow-up soil health test after 4 or 5 years of cover cropping (Missouri Department of Natural Resources, 2016).

In addition to per-acre payments to plant a cover crop, several other types of incentives or cover crop support also exist. Examples of other support include tax credits and programs that rent out or loan equipment related to cover cropping, such as no-till drills, cover crop inter-seeders, or roller crimpers. Pennsylvania has a tax credit program that gives farmers a 50-percent tax credit for eligible cover crop costs (such as equipment and cover crop seed) in their first year of cover cropping.⁶ The Scott Soil and Water Conservation District in Minnesota rents out no-till drills and inter-seeders (Scott Soil and Water Conservation District, 2017), and the Three Rivers Soil and Water Conservation District in Virginia rents out no-till drills and has a pilot project providing free use of a roller crimper to terminate cover crops (Three Rivers Soil and Water Conservation District, 2018). In the fall of 2017, the Iowa Department of Agriculture and Land Stewardship began a 3-year demonstration project offering farmers a \$5 per acre reduction on their crop insurance premium if they planted a cover crop in the fall and were not enrolled in other State or Federal cover crop programs (Iowa Department of Agriculture and Land Stewardship, 2017).

⁵Other States that offer either statewide or conservation district-level cover crop incentive programs include California, Georgia, Idaho, Illinois, Minnesota, New Jersey, New York, North Carolina, North Dakota, Pennsylvania, South Dakota, Tennessee, Vermont, West Virginia, and Wisconsin. Since a few programs allow participants to receive assistance from multiple sources, simply adding acreage across programs can lead to some double counting. However, such allowances are an exception to most programs and the total acreage receiving payments is consistent with reported acreage receiving assistance in ARMS.

⁶The 50-percent tax credit in Pennsylvania was capped at a maximum \$45 per acre in FY 2018 (Pennsylvania State Conservation Commission, 2016).

Table 1

Comparison of incentive payments for cover crops in USDA working lands conservation programs

Program	Practices or enhancement	Scope of program	Payment range in FY 2017
Environmental Quality Incentives Program (EQIP) 1997-present	Cover crop (basic, or with multiple species)	About 2.4 million acres planned in 2018	Median per-acre-payment from \$62.33 (Illinois) to \$92.27 (Delaware)
Conservation Stewardship Program (CSP) 2010-present	Various types of cover crops and management	More than 2 million acres in 2015	Median per-acre-payment from \$7.96 (Arizona) to \$14.65 (Wyoming).

Note: Per-acre median payment range for CSP enhancements represent the additional activity payment for a single cover crop enhancement, not the total amount of the farmer's per-acre CSP payment.

Source: USDA, Economic Research Service using USDA, Natural Resources Conservation Service (NRCS) online resources and NRCS ProTracts data.

Table 2

Summary of select State programs for cover crops

State (years active)	Program/ Implementing agency	Scope of program (acres)	Per-acre payment range (dollars)	Annual State spending (dollars)
Maryland (2009-present)	Agricultural Water Quality Cost-Share	639,710	30-75	22.5 million
Iowa (2013-present)	Department of Agriculture and Land Stewardship (IDALS)	250,000	15-25	5 million
Virginia (1998-present)	Virginia Department of Conservation and Recreation with funding from Water Quality Improvement Fund and real estate recordation fees	200,539 (2016)	15-33	5.1 million (2016)
Missouri (2015-present)	Department of Natural Resources	117,175	30-40	3.8 million
Delaware (at least 2011-present)	County conservation districts	85,438	30-50	
Ohio (2012-present)	Various, including Muskingum Watershed Conservancy Project, Ohio Department of Natural Resources, and Ohio Department of Agriculture	~50,000	12-40	~600,000
Indiana (2015-present)	Watersheds and county conservation districts with funding from Indiana State Department of Agriculture (ISDA) Clean Water Indiana Grants	18,278	Up to 20	307,385

Source: USDA, Economic Research Service, drawing from publicly available information on State websites and personal communication with staff at programs and implementing agencies.

Cover Crop Management

Field-level surveys reveal the many variations in how farmers manage cover crops, including the types of cover crops, the frequency of cover crop use, and the method of terminating growth of the cover crop to prepare for planting a cash crop. These cover crop management decisions can affect the success of the cover cropping, the cost of cover cropping, and strategies for managing cash crops on the field.

Crop Rotation

The crops preceding and following a cover crop can influence the decisions about cover crop selection and cover crop management. In most fields, cash crops are rotated to improve nutrient cycling, control pests, and improve soil health. For example, alternating corn and soybeans is a very common rotation. One challenge for farmers in managing cover crops is determining how to fit them into an existing rotation.

Since cash crop planting and harvesting occur at different times of the year, the sequence of cash crops planted can influence decisions about whether to use a cover crop and how that cover crop is managed. The earlier a spring cash crop is planted, the tighter the window to terminate the cover crop and prepare the soil for planting. Similarly, the later the cash crop is harvested, the shorter the window in the fall to plant the cover crop. For example, in major corn and soybean regions, soybeans are planted in late May and early June, while corn tends to be planted earlier—in late April and early May. On the other end of the season, corn-for-silage is harvested in September, while corn-for-grain is harvested in October and early November. Such differences in timing may affect the viability of planting cover crops before and after certain crops; later planting and earlier harvest of the cash crop both increase the length of the cover crop season and facilitate cover crop use.

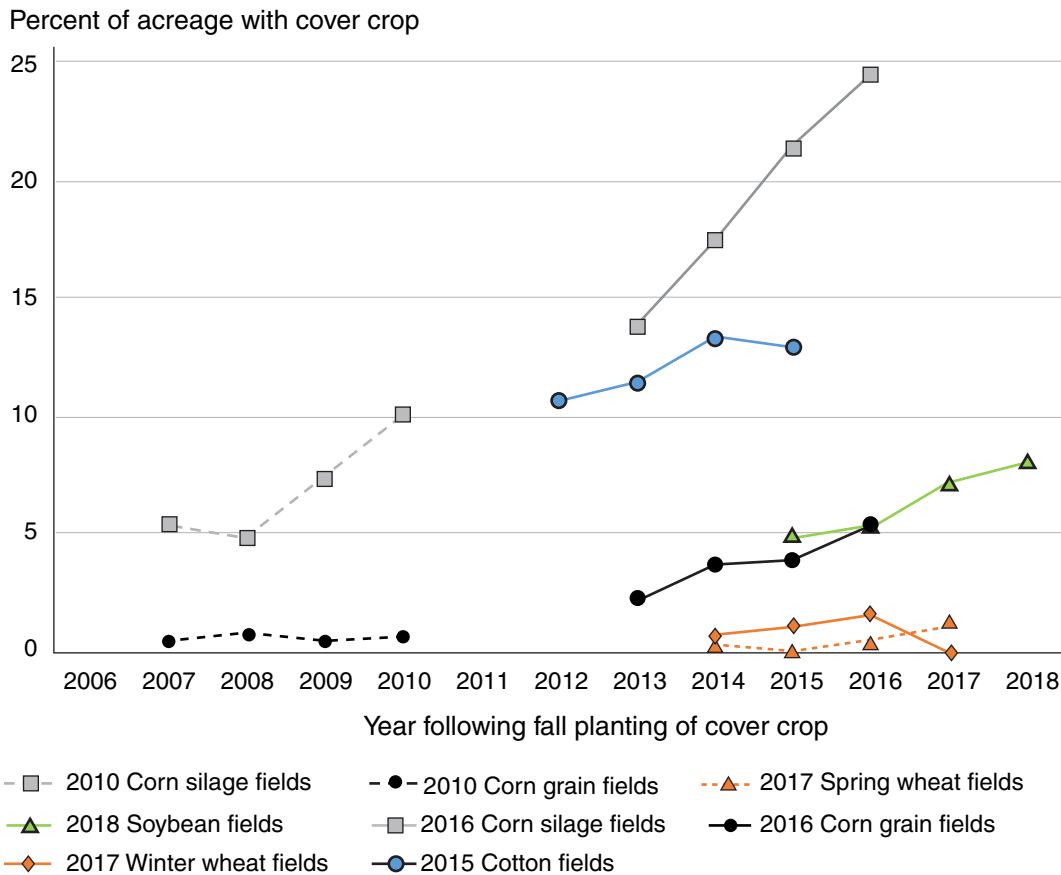
The benefits of cover crops depend upon the planned cash crops in the rotation. Legume cover crops, which increase available nitrogen, will be more beneficial to subsequent nitrogen feeding crops (e.g., corn) than to a legume crop (e.g., soybean). However, legume cover crops often take longer to produce biomass in the spring. In contrast, grasses or small grains work well to scavenge leftover nitrogen from the preceding crop. However, these high-residue cover crops have a high carbon-to-nitrogen ratio, which reduces the availability of nitrogen for the following cash crop (USDA-NRCS, 2011). In addition to their potential nutrient benefits, cover crops also increase residue on the soil surface, which can reduce erosion between cash crop seasons, contribute organic matter to the soil for long-term soil health, suppress weeds, and buffer soil temperature extremes. This residue can be especially beneficial following low-residue crops such as corn silage, cotton, and soybeans.

Cash Crops and Cover Crop Adoption Rates

To examine differences in cover crop adoption by rotation, we draw on commodity-specific field-level data from the Phase 2 Agricultural Resources Management Survey (ARMS). For this report, we use a sample of fields that were planted as corn in 2010 or 2016, cotton in 2015, wheat in 2017, or soybeans in 2018. For each survey year and targeted commodity, we also ask about 4 years of cropping history including cover crops.

The level of cover crop adoption varies considerably by the primary commodity (figure 7). In the fall preceding the survey year, cover crop adoption ranged from just over 5 percent of acreage on corn-for-grain (2016), to 8 percent on soybeans (2018), just under 13 percent on cotton (2015), and just under 25 percent on corn-for-silage (2016). Wheat has an adoption below 2 percent of acreage (2017) for the preceding fall on spring wheat and the previous year on winter wheat. Some fields, particularly those with winter wheat, have 4-year crop sequences that mix spring-planted and fall-planted cash crops in different years. In some cases, these include spring-planted rather than fall-planted cover crops. The statistics above look only at fall-planted cover crops since they are much more common, which is true even for the surveyed winter wheat fields.

Figure 7
Trends in fall cover crop adoption by related cash crop



Note: For each crop, the sampled fields are planted with the designated crop in the survey year and a mix of other crops in earlier years. The samples used to calculate these adoption percentages are restricted to fields that had a 4-and-a-half-year history of crops.

Source: USDA, Economic Research Service and USDA, National Agricultural Statistics Service; 2010, 2016, 2017, 2018 Agricultural Resource Management Surveys.

Cornfields harvested for silage differ from cornfields harvested for grain in three primary ways. First, and probably most importantly for cover crops, corn silage involves removing both the grain and stalks, thus leaving a low amount of residue in the field after harvest. Second, corn silage is used exclusively for feeding livestock, which may imply that farmers growing corn silage are capitalizing on the opportunity to grow cover crops for both the soil health and the grazing or forage benefits. Third, corn silage is harvested much earlier than corn-for-grain, allowing for more time to plant cover crops in the fall.

Like corn for silage, cotton is also a low-residue crop. In addition, cotton is the dominant crop in the rotation with non-cotton crops rotated in every 3 to 4 years. Because of the prevalence of low-residue crops in these fields, cover crops provide an opportunity for cotton farmers to increase residue. This may reflect the common practice of growing cotton following a winter cover crop such as winter wheat so that the stalks protect the cotton seedlings from early spring winds.

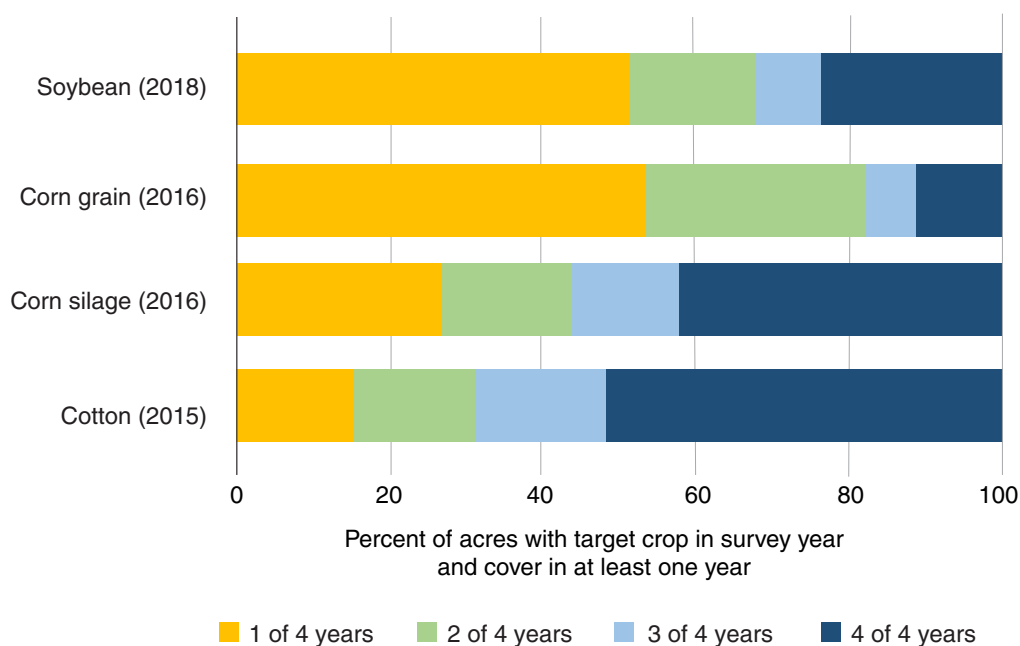
The trends evident in these field-level surveys largely mirror the national trends revealed in the Census of Agriculture data; however, there are important differences between the crops. The differences between the 2010 corn survey and the 2016 corn survey track the year-by-year trends within the different fields captured by each of those surveys. The soybean and corn-for-grain trends largely overlap, reflecting the fact that a random survey of cornfields and a random survey of soybean fields will capture similar fields given the prevalence of a 2-year rotation of corn-for-grain and soybeans. The trend within fields for 2016 corn-for-silage fields is much steeper than any of the other crops.

Frequency of adoption

Some of the benefits of cover crops, particularly the accumulation of soil organic matter, require frequent or sustained adoption. The ARMS data on crop history provide detail on the frequency with which cover crops are adopted (figure 8). With the upward trend in adoption, these numbers are impacted by new adopters, so fields that are adopting cover crops in only 1 or 2 years out of the 4 years will be more common than they would be if cover crop adoption were stable.

Figure 8

Frequency of cover crops within 4-year crop sequences



Note: For each surveyed commodity, fields with a full 4 years of reported cropping history and at least 1 year with a cover crop are included. Percentages are weighted to reflect the share of total planted acreage for the targeted commodity. Of acres with a cover crop planted in at least 1 of the last 4 years, 16 percent of 2015 cotton acres, 27 percent of 2016 corn silage acreage, 53 percent of 2016 corn grain acres, and 52 percent of soybean acres planted a cover crop. The share of adoption in all 4 years also varies across crops with 52 percent of 2015 cotton, 42 percent of 2016 corn silage, 11 percent of 2016 corn grain, and 24 percent of 2018 soybean acres.

Source: USDA, Economic Research Service and USDA, National Agricultural Statistics Service, 2015 (cotton), 2016 (corn), and 2018 (soybeans), Agricultural Resource Management Survey.

Looking at the subpopulation of fields with cover crops in at least 1 of 4 years, sustained cover cropping over the 4-year history, which we define as 3 or 4 years of adoption, occurs on 19 percent of (2016) corn-for-grain acres, 56 percent of (2016) corn-for-silage acres, 69 percent of (2015) cotton acres, and 32 percent of (2018) soybean acres. Given the similar trajectories for corn-for-grain and soybeans, the greater sustained adoption among soybean acreage may have more to do with the later timing of the soybean survey (2018) relative to the corn survey (2016).

A closer look at the fields with only 1 or 2 years of adoption reveals that many of these appear to be farmed by new adopters. Half of the corn-for-grain acres (2016) using a cover crop in 2016 had not used a cover crop in the previous 3 years. On corn-for-silage fields that used cover crops in 1 or 2 out of every 4 years, many (79 percent) had not used cover crops at all in 2013 or 2014. On just over half of soybean fields (52 percent), cover crops were used only once in the 4 years preceding the survey.

We find mixed evidence on whether the frequency of cover crop adoption is related to the specific crops grown within a 4-year rotation. On corn-for-grain (2016) fields, the frequency of cover crop adoption in the prior years is not statistically different for different spring crops. In contrast, on corn-for-silage fields, patterns of cover crop usage were correlated with crops in the rotation. When corn-for-silage was rotated with soybeans and cover crops, cover crops were used on average about half the time (47 percent). However, when corn-for-silage was grown every spring and rotated with cover crops, cover crops were used almost all the time (92 percent). These patterns of usage suggest a strong link between growing corn-for-silage and cover crop usage. A similar relationship holds for cotton; rotations that planted cotton more often used cover crops.

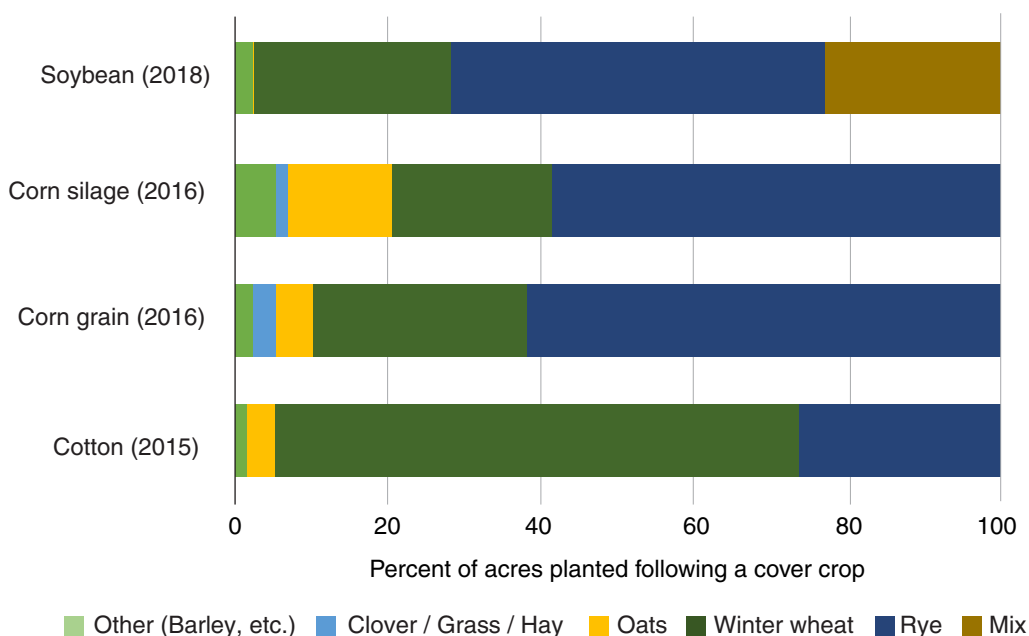
Type of Cover Crop

When planting cover crops, farmers have a myriad of choices for the type of cover crop to plant. The choice of cover crop typically depends on its purpose as well as its limitations because of harvesting and planting dates of the cash crops in the crop rotation. If the cover crop is harvested for forage or grazed, farmers may choose a cover crop that provides abundant and nutritious forage. If the purpose of planting the cover crop is to build soil organic matter, then the farmer may choose a high-residue cover crop. The farmer may also be using the cover crop to reduce erosion or provide nutrients to the succeeding cash crop. The costs of the cover crop are also a consideration. In corn, cotton, and soybeans—the crops for which we have a statistically reliable sample of the type of cover crops—small grains are planted most often preceding these spring crops (figure 9). Small grains are used as a cover crop in corn most of the time (94 percent). Rye, which in the earlier years of the ARMS questionnaire included both cereal rye and annual ryegrass, is used before corn more than twice as often as winter wheat, regardless of whether the corn was harvested for grain or silage. Rye is also commonly used in soybeans. In contrast, winter wheat is used most often as a cover crop on cotton acres. In 2018, for the first time, the field-level ARMS asked farmers about the use of a cover crop mix and found that just under a quarter of soybean fields with cover crops were planted with a cover crop mix.

One important consideration when choosing a cover crop is the cost of the seed. In corn, cotton, and soybeans, the average cover crop seed costs (table 3) did not differ statistically by the type of seed (i.e., winter wheat, rye, oats, mixed, or other). Seed costs for these cover crops were also similar to seed costs for cash crops as captured in other USDA surveys (USDA-ERS, 2019).

Figure 9

Type of cover crop planted in the fall before the cash crop



Note: The 2015 and 2016 ARMS did not ask farmers about the use of a cover crop mix.

Source: USDA, Economic Research Service and USDA, National Agricultural Statistics Service, 2015 (cotton), 2016 (corn), and 2018 (soybeans) Agricultural Resource Management Survey (ARMS).

Cover Crop Termination

Farmers who use cover crops must plant either a cover crop killed by cold (e.g., “winter kill” cover crops such as oats or radishes) or terminate (kill) their cover crop so that it does not compete with their cash crop. This could include terminating the cover crop after the cash crop is planted (i.e., planting green). Farmers have four main ways to terminate a cover crop: mechanical (i.e., tillage, mowing, or rolling); chemical (i.e., herbicides); livestock (i.e., grazing); or harvest (i.e., forage). The choice of method will depend on the purpose of the cover crop, type of cover crop, need for livestock forage, seedbed preparation needs of the cash crop, and the need to minimize tillage in the field.

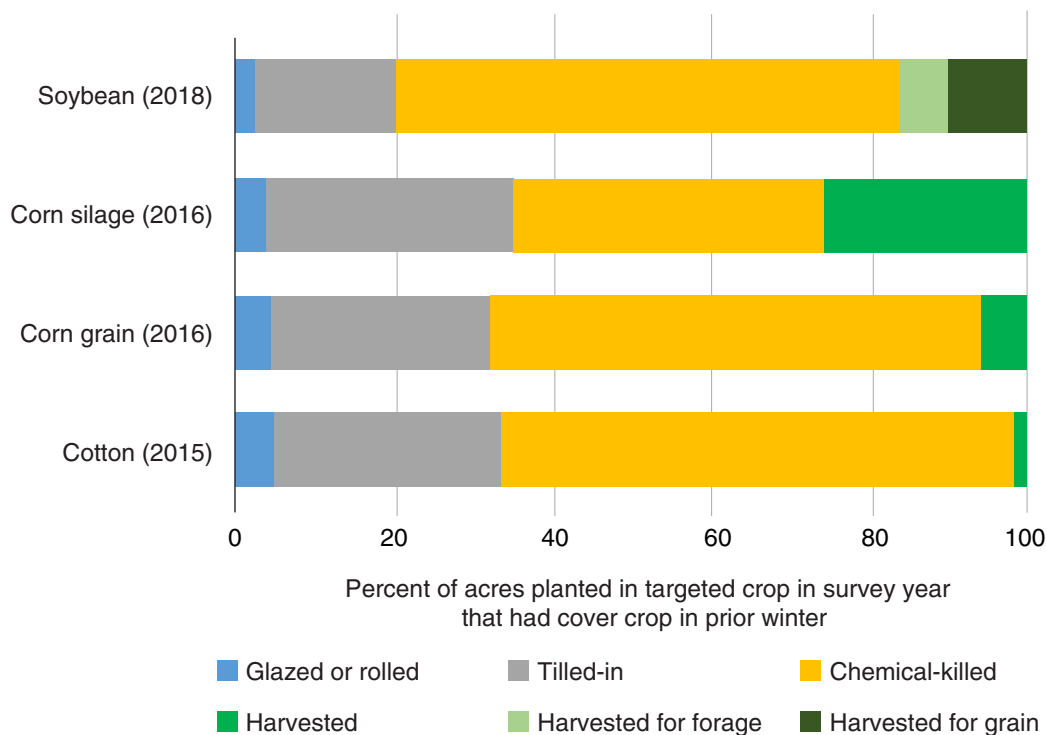
In soybean, corn-for-grain, and cotton fields, chemical termination was used on almost two-thirds of the acreage (figure 10). Tillage was also a common termination method, used on about 30 percent of the acreage surveyed. Termination methods on corn-for-silage fields are somewhat different. Corn silage growers report termination through harvest on more than 25 percent of acres. They are less likely to use herbicide for termination and more likely to use tillage.

Harvesting is a common termination method for cover crops in soybeans and corn-for-silage. According to the USDA, NRCS practice standard, a farmer can harvest a cover crop for forage but not for grain. If a farmer harvests a winter crop for grain, then the field is double-cropped. In about 10 percent of the soybean fields in 2018, farmers self-reported planting cover crops and harvesting that cover crop for grain. This is about 550,000 acres of self-reported cover crops in soybeans that appear to be double cropping. Most of this acreage (84 percent) is winter wheat followed by soybeans and is found only in States that typically double crop (i.e., Kentucky, North Carolina, South Carolina, Tennessee, and Virginia). As noted above, the distinction between cover crops and

double cropping is based on the intended use of the cover crop. The expansion of survey questions to include information about harvesting for grain and termination through grazing reveals that, given the multiple uses and purposes of cover crops, national statistics on cover crop adoption necessarily include some fields that might not meet practice standard definitions of cover crops.

Figure 10

Cover crop termination method



Note: The grazed and rolled categories are combined because, for some crops, the number of positive responses is too low to report individually. Soybeans (2018) was the first year the survey asked separately about harvesting for forage and harvesting for grain.

Source: USDA, Economic Research Service and USDA, National Agricultural Statistics Service, 2015 (cotton), 2016 (corn), and soybean (2018) Agricultural Resource Management Survey.

Table 3

Cover crop seed costs on cotton, corn, and soybean fields, and commodity seed costs

	Cotton			Corn			Soybean			Commodity seed cost		
	2015			2016			2018			2015	2016	2018
	(Dollars per acre)			(Dollars per acre)			(Dollars per acre)			(Dollars per acre)		
Oats	20.48	±	7.05	11.09	±	4.30				20.65	19.54	19.08
Rye	16.22	±	6.55	14.26	±	2.03	16.27	±	5.96			
Winter wheat	14.22	±	2.76	12.79	±	5.01	27.38	±	7.68	16.12	15.26	15.08
Mix							21.99	±	11.09			
Other	D			14.51	±	4.97	26.12	±	14.51			

Note: "D" indicates a disclosure limitation. The estimate cannot be reported due to sample size limitations.

Source: USDA, Economic Research Service and USDA, National Agricultural Statistics Service, 2015 (cotton), 2016 (corn), and 2018 (soybeans) Agricultural Resource Management Survey; USDA, Economic Research Service, Commodity Costs and Returns.

Conservation Rotation, Tillage, and Nutrient Management

While cover crops can help conserve soil, keep nutrients in place for the next cash crop, and promote improved soil health, these benefits may be more fully realized when cover crops are used in conjunction with other practices. We consider conservation crop rotation, several forms of conservation tillage, manure and compost applications, as well as testing for soil organic matter, nitrogen, and phosphorous. The exact mix of practices that is optimal on any given farm will depend on the climate, ecosystem, soil, and other factors (USDA, 2018a).

ARMS data for corn (2016), cotton (2015), and soybean (2018) provide evidence that farmers who planted cover crops in the fall before planting these crops are more likely than other farmers to use other conservation practices along with cover crops. The descriptive analysis presented here suggests cover crop users might be adopting a suite of practices to promote soil health or that they believe the benefits of these practices are greater when used together (i.e., that cover crops complement other practices).

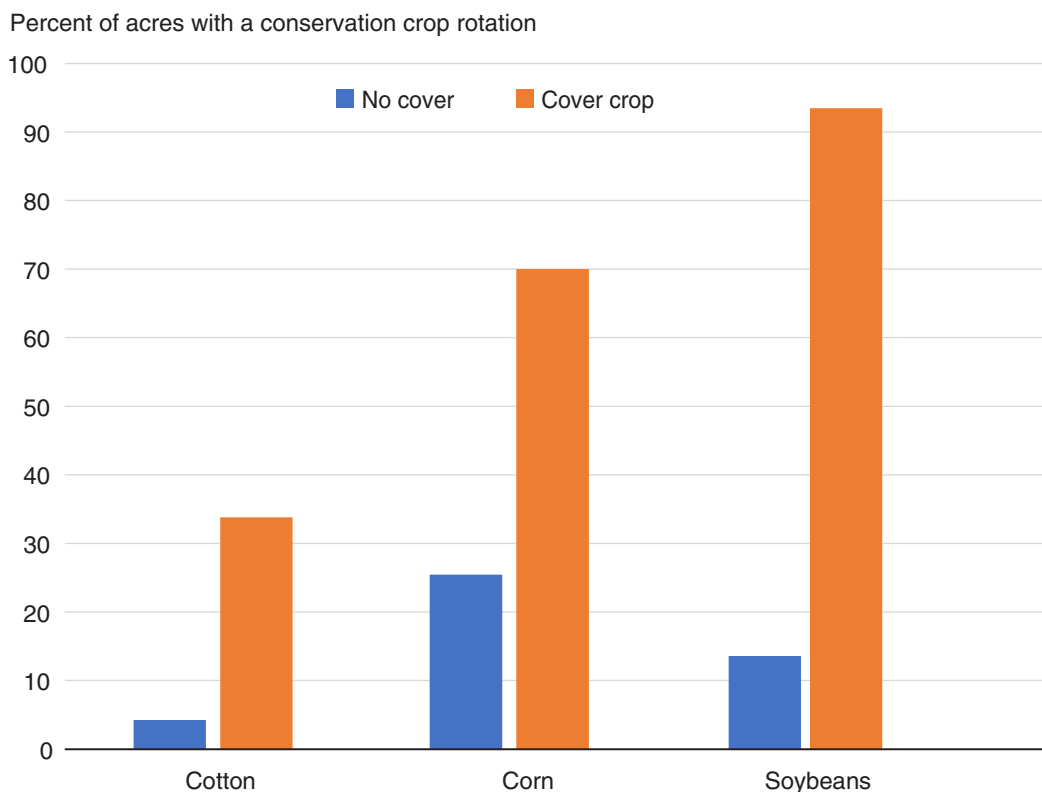
Conservation crop rotation is growing a planned sequence of various crops on the same piece of land for a variety of conservation purposes including soil erosion control, soil health, and others (USDA-NRCS, 2014f). In terms of soil health management principles, conservation rotations can help ensure soil cover and promote crop diversity (USDA-NRCS, 2017a). While crop rotation is common in the United States, not all rotations are conservation rotations. We use a definition of a conservation rotation based on four criteria:⁷ (1) an average residue rating greater than 1.5; (2) inclusion of more than one crop; (3) including a low-nitrogen-demand crop; (4) and at least 1 crop with residue rating greater than or equal to 2. The average residue rating is the sum of residue ratings for individual crops in the conservation rotation divided by the number of years in the rotation. For each crop in the crop history, we assign an annual residue rating obtained from NRCS. Residue ratings range from 0.25 to 4.0 for each crop. Very high-residue perennial crops (e.g., alfalfa and grasses) have a residue rating of 4. High-residue annual crops (e.g., corn, wheat, sorghum, and barley) have a residue rating of 2. Low-residue annual crops (e.g., soybeans and cotton) have a residue rating of 1. Extremely low-residue rotations typically involve the harvesting of nearly all biomass, such as in corn silage rotations. To examine conservation rotations, we used all 4 years of cropping information available in the field-level ARMS, while acknowledging that not all crop rotations fit neatly into a 4-year timeframe.

Cropping systems that include cover crops are, in fact, more likely to be in conservation rotations because cover crops help satisfy residue and crop diversity requirements (figure 11). For example, a simple corn and soybean rotation would not meet the definition of a conservation rotation, but a corn and soybean rotation with winter cover crops would meet the definition. For corn (2016), 70 percent of acres preceded by a cover crop were in a conservation rotation; for cornfields not preceded by a cover crop, only 26 percent of acres were in a conservation rotation. For cotton (2015), 34 percent of acres preceded by a cover crop were in a conservation rotation; only 4 percent of cotton not preceded by a cover crop was in a conservation rotation. For soybeans (2018), 94 percent of acres preceded by a cover crop were cropped in a way that met the definition of a conservation rotation, compared

⁷These criteria are designed to be consistent with characterizations of conservation crop rotations used in the Conservation Effects Assessment Project (CEAP) carried out by USDA's Natural Resources Conservation Service (NRCS) (Norfleet, 2018).

Figure 11

Adoption of conservation rotations with and without cover crops



Note: Acres adopting cover crops are based on whether the selected fields had a cover crop on the field in the survey year.

Source: USDA, Economic Research Service and USDA, National Agricultural Statistics Service, 2015 (cotton), 2016 (corn), and 2018 (soybean) Agricultural Resource Management Survey.

to only 13 percent of acres on fields without a preceding cover crop. The association between cover crops and the use of conservation rotations in corn and cotton is more limited than for soybeans because corn and cotton fields do not always include a legume or other crop with low-nitrogen fertilizer demands.

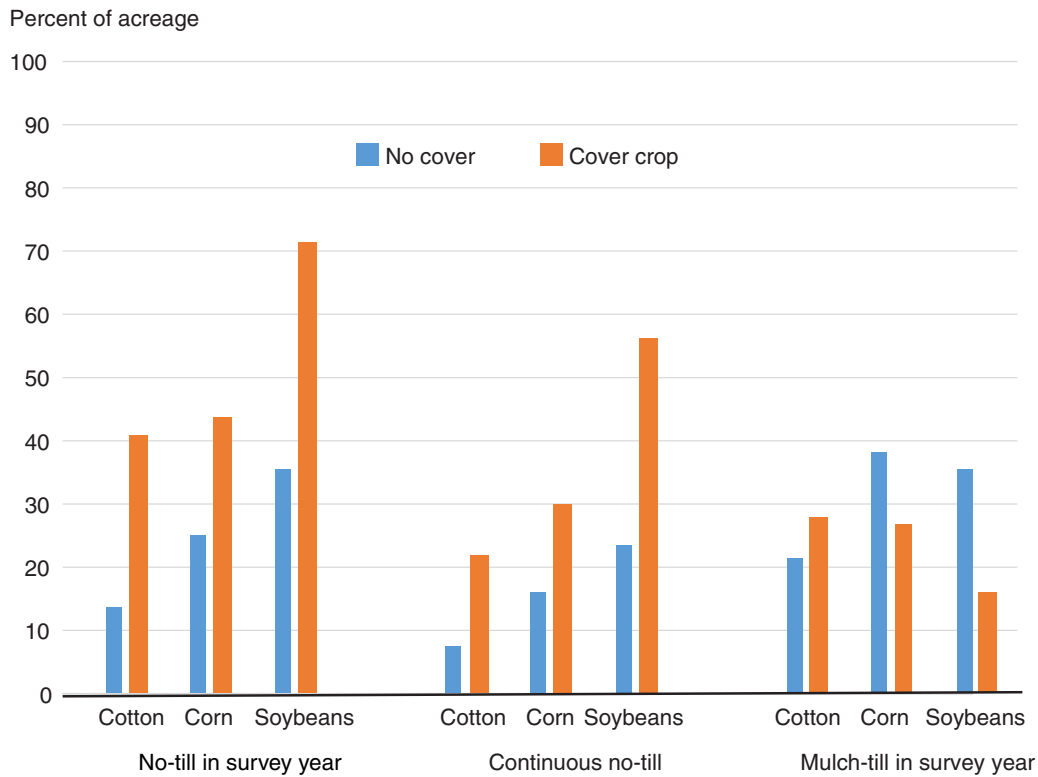
No-till can help minimize physical soil disturbance (including soil compaction), particularly when farmers use no-till continuously over time. Farmers who reported using a cover crop in the fall before planting were also more likely to use no-till in corn (43 percent versus 26 percent), cotton (41 percent versus 14 percent), and soybeans (72 percent versus 36 percent) (figure 12). Continuous no-till (no-till in the survey year and on all crops in the crop history—a total of 4 years)—is less frequent. In 2016, for example, 27 percent of corn was in no-till, but less than 20 percent of surveyed fields had been in no-till continuously for more than 4 years (Claassen et al., 2018). No-till is often rotated with other tillage practices and is frequently based on the crop grown in any given year (e.g., no-till is more likely in soybeans than in corn) (Wade et al., 2015). Land with a cover crop in 2015 was also more likely to have been in no-till continuously over the full 4-year crop history compared to fields without cover crops (30 percent versus 17 percent in corn; 21 percent versus 8 percent in cotton; and 57 percent versus 24 percent for soybeans). Differences in mulch till⁸ adoption rates

⁸Mulch till involves full-width tillage that is limited so that the Soil Tillage Intensity Rating (STIR) is 80 or less. What we define as “mulch tillage” is similar to “reduced tillage” in the most recent Natural Resources Conservation Service (NRCS) practice standards (USDA NRCS).

between cover crop and non-cover crop fields were not statistically significant in corn or cotton; soybean farmers who reported cover crops were less likely than all other farmers—non-cover crop soybeans as well as cotton and cornfields regardless of cover crop use—to use mulch till.

Figure 12

Adoption of selected tillage practices with and without cover crops

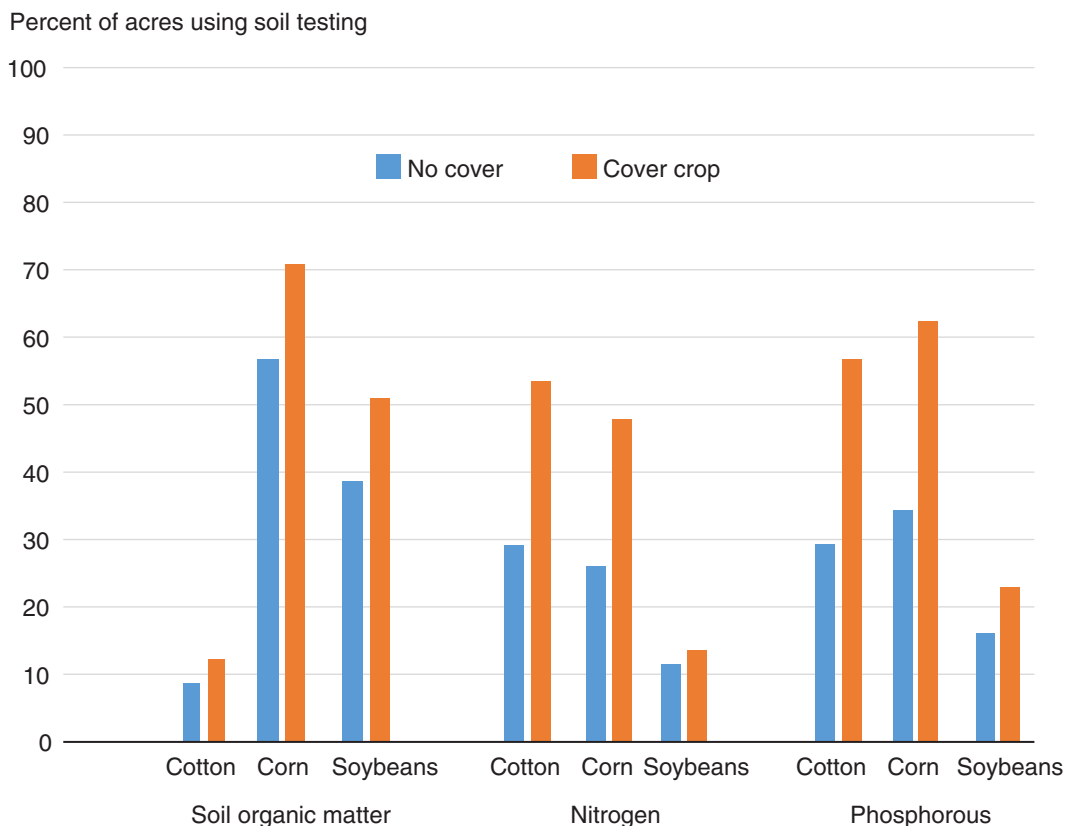


Note: Acres adopting cover crops are based on whether the selected fields had a cover crop on the field in the survey year.

Source: USDA, Economic Research Service and USDA, National Agricultural Statistics Service, 2015 (cotton), 2016 (corn), and 2018 (soybean) Agricultural Resource Management Survey.

Nutrient management is also important when applying soil health principles. This is one reason that USDA working lands programs sometimes provide financial assistance for soil testing. Adjustments to nutrient management strategies may be needed to account for changes in the availability of nitrogen from increased use of legumes (as cover crops or part of conservation rotations), higher levels of crop residue, reduced tillage, and the amount of nitrogen mineralized from soil organic matter (Kabir, 2018; Geisseler et al., 2018). Nitrogen may also be tied up in the residue of small grain cover crops during the early part of the season, a situation that could require additional fertilizer early in the growing season for some crops. Corn farmers who planted a fall cover crop were more likely than other corn farmers to have performed a soil nitrogen test within 2 years (48 percent versus 26 percent), a soil phosphorous test within 2 years (62 percent versus 35 percent), or a soil organic matter test within 10 years (71 percent versus 58 percent) (figure 13). For cotton preceded by a cover crop, soil testing is more likely for both nitrogen (54 percent versus 29 percent) and phosphorous (57 percent versus 30 percent). On soybean fields, there is no difference in the frequency of soil nitrogen testing, but fields with cover crops were more likely to be tested for soil organic matter (52 percent versus 39 percent) and soil phosphorous (24 percent versus 17 percent).

Figure 13
Use of soil testing with and without cover crops



Note: Acres adopting cover crops are based on whether the selected fields had a cover crop on the field in the survey year
 Source: USDA, Economic Research Service and USDA, National Agricultural Statistics Service, 2015 (cotton), 2016 (corn), and 2018 (soybean) Agricultural Resource Management Survey.

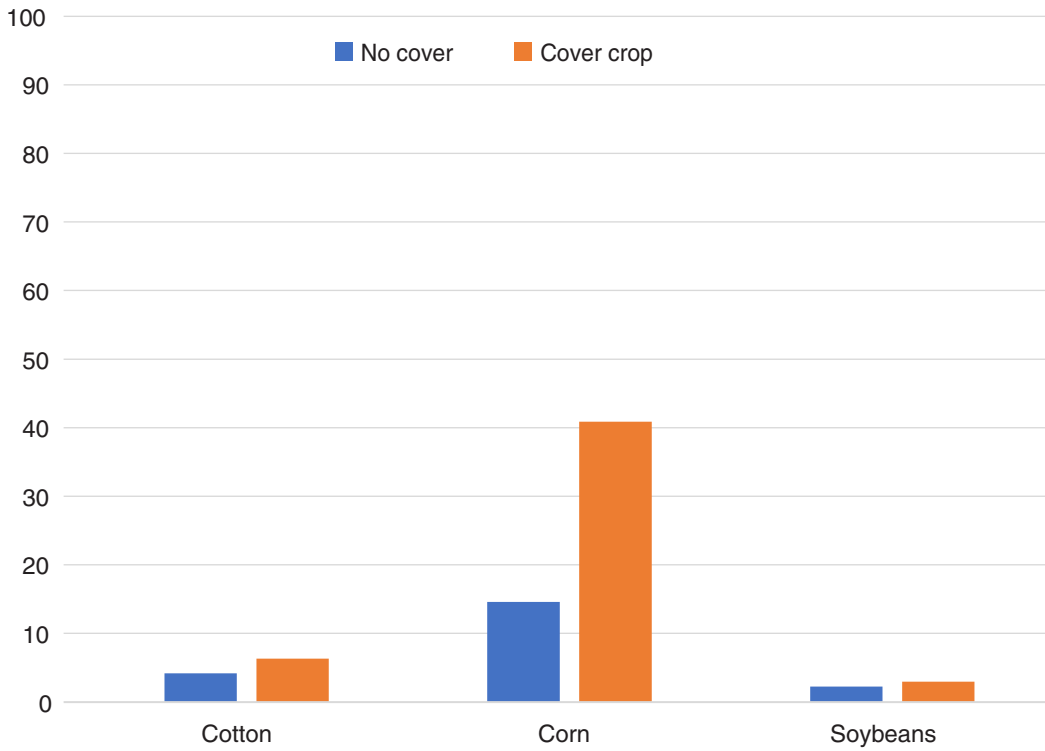
Manure and composted manure are soil amendments that have been shown to increase soil organic matter, soil microbial activity, and improve soil physical properties (e.g., water holding capacity) when applied consistently at agronomic rates (Haynes and Naidu, 1998). Corn farmers who planted a cover crop were more likely to apply manure or compost compared to other farmers (41 percent versus 15 percent) (figure 14). On cotton and soybean fields, the data suggest there is no statistically significant difference in the frequency of manure or compost application or soil organic matter testing on cover crop and non-cover crop fields. Compared to corn, a relatively small portion of land in cotton (4 percent of acres without cover crops) and soybeans (2 percent of acres without cover crops) receive manure.

Our descriptive analysis suggests that cover crop users also are more likely than other farmers to engage in other soil health-related conservation practices. However, since cover crop adoption is still quite modest, the use of management systems that include cover crops as well as other soil health practices is occurring on only a limited number of acres.

Figure 14

Application of manure or compost with and without cover crops

Percent of acres applying manure or compost



Note: Acres adopting cover crops are based on whether the selected fields had a cover crop on the field in the survey year.

Source: USDA, Economic Research Service and USDA, National Agricultural Statistics Service, 2015 (cotton), 2016 (corn), and 2018 (soybean) Agricultural Resource Management Survey.

Conclusions

In 2017, farmers in the United States planted an estimated 15.4 million acres of cover crops. This area is larger than the area planted to spring wheat, cotton, sorghum, or rice. The recent growth in cover crop acreage has been rapid, with cover crop acreage increasing 50 percent between 2012 and 2017. Corn-for-grain and soybean fields accounted for most of this growth in acreage. However, corn-for-silage and cotton fields had the highest adoption rates. Compared to practices such as no-till, overall adoption rates remain low with only about 5 percent of cropland using a cover crop in 2017.

Some of the growth in cover crop acreage is due to Federal and State conservation programs that pay farmers to plant cover crops. In 2015, more than 3 million acres received a cover crop payment from either CSP or EQIP. In EQIP alone, funding for cover crops has increased by nearly \$150 million (2018 dollars) between 2005 and 2018. In addition to the Federal programs, at least 22 States also had cover crop programs of their own. The largest of these are the Maryland and Iowa programs with approximately 640,000 acres and 250,000 acres in 2017, respectively.

In the spring, most cover crop farmers commonly terminate their cover crops using chemicals. On corn-for-silage fields, using chemicals for termination is less common than on fields in corn-for-grain, soybeans, and cotton. Harvesting of cover crops is also practiced on more than 25 percent of corn-for-silage acreage.

Managing for soil conservation and soil health requires more than just the use of cover crops. Conservation tillage, conservation crop rotations, and nutrient management are among the practices that can make up a soil-health-focused management system. In corn, soybean, and cotton fields that used cover crops, no-till, including continuous no-till, is more common than it is on fields without cover crops. The use of manure or compost is also more common on cornfields with cover crops than those without. Cover crop fields are also more likely to be testing for soil organic matter and nutrients (with the exception of soil organic matter on cotton fields).

While this report provides a number of insights, future cycles of the ARMS will be able to provide additional information about cover crop trends and management in U.S. field crops as cover crops become a more common practice. Of particular interest will be the impact of Government programs on adoption, the impact of cover crops on production practices (e.g., nutrient management), and the impact of cover crops on soil health and yields.

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