USDA Economic Research Service
U.S. DEPARTMENT OF AGRICULTURE

Economic Research Service

Economic Information Bulletin Number 270

March 2024

Farmland Rental and Conservation Practice Adoption

J. Wesley Burnett, Daniel Szmurlo, and Scott Callahan

Economic Research Service
U.S. DEPARTMENT OF AGRICULTURE

Economic Research Service
www.ers.usda.gov

Recommended citation format for this publication:

Burnett, J. W., Szmurlo, D., and Callahan, S., (2024). *Farmland rental and conservation practice adoption* (Report No. EIB-270). U.S. Department of Agriculture, Economic Research Service.

Cover photos from USDA Flickr and Adobe Stock.

To ensure the quality of its research reports and satisfy governmentwide standards, ERS requires that all research reports with substantively new material be reviewed by qualified technical research peers. This technical peer review process, coordinated by ERS' Peer Review Coordinating Council, allows experts who possess the technical background, perspective, and expertise to provide an objective and meaningful assessment of the output's substantive content and clarity of communication during the publication's review.

USDA Economic Research Service
U.S. DEPARTMENT OF AGRICULTURE

Economic Research Service

Economic Information Bulletin Number 270

March 2024

Farmland Rental and Conservation Practice Adoption

J. Wesley Burnett, Daniel Szmurlo, and Scott Callahan

Abstract

This report explores patterns across cropland owner-operators and cropland renters in the adoption of conservation tillage, cover cropping, and six permanent structural practices (riparian buffers, field borders, filter strips, terraces, grass waterways, and contour farming). Data from the Agricultural Resource Management Survey (ARMS) (2011–2021) on corn, soybeans, cotton, barley, and sorghum growers show little evidence of systemic differences in conservation practice adoption on owner-operated fields compared to cash-rented fields. Differences between owner-operated plots and share-rented plots persist for certain practices and regions of the United States. The report also examines how the institutional factors surrounding farmland rental markets challenge the notion that land renters are inclined to exploit long-term soil quality for short-term profits.

Keywords: land tenure, conservation behavior and practice adoption, cropland tenancy, rental agreement, ARMS, TOTAL survey

Acknowledgments

The authors thank associate professor Jennifer Ifft of the Department of Agricultural Economics, Kansas State University for early discussions and analyses and research agricultural economists Maria Bowman, Steven Wallander, Ben Gramig, and Andrew Rosenberg of the U.S. Department of Agriculture (USDA), Economic Research Service (ERS) for advice and insights. Thanks also to Mark Peters from the USDA, Farm Production and Conservation Business Center for review, and Jeff Chaltas, Jana Goldman, and Adele Wilcoxen of USDA, ERS for editing and designing the report.

About the Authors

Wesley Burnett, Daniel Szmurlo, and Scott Callahan are research economists, USDA, Economic Research Service.

Contents

USDA Economic Research Service
U.S. DEPARTMENT OF AGRICULTURE

A report summary from the Economic Research Service *March 2024*

Farmland Rental and Conservation Practice Adoption

J. Wesley Burnett, Daniel Szmurlo, and Scott Callahan

What Is the Issue?

The renting of farmland potentially affects access to agricultural production opportunities, land transfer across generations, and the maintenance of soil and water quality. Tenant farmers may operate farms differently than owner-operators, as a land lease may be modified, terminated, or not renewed before the benefits or consequences of a tenant's management choices are realized. Moreover, agricultural tenancy differs from other economic sectors due to the prevalence of informal lease contracts and nonarm's-length transactions (a purchase transaction in which there is a relationship or business affiliation between the seller and buyer of the property). Against this backdrop, this report examines the adoption of conservation practices across owner-operators and cropland tenants across several principal commodity types and years.

What Did the Study Find?

This report found the following key results regarding owner-operated versus cash- and share-rented cropland:

- Soil disturbance decreased over time for all five of the surveyed crops (corn, soybeans, cotton, barley, and sorghum), with very few statistically significant differences across land tenure groups at the national level.

Share- and cash-rented plots exhibited lower soil disturbance than owner-operated plots for corn growers in 2016, but the soil disturbance on owner-operated plots is similar to share- and cast-rent plots by the time corn is surveyed again in 2021.

Share-rented plots exhibited higher soil disturbance than owner-operated plots for cotton growers at the national level in 2019, with the differential driven by operators in the Southern Seaboard and Mississippi Portal.

- Share-rented plots trail owner-operated plots in cover crop adoption across several crops and years at the national level. This pattern is primarily driven by regions outside of the main regions of U.S. production.

Share-rented plots trail owner-operated plots across all surveyed crop years, with the difference being statistically significant at the 5-percent level for corn growers in 2016, soybean growers in 2018, and barley growers in 2019. When divided by USDA's Economic Research Service (ERS) Farm Resource Regions, these differences are not universally shared across regions and typically do not manifest in the regions of highest production for the surveyed crop.

- For all five surveyed crops, very few differences across land tenure groups are statistically significant for the adoption of structural practices.

For both on-field structural practices and off-field structural practices, share-rented and cash-rented plots are often at parity with owner-operated plots, with the exceptions being cash-rented plots for corn growers in 2021 (lower rates for on-field practices) and share-rented plots for soybean growers in 2018 (lower rates for off-field practices).

How Was the Study Conducted?

Results in this report are derived from the analysis of data collected from the 2011–21 Agricultural Resource Management Surveys (ARMS) and the 2014 Tenure, Ownership, and Transition of Agricultural Land (TOTAL) survey. The ARMS data include corn (2016, 2021), soybeans (2012, 2018), barley (2011, 2019), cotton (2015, 2019), and sorghum (2011, 2019). The ARMS is administered by the U.S. Department of Agriculture's Economic Research Service and the National Agricultural Statistics Service. The TOTAL survey is a follow-on component of the 2012 Census of Agriculture to collect data from the owners and operators of agricultural land.

Farmland Rental and Conservation Practice Adoption

Introduction

Conservation practices in agriculture, such as conservation tillage systems, cover crops, or filter strips, can produce notable on-farm and off-farm environmental benefits, including erosion control, nutrient management, and carbon sequestration. The motivations, determinants, and persistence of practice adoption are of interest to domestic agricultural policymakers. The U.S. Department of Agriculture (USDA) spends more than $5 billion per year on farm conservation programs to encourage practice adoption on working lands. The Department is particularly interested in identifying historically underserved producers for its conservation programs. These producers are often eligible for special provisions, including specific incentives, waivers, priorities, set asides, and other flexibilities (USDA, Natural Resources Conservation Service, 2023).

With land being a primary asset in crop production, the tenure status of the plots on which crops are cultivated is arguably a major component of an operator's decision to adopt conservation practices. Agricultural land is either owner-operated or rented under a variety of contract types (including cash rent and share rent).

This report builds on previous empirical studies that explored the relationship between cropland tenancy and conservation practice adoption.[1] Soule et al. (2000) examined conservation behavior for one crop (corn production) and 1 year (1996) of the Agricultural Resource Management Survey (ARMS). Using the same survey series, this report examines conservation behaviors across several years and field crops. The results suggest that the adoption of conservation tillage systems and structural practices do not differ systematically between cash-rented, share-rented, and owner-operated plots at the national level. This report's results show that cover crop adoption does not differ statistically between cash-rented and owner-operated plots at the national level, but share-rented plots trail owner-operated plots in adoption for several of the surveyed crop years. Through further exploring these differentials across USDA's Economic Research Service (ERS) Farm Resource Regions, ERS researchers find the lower national cover crop adoption rate for share-rented plots is often driven by operators in regions outside of the main production regions for that particular crop. Using the 2014 Tenure, Ownership, and Transition of Agricultural Land (TOTAL) survey, this report examines several institutional factors that could explain the general parity between groups.

The conventional wisdom surrounding soil stewardship and farmland tenancy is as follows: Conservation practices exhibit various timelines in which the costs and (private) benefits of adoption are realized. If tenant turnover is high on a particular plot of land or the average tenancy duration is low enough, tenants may not be present on a plot when the negative or positive consequences of their management decisions are realized. Due to tenure uncertainty, a cropland renter may be less inclined to adopt conservation practices or otherwise engage in soil stewardship (Stevens, 2022). In other words, renters are generally motivated by the land's use value, whereas the landowner is motivated by the land's asset value. Thus, a tenant may not be incentivized to adopt costly investments that increase the land's asset value without also improving the tenant's use value (e.g., increasing yields or reducing yield variability).

[1] This report uses both the terms "cropland" and "farmland." Cropland is designated as lands in which crop commodities are cultivated. Farmland is a more generic designation that includes cropland, as well as grazing or pastureland, orchards, vineyards, farm woodlands, and other land uses. All the Agricultural Resource Management Survey (ARMS) (Phase II) data within this study apply to cropland, whereas Tenure, Ownership, and Transition of Agricultural Land (TOTAL) survey data apply to any lands used for agricultural purposes. Hence, the term cropland refers to ARMS data analyses, whereas the term farmland refers to TOTAL data analyses.

The norms and institutions of farmland renting provide an environment that could challenge, or exacerbate, the hypothesized effect of tenure uncertainty empirically. The agricultural industry has evolved considerably over the past several decades, yet the transaction costs associated with farming (including issues of monitoring, timeliness, and the uncertainty of weather) have contributed to the perpetuation of certain features, such as informal land contracting. Many agricultural land tenants have leases that are automatically renewed yearly without an explicit written contract. Knutson (1989) noted this informal process when the author stated, "It is a common scene in U.S. agriculture: A landowner and tenant talk for a few minutes over a cup of coffee, then shake hands to clinch a 1-year deal to rent a farm or piece of land. No fuss, no bother, no paperwork." The prevalence of informal or simple verbal contracts in the sector could be indicative of an accumulated trust between the landlord and tenant that suggests the tenant will not exploit the soil for short-term gain.

In addition, as indicated by the TOTAL survey in 2014, about 28 percent of farmland acres had been rented to tenants for more than 10 years (Bigelow et al., 2016). Thus, rental agreements can resemble land ownership such that renters may occupy a plot long enough and have enough certainty in their future tenure to consider long-term soil quality. Allen and Lueck (1992a) contended that the tenant effectively owns many of the land's attributes for the contract period. In addition, prior studies have shown how the power of enforcement through reputation in rural communities plays a role in shaping farmer behavior (Herzfeld & Jongeneel, 2012; Saak, 2012), which suggests that tenants will engage in land stewardship in the absence of landowner monitoring.

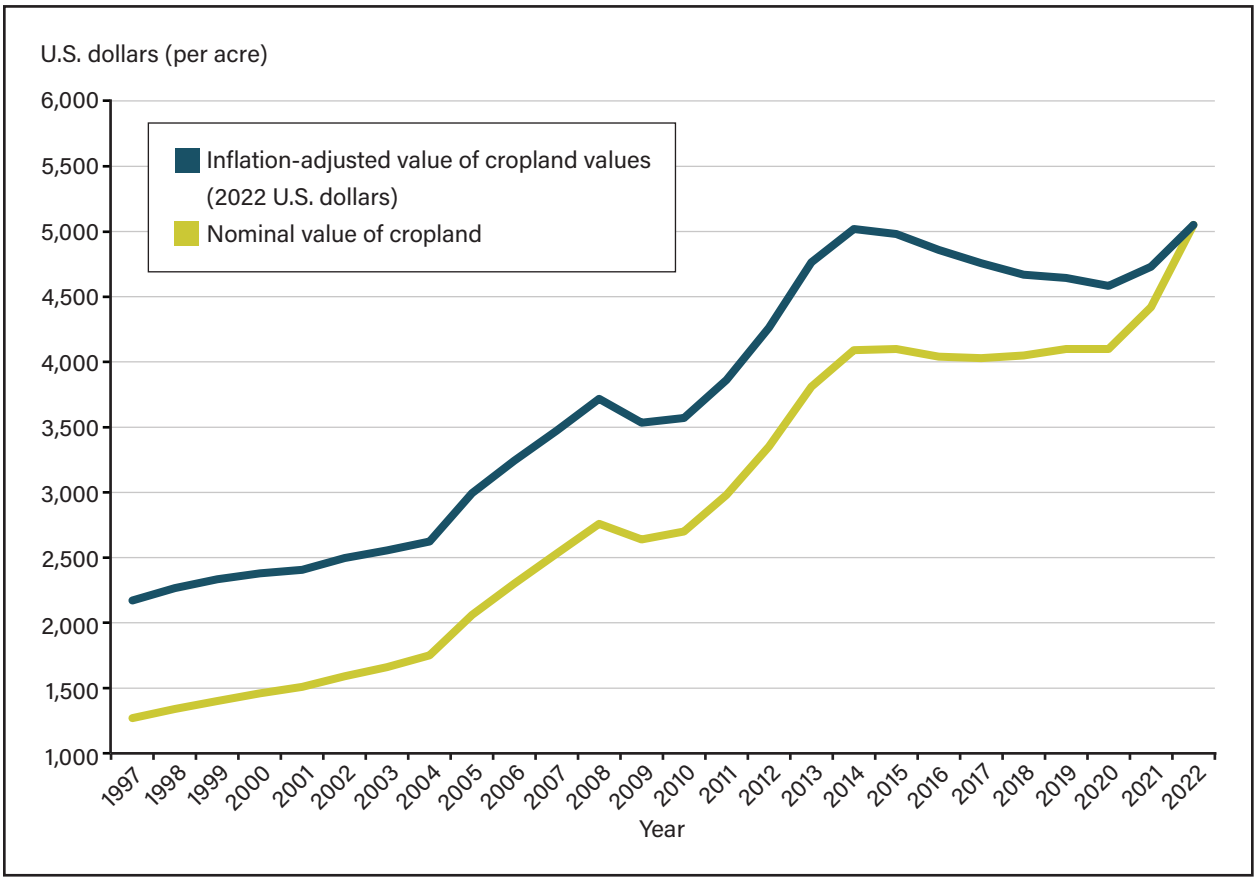
Alternatively, difficulties in contracting and monitoring and the prevalence of nonoperating landowners can exacerbate any incentives a tenant has to exploit the soil. If an agricultural land lease is written, the contract usually pertains to one attribute of the land—the surface area. Yet land comprises many different attributes, including soil nutrients and moisture, all which landowners value. While landowners could attempt to contract over these attributes or be involved with conservation decisions (explored later in this report), monitoring and measuring certain soil and water quality attributes can prove exceedingly difficult (Allen & Lueck, 2002). This is especially true if the owner is a nonoperator (absentee) landlord or does not live in the same location of the owned farm. According to Ranjan et al. (2019), about 80 percent of agricultural rented land is owned by nonoperating landowners. Lack of effective monitoring and/or lack of a relationship with the landlord may provide an opportunity for a tenant to work the soil in a way that they wouldn't if the tenant owned the plot.

Incentives to practice adoption could differ by the lease agreement as well. Input costs are often typically split between the landlord and tenant in share-rental agreements when there is a clear mapping between the practice and the output. Share-renters may be more inclined to adopt conservation practices than cash renters if they split the costs of implementation with the landlord. However, the effect of conservation practices on yields is often less clear than the effects of typical farm management practices (e.g., fertilizer application), which may dissuade share landlords from splitting the costs of conservation practices or even allowing the tenant to implement the practice.

The effect of land tenure on conservation practice adoption has implications for the USDA's Climate-Smart Agriculture and Forestry (CSAF) initiative, which is a broad set of climate-change strategies to help improve soil health, sequester carbon, reduce greenhouse gas emissions, enhance productivity, and mitigate the impacts of climate change (USDA, 2022). CSAF seeks to leverage existing USDA programs, including the Conservation Stewardship Program (CSP), the Conservation Reserve Program (CRP), and the Environmental Quality Incentives Program (EQIP), to support the initiative's climate change strategies.

There are additional policy implications associated with access to affordable farmland. Approximately 40 percent, or 355 million acres, of farmland in the lower 48 States is rented (Bigelow et al., 2016; USDA, NASS, 2021a). According to the USDA's NASS (2021b), average cropland values increased 75 percent between 2007 and 2021—from $2,500 per acre to $4,400 per acre. The national average of cropland value (inflation adjusted) in 1997 was approximately $2,200 per acre, whereas the average price in 2022 was about $5,050 per acre (figure 1). As a result, it can be financially challenging for younger and beginning farmers to start a farm operation with owned land, which may present barriers to conservation if renting is associated with lesser degrees of practice adoption.

Figure 1
Average U.S. cropland values, 1997–2022



Note: Cropland values reflect values as of June 1 of each year as reported in USDA's annual June Area Survey. The annual gross domestic product implicit price deflator was used to convert nominal values to 2022 U.S. dollars. The estimates exclude Alaska and Hawaii.

Source: USDA, Economic Research Service using data from USDA, National Agricultural Statistics Service (2022).

This report mainly used data from ARMS Phases II and III, which elicit data at the commodity field level and at the operation level, respectively. In general, ARMS Phases II and III lack an indepth examination of the contractual arrangements within cropland tenancy. The section entitled "Contract Characteristics: Norms and Institutions" complements the preceding sections by offering a qualitative assessment of farmland tenancy based on data from the TOTAL survey. As an example, the ARMS data reveal the total acreage of production from cropland tenants in a particular year, but the TOTAL data reveal how much autonomy a tenant has with on-farm decision making based on the rental contract.

Past Research

Issues of landownership and agricultural land tenancy have been disputed for over three centuries among philosophers, economists, and lawyers. The dispute is based on differing incentives faced by tenants and owner-operators (or absentee owners) over land use. Early contributors to this debate included Adam Smith (1776) and John Stuart Mill (1857), among several other historical figures. The original debates surrounded the various merits of lease contract design based on the underlying economic returns and risks faced by the landowners and tenants. The conventional wisdom, reflected in the nearly 300-year-old debate, implies that tenant farmers are primarily motivated by short-run economic returns, and therefore, their consequent production practices may come at the expense of the landowner's welfare. Whereas landowners are often interested in intergenerational transfer (e.g., keeping the land for farming) and consider the future value of the land as an asset (Dubois, 2002).

Many economic studies within the mid to late 20th century offered theoretical examinations based on differing incentives between the landowner and farmland tenant. For example, Stiglitz (1974) argued that share tenancy is akin to a labor contract and that cash-rental contracts misallocate risks. In a follow-up study, Newberry and Stiglitz (1979) outlined an optimal set of incentives for a given level of production uncertainty and risk aversion of the tenant.

More recently, several studies empirically examined the nature of farmland rental contracts. Allen and Lueck (1992a, 1992b, 1993, 1995, 1999, 2002) examined the structure of farmland contracts, including transaction costs, issues of monitoring, risk sharing, and the formalness of contracting (i.e., whether a contract is written or verbal), among other aspects.

A different stream of the farmland tenancy literature involves an empirical examination of conservation behavior (Ervin & Ervin, 1982; Young & Shortle, 1984; Norris & Batie, 1987; Lynne et al., 1988; Nielsen et al., 1989; D'Souza et al., 1993; Featherstone & Goodwin, 1993; Soule et al., 2000; Sklenicka et al., 2015; Varble et al., 2016; Allen & Borchers, 2016). For example, Soule et al. (2000) used data from the USDA's ARMS to determine if contract choice influenced the adoption of conservation practices by comparing a tenant's behavior to that of owner-operators. Intuitively, the researchers found that cash- and share-renters are less likely to adopt practices that provide only long-run benefits, such as strip-cropping and contour farming. They also found that both cash- and share-renters are more likely than owner-operators to adopt short-term practices, such as conservation tillage, on highly erodible land—an effect that Soule et al. (2000) stated may be due to conservation compliance requirements to receive USDA conservation program funding. In a more recent study, Allen and Borchers (2016) found a strong correlation between the adoption of no-till cultivation and the prevalence of cash-rent leases over share-rent leases.

More recent studies have offered a review of the literature pertaining to the adoption of conservation practice in agriculture (Knowler & Bradshaw, 2007; Lambert et al., 2007; Baumgart-Getz et al., 2012; Prokopy et al., 2019). Knowler and Bradshaw (2007) claimed that the literature has not identified any universal indicators of conservation adoption, and instead, only contextual factors matter, such as the study locale. Lambert et al. (2007) contended that land tenure security, scale effects (i.e., size of farm operation), economic costs, and government payments all affect the adoption of conservation agriculture. Baumgart-Getz et al. (2012) conducted a meta-analysis of U.S. agricultural Best Management Practices and found that environmental awareness and attitudes, along with other complementary social factors, were key determinants of adoption. Prokopy et al. (2019) argued that a farmer's self-identification as motivated by stewardship, their environmental attitudes, and previous experience with conservation practices (among other factors) were the main determinants of the adoption of conservation agriculture. Prokopy et al. (2019) also found that land tenure offered mixed evidence of conservation adoption among past studies.

Land Leasing

Land tenure is broadly defined as the laws, rules, and customs regarding the use, control, and transfer of land (Bigelow et al., 2016). Rules of tenure define how property rights to land are to be allocated within societies and the associated responsibilities and restraints (Food and Agriculture Organization of the United Nations (FAO), 2002). Put simply, tenure determines who can use the resource, for how long, and under what conditions. A landowner is defined as a person or entity that owns agricultural land, and a landlord is a type of landowner who rents the land to one or more agricultural operators. There are two major types of landlords: operator landlords and nonoperator landlords. Operator landlords are a subset of owner-operators who operate a portion of their land and rent out the remainder. Nonoperators rent their land to an agricultural tenant but are not actively involved in farming operations and/or the tenant's production decisions.

A rental or lease agreement refers to a legally binding contract that specifies the right of the tenant to use the land, which is the sole property of a landowner, in exchange for a defined rental amount and time period. When referencing a specific contractual agreement, the terms lease and rental agreement are used interchangeably throughout the rest of this report.

Types of Farmland Lease Agreements

There are four broad categories of farmland lease agreements.

Share contracts: The landlord and tenant generally split input costs, and the tenant provides all the labor and remaining costs of operation.[2] The harvests or revenues are then generally divided according to the contractual agreement (e.g., a 50/50 percentage or 25/75 percentage split between landlord and renter) (Schnitkey et al., 2021). Input costs and harvest or revenues are usually split along the same ratio. In such agreements, the landlord reduces the tenant's production risks by covering some of the costs, and the landlord is compensated by part of the economic returns.

Cash-rental contracts: The tenant pays a fixed dollar amount in rent, and the landlord is generally not involved in production, giving the tenant more autonomy. The tenant assumes all market risks and is generally entitled to all returns. Cash-rental arrangements are the most common lease type, covering approximately 70 percent of all rented farmland in the Midwest, as measured in 2014 (Bigelow et al., 2016).

Flexible or hybrid contracts: Generally, these contracts are a combination of cash and share payments. Alternatively, the rental payment is based on commodity prices after the crop is harvested. Some hybrid contracts account for yields, expenses, and government payments.

Free land contracts: The land is rented without any stated financial remuneration. These contracts are often based on nonarm's-length transactions (e.g., the tenant is related to the landowner).

[2] Landlords often share the cost of seed, fertilizer, and pesticides but rarely share the cost of fuel or machinery (Allen & Lueck, 2005).

Land Leasing Across Crops

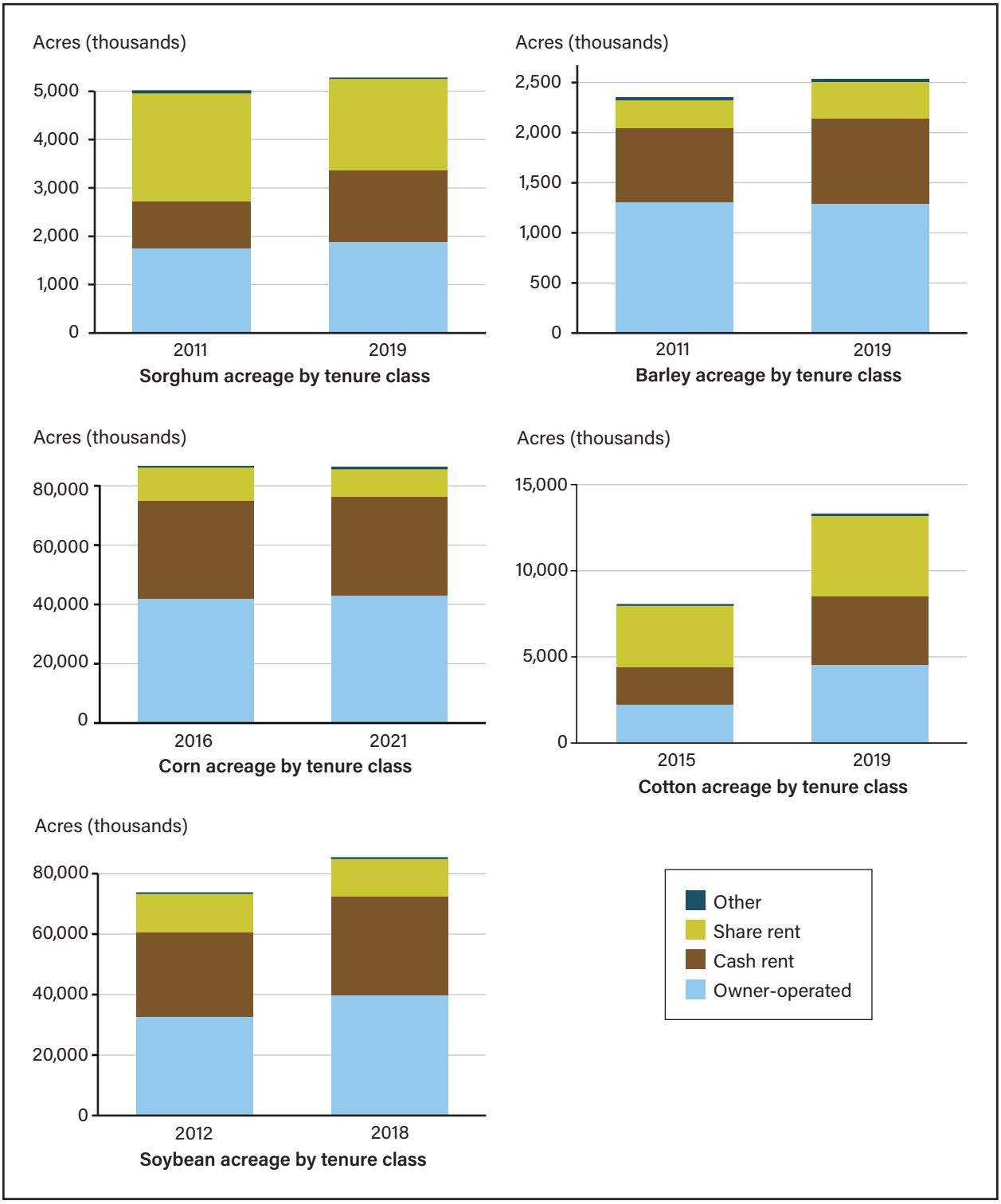
Proportions of owner-operated land versus rented land can be determined for individual crops. For five crops surveyed by ARMS from 2011–21 (Phase II), the total acreage is plotted under each tenure classification as a stacked bar graph (figure 2). Given the rarity of hybrid and free land contracts, the two categories are combined into a single "Other" category. The acreage totals are also displayed, along with the proportion of acreage under each tenure classification for that crop-year (table 1).

The proportions of owner-operated land versus different types of tenancy vary across crop type (figure 2). Corn, soybeans, and barley are highly owner-operated and cash-rent dominant, with the sum of owner-operated and cash-rent acreage comprising over 80 percent of each crop's survey year acreage. Cotton and sorghum have greater proportions of acreage in share contracts, which comprise at least 35 percent of each crop's survey year acreage.

Paulson and Schnitkey (2013) noted that the overall trend in the market favored cash-rent over share-based contracts and this looks to be the case for the surveyed commodities (table 1). Barley (2011 and 2019), sorghum (2011 and 2019), soybeans (2012 and 2018), corn (2016 and 2021), and cotton (2015 and 2019) all experience an increase in both the gross acreage planted on cash-rented land and in the proportion of acreage planted on cash-rented land.

Figure 2

Cropland acreage by ownership status (owner-operated versus leased) by principal field crop, 2011–21



Note: Responses are weighted by USDA's National Agricultural Statistics Service Phase II field-level survey weights for each commodity crop.

Source: USDA, Economic Research Service using Agricultural Resource Management Survey data.

Table 1

Cropland acreage by ownership status by principal field crop (thousands of acres) with the percentage of that crop year's total acreage, 2011–21

Crop	Survey year 1			Survey year 2		
	Owner-operated	Cash-rented	Share-rented	Owner-operated	Cash-rented	Share-rented
Corn	41,850.93	33,203.68	11,083.16	42,987.60	33,232.99	9,348.50
	(48.35)	(38.35)	(12.80)	(49.80)	(38.50)	(10.83)
Soybeans	32,752.00	27,983.48	12,725.24	39,847.04	32,668.77	12,360.83
	(44.46)	(37.99)	(17.28)	(46.67)	(38.27)	(14.48)
Barley	1,312.68	731.79	280.88	1,291.78	852.01	365.29
	(55.79)	(31.10)	(11.94)	(51.07)	(33.68)	(14.44)
Sorghum	1,747.94	971.10	2,247.55	1,882.42	1,488.87	1,880.92
	(34.93)	(19.40)	(44.91)	(35.66)	(28.21)	(35.63)
Cotton	2,237.97	2,179.66	3,561.53	4,534.90	3,983.50	4,664.21
	(27.78)	(27.05)	(44.20)	(34.13)	(29.98)	(35.10)

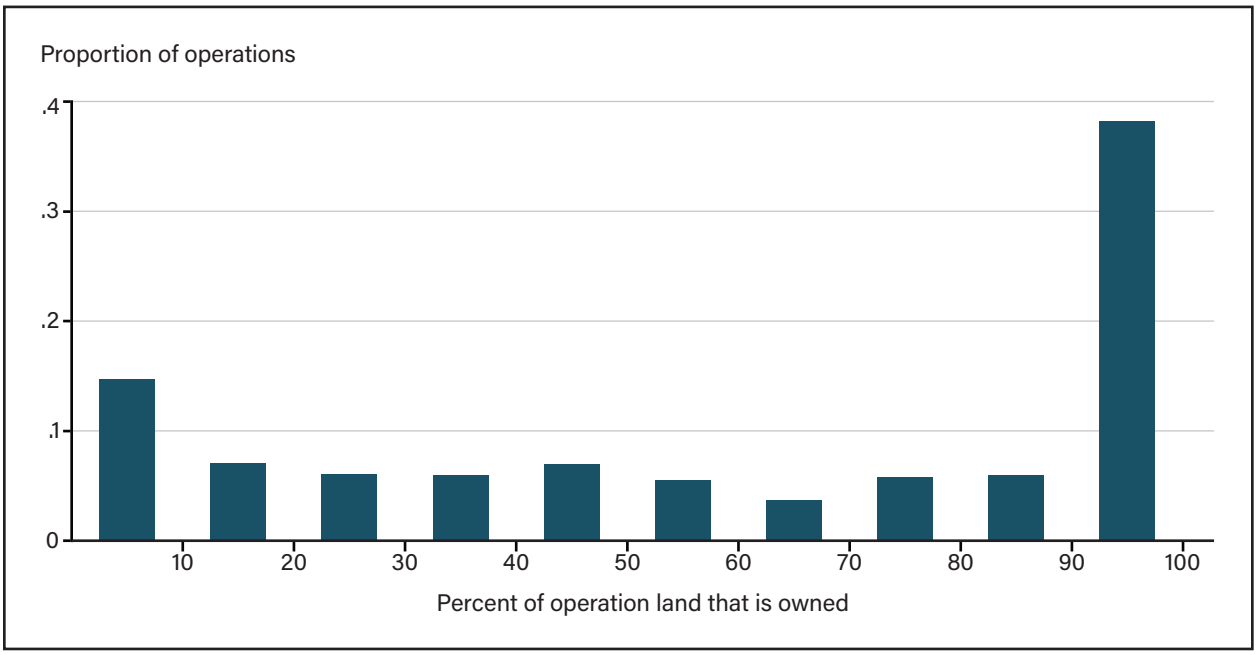
Note: The numbers in parentheses indicate percent. Those not in parentheses indicate acres. The first year for each crop is corn in 2016, soybeans in 2012, barley in 2011, sorghum in 2011, and cotton in 2015. The second year for each crop is corn in 2021, soybeans in 2018, barley in 2019, sorghum in 2019, and cotton in 2019. Responses are weighted by USDA's National Agricultural Statistics Service Phase II field-level survey weights for each commodity crop.

Source: USDA, Economic Research Service using Agricultural Resource Management Survey data.

Land Leasing Within an Operation

An operation can consist of owned land, rented land, or a combination of both. Operators often supplement their own land with rented parcels. Using ARMS Phase III, the authors calculate the percent of land within an operation that is owned (for surveyed soybean growers in 2018) and create a histogram displaying the frequency of each percent (by bins of 10 percent; figure 3). The largest two groups of operators own less than 10 percent of their operation's land (full renters) or greater than 90 percent of the land (full owner-operators). Approximately 47 percent of operations, however, fall somewhere in the middle. This has implications for the adoption of conservation practices such as tillage, as farmers may not want to switch between two systems when going from owned to rented land (Lynne et al., 1988). Similar histograms for surveyed operators growing barley in 2019, sorghum in 2019, cotton in 2019, and corn in 2021 are displayed in Appendix A. These histograms also reveal a sizable number of operations using a combination of owned and rented land.

Figure 3
Histogram of the percentage of operation land that is owned for surveyed soybean operators, 2018

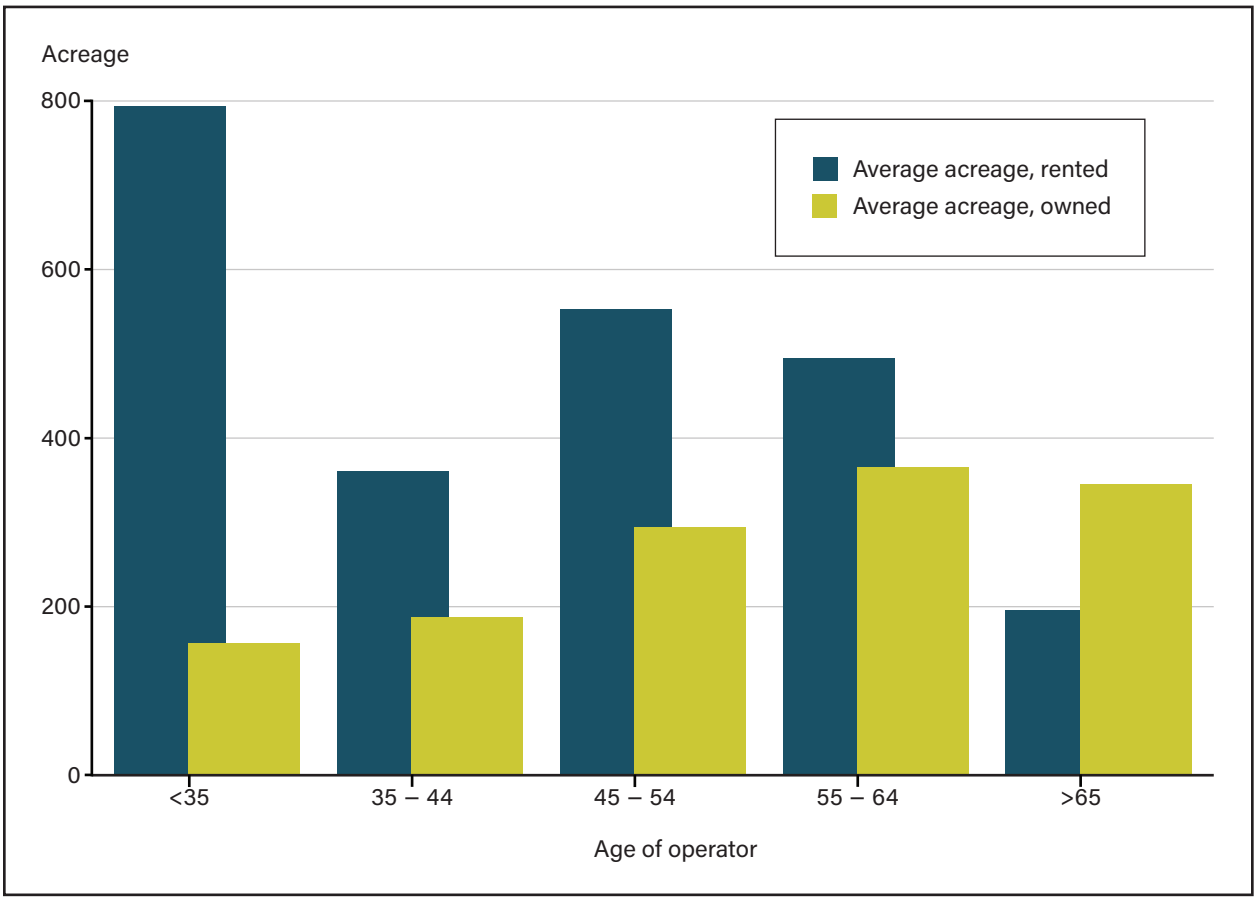


Note: Responses are weighted by USDA's National Agricultural Statistics Service Phase III operation-level survey weights for each commodity crop.

Source: USDA, Economic Research Service using Agricultural Resource Management Survey Phase III data.

The proportion of operation land that is owned may vary with certain operator demographics. Operators who rent most of their land are often thought of as younger or less experienced. For surveyed soybean growers in 2018, the average rented acreage decreases as an operator's age increases, while average owned acreage expands as age increases, suggesting that new and beginning farmers are more likely to rent the land of their operation (figure 4). Similar plots for surveyed operators growing barley in 2019, sorghum in 2019, cotton in 2019, and corn in 2021 are displayed in Appendix A. These plots reveal that these trends are not universal. While ownership patterns for corn growers resemble that of soybean growers, rented acreage remains prevalent for cotton operations across the age spectrum.

Figure 4
Average owned acreage and rented acreage, based on USDA's Agricultural Resource Management Survey (ARMS) responses from soybean growers, 2018



Note: Responses are weighted by USDA's National Agricultural Statistics Service Phase III operation-level survey weights for each commodity crop.

Source: USDA, Economic Research Service using Agricultural Resource Management Survey data.

Conservation Practices: Patterns of Practice Adoption by Land Tenure

Conservation Practices

Farming practices can potentially degrade the natural environment over time. Agricultural operations can negatively impact water quality, air quality, soil organic matter, and wildlife habitat. For example, tillage can result in soil erosion and loss of soil nutrients, and sediment, nutrient, or pesticide runoff can impair water quality. Conservation practices can be integrated into farm operations to address resource concerns and mitigate any ongoing environmental degradation. In addition to offering public benefits in the form of improved environmental outcomes, conservation practices often result in private benefits to the operator, such as reduced yield volatility or reduced variable costs (Anderson et al., 2020).

Conservation practices can be adopted by farm operators voluntarily without Government assistance, adopted voluntarily with Government assistance, or mandated by the Federal Government in certain cases (conservation compliance). USDA administers a portfolio of voluntary incentive programs to promote conservation. The programs include the Conservation Reserve Program (CRP), Agricultural Conservation Easement Program (ACEP), the Environmental Quality Incentives Program (EQIP), Conservation Stewardship Program (CSP), Regional Conservation Partnership Program (RCPP), and Conservation Technical Assistance (CTA), among others. In particular, the EQIP and CSP programs provide financial and technical assistance to farmers who adopt, install, or maintain conservation practices on land in production (working lands).

Conservation Practice Typology

The conservation practices explored in this report can be broadly divided into three categories: short-run, medium-run, and long-run practices.

Short-Run Practices

Conservation tillage (CT) is a generic term used to describe tillage systems that have the potential to conserve soil and water by reducing soil losses relative to more intensive conventional forms of tillage. CT often requires substantial upfront investment in capital, such as shifting to a no-till planter. Despite this, the authors classify CT as a short-run practice because private benefits to the operator are generally realized immediately through reduced labor costs and fuel savings.[3] The yield effects of switching to CT systems can be positive or negative based on rotation, soil drainage, and other factors (Al-Kaisi et al., 2015). The main CT types include mulch-till, ridge-till, zone-till, and no-till (Carter, 2005; USDA-NRCS, 2006a). CT practices offer benefits to production and the environment by reducing the likelihood of soil erosion, increasing the amount of soil organic matter, improving water infiltration, and lowering soil carbon losses (USDA, Natural Resources Conservation Service (NRCS), 2017).

Medium-Run Practices

Cover crops (CCs) are unharvested plantings that occur between two commodity or forage crop plantings and generally consist of cereal rye, oats, winter wheat, clover, or other seed mixes (Wallander et al., 2021). CCs require upfront seed costs, planting labor costs, and possibly termination costs after the growing season, in addition to new management knowledge. No land is taken out of production, although cover cropping can potentially result in decreases in yields (Abdalla et al., 2019). CCs have been demonstrated to improve soil health, prevent water and wind erosion, improve the availability of soil water, suppress weeds, and feed cattle, among other benefits (USDA, NRCS, 2021). Cover cropping is classified as a medium-run practice because any improvements to soil health and stability may result in increased resilience to adverse weather events and reduced crop insurance claims in the medium- to long-run (Won et al., 2023). The conventional wisdom that farmland tenants are more interested in short-run economic gains because increases in asset value from land improvement only accrue to landowners may suggest that renters are less inclined to adopt CC practices due to the upfront costs.

[3] It is possible that the adoption of conservation tillage would appeal equally to farmland tenants and owner-operators due to the operational cost reductions in lieu of medium-run or longer-horizon soil benefits. Therefore, any inference drawn from tests of statistical differences between owner-operators and renters must be interpreted with caution. That is, a tenant's cost-saving motives should not be conflated with their attitudes toward land stewardship.

Long-Run Practices

Structural practices are considered long-run practices. These practices can filter runoff and remove contaminants before they reach water bodies. In addition, they also can reduce soil erosion, provide wildlife habitat, and protect against flooding. These practices are generally expensive to implement because they often involve planning and heavy equipment. Additional costs may include seed, labor, as well as the opportunity cost of cultivation (taking land out of production). It is generally difficult to reverse the land use back to crop cultivation. Long-run yield benefits can accrue to the farmer in the form of greater yield resilience to extreme weather events.

There are two broad distinctions between short- and medium-run versus long-run practices: the irreversibility of the practice and the universality of the practice. Regarding irreversibility, an operator can choose to immediately stop engaging in CT or cover cropping, but longer-run structural practices (such as filter strips or grass waterways) take longer to reverse. Another distinction between the short- and medium-run versus the long-run practice is the universality of the practice. Regarding universality, almost any operator can adopt CT or cover cropping, but structural practices are not necessarily universally adopted. For example, a grass waterway is unnecessary if a plot of farmland does not contain a waterway. Adoption rates for long-run practices are explored in Appendix B.

Practice Adoption by Tenure Group

CT is measured on a farm field using the Soil Tillage Intensivty Rating (STIR) index, which is defined by the USDA's Natural Resources Conservation Service (NRCS) as a way to evaluate the kind, severity, and number of ground-disturbing passes on soil quality (Claassen et al., 2018). STIR index values are determined by the operational speed of tillage equipment, tillage type, depth of the tillage operation, and degree of disturbance of the soil surface (Claassen et al., 2018).

STIR index values are calculated using the ARMS data based on detailed information about all field operations (tillage, planting, fertilization, etc.) collected in the operations table of the Phase II survey. For additional specifics about the estimation of the STIR index, refer to Claassen et al. (2018).

Values of the STIR index range from 0 to 200, with lower values indicating less soil disturbance. CT systems are defined as any operation that achieves a STIR of 80 or less, while conventional tillage is any operation that achieves a STIR higher than 80.[4] Within the CT category, no-till is defined as a system that refrains from any tillage operation, while mulch or reduced tillage is any system where the soil is tilled, but soil disturbance is low (USDA, NRCS, 2016).

Across most tenure groups and crops, the average STIR value decreases from the first year to the second, representing an increase in the number of farmers implementing more soil conserving (or less intensive) tillage systems (figure 5). Cotton tends to have the highest average STIR values out of the five major commodities displayed, while soybeans tend to have the lowest average STIR value with the tightest confidence intervals.

Between rented and owner-operated plots, there are few instances in which differences in average STIR values are statistically significant (i.e., *p*-value less than 5 percent).[5] The exceptions are corn in 2016, in which cash-

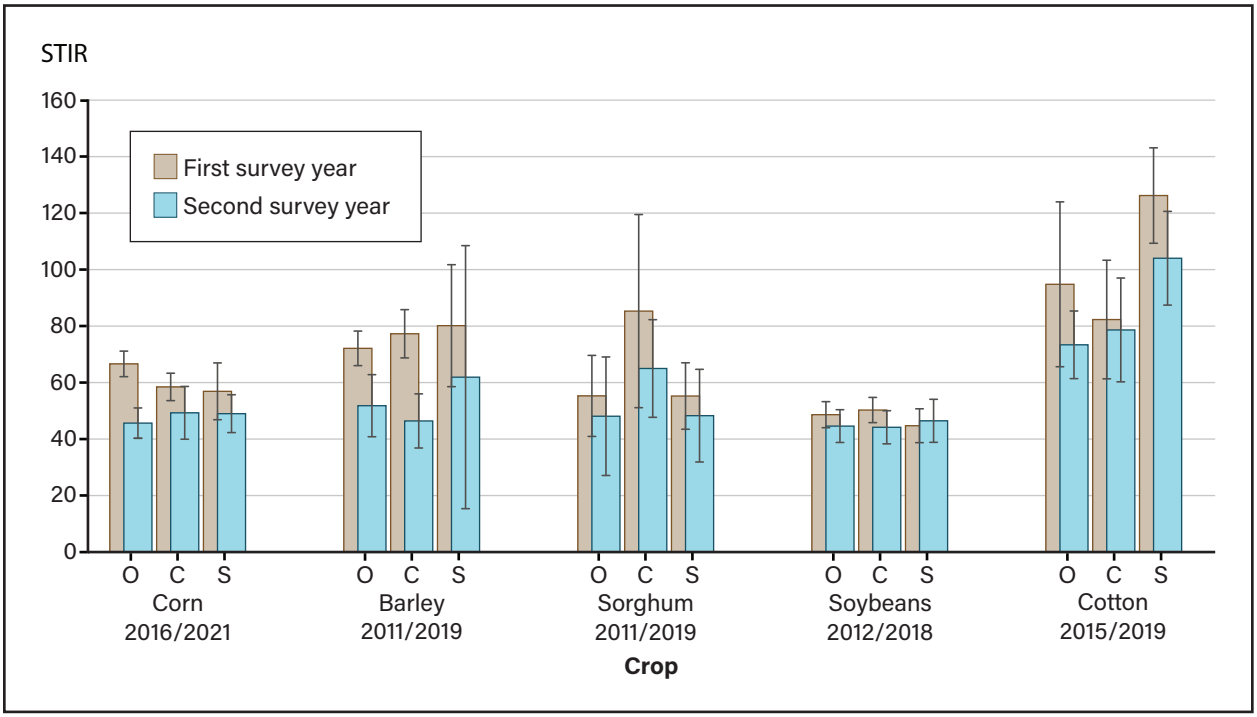
[4] The index value of 80 or less is a national standard for conservation tillage established by the Natural Resources Conservation Service, although individual States can set lower thresholds. The national standard for no-till systems is a STIR index value of no greater than 20.

[5] A *p*-value is a number calculated from a statistical test that describes how likely a researcher is to have found a particular set of observations if the null hypothesis were true. The null hypothesis for this test is that the average STIR index value does not differ between the owned and rented plots. A rejection of the null hypothesis suggests that the average index values differ statistically. The *p*-value provides the smallest level of statistical significance at which the null hypothesis would be rejected. A smaller *p*-value means that there is stronger evidence in favor of the alternative hypothesis.

rented plots are lower than owner-operated plots in STIR, and for cotton in 2019, in which share-rented plots have higher STIR values than owner-operated plots (table 2). Soybeans and corn have the tightest confidence intervals, reflecting relatively lower variance within each tenure group but also the larger number of observations (soybean and corn surveys have relatively more respondents).

USDA's NRCS observed CT on cultivated cropland using the Conservation Effects Assessment Project (CEAP) data. Although the survey method is different from the ARMS data used within the current study, the NRCS found similar results for the adoption of CT on U.S. croplands (USDA NRCS, 2022b).

Figure 5
Soil Tillage Intensity Rating on selected crops and survey years, 2011–21



STIR = Soil Tillage Intensity Rating; O = owner-operated plots; C = cash-rented plots; S = share-rented plots.

Note: Error bars denote the 95-percent confidence interval. Responses are weighted by USDA's National Agricultural Statistics Service Phase II field-level survey weights for each commodity.

Source: USDA, Economic Research Service using Agricultural Research Management Survey Phase II data.

Table 2
Average Soil Tillage Intensity Rating for rented plots versus owner-operated plots, 2011–21

Crop	Survey year 1			Survey year 2		
	Owner-operated	Cash-rented	Share-rented	Owner-operated	Cash-rented	Share-rented
Corn	66.62	58.46**	56.91*	45.65	49.29	48.99
Soybeans	48.63	50.28	44.72	44.59	44.17	46.46
Barley	72.12	77.28	80.14	51.81	46.42	61.92
Sorghum	55.28	85.30	55.24	48.08	64.98	48.28
Cotton	94.79	82.31	126.22*	73.36	78.64	104.02**

Statistical significance levels: ** = 5 percent; * = 10 percent.

Note: The first year for each crop is corn in 2016, soybeans in 2012, barley in 2011, sorghum in 2011, and cotton in 2015. The numbers under "Survey year 2" indicate the average Soil Tillage Intensity Rating value for the second observed survey year. The second year for each crop is corn in 2021, soybeans in 2018, barley in 2019, sorghum in 2019, and cotton in 2019. The asterisks indicate if the averages for cash- or share-rented fields are statistically different from the averages for owner-operated fields. Responses are weighted by USDA's National Agricultural Statistics Service Phase II field-level survey weights for each commodity.

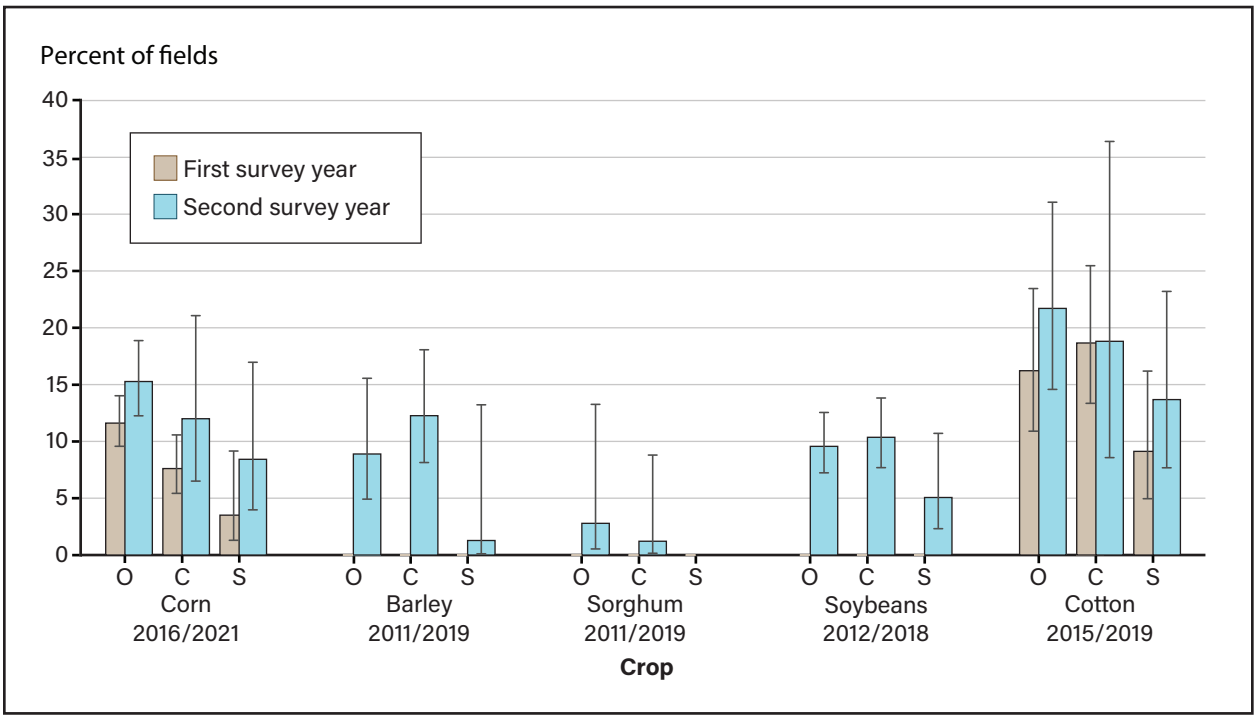
Source: USDA, Economic Research Service using Agricultural Resource Management Survey Phase II data.

For cover crop adoption rates, the confidence intervals are quite wide for each category across most crops, reflecting the relatively low frequency of cover crop adoption and high variance within tenure groups (figure 6). For corn and cotton, adoption rates increase over time for all three tenure groups. The cover crop adoption rates are similar to the findings of 6 percent reported by USDA's NRCS (2022b).

The adoption of cover crops by cash- and share-rented plots for corn growers trails owner-operated plots in 2016 and 2021, perhaps reflecting the relatively longer timeline required for realized private benefits (table 3). For corn, the differences are statistically significant for cash- and share-rented plots in 2016. Share-rented plots are generally lower than owner-operated plots in cover crop adoption, with the differences being statistically significant at the 5-percent level for corn in 2016, soybeans in 2018, and barley in 2019. The differences are statistically significant at the 10-percent level for corn in 2021 and cotton in 2015.

Figure 6

Adoption rate of cover cropping by commodity type and survey year, 2015–21



O = owner-operated plots; C = cash-rented plots; S = share-rented plots.

Note: Error bars denote the 95-percent confidence interval. Adoption rates are estimated as proportions, and the limits of the confidence intervals are calculated using a logit transformation. An explicit question about cover crop adoption was not posed in the 2011 through 2013 Agricultural Resource Management Survey (ARMS) years, so those years are omitted for soybeans, barley, and sorghum. Responses are weighted by USDA's National Agricultural Statistics Service Phase II field-level survey weights for each commodity.

Source: USDA, Economic Research Service using ARMS Phase II data.

Table 3

Average rate of cover crop adoption for rented plots versus owner-operated plots, 2011–21

Crop	Survey year 1 (percent)			Survey year 2 (percent)		
	Owner-operated	Cash-rented	Share-rented	Owner-operated	Cash-rented	Share-rented
Corn	11.61	7.61**	3.51**	15.27	11.99	8.42*
Soybeans	NA	NA	NA	9.56	10.36	5.06**
Barley	NA	NA	NA	8.89	12.26	1.28**
Sorghum	NA	NA	NA	2.79	1.21	0.00
Cotton	16.22	18.66	9.12*	21.70	18.81	13.68

Statistical significance levels: ** = 5 percent; * = 10 percent.

NA = not available.

Note: The first year for each crop is corn in 2016, soybeans in 2012, barley in 2011, sorghum in 2011, and cotton in 2015. The second year for each crop is corn in 2021, soybeans in 2018, barley in 2019, sorghum in 2019, and cotton in 2019. The asterisks indicate if the averages for cash- or share-rented fields are statistically different from the owner-operated category at the stated significance level. Responses are weighted by USDA's National Agricultural Statistics Service Phase II field-level survey weights for each commodity.

Source: USDA, Economic Research Service using Agricultural Resource Management Survey Phase II data.

Practice Adoption by Tenure Group, Across Regions

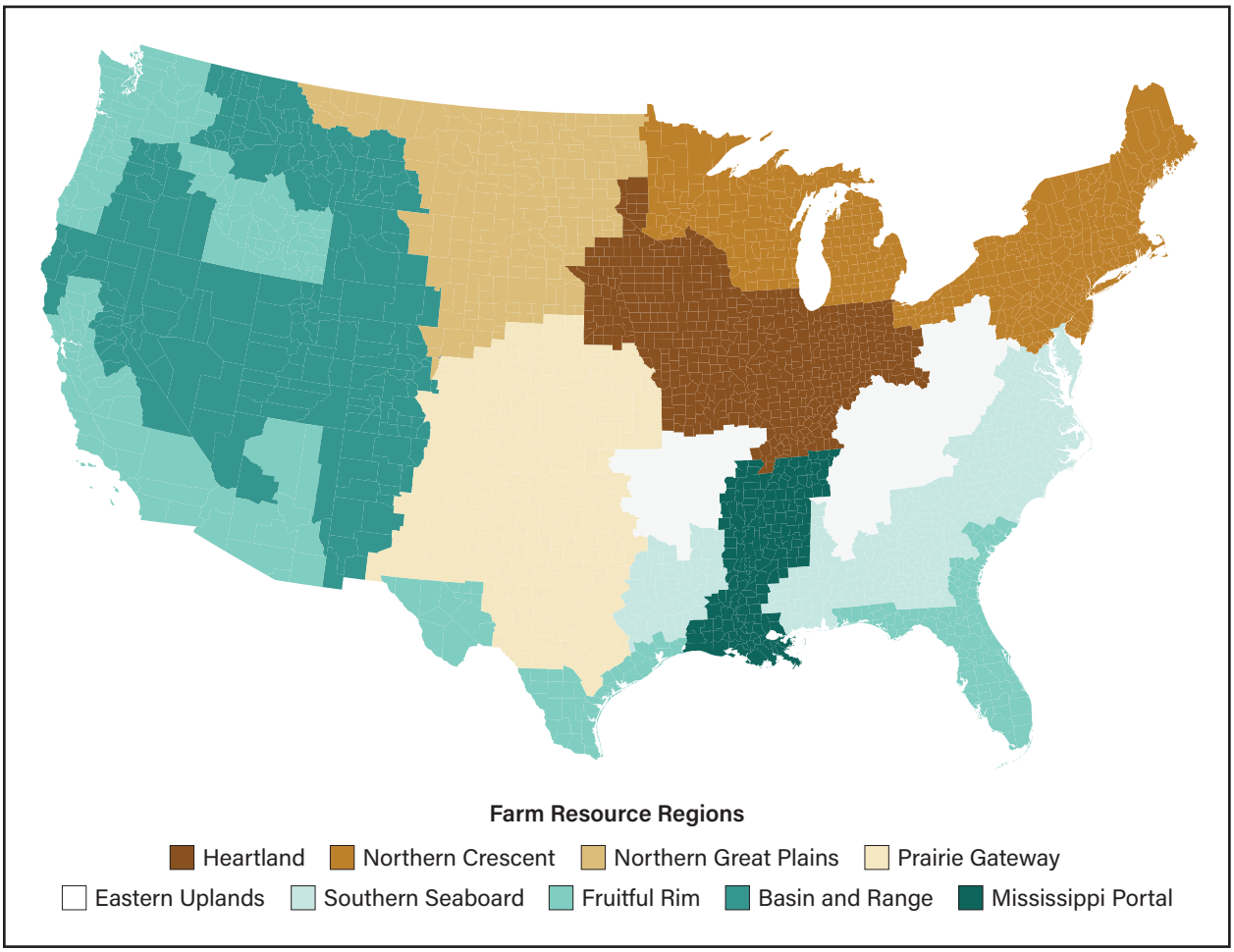
National-level adoption statistics may hide differences across U.S. regions. For example, the differential across owner-operated plots and share-rented plots in cover crop adoption may be driven by social norms among production practices within regions.

The authors employ USDA's ERS Farm Resource Regions (figure 7), which depict geographic specialization in production of U.S. farm commodities (Heimlich, 2000).

For each region or group of regions, the mean STIR values and cover crop adoption rates are displayed for owner-operated, cash-rented, and share-rented plots based on total regional production shares.[6]

[6] Production shares are approximate, as the USDA's NASS county-level statistics used to calculate region-level shares are often not available for every county. For the cotton in 2015 and 2019 maps, production shares were calculated from the 2012 and 2017 Censuses of Agriculture, respectively, as the contemporaneous county-level statistics are incomplete for those years.

Figure 7
USDA, Economic Research Service Farm Resource Regions, 2000



Note: USDA's Economic Research Service (ERS) Farm Resource Regions depict geographic specialization in production of U.S. farm commodities. USDA, ERS Farm Resource Regions do not include Alaska and Hawaii.

Source: USDA, Economic Research Service.

The authors found regional differences based on the survey results from corn in 2021, soybeans in 2018, barley in 2019, sorghum in 2019, and cotton in 2019, respectively (tables 4–8). The lower 48 States are segmented into different region groups based on the number of observations available, geography, and production shares (figures 8–12). Results based on the previous ARMS year for each crop—corn in 2016, soybeans in 2012, barley in 2011, sorghum in 2011, and cotton in 2015—are displayed in Appendix C (tables C.1–C.5).

Notably, for corn there are no statistically significant differentials between owner-operated plots and rented plots in the Heartland region, where the majority of U.S. corn production occurs (table 4, figure 8).

For the Northern Great Plains and Prairie Gateway regions, cash-rented plots showed higher cover crop adoption rates than owner-operated plots, but the difference is not statistically significant. Cash- and share-rented plots do, however, exhibit higher soil disturbance than owner-operated-plots.

For the remaining United States, cover crop adoption rates for owner-operated plots are much higher than cash- and share-rented plots. However, given the low number of observations in the share-rented category, that estimate should be interpreted with caution.

Table 4

Regional patterns in conservation adoption rates among corn production (2021 USDA's Agricultural Resource Management Survey (ARMS))

	Owner-operated	Cash-rented	Share-rented
Panel A Heartland region (60 percent of total production, measured in thousands of bushels)			
STIR value	49.62	43.37	48.89
Cover cropping rate (percent)	9.91	10.00	10.93
Number of observations	262	172	52
Panel B Northern Great Plains and Prairie Gateway regions (19 percent of total production, measured in thousands of bushels)			
STIR value	18.74	45.81**	45.56**
Cover cropping rate (percent)	4.07	10.91	S
Number of observations	124	81	33
Panel C Rest of the country (21 percent of total production, measured in thousands of bushels)			
STIR value	52.20	60.29	73.51
Cover cropping rate (percent)	29.72	15.68**	0.00***
Number of observations	238	152	7

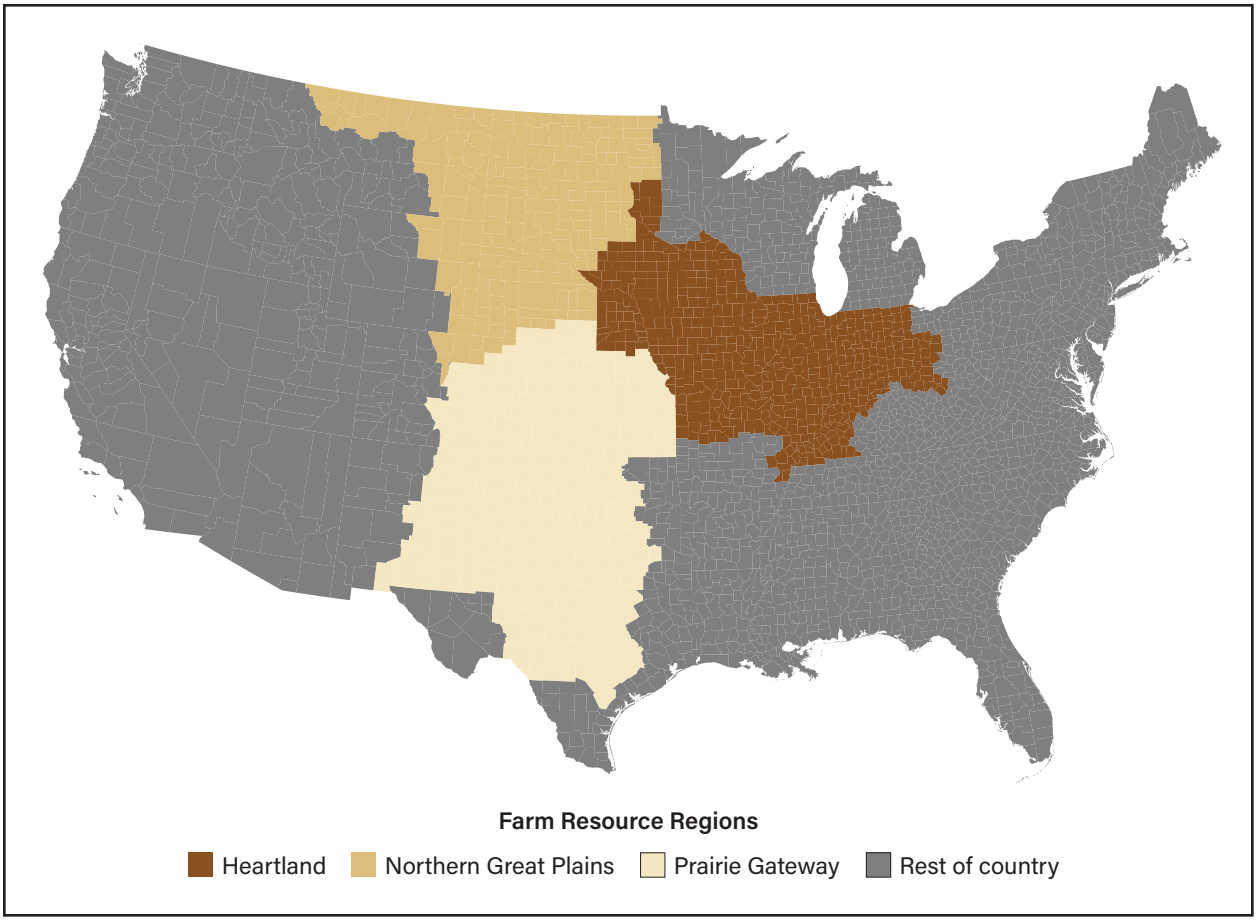
Statistical significance levels: *** = 1 percent, ** = 5 percent.

STIR = Soil Tillage Intensity Rating.

Note: Groups are selected based on approximate production shares, as calculated with USDA, National Agricultural Statistics Service (NASS) county-level statistics. The asterisks indicate if the averages for cash- or share-rented fields are statistically different from the averages for owner-operated fields. Responses are weighted by USDA's NASS Phase II field-level survey weights for each commodity. The marker "S" identifies estimates that cannot be disclosed due to insufficient sample size, exceedingly low adoption rates, or other disclosure issues.

Source: USDA, Economic Research Service using 2021 Agricultural Resource Management Survey Phase II data and USDA, NASS county-level crop production statistics.

Figure 8
U.S. corn-growing fields by USDA, Farm Resource Region, 2021



Note: USDA, Economic Research Service Farm Resource Regions do not include Alaska and Hawaii.

Source: USDA, Economic Research Service.

For barley, share-rented plots exhibit lower STIR values than owner-operated-plots in the Northern Great Plains, and Basin and Range regions, where 72 percent of barley production occurred in 2019 (table 5, figure 9).

For the remaining United States, cover crop adoption rates for owner-operated plots are much higher than share-rented plots. However, given the low number of observations in the share-rented category, that estimate should be interpreted with caution.

Table 5

Regional patterns in conservation adoption rates among barley production (2019 USDA's Agricultural Resource Management Survey (ARMS))

	Owner-operated	Cash-rented	Share-rented
Panel A Northern Great Plains, and Basin and Range regions (72 percent of total production, measured in thousands of bushels)			
STIR value	47.78	45.72	31.11*
Cover cropping rate (percent)	3.52	S	S
Number of observations	163	101	36
Panel B Rest of the country (28 percent of total production, measured in thousands of bushels)			
STIR value	56.37	47.39	131.14
Cover cropping rate (percent)	14.97	28.87*	0.00***
Number of observations	197	97	20

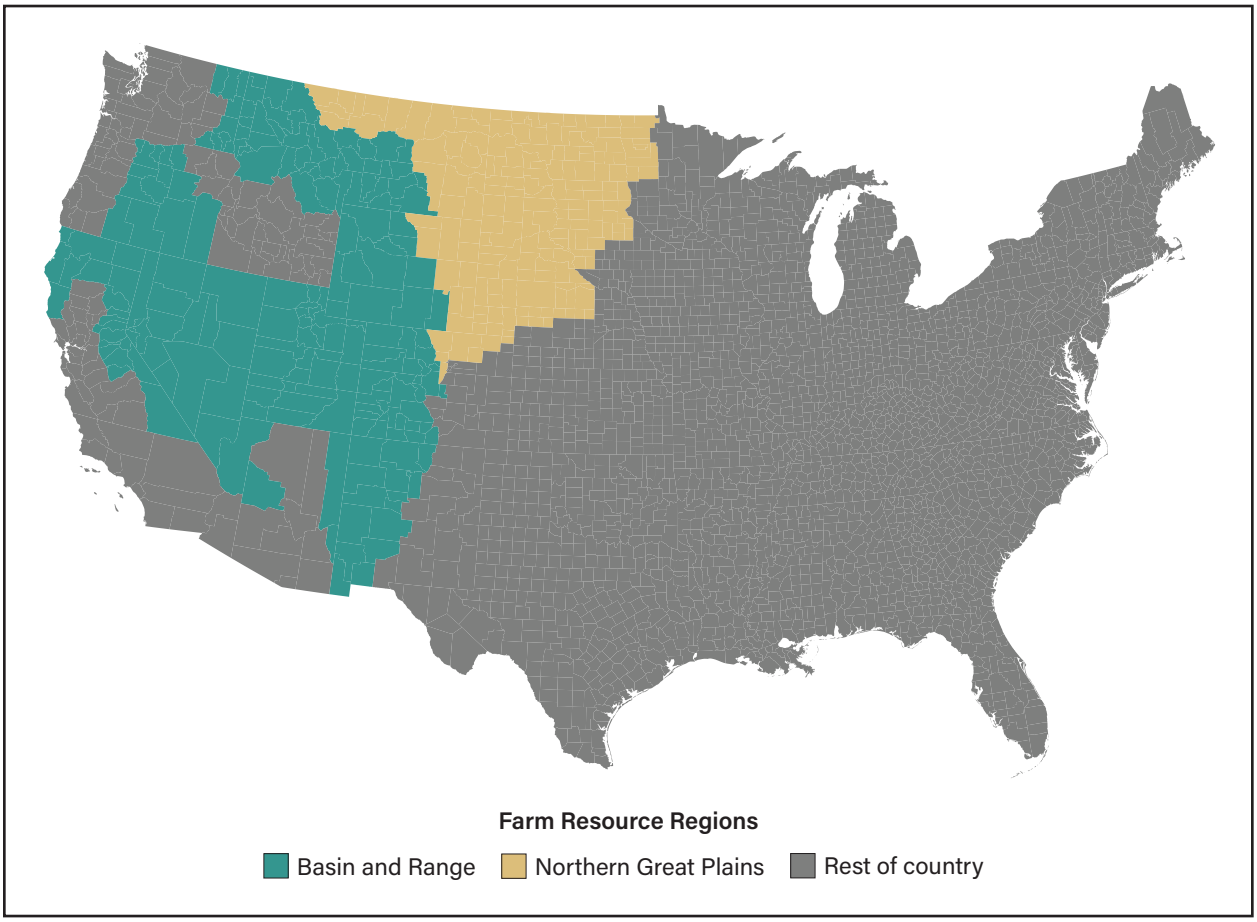
Statistical significance levels: *** = 1 percent; * = 10 percent.

STIR = Soil Tillage Intensity Rating.

Note: Groups are selected based on approximate production shares, as calculated with USDA, National Agricultural Statistics Service (NASS) county-level statistics. The asterisks indicate if the averages for cash- or share-rented fields are statistically different from the averages for owner-operated fields. Responses are weighted by USDA's NASS Phase II field-level survey weights for each commodity. The marker "S" identifies estimates that cannot be disclosed due to insufficient sample size, exceedingly low adoption rates, or other disclosure concerns.

Source: USDA, Economic Research Service using 2019 Agricultural Resource Management Survey Phase II data and USDA, NASS county-level crop protection statistics.

Figure 9
U.S. barley-growing fields by USDA, Farm Resource Region, 2019



Note: USDA, Economic Research Service Farm Resource Regions do not include Alaska and Hawaii.

Source: USDA, Economic Research Service.

There are no significant differences among sorghum owner-operated and rented plots in STIR values in the Prairie Gateway region, where 73 percent of production occurred in 2019 (table 6, figure 10). For the "Rest of the country," cash- and share-rented plots exhibit much higher STIR values than owner-operated plots.

Table 6

Regional patterns in conservation adoption rates among sorghum production (2019 USDA's Agricultural Resource Management Survey (ARMS))

	Owner-operated	Cash-rented	Share-rented
Panel A Prairie Gateway region (73 percent of total production, measured in thousands of bushels)			
STIR value	44.36	37.21	35.53
Cover cropping rate (percent)	2.73	S	0.00
Number of observations	109	59	75
Panel B Rest of the country (27 percent of total production, measured in thousands of bushels)			
STIR value	69.11	123.67**	120.03***
Cover cropping rate (percent)	S	S	0.00
Number of observations	34	38	25

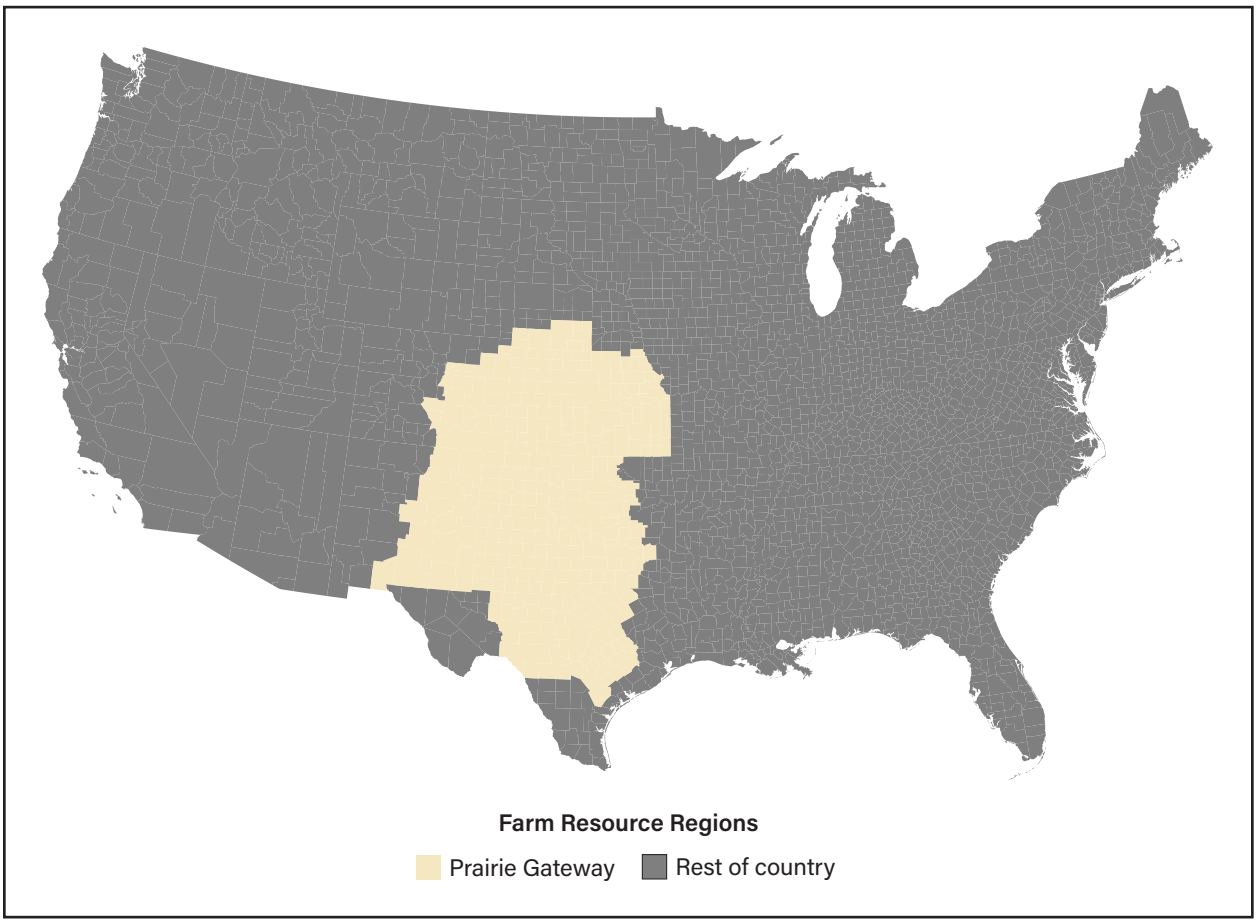
Statistical significance levels: *** = 1 percent; ** = 5 percent.

STIR = Soil Tillage Intensity Rating.

Note: Groups are selected based on approximate production shares, as calculated with USDA, National Agricultural Statistics Service (NASS) county-level statistics. The asterisks indicate if the averages for cash- or share-rented fields are statistically different from the averages for owner-operated fields. Responses are weighted by USDA's NASS Phase II field-level survey weights for each commodity. The marker "S" identifies estimates that cannot be disclosed due to insufficient sample size, exceedingly low adoption rates, or other disclosure issues.

Source: USDA, Economic Research Service using 2019 Agricultural Resource Management Survey Phase II data and USDA, NASS county-level crop production statistics.

Figure 10
U.S. sorghum-growing fields by USDA, Farm Resource Region, 2019



Note: USDA, Economic Research Service Farm Resource Regions do not include Alaska and Hawaii.

Source: USDA, Economic Research Service.

For soybean growers surveyed, there are no statistically significant differences between owner-operated and rented plots for STIR nor cover crops in the Heartland region, where 61 percent of total U.S. production occurred in 2018 (table 7, figure 11). For the Mississippi Portal region, where 9 percent of total U.S. soybean production occurred, share-rented plots exhibit higher STIR values than owner-operated plots. Cash-rented plots did not exhibit such differences with owner-operated plots in the Mississippi Portal region.

Table 7

Regional patterns in conservation adoption rates among soybean production (2018 USDA's Agricultural Resource Management Survey (ARMS))

	Owner-operated	Cash-rented	Share-rented
Panel A Heartland region (61 percent of total production, measured in thousands of bushels)			
STIR value	43.36	49.14	40.55
Cover cropping rate (percent)	7.30	7.46	5.24
Number of observations	468	279	121
Panel B Northern Great Plains and Prairie Gateway regions (17 percent of total production, measured in thousands of bushels)			
STIR value	41.73	37.15	36.58
Cover cropping rate (percent)	1.53	5.93	S
Number of observations	173	124	54
Panel C Mississippi Portal region (9 percent of total production, measured in thousands of bushels)			
STIR value	58.26	61.04	83.85**
Cover cropping rate (percent)	6.66	9.26	S
Number of observations	151	205	149
Panel D Rest of the country (13 percent of total production, measured in thousands of bushels)			
STIR value	46.18	36.35	24.98
Cover cropping rate (percent)	19.01	15.49	19.65
Number of observations	267	259	25

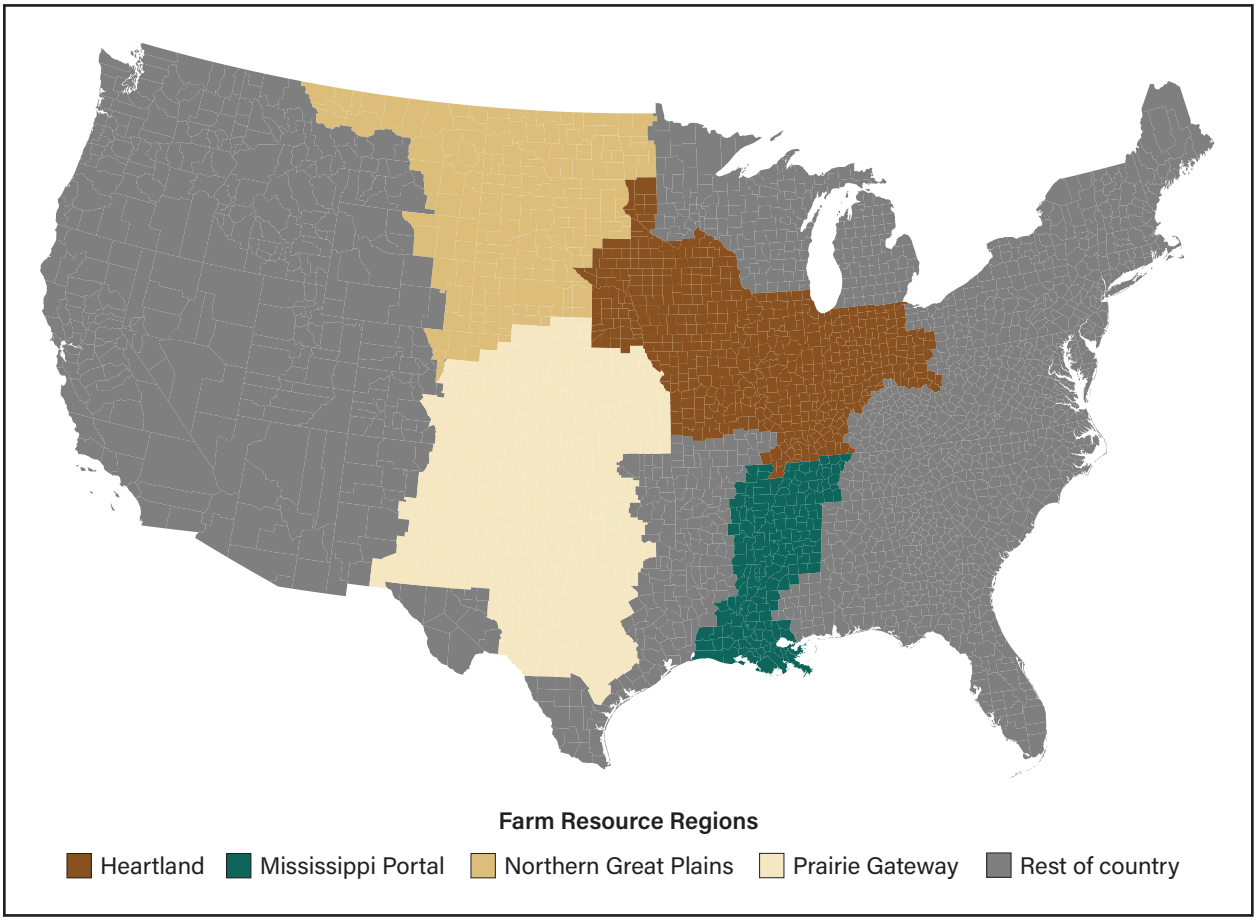
Statistical significance levels: ** = 5 percent.

STIR = Soil Tillage Intensity Rating.

Note: Groups are selected based on approximate production shares, as calculated with USDA, National Agricultural Statistics Service (NASS) county-level statistics. The asterisks indicate if the averages for cash- or share-rented fields are statistically different from the averages for owner-operated fields. Responses are weighted by USDA's NASS Phase II field-level survey weights for each commodity. The marker "S" identifies estimates that cannot be disclosed due to insufficient sample size, exceedingly low adoption rates, or other disclosure concerns.

Source: USDA, Economic Research Service using 2018 Agricultural Resource Management Survey Phase II data and USDA, NASS county-level crop production statistics.

Figure 11
U.S. soybean-growing fields by USDA, Farm Resource Region, 2018



Note: USDA, Economic Research Service Farm Resource Regions do not include Alaska and Hawaii.

Source: USDA, Economic Research Service.

Among cotton producers, share-rented plots exhibit higher STIR values than owner-operated plots in the Mississippi Portal and Southern Seaboard (table 8, figure 12). The difference is statistically significant at the 1-percent level. Such differential does not exist between owner-operated plots and cash-rented plots in this region.

For the Prairie Gateway and Fruitful Rim regions, where 58 percent of total U.S. production occurred in 2019, there are no statistically significant differences between owner-operated and rented plots for both STIR and cover crop adoption.

Table 8

Regional patterns in conservation adoption rates among cotton production (2019 USDA's Agricultural Resource Management Survey (ARMS))

	Owner-operated	Cash-rented	Share-rented
Panel A Mississippi Portal and Southern Seaboard regions (36 percent of total production, measured in thousands of bushels)			
STIR value	41.37	46.56	84.63***
Cover cropping rate (percent)	28.90	26.07	S
Number of observations	217	291	109
Panel B Prairie Gateway and Fruitful Rim regions (58 percent of total production, measured in thousands of bushels)			
STIR value	131.50	149.30	120.34
Cover cropping rate (percent)	10.77	3.97	18.30
Number of observations	102	99	65

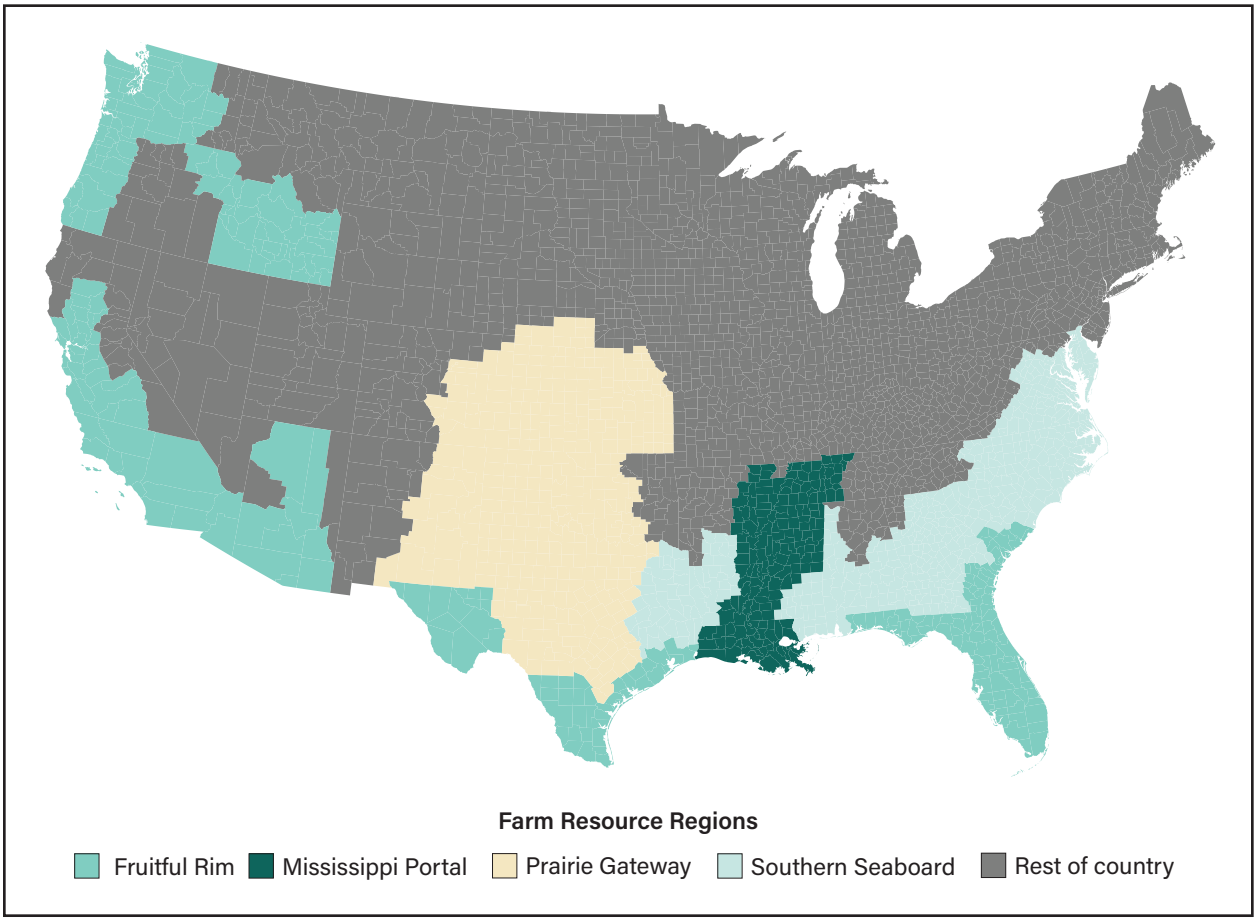
Statistical significance levels: *** = 1 percent; ** = 5 percent.

STIR = Soil Tillage Intensity Rating.

Note: Groups are selected based on approximate production shares, as calculated with USDA, National Agricultural Statistics Service (NASS) county-level statistics. The asterisks indicate if the averages for cash- or share-rented fields are statistically different from the averages for owner-operated fields. Responses are weighted by USDA's NASS Phase II field-level survey weights for each commodity. The marker "S" identifies estimates that cannot be disclosed due to insufficient sample size, exceedingly low adoption rates, or other disclosure concerns.

Source: USDA, Economic Research Service using 2019 Agricultural Resource Management Survey Phase II data and USDA, NASS 2017 Census of Agriculture county-level crop production statistics.

Figure 12
U.S. cotton-growing fields by USDA, Farm Resource Region, 2019



Note: USDA, Economic Research Service Farm Resource Regions do not include Alaska and Hawaii.

Source: USDA, Economic Research Service.

Institutions and Features of Rental Markets

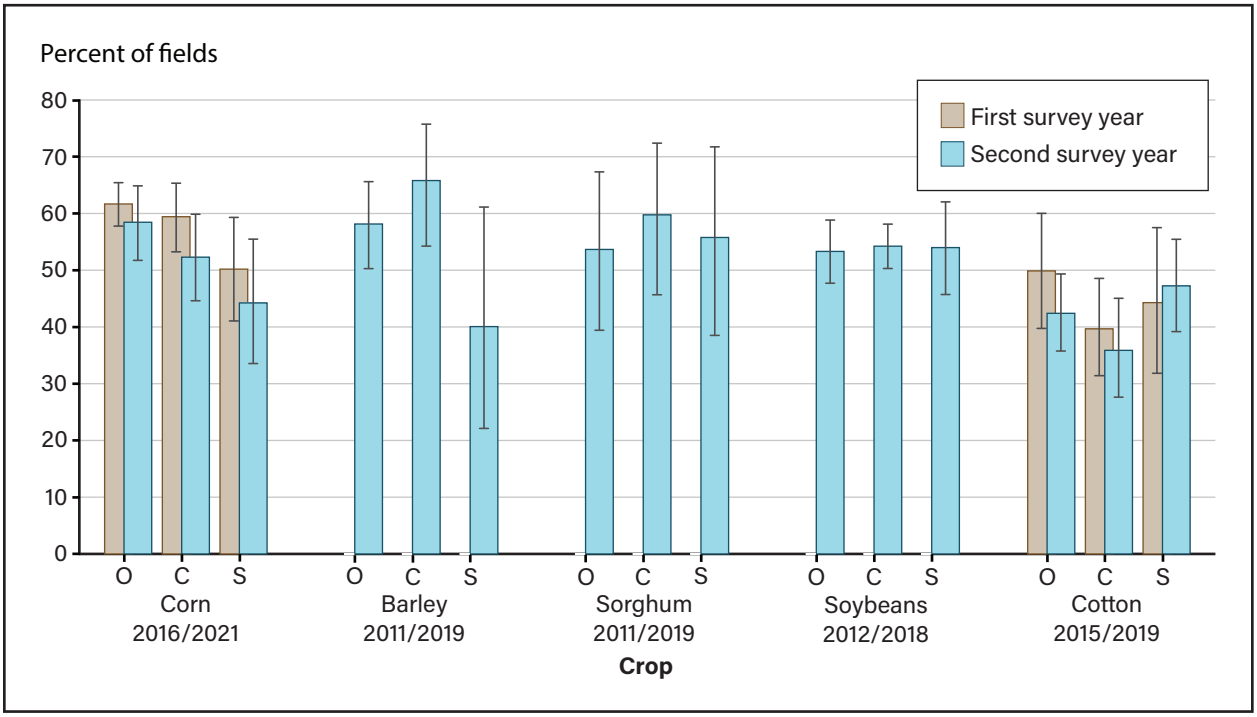
There are several factors that could affect the relationship between land tenure and practice adoption, such as the incentives of the contract itself, the demographics of owners versus renters, and the institutions of rental markets. The following features and institutions of rental markets provide context to this report's findings on practice adoption.

Soil Quality

Farm fields with a high degree of slope are susceptible to a greater risk of erosion and may require conservation practices to better fortify the soil. For example, heavily sloped fields require terraces to reduce the flow rate of water down the gradient of the hill. Differentials in the slopes of owner-operated plots versus rented plots may inform how practice adoption would differ across the two groups. ARMS Phase II provides information about the slope of each surveyed field, which can be denoted as level (0–2 percent slope), moderate (3–9 percent slope), or steep (10 percent and greater slope).

Across five crops, there are no systemic differences between owner-operated plots and rented plots in the proportions of fields that are moderately or steeply sloped (table 9, figure 13). The one exception is share-rented fields growing corn, which have a lower proportion of sloped fields than owner-operated fields in both survey years, with the difference being statistically significant at the 5-percent level.

Figure 13
Proportion of fields by tenure group with moderate or steep grades, 2011–21



O = owner-operated plots; C = cash-rented plots; S = share-rented plots.

Note: An explicit question about slope was not posed in the 2011 through 2013 survey years, so those years are omitted for soybeans, barley, and sorghum. The survey years for each crop are provided below the surveyed crop. Error bars denote the 95-percent confidence interval. Percent of fields is estimated as a proportion, and the limits of the confidence intervals are calculated using a logit transformation. Responses are weighted by USDA's National Agricultural Statistics Service Phase II field-level survey weights for each commodity.

Source: USDA, Economic Research Service using Agricultural Resource Management Survey Phase II data.

Table 9

Proportion of fields by tenure group with moderate or steep grades, by percentage, 2011–21

Crop	Survey year 1 (percent)			Survey year 2 (percent)		
	Owner-operated	Cash-rented	Share-rented	Owner-operated	Cash-rented	Share-rented
Corn	61.68	59.43	50.19**	58.45	52.30	44.23**
Soybeans	NA	NA	NA	53.32	54.24	53.99
Barley	NA	NA	NA	58.14	65.80	40.06
Sorghum	NA	NA	NA	53.66	59.76	55.77
Cotton	49.88	39.67*	44.29	42.41	35.88	47.24

Statistical significance levels: ** = 5 percent; * = 10 percent.

NA = not available.

Note: The numbers under "Survey year 1" indicate the proportion for the first observed survey year. The first year for each crop is corn in 2016, soybeans in 2012, barley in 2011, sorghum in 2011, and cotton in 2015. The numbers under "Survey year 2" indicate the proportion for the second observed survey year. The second year for each crop is corn in 2021, soybeans in 2018, barley in 2019, sorghum in 2019, and cotton in 2019. The asterisks indicate if the averages for cash- or share-rented fields are statistically different from the averages for owner-operated fields. Responses are weighted by USDA's National Agricultural Statistics Service Phase II field-level survey weights for each commodity.

Source: USDA, Economic Research Service using Agricultural Resource Management Survey Phase II data.

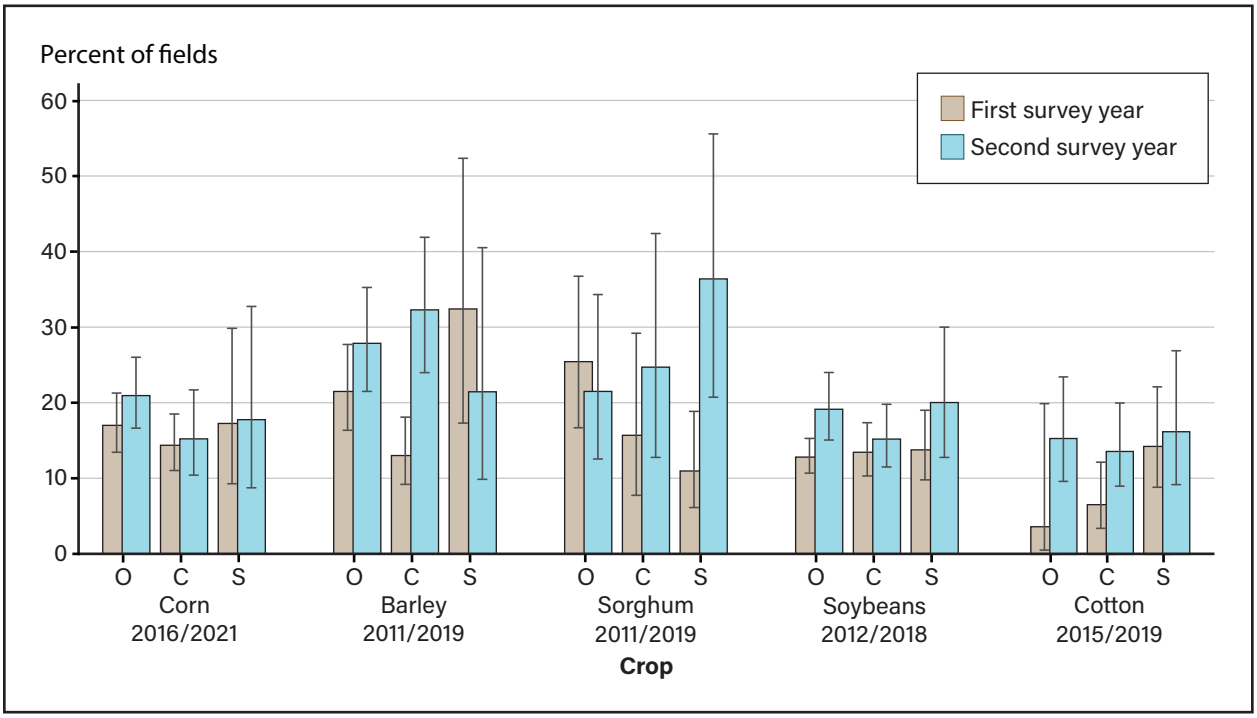
To participate in most USDA programs, operators managing highly erodible land (HEL) fields, as designated by USDA's Farm Service Agency, must follow an approved conservation plan, which could include practices such as no-till or cover-cropping. The authors find no systemic differences between owner-operated plots and rented plots in the proportions of fields that are designated as highly erodible. (table 10, figure 14).[7] There are three crop-survey years in which the differences between owner-operated plots and rented plots are statistically significant at the 5-percent level (cash-rented fields for barley growers in 2011, share-rented fields for sorghum growers in 2011, and share-rented fields for cotton growers in 2015), two of which the renter group has a lower average than the owner-operator group (cash-rented fields for barley growers in 2011 and share-rented fields for sorghum growers in 2011).

The overall parity between owner-operated and rented plots in the prevalence of both sloped and highly erodible fields may speak to the overall flexibility of land rental markets. If renters are less willing to operate on sloped or previously designated HEL fields, landlords will have to lower the rental rate and/or contribute to the efforts to follow a conservation plan.

[7] The provisions for highly erodible land and wetland conservation policies can be found on the USDA's Farm Service Agency's Conservation Compliance website.

Figure 14

Percentage of crop acreage with highly erodible land across crops and years of USDA's Agricultural Resource Management Survey (ARMS), 2011–21



O = owner-operated plots; C = cash-rented plots; S = share-rented plots.

Note: Error bars denote the 95-percent confidence interval. Percent of fields is estimated as a proportion, and the limits of the confidence intervals are calculated using a logit transformation. Responses are weighted by USDA's National Agricultural Statistics Service Phase II field-level survey weights for each commodity.

Source: USDA, Economic Research Service using Agricultural Resource Management Survey (ARMS) Phase II data.

Table 10

Prevalence of highly erodible land designations for rented plots versus owner-operated plots, by percentage, 2011–21

Crop	Survey year 1 (percent)			Survey year 2 (percent)		
	Owner-operated	Cash-rented	Share-rented	Owner-operated	Cash-rented	Share-rented
Corn	17.00	14.37	17.26	20.94	15.22*	17.76
Soybeans	12.80	13.45	13.76	19.13	15.19	20.02
Barley	21.49	13.01**	32.41	27.86	32.29	21.44
Sorghum	25.43	15.69	10.97**	21.49	24.71	36.38
Cotton	3.66	6.58	14.29**	15.34	13.63	16.24

Statistical significance levels: ** = 5 percent; * = 10 percent.

HEL = highly erodible land.

Note: The first year for each crop is corn in 2016, soybeans in 2012, barley in 2011, sorghum in 2011, and cotton in 2015. The numbers under "Survey year 2" indicate the average HEL rate for the second observed survey year. The second year for each crop is corn in 2021, soybeans in 2018, barley in 2019, sorghum in 2019, and cotton in 2019. The asterisks indicate if the averages for cash- or share-rented fields are statistically different from the averages for owner-operated fields. Responses are weighted by USDA's National Agricultural Statistics Service Phase II field-level survey weights for each commodity.

Source: USDA, Economic Research Service using Agricultural Resource Management Survey Phase II data.

Contract Characteristics: Norms and Institutions

The nature of land contracting in the domestic agricultural sector can inform how tenants may behave in the context of soil stewardship and conservation practice adoption. As displayed in the previous section, rented cropland is present at different acreage proportions for major commodity crops. Although how remuneration takes place is the main difference between the forms of agreements, contracts can differ across other dimensions in ways that may impact conservation. The level of contract formality, the level at which landlords get involved in decision making on the plot of rented land, the role of family, and the frequency of long-term rental relationships are explored in the TOTAL survey.

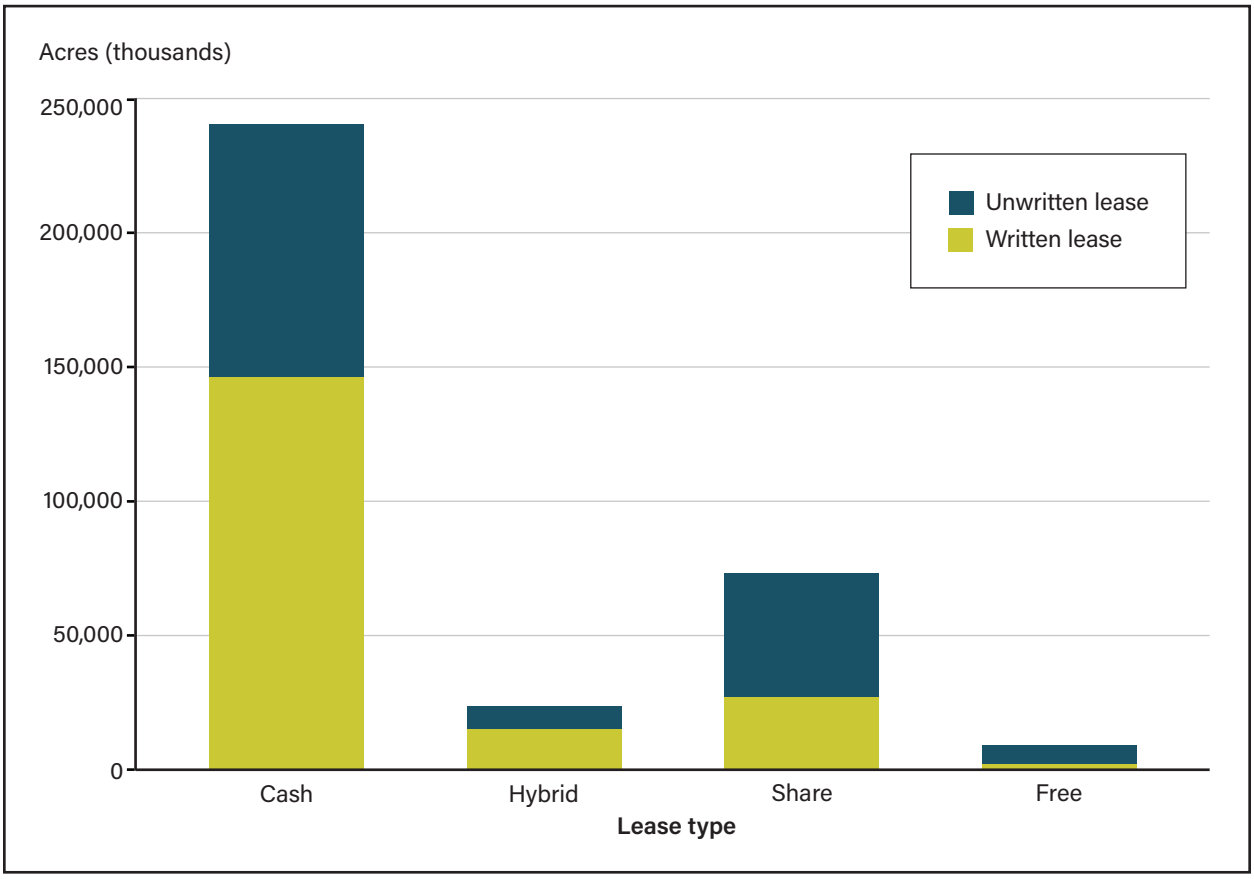
Informal Contracts

The 2014 TOTAL survey questioned landlords across all types of farmlands (cropland, pastureland, orchards, vineyards, farm woodlands, and other land uses) about the written formality of their rental contracts with tenants.[8] As of 2014, 39 percent of all rented farmland acreage in the lower 48 States in cash contracts is under unwritten rental agreements (figure 15). Of the acreage in share contracts, 63 percent are under unwritten rental agreements. Hybrid contracts had the highest proportion of acreage under written rental agreements, with 35 percent of acreage under unwritten rental agreements. This is intuitive as hybrid contracts tend to be more complicated in nature; that is, hybrid leases arguably require more clauses than a cash-rental contract. Free contracts, which require no remuneration from the tenant, show the largest share (75 percent) of acreage under unwritten agreements. Intuitively, free contracts would likely be unwritten as such agreements are arguably based on nonarm's-length transactions. Across total acreage, 45 percent of agreements are under unwritten contracts.

In the United States, about 155 million acres of farmland is under unwritten rental contracts (figure 15). Because conservation programs require that participants present proof of the use of the working land (such as a written lease agreement) to obtain a farm tract number, this implies that it would be nearly impossible to enroll in any of the incentive programs for operators with unwritten leases (USDA, NRCS, 2022a).

[8] The TOTAL survey asked landlords detailed questions about the rental agreements with their three largest (in terms of acres rented) tenants. Information collected on rental agreements through the TOTAL survey represents 98 percent of rented farmland. A note has been provided under each figure affected by this truncation.

Figure 15
Farmland acreage by lease type, 2014



TOTAL = Tenure, Ownership, and Transition of Agricultural Land.

Note: Each response is weighted by TOTAL renter-level survey weights.

Source: USDA, Economic Research Service using data from USDA's 2014 Tenure, Ownership, and Transition of Agricultural Land survey.

In a survey of farms in Nebraska and South Dakota, Allen & Lueck (1992a) found that 57 percent of all contracts were oral in nature, and the nonverbal (or written) contracts were short (generally one to three pages) and stipulated little details about land use. Farmland lease agreements tend to be simple contracts—the lease agreements generally do not contain transaction-specific assets other than the surface area of the land itself. Thus, the transaction costs appear to be too high for more complicated agreements, and these types of arrangements can perpetuate through time, provided that both parties are satisfied with the contractual agreement. The prevalence of verbal contracts could be indicative of an accumulated trust between the landlord and tenant, which suggests the tenant will not exploit the soil for short-term gain.

Monitoring and Enforcement

Monitoring serves to document a firm's or individual's compliance with the law (Langevoort, 2002). Monitoring is the formal (or informal) process by which the principal (landlord) or agent (farmland tenant) ensures that the other party is fulfilling the tenancy contract. When leasing land, to prevent a tenant from overworking the soil, a landlord may attempt to contract certain production decisions—the types of crops grown, the types of fertilizer or pesticide used, tillage decisions, conservation practices adopted, or participation in government programs (regardless of whether the contract is written, although it is usually easier to enforce provisions if the contract is written). Whether a landlord includes such clauses will depend on how easy it is to monitor tenant behavior and the payoff from monitoring.

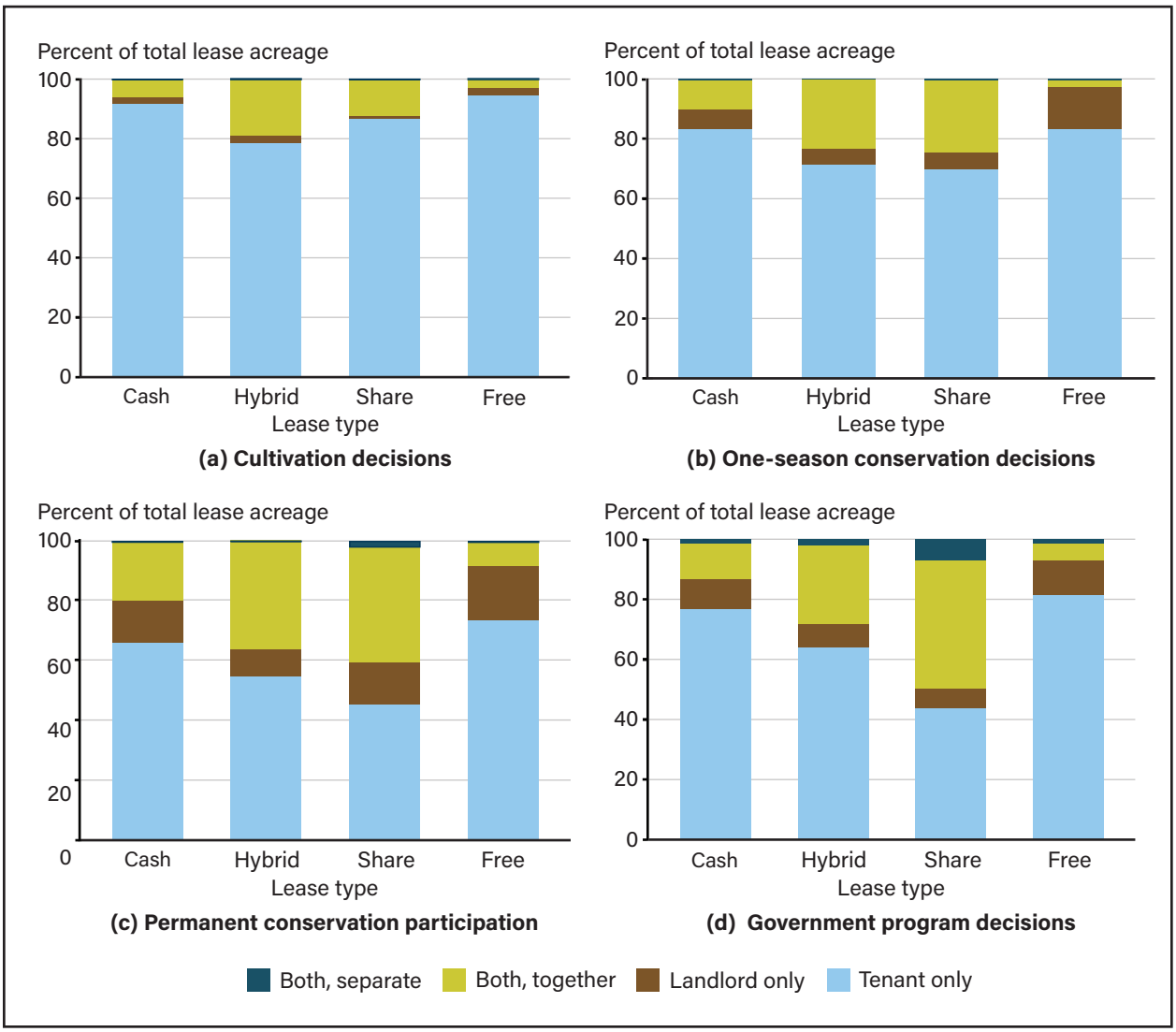
The 2014 TOTAL survey questioned landlords on how involved they are in certain aspects of decision making on leased plots. Four of those questions dealt with decisions related to conservation practices—cultivation decisions, adoption of one-season conservation practices, adoption of permanent cultivation practices, and participation in government programs.[9] Available answers included decisions made by the tenant only, landlord only, tenant and landlord together, and tenant and landlord separately.

Cultivation and one-season conservation practice decisions are primarily made by the tenant only for most acreage across the four rental contract types (figure 16).[10] Intuitively, the landlord is involved in some capacity for hybrid and share contracts more often than cash contracts, as input costs are often shared in hybrid or share arrangements. If the landlord is involved in the decision making, it is most often done together with the tenant. These findings are in line with prior literature. Ranjan et al. (2019) found that nonoperating landowners are generally not involved with short-term farm management practices and decisions. Permanent conservation practices and government program participation decisions more often involve the landlord, especially with hybrid and share arrangements.

[9] It should be noted that government programs service numerous facets of domestic agriculture outside of conservation. Examples include USDA's Farm Service Agency loans, crop and livestock insurance, and Federal State Marketing Improvement grants, among several others.

[10] The landlord may exercise some control over production and conservation decisions by selecting a specific tenant. This is based on conjecture as the TOTAL survey does not provide data on whether a landlord selects a tenant based on farming practices.

Figure 16
Percent of total lease acreage by lease type and decision-making authority: Government program participation, management decisions, and conservation practices, 2014



TOTAL = Tenure, Owenership, and Transition of Agricultural Land.

Note: Each response is weighted by TOTAL renter-level survey weights.

Source: USDA, Economic Research Service using data from USDA's 2014 Tenure, Ownership, and Transition of Agricultural Land survey.

Social Norms as an Enforcement Mechanism

The monitoring of the production practices of a farmer can come from local peer groups (Saak, 2012). Social norms are defined as the customary or ideal forms of behavior by which individuals within a group attempt to conform (Burke & Young, 2011). According to Burke and Young (2011), social norms induce positive feedback loops between individual members and a group such that the more widely a norm is practiced by the group, the more strongly the motivations for each individual member.

Saak (2012) suggests that monitoring and social norms influence the reputation of regional products and production.[11] Also, Allen and Lueck (1992a) found that monitoring and social norms act as an enforcement mechanism for farmland contracts, in which cheaters are punished through lost future trades and a farmer's collective reputation encourages cooperation between contract parties.

Social norms are not covered explicitly in either the ARMS or TOTAL surveys. Yet, social norms can serve as powerful motivating factors to encourage land stewardship outside of governmental policies.

Family as Tenants

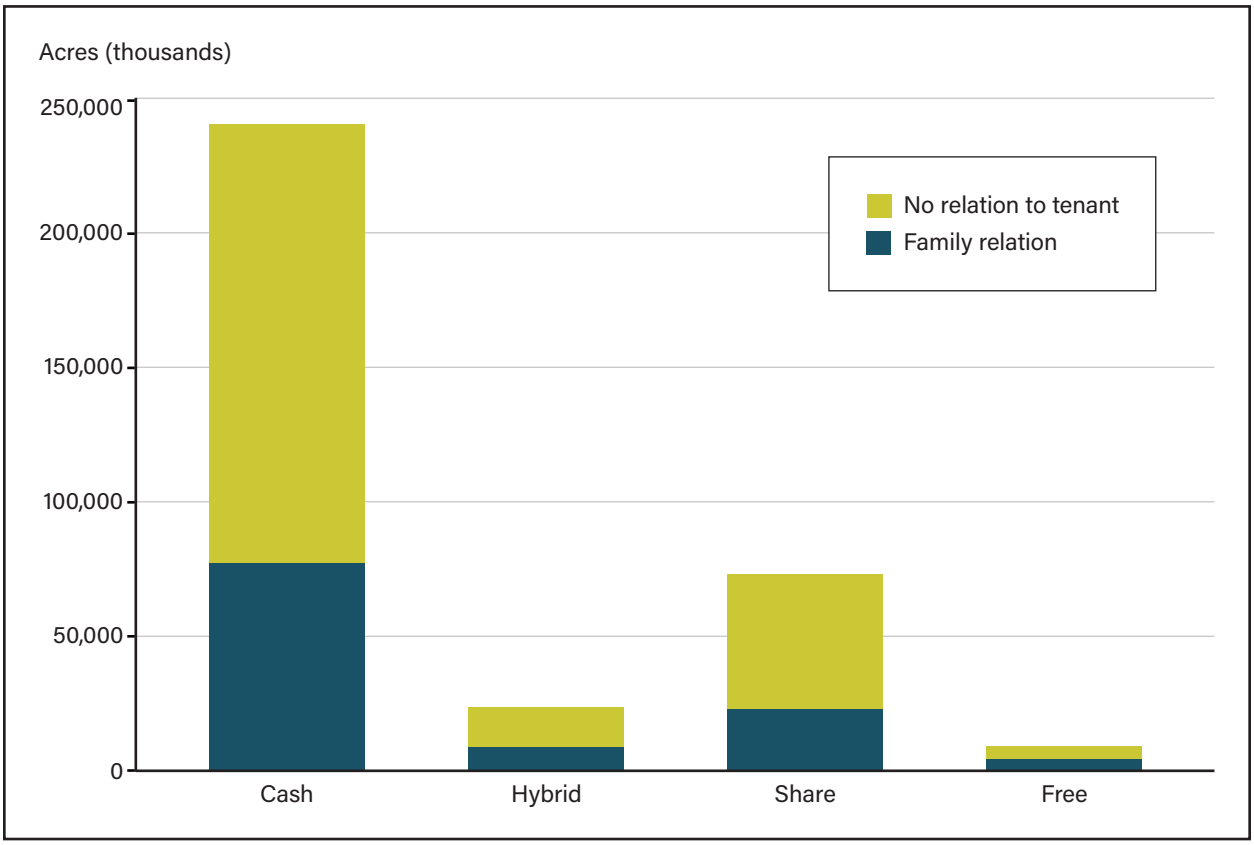
Small family farms comprised 89 percent of farm operations and 48.3 percent of farm acreage in the United States in 2020 (Whitt et al., 2021).[12] Family farms across size categories (small, midsize, and large-scale) comprised 93.5 percent of all farm acreage in 2020. Given the prevalence of family operations, one would expect land rentals to family members to be common. As of 2014, 32.2 percent of all cash-rented acreage in the lower 48 States is rented to a relation, compared with 37.6 percent of hybrid-lease acreage, 31.9 percent of share acreage, and 50.5 percent of free acreage (figure 17).

A tenant renting from a family member may potentially inherit the land or be a preferred buyer if the current owner decides to sell. Therefore, it is an open question as to whether a family tenant would be more likely to engage in conservation practices or soil stewardship if that person may own the land in the future when compared with an unrelated tenant. Otherwise, even if ownership is not a future possibility, simply the existence of a familial relationship with the landlord may be enough for a tenant to engage in enhanced soil stewardship.

[11] Social norms can be a motivating factor for the adoption of agricultural conservation practices (Schwartz, 1977; Stern, 2000; Fishbein & Ajzen, 2010). As such, farmland tenants may choose to adopt conservation in the absence of monitoring.

[12] Family farms are defined by the USDA as any farm organized as a sole proprietorship, partnership, or family corporation. This category of farms excludes farms organized as nonfamily corporations or cooperatives (USDA, National Institute of Food and Agriculture, 2023).

Figure 17
Farmland acreage by lease type and family relation, 2014



TOTAL = Tenure, Ownership, and Transition of Agricultural Land.

Note: Each response is weighted by TOTAL renter-level survey weights.

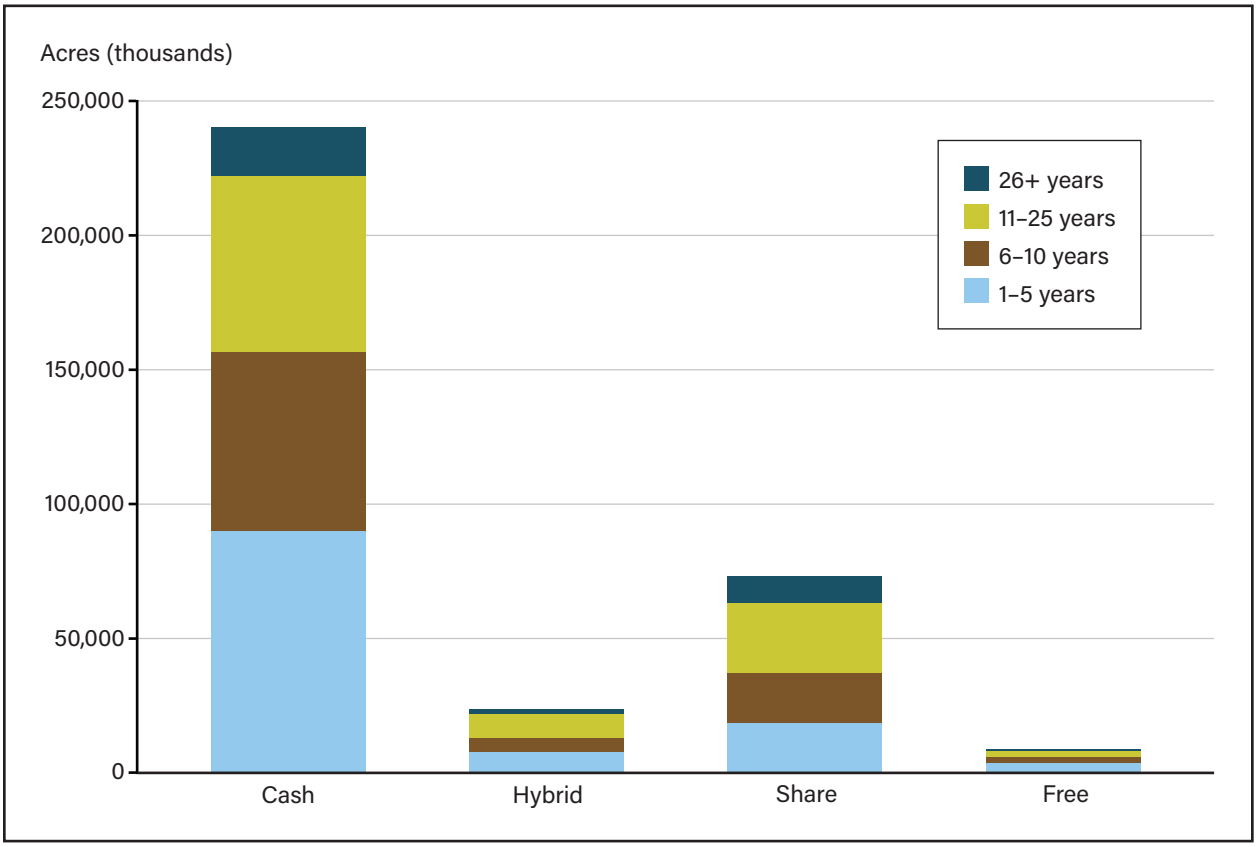
Source: USDA, Economic Research Service using data from USDA's 2014 Tenure, Ownership, and Transition of Agricultural Land survey.

Long-Term Rental Relationships

Tenants who have operated a particular plot for several years and have an expectation of long-term cultivation might act as if they own the attributes of the land, and any negative or positive consequences of their management practices will materialize during their tenure.[13] The 2014 TOTAL survey questioned landlords on how long they had been leasing to their current tenants. As of 2014, 34.7 percent of all cash-rented acreage in the lower 48 States is rented to tenants who have occupied the plot for longer than 10 years (figure 18). Also, 48.9 percent of share-rented acreage is rented by tenants who have occupied the plot for longer than 10 years. Given the relatively large percentage of renters who have occupied a field for more than 10 years, it is conjecturable whether such a tenant will operate as if they own the land when making management decisions.

[13] This argument is conjecturable. Even though a tenant has been renting the same plot of land for a lengthy period, there is no guarantee that the landlord will continue the agreement. Farmland lease contracts are often set for 1 year with the option to renew. Thus, the length of time a tenant has been operating a land parcel may not determine the tenant's willingness to implement long-term practices.

Figure 18
Farmland acreage by lease type and tenure duration, 2014



+ = more than

TOTAL = Tenure, Ownership, and Transition of Agricultural Land.

Note: Each response is weighted by TOTAL renter-level survey weights.

Source: USDA, Economic Research Service using data from USDA's 2014 Tenure, Ownership, and Transition of Agricultural Land survey.

Conclusion

There is a longstanding debate about whether farmland renters treat the land the same as landowners. The debate is based on the premise that renters potentially invest less time and resources in land stewardship (relative to owner-operators) and are more concerned with short-run economic returns due to tenure insecurity. Based on this premise, this report examines patterns in conservation practice adoption across numerous crop types and years of the Agricultural Resource Management Survey (ARMS).

As about 40 percent (or approximately 355 million acres) of farmland in the 48 contiguous States is rented, understanding farmland tenants' motivations and behaviors offers potential implications for conservation, water quality, carbon sequestration, and wildlife habitat.

This report covers conservation practice adoption and behavior across 10 survey years of the USDA's ARMS, from 2011 to 2021 (as well as the 2014 TOTAL survey). Arguably, landowners are incentivized to support the quality of their agricultural land (one of the largest assets for their farm operation), so renter conservation behavior relative to owners is also examined. Different from the findings of Soule et al. (2000), this report finds that for most surveyed crop years at the national level, cash- and share-rented plots adopt conservation tillage systems as often as owner-operated plots.

There are, however, notable regional exceptions to this report's findings on the adoption of conservation tillage systems. For example, in the Prairie Gateway and Northern Great Plains regions, share-rented plots exhibit higher soil disturbance than owner-operated plots for corn growers in 2021 and corn growers in 2016. Soil disturbance is also higher for share-rented cotton plots in the Mississippi Portal and Southern Seaboard. Such a differential does not exist in the other cotton-producing regions (Fruitful Rim and Prairie Gateway). Soil disturbance is also higher in the Mississippi Portal for share-rented soybean plots.

The general parity between owner-operated and rented plots in soil disturbance could potentially reflect the benefits schedule exhibited by conservation tillage systems. Conservation tillage yields immediate benefits in the form of reduced labor, energy use, and time. In addition, operators can purchase a no-till planter and use it on both owner-operated and rented plots without having to switch machinery.

This report extends the original journal article of Soule et al. (2000) on conservation tillage adoption to also explore cover cropping and the adoption of structural practices. The analyses for cover cropping adoption are slightly mixed. That is, cash-rented plots initially trail owner-operated plots (in the adoption of cover cropping) at the national level in 2016 among corn growers, but the difference in 2021 is not significant. Share-rented plots trail owner-operated plots at the national level across all surveyed crop years, with the difference being statistically significant at the 5-percent or 10-percent level for corn in 2016, corn in 2021, soybeans in 2018, barley in 2019, and cotton in 2015.

These differences between share-rented and owner-operated plots for cover crop adoption, however, are usually not present in the regions of highest production for the specific crop. For example, the Heartland region generated 60 percent of total U.S. corn production in 2021 and 61 percent of total U.S. soybean production in 2018. Focusing on the Heartland region reveals that adoption rates of share-rented plots in that region are not statistically different than adoption rates of owner-operated plots in 2016, 2018, or 2021. Similarly, while share-rented plots trail owner-operated plots nationally for cotton growers in 2015 and 2019, they do not trail owner-operated plots in the Prairie Gateway and Fruitful Rim regions, which generated 58 percent of total U.S. cotton production in 2017.

Analyses of structural practice adoption are offered in the appendix. This report finds there is often no statistically significant difference in the adoption of both on-field and off-field structural practices on cash- or share-rented fields compared with owner-operated fields. Exceptions include cash-rented plots for corn growers in 2021—for which lower rates of adoption for on-field structural practices were found—and share-rented plots for soybean growers in 2018—for which lower rates of adoption for off-field structural practices were noted. The general parity between owner-operated and rented plots could reflect how the question of structural practice adoption is presented in ARMS. The question asks if the practice was solely used in the survey year, but there is not a question about whether the practice was installed prior to the survey year. The terrace, waterway, or contour system could have been installed by the landlord in the past when the field was owner-operated or otherwise installed by the landlord unilaterally to try to increase the field's rental or sales price.

The current analyses in this report cannot control for confounding factors that may affect an operator's decision to adopt conservation agriculture. Examples of such confounders include how operators would behave in the absence of Government agricultural conservation programs or an operator's general attitudes toward conservation. Additionally, this report raises a potentially interesting issue, which is the inverse of the hypothesis posed here: Does a tenant's conservation behavior potentially affect tenure security? In other words, a tenant's conservation behavior may affect their tenure security instead of tenure security affecting their conservation behavior. Finally, the research in this report could have benefited by using panel data regression analyses in which the observations are pooled across time. Such an approach would allow for USDA, ERS researchers to control for some heterogeneous and unobserved confounders that would affect conservation adoption among farmland tenants. Arguably, this approach would not invalidate the current report's findings, but it would likely yield more precise estimates of conservation adoption by tenure groups.

The 2014 TOTAL survey was used to explore the institutional factors of the farm economy that could influence practice adoption across owners and renters. Although conventional wisdom would suggest that the medium- to long-term benefit schedules of certain practices may dissuade renters from adopting them, the social capital in a farm community—trust, landlords active in decision-making, the presence of long-term rental relationships, and family relations—have the potential to mitigate this impediment to conservation.

References

Abdalla, M., Hastings, A., Cheng, K., Yue, Q., Chadwick, D., Espenberg, M., Truu, J., Rees,R. M., & Smith, P. (2019). A critical review of the impacts of cover crops on nitrogen leaching, net greenhouse gas balance and crop productivity. Global Change Biology, 25(8), 2530–2543.

Al-Kaisi, M. M., Archontoulis, S. V., Kwaw-Mensah, D., & Miguez, F. (2015). Tillage and crop rotation effects on corn agronomic response and economic return at seven Iowa locations. Agronomy Journal, 107(4), 1411–1424.

Allen, D. W., & Borchers, A. (2016). Conservation practices and the growth of US cash rent leases. *Journal of Agricultural Economics*, 67 (2): 491–509.

Allen, D. W., & Lueck, D. (1992a). The "Back Forty" on a handshake: Specific assets, reputation, and the structure of farmland contracts. *Journal of Law, Economics, and Organization*, 8(2), 366–376.

Allen, D. W., & Lueck, D. (1992b). Contract choice in modern agriculture: Cash rent vs. cropshare. *Journal of Law and Economics*, 35, 397–426.

Allen, D. W., & Lueck. D. (1993). Transaction costs and the design of cropshare contracts. *RAND Journal of Economics*, 24(1), 78–100.

Allen, D. W., & Lueck, D. (1995). Risk preferences and the economics of contracts. *American Economic Review*, *Papers and Proceedings*, 447–451.

Allen, D. W., & Lueck, D. (1999). The role of risk in contract choice. *Journal of Law, Economics, and Organization*, 15(3), 704–736.

Allen, D. W., & Lueck. D. (2002). *The Nature of the Farm: Contracts, Risks, and Organization in Agriculture* (8th ed.). Cambridge: MIT Press.

Allen, D. W., & Lueck, D. (2005). *Handbook of New Institutional Economics: Agricultural Contracts*. In C. Ménard and M. M. Shirley (Eds.), *Handbook of New Institutional Economics* (pp. 465–490). Amsterdam: Springer.

Anderson, A. E., Hammac, W. A., Stott, D. E., & Tyner, W. E. (2020). An analysis of yield variation under soil conservation practices. *Journal of Soil and Water Conservation*, 75(1), 103–111.

Baumgart-Getz, A., Prokopy, L. S., & Floress, K. (2012). Why farmers adopt best management practice in the United States: A meta-analysis of the adoption literature, *Journal of Environmental Management*, 96(1), 17–25.

Bigelow, D., Borchers, A., & Hubbs, T. (2016). *U.S. farmland ownership, tenure, and transfer* (Report No. EIB-161). U.S. Department of Agriculture, Economic Research Service.

Braverman, A., & Stiglitz, J. E. (1986). Cost-sharing arrangements under sharecropping: Moral hazard, incentive flexibility, and risk. *American Journal of Agricultural Economics*, 68(3), 642–652.

Burke, M. A., & Young, H. P. (2011). Social Norms. In A. Bisin, J. Benhabib & M. Jackson (Eds.), *The Handbook of Social Economics*. Amsterdam: North-Holland.

Carter, M. R. (2005). Encyclopedia of soils in the environment: Conservation tillage. (D. Hillel, Ed.). Elsevier.

Cassida, K. (2020). *Using the sorghum family as both cover crop and forage*. Michigan State University Extension. Retrieved November 2022.

Cheung, S. N. S. (1969). *The theory of share tenancy*. University of Chicago Press.

Claassen, R., Bowman, M., Breneman, V., Wade, T., Williams, R., Fooks, J., Hansen, L., Iovanna, R., & Loesch, C. (2017) *Conservation compliance: How farmer incentives are changing in the crop insurance era* (Report No. ERR-234). U.S. Department of Agriculture, Economic Research Service.

Claassen, R., Bowman, M., McFadden, J., Smith, D., & Wallander, S. (2018). *Tillage intensity and conservation cropping in the United States* (Report No. EIB-197). U.S. Department of Agriculture, Economic Research Service.

Creech, E. (2021). *Saving money, time and soil: The economics of no-till farming*. U.S. Department of Agriculture, Natural Resources Conservation Service. Retrieved February 2023.

Dorner, P. (1964). Land tenure, income distribution and productivity interactions. *Land Economics*, 40(3), 247–254.

D'Souza, G., Cyphers, D., & Phipps, T. (1993). Factors affecting the adoption of sustainable agricultural practices. *Agricultural and Resource Economics Review*, 22(2), 159–165.

Dubois, P. (2002). Moral hazard, land fertility and sharecropping in a rural area of the Philippines. *Journal of Development Economics*, 68, 35–64.

Ervin, C. A., & Ervin, D. E. (1982). Factors affecting the use of soil conservation practices: Hypotheses, evidence and policy implications. *Land Economics*, 58(3), 277–292.

Food and Agriculture Organization of the United Nations. (2002). *Land tenure and rural development*. FAO Land Tenure Studies 3. Retrieved September 2021.

Featherstone, A.M., & Goodwin, B.K. (1993). Factors influencing a farmer's decision to invest in long-term conservation improvements. *Land Economics*, 69(1), 67–81.

Fishbein, M., & Ajzen, I. (2010). *Predicting and changing behavior: The reasoned action approach*. Psychology Press.

Fukunaga, K., & Huffman, W. E. (2009). The role of risk and transaction costs in contract design: Evidence from farmland lease contracts in U.S. agriculture. *American Journal of Agricultural Economics*, 91(1), 237–249.

Goldney, G. P., Cooke, G. W., & Griffiths, W. R. (1882). *A Treatise on the Law and Practice of Agricultural Tenancies*. London: Stevens and Sons.

Hart, O.D. (1988). Incomplete contracts and the theory of the firm. *Journal of Law, Economics, and Organization*, 4(1), 119–139.

Heady, E. (1947). Economics of farm leasing systems. *Journal of Farm Economics*, 29, 659–678.

Heimlich, R. (2000). *Farm resource regions* (Report No. AIB-760). U.S. Department of Agriculture, Economic Research Service.

Herzfeld, T. & Jongeneel, R. (2012). Why do farmers behave as they do? Understanding compliance with rural, agricultural, and food attribute standards. *Land Use Policy*, 29(1), 250–260.

Knutson, J. (1989). Multi-year leases encourage conservation and long-term farming goals. Ag Week 24 (December 11).

Knowler, D., & Bradshaw, B. (2007). Farmers' adoption of conservation agriculture: A review and synthesis of recent research. *Food Policy*, 32, 25–48.

Lambert, D. M., Sullivan, P., Claassen, R., & Foreman, L. (2007). Profiles of US farm households adopting conservation-compatible practices. *Land Use Policy*, 24(1), 72–88.

Langevoort, D. C. (2002). Monitoring: The behavioral economics of corporate compliance with law. *Columbia Business Law Review*, 71, 71–117.

Lynne, G. D., Shonkwiler, J. S., & Rola, L. R. 1988. Attitudes and farmer conservation behavior. *American Journal of Agricultural Economics*, 70(1), 12–19.

Marshall, A. (1890). *Principles of Economics* (8th ed.). London: Macmillan.

Mill, J. S. (1857). *Principles of Political Economy* (4th ed.). London: John W. Parker.

Newberry, D. M. G., & Stiglitz, J. E. (1979). Sharecropping, Risk Sharing and the Importance of Imperfect Information. In J.A. Roumasset (Ed.), *Risk, Uncertainty, and Agricultural Development*, (pp 311–341). New York: Agricultural Development Council.

Nielsen, E. G., Miranowski, J. A., & Morehart, M. J. (1989). *Investments in soil conservation and land improvements: Factors explaining farmers' decisions* (Report No. AER-601). U.S. Department of Agriculture, Economic Research Service.

Norris, P. E., & Batie, S. S. (1987). Virginia farmers' soil conservation decisions: An application of tobit analysis. *Southern Journal of Agricultural Economics*, 79–90.

Otsuka, K., Chuma, H., & Hayami, Y. (1992). Land and labour contracts in agrarian economies: Theories and facts. *Journal of Economic Literature*, 30, 1965–2018.

Paulson, N. D., & Schnitkey, G. D. (2013). Farmland rental markets: Trends in contract type, rates, and risk. *Agricultural Finance Review*, 73(1), 32–44.

Prokopy, L. S., Floress, K., Arbuckle, J. G., Church, S. P., Eanes, F. R., Gao, Y., Gramig, B. M., Ranjan, P., & Singh, A. S. (2019). Adoption of agricultural conservation practices in the United States: Evidence from 35 years of quantitative literature. *Journal of Soil and Water Conservation*, 74(5), 520–534.

Ranjan, P., Wardropper, C. B., Eanes, F. R., Reddy, S. W., Harden, S. C., Masuda, Y. J., & Prokopy, L. S. (2019). Understanding barriers and opportunities for adoption of conservation practices on rented farmland in the U.S. *Land Use Policy*, 80, 214–223.

Ranjan, P., Arbuckle, J. G., Church, S. P., Eanes, F. R., Floress, K., Gao, Y., Gramig, B. M., Singh, A. S., & Prokopy, L.S. (2022). Understanding the relationship between land tenure and conservation behavior: Recommendation for social science research. *Land Use Policy*, 106161.

Roumasset, J. (1995). The nature of the agricultural firm. *Journal of Economic Behavior and Organization*, 26, 161–177.

Saak, A.E. (2012). Collective reputation, social norms, and participation. *American Journal of Agricultural Economics*, 94(3), 763–785.

Sawadgo, W., Zhang, W., & Plastina, A. (2021). What drives landowners' conservation decisions? Evidence from Iowa. *Journal of Soil and Water Conservation*, 76(2), 1–11.

Schnitkey, G., Swanson, K., & Paulson, N. (2021). *Weekly farm economics: Impacts of rental arrangements on cover crop and conservation practice adoption*. Department of Agricultural and Consumer Economics, University of Illinois at Urbana-Champaign.

Schwartz, S.H. (1977). Normative Influences on altruism. *Advances in Experimental Social Psychology*, 10, 221–279.

Sklenicka, P., Janeckova Molnarova, K., Salek, M., Simova, P., Vlasak, J., Sekac, P., & Janovsa, V. (2015). Owner or tenant: Who adopts better soil conservation practices? *Land Use Policy*, 47, 252–261.

Smith, A. (1776). The Wealth of Nations. Modern Library.

Soule, M. J., Tegene, A., & Wiebe, K. D. (2000). Land tenure and the adoption of conservation practices. *American Journal of Agricultural Economics*, 82(2), 993–1005.

Stevens, A. W. (2022). The economics of land tenure and soil health. *Soil Security*, 6.

Stern, M.J. (2018). *Social Science Theory for Environmental Sustainability: A Practical Guide*. Oxford: Oxford University Press.

Stiglitz, J.E. (1974). Incentive and risk sharing in sharecropping. *Review of Economic Studies*, 41, 219–255.

Sustainable Agriculture and Research Education. (2007). *Managing Cover Crops Profitability* (3rd ed.).

The Nature Conservancy. (2019). *Non-operating landowners and conservation on rented farmland: Lessons learned from a year of exploration*. Retrieved February 2023.

U.S. Department of Agriculture. *Climate-smart agriculture and forestry*. Retrieved March 2022.

U.S. Department of Agriculture, Economic Research Service. (2020). *Farmland value*. Retrieved January 2022.

U.S. Department of Agriculture, Economic Research Service. (2021). *ARMS farm financial and crop production practices: What is the Agricultural Resource Management Survey (ARMS)?* Retrieved September 2021.

U.S. Department of Agriculture, National Agricultural Statistics Service. (2021a). *Surveys: Tenure, ownership, and transition of agricultural land*. Retrieved November 2021.

U.S. Department of Agriculture, National Agricultural Statistics Service. (2021b). *Land values: 2021 summary*. Retrieved May 2022.

U.S. Department of Agriculture, National Agricultural Statistics Service. (2022). *Quick stats*. Retrieved January 2023.

U.S. Department of Agricultural, National Institute of Food and Agriculture. (2022). *Family farms*. Retrieved January 2023.

U.S. Department of Agriculture, Natural Resources Conservation Service. (2006a). *Tillage practice guide*. Retrieved May 2022.

U.S. Department of Agriculture, Natural Resources Conservation Service. (2006b). Filter Strip: Michigan Conservation Reserve Program CRP–CP21. Retrieved May 2022.

U.S. Department of Agriculture, Natural Resources Conservation Service. (2016). *Conservation practice standard code 345: Residue and tillage management, reduced tillage.*

U.S. Department of Agriculture, Natural Resources Conservation Service. (2017). *Soil tillage intensity rating*. Retrieved December 2020.

U.S. Department of Agriculture, Natural Resources Conservation Service. (2021). *Cover crops and soil health*. Retrieved December 2021.

U.S. Department of Agriculture, Natural Resources Conservation Service (2022a). *Agricultural conservation easement program*. Retrieved March 2022.

U.S. Department of Agriculture, Natural Resources Conservation Service, (2022b). *Conservation practices on cultivated cropland: A comparison of CEAP I and CEAP II survey data and modeling*. Retrieved February 2023.

U.S. Department of Agriculture, Natural Resources Conservation Service (2023). *Historically underserved farmers and ranchers.* Retrieved August 2023.

Varble, S., Secchi, S., & Gottschalk Druschke, C. (2016). An examination of growing trends in land tenure and conservation practice adoption: Results from a farmer survey in Iowa. *Environmental Management*, 57, 318–330.

Wallander, S., Smith, D., Bowman, M., & Claassen, R. (2021). *Cover crop trends, programs, and practices in the United States* (Report No. EIB-222). U.S. Department of Agriculture, Economic Research Service.

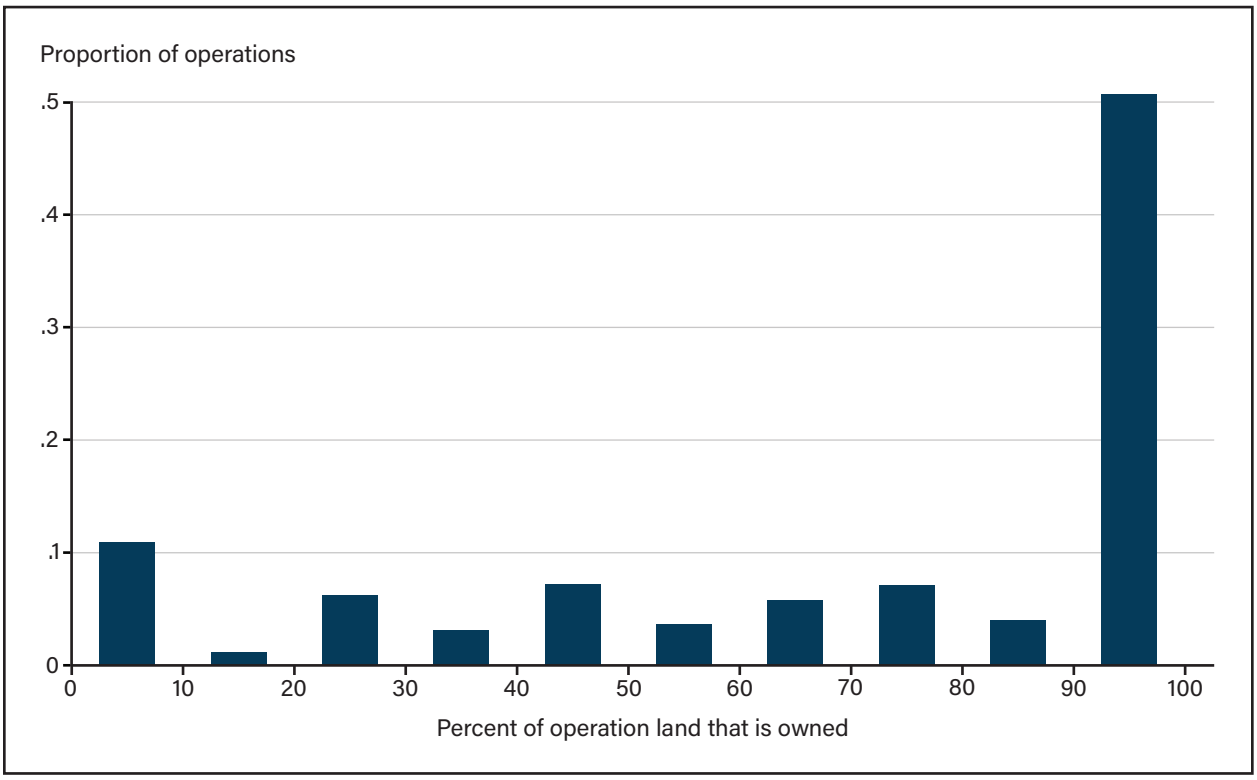
Whitt, C., Todd J., & Keller, A. (2021*). Cover crop trends, America's diverse family farms: 2021 edition* (Report No. EIB-231). U.S. Department of Agriculture, Economic Research Service.

Won, S., Rejesus, R. M., Goodwin, B. K., & Aglasan, S. (2023). Understanding the effect of cover crop use on prevented planting losses. *American Journal of Agricultural Economics*, 106(2), 659–683.

Young, C. E., & Shortle, J. S. (1984). Investments in soil conservation structures: The role of operator and operation characteristics. *Agricultural Economics Research*, 36(2), 10–15.

Appendix A. Land Leasing Within an Operation (Additional Figures)

Figure A.1
Histogram of the percentage of operation land that is owned, based on USDA's Agricultural Resource Management Survey (ARMS) responses from barley growers, 2019

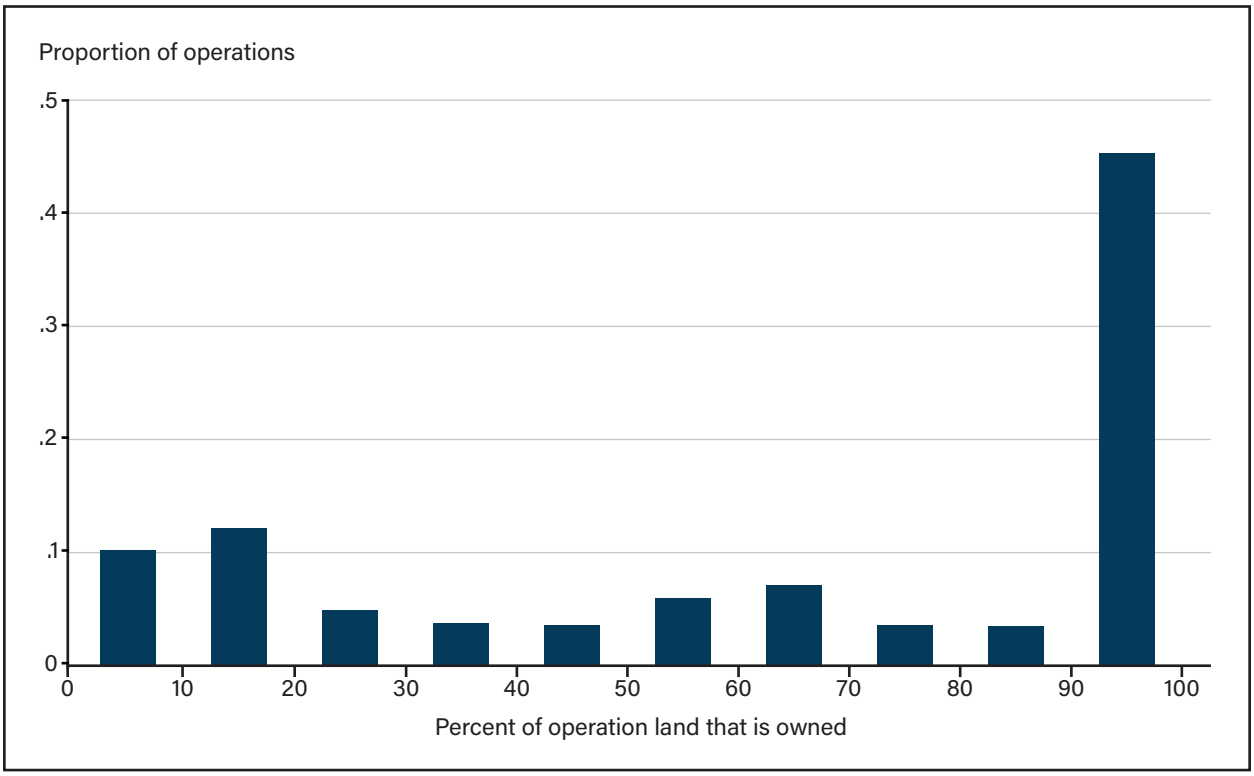


Note: Responses are weighted by USDA's National Agricultural Statistics Service Phase III operation-level survey weights for each commodity.

Source: USDA, Economic Research Service using ARMS Phase III data.

Figure A.2

Histogram of the percentage of operation land that is owned, based on USDA's Agricultural Resource Management Survey (ARMS) responses from sorghum growers, 2019

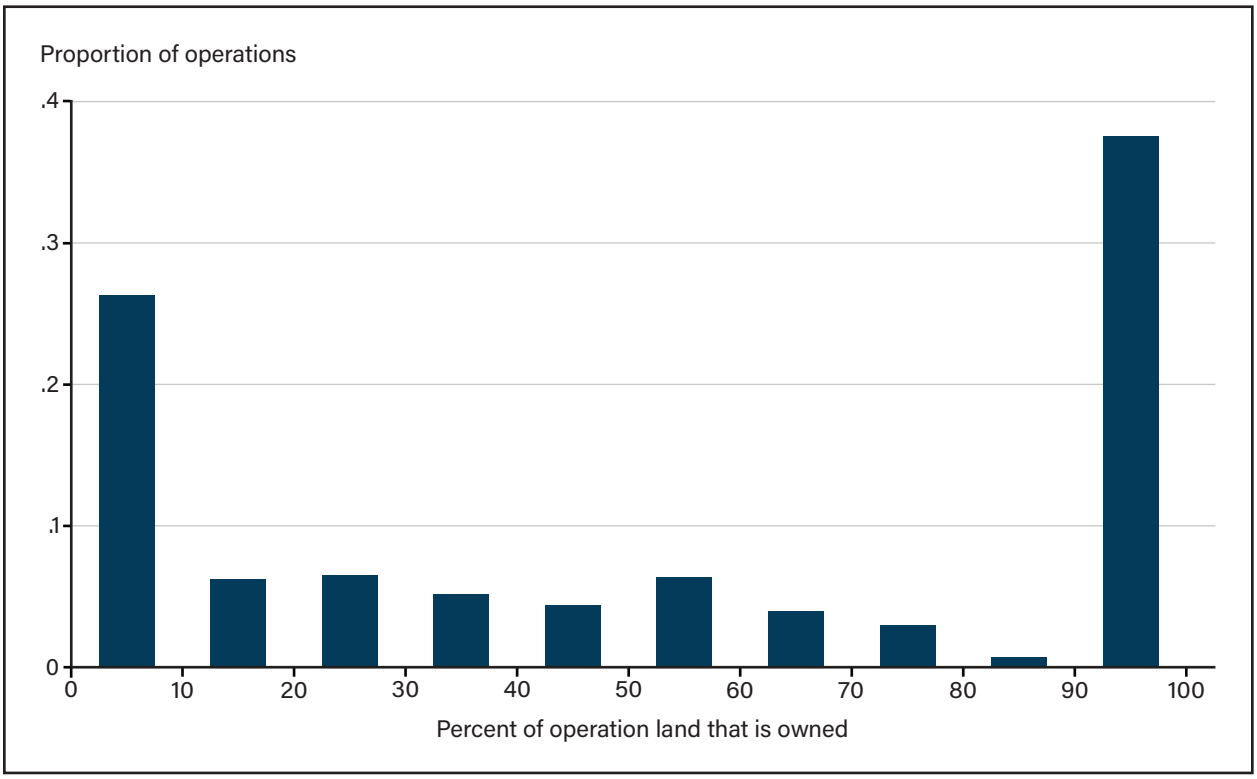


Note: Responses are weighted by USDA's National Agricultural Statistics Service (NASS) Phase III operation-level survey weights for each commodity.

Source: USDA, Economic Research Service using ARMS Phase III data.

Figure A.3

Histogram of the percentage of operation land that is owned, based on USDA's Agricultural Resource Management Survey (ARMS) responses from cotton growers, 2019

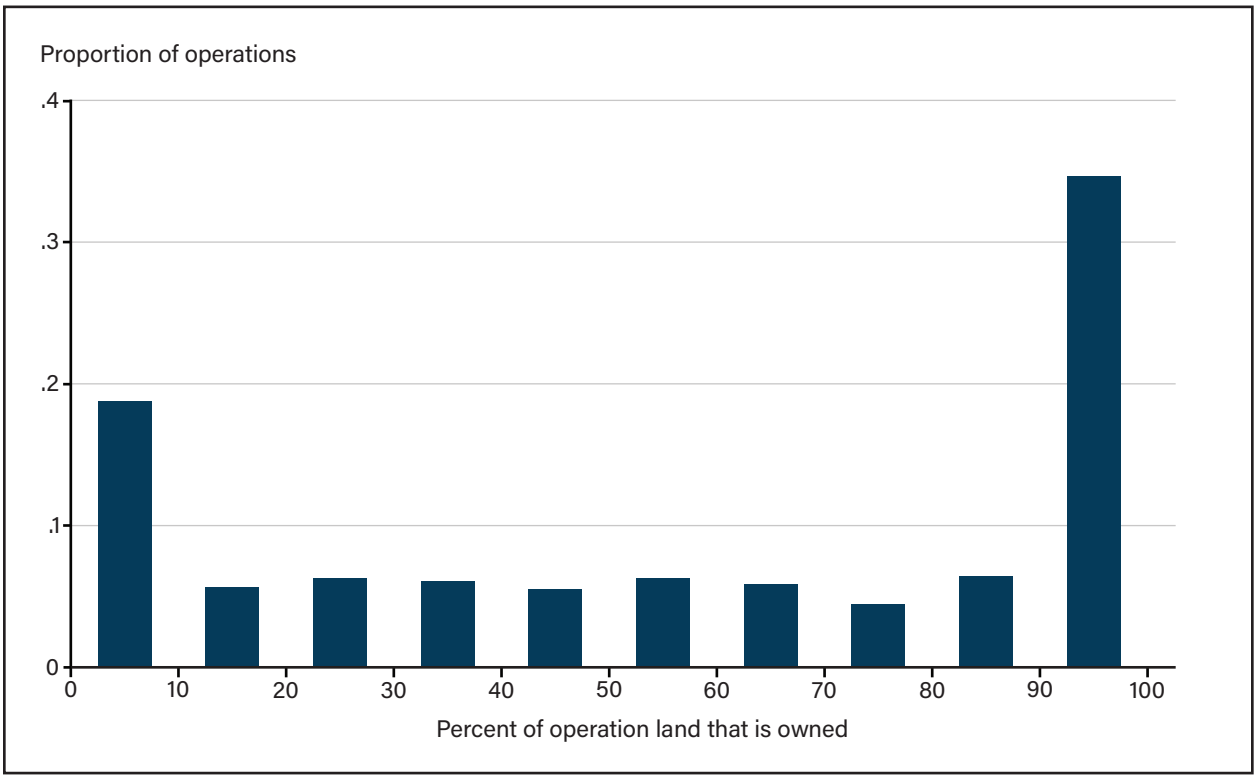


Note: Responses are weighted by USDA's National Agricultural Statistics Service (NASS) Phase III operation-level survey weights for each commodity.

Source: USDA, Economic Research Service using ARMS Phase III data.

Figure A.4

Histogram of the percentage of operation land that is owned, based on USDA's Agricultural Resource Management Survey (ARMS) responses from corn growers, 2021

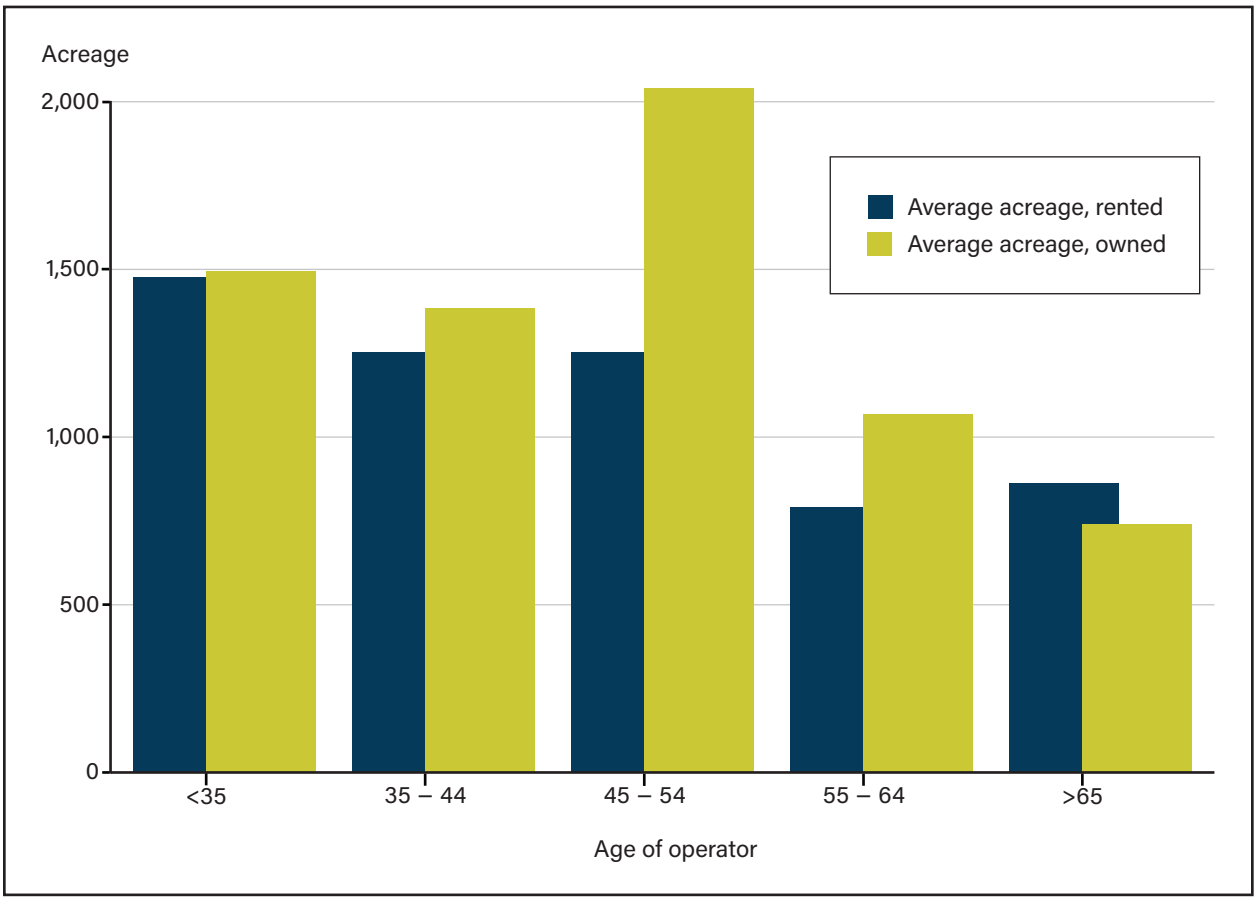


Note: Responses are weighted by USDA's National Agricultural Statistics Service (NASS) Phase III operation-level survey weights for each commodity.

Source: USDA, Economic Research Service using ARMS Phase III data.

Figure A.5

Average owned acres and average rented acres, based on USDA's Agricultural Resource Management Survey (ARMS) responses from barley growers, 2019

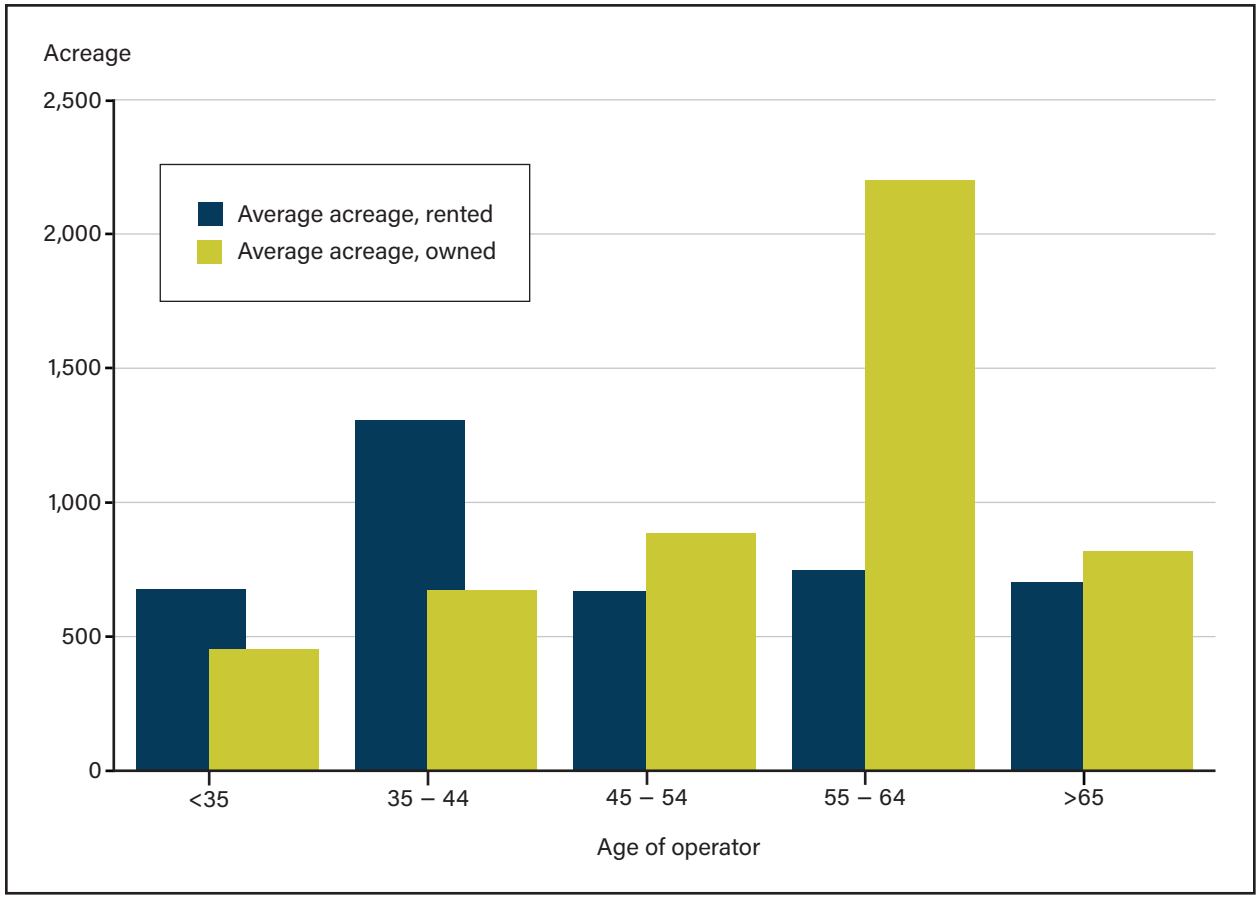


Note: Responses are weighted by USDA's National Agricultural Statistics Service Phase III operation-level survey weights for each commodity crop.

Source: U.S. Department of Agriculture, Economic Research Service using ARMS Phase III data.

Figure A.6

Average owned acreage and rented acreage, based on responses from USDA's Agricultural Resource Management Survey (ARMS) sorghum growers, 2019

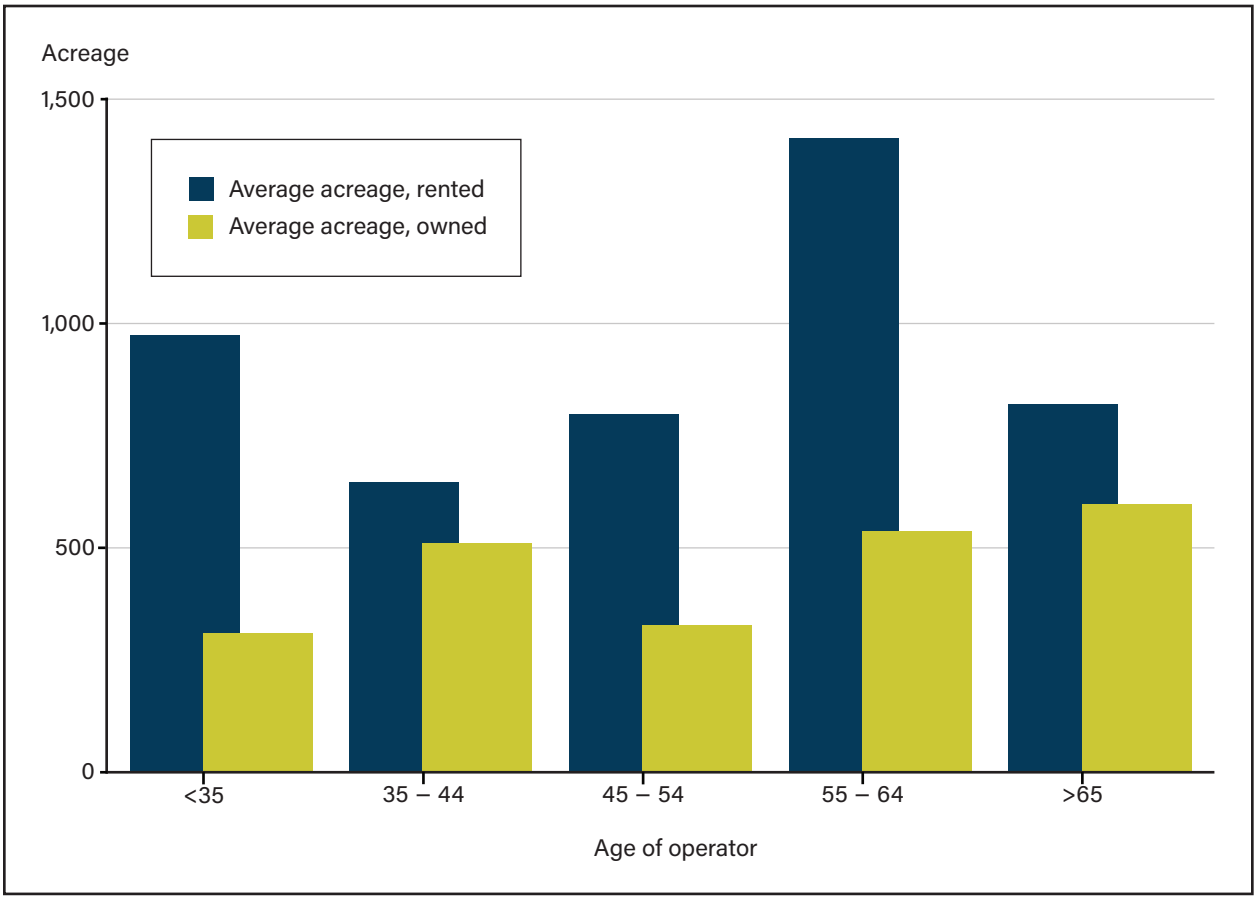


Note: Responses are weighted by USDA's National Agricultural Statistics Service Phase III operation-level survey weights for each commodity crop.

Source: USDA, Economic Research Service using ARMS Phase III data.

Figure A.7

Average owned acreage and rented acreage, based on responses from USDA's Agricultural Resource Management Survey (ARMS) cotton growers, 2019

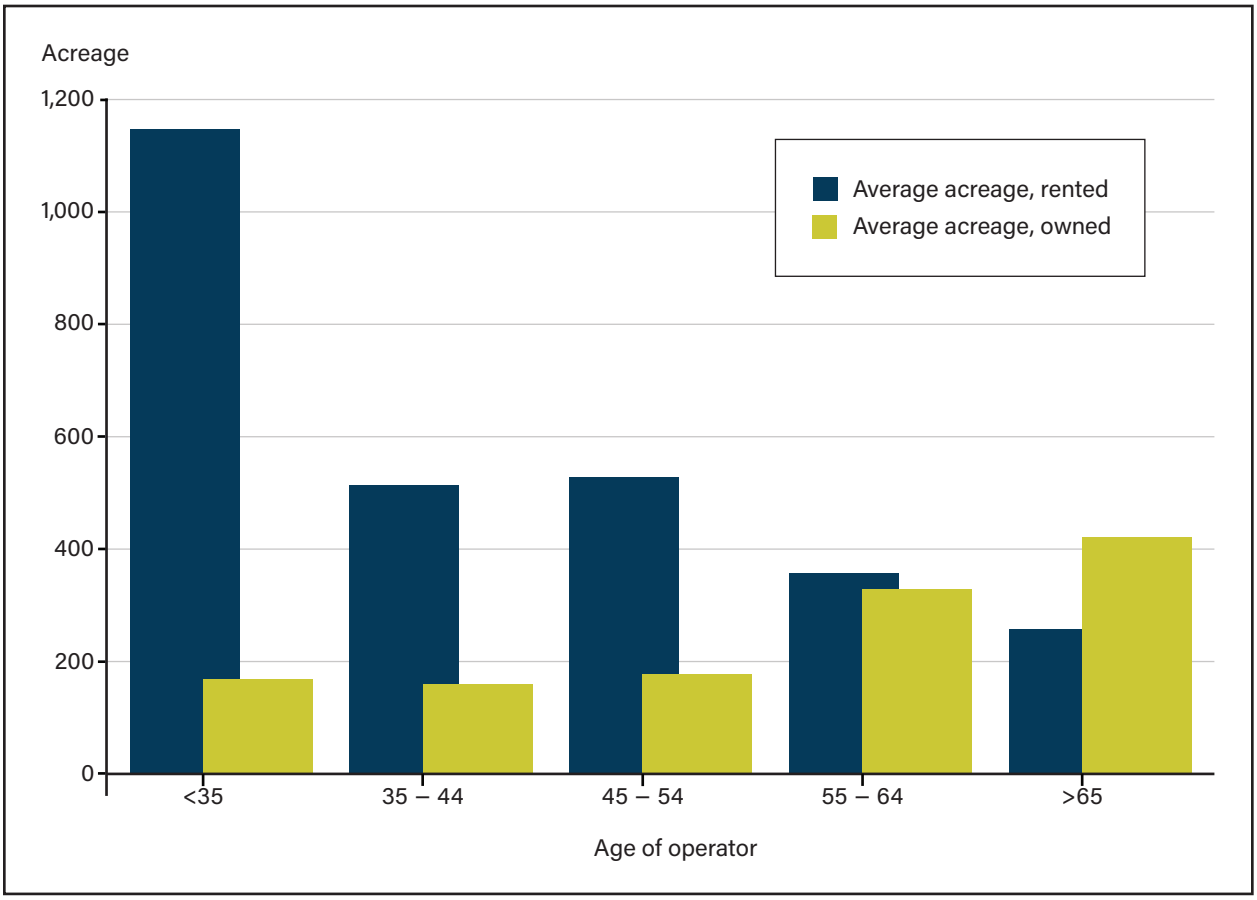


Note: Responses are weighted by USDA's National Agricultural Statistics Service Phase III operation-level survey weights for each commodity crop.

Source: USDA, Economic Research Service using ARMS Phase III data.

Figure A.8

Average owned acreage and rented acreage, based on USDA's Agricultural Resource Management Survey (ARMS) responses from corn growers, 2021



Note: Responses are weighted by USDA's National Agricultural Statistics Service Phase III operation-level survey weights for each commodity crop.

Source: USDA, Economic Research Service using ARMS Phase III data.

Appendix B. Structural Practices

This report covers the adoption of structural practices among owner-operators and cropland renters. To better understand this adoption, it is important to define structural practices according to conservation typology, which can be divided either as on-field and off-field structural practices. ARMS Phase II data is used to examine the differences in the adoption of structural practices among owners and tenants.

Off-field, or edge-of-field practices, consist of riparian buffers, field borders, and filter strips. Riparian buffers are areas predominantly covered by trees and/or shrubs located adjacent to and up-gradient from a watercourse or water body. These buffers are meant to protect aquatic resources from the adverse effects of agricultural operations. Field borders are strips of permanent vegetation (grasses, legumes, forbs, or shrubs) established on one or more sides of a field. Filter strips are narrows band of grasses, legumes, and forbs adjacent to water bodies used to limit sediment, nutrients, pesticides, and other contaminants from entering water bodies (USDA, NRCS, 2006b).

On-field structural practices consist of terraces, grass waterways, and contour farming. Terraces are earth embankments constructed across the field slope. Grass waterways are constructed graded channels across a field that are seeded to grass or other suitable vegetation. Contour farming is using a system of ridges, furrows, and roughness formed by tillage, planting, and other farming operations.

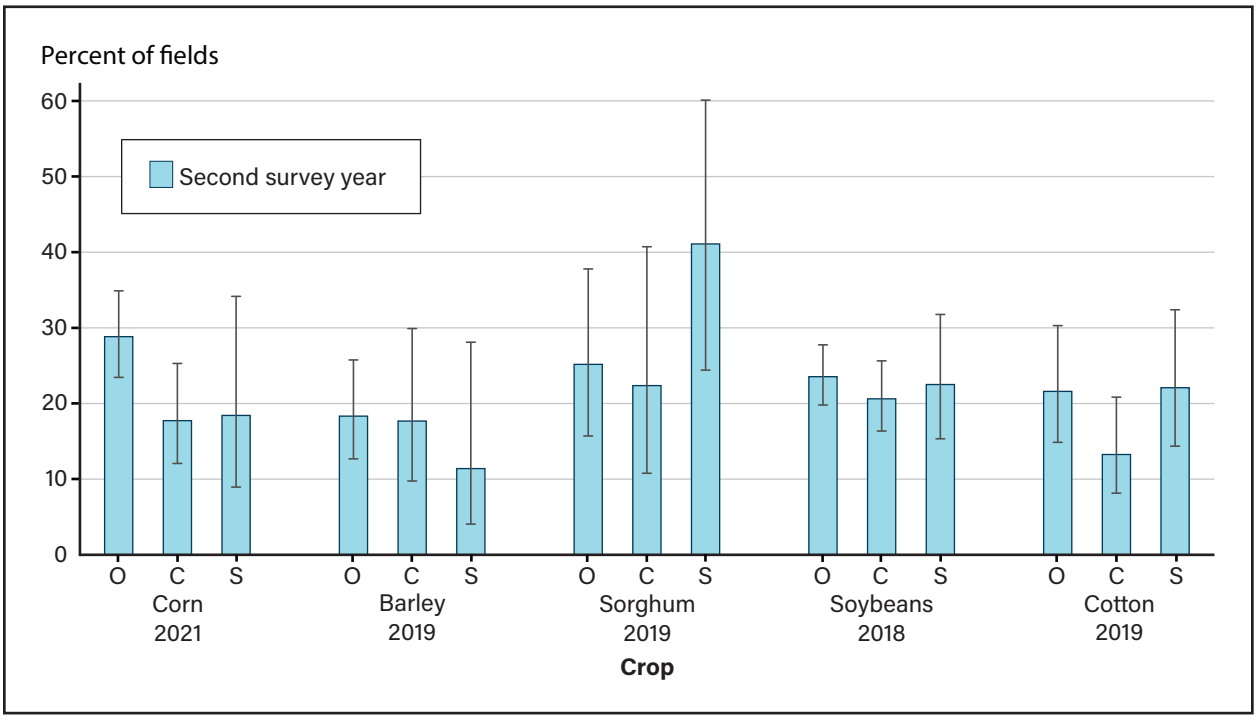
Adoption rates are measured by crop and year for on-field structural practices, classified by owner-operated plot, cash-rented plot, and share-rented plot. ARMS did not ask about individual practices until 2018, so there are only data for adoption rates for the later of the 2 survey years for each crop (figure A.4). The structural practice adoption rates, as a whole, are similar to the findings of USDA's NRCS (2022b).

Regarding the proportion of acreage dedicated to on-field structural practices between rented plots, besides cash-rented plots for corn 2021, there are no statistically significant differences in the adoption rates across the tenure groups (figure A.4).

The lack of differences in average adoption rates could be due to how the question is elicited in ARMS. The question asks if the practice was solely used in the survey year. The conservation system could have been installed by the landlord in the past when the field was under an owner-operator, or otherwise installed by the landlord unilaterally with the hopes of increasing its rental or sales price. There are also wide confidence intervals, possibly due to the aggregation of three different practices into one category. Confidence intervals are generally wider for share-rented fields as there are fewer observations in that category.

Adoption rates for off-field structural practices across crops and groups are low with averages within groups across crops generally between five and 15 percent of acreage (figure B.1). Besides share-rented fields for soybeans 2018, there are no statistically significant differences in the adoption rates across the tenure groups (table B.1). Similar to on-field structural practices, off-field practices could have been installed previously by the landlord and later incorporated into the rental price.

Figure B.1
On-field structural practices adoption rates across several crops and years of the USDA's Agricultural Resource Management Survey (ARMS), 2018–21



O = owner-operated plots; C = cash-rented plots; S = share-rented plots.

Note: Error bars denote the 95-percent confidence interval. Adoption rates are estimated as proportions, and the limits of the confidence intervals are calculated using a logit transformation.

Source: USDA, Economic Research Service using Agricultural Resource Management Survey (ARMS) data.

Table B.1
On-field structural adoption for rented plots versus owner-operated plots, 2018–21

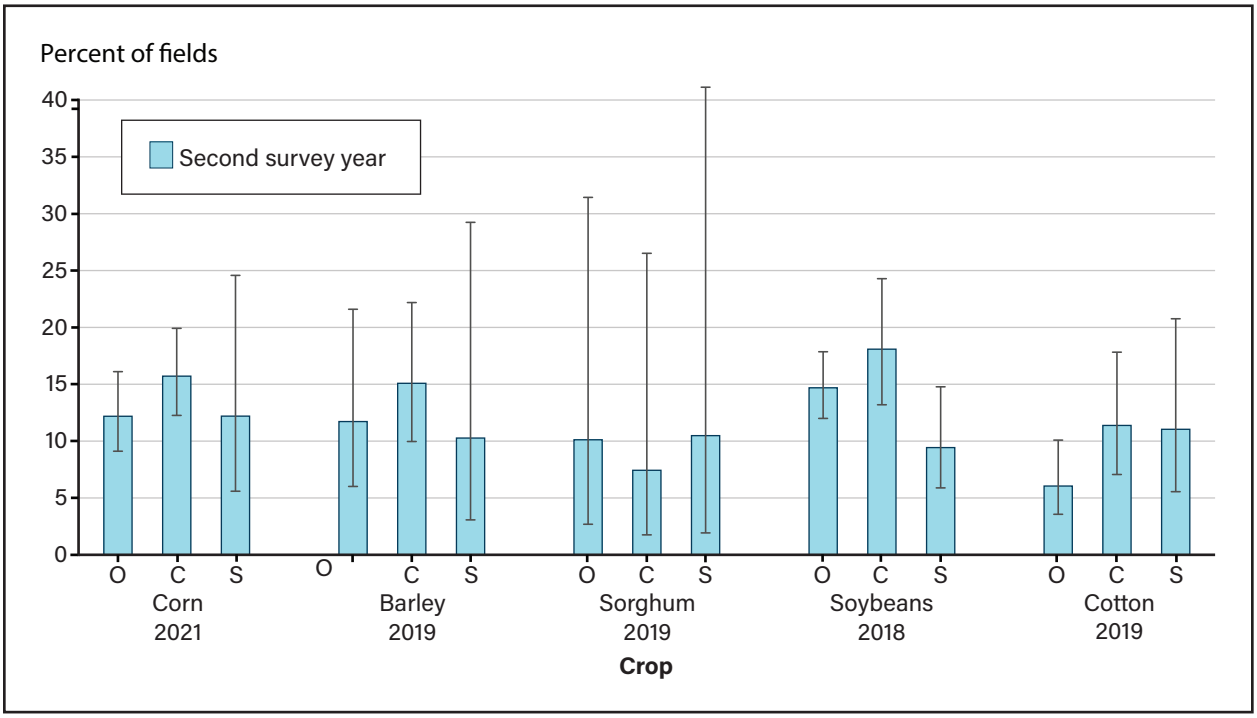
Crop	Survey year 2 (percent)		
	Owner-operated	Cash-rented	Share-rented
Corn	28.83	17.74**	18.42
Soybeans	23.55	20.62	22.51
Barley	18.33	17.68	11.40
Sorghum	25.18	22.37	41.09
Cotton	21.60	13.26	22.09

Statistical significance level: ** = 5 percent.

Note: The second year for each crop is corn in 2021, soybeans in 2018, barley in 2019, sorghum in 2019, and cotton in 2019. The asterisks indicate if the averages for cash- or share-rented fields are statistically different from the averages for owner-operated fields.

Source: USDA, Economic Research Service using Agricultural Resource Management Survey data.

Figure B.2
Off-field structural practices adoption rates across several crops and years of the USDA's Agricultural Resource Management Survey (ARMS), 2018–21



O = owner-operated plots; C = cash-rented plots; S = share-rented plots.

Note: Error bars denote the 95-percent confidence interval. Adoption rates are estimated as proportions, and the limits of the confidence intervals are calculated using a logit transformation.

Source: USDA, Economic Research Service using Agricultural Resource Management Survey (ARMS) data.

Table B.2
Off-field structural practices adoption rates (percentages) for rented plots versus owner-operated plots, 2018–21

Crop	Survey year 2 (percent)		
	Owner-operated	Cash-rented	Share-rented
Corn	12.18	15.71	12.20
Soybeans	14.68	18.09	9.43**
Barley	11.72	15.08	10.27
Sorghum	10.11	7.43	10.48
Cotton	6.05	11.38	11.04

Statistical significance level: ** = 5 percent.

Note: The second year for each crop is corn in 2021, soybeans in 2018, barley in 2019, sorghum in 2019, and cotton in 2019. The asterisks indicate if the averages for cash- or share-rented fields are statistically different from the averages for owner-operated fields.

Source: USDA, Economic Research Service using Agricultural Resource Management Survey data.

Appendix C. Practice Adoption by Tenure Group, Across Regions (Additional Figures)

Table C.1
Regional patterns in conservation adoption rates among corn production, 2016

	Owner-operated	Cash-rented	Share-rented
Panel A Heartland region (30 percent of total production, measured in thousands of bushels)			
STIR value	62.32	54.95	53.17
Cover cropping rate (percent)	6.57	4.99	4.35
Number of observations	488	324	120
Panel B Northern Great Plains and Prairie Gateway regions (69 percent of total production, measured in thousands of bushels)			
STIR value	44.07	46.81	60.75*
Cover cropping rate (percent)	3.02	S	0.00
Number of observations	221	140	66
Panel C Rest of the country (1 percent of total production, measured in thousands of bushels)			
STIR value	76.50	65.93	70.07
Cover cropping rate (percent)	18.48	12.11*	S
Number of observations	492	283	24

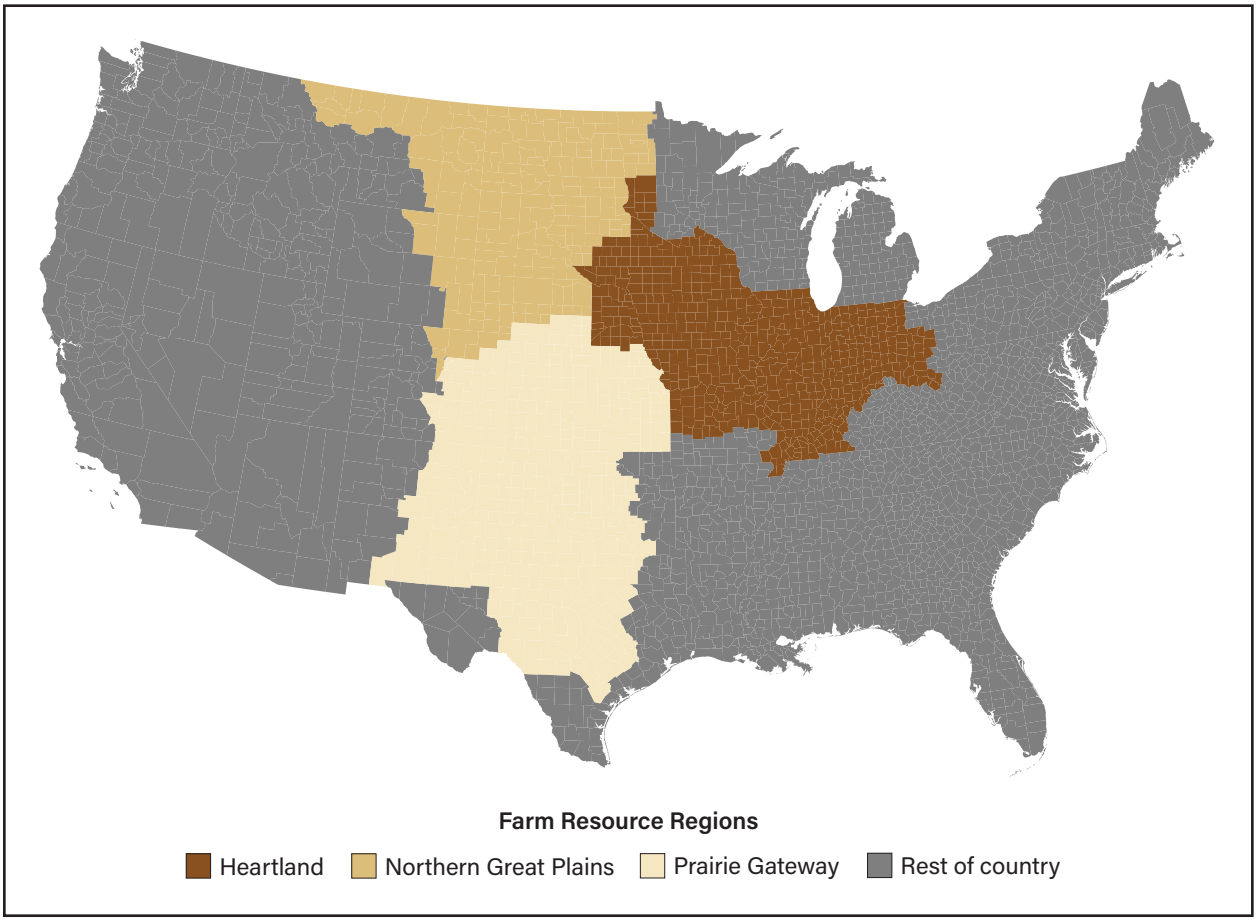
Statistical significance levels: ** = 5 percent; * = 10 percent.

STIR = Soil Tillage Intensity Rating.

Note: Groups are selected based on approximate production shares, as calculated with USDA, National Agricultural Statistics Service (NASS) county-level statistics. The asterisks indicate if the averages for cash- or share-rented fields are statistically different from the averages for owner-operated fields. The marker "S" identifies estimates that cannot be disclosed due to insufficient sample size, exceedingly low adoption rates, or other disclosure concerns.

Source: USDA, Economic Research Service using 2016 Agricultural Resource Management Survey Phase II data and USDA's NASS county-level crop production statistics.

Figure C.1
U.S. corn-growing fields by USDA Farm Resource Region, 2016



USDA, Economic Research Service Farm Resource Regions do not include Alaska and Hawaii.

Source: USDA, Economic Research Service.

Table C.2

Regional patterns in conservation adoption rates among barley production (2011 USDA's Agricultural Resource Management Survey (ARMS))

	Owner-operated	Cash-rented	Share-rented
Panel A Northern Great Plains and Basin and Range regions (52 percent of total production, measured in thousands of bushels)			
STIR value	65.75	71.67	73.24
Cover cropping rate (percent)	NA	NA	NA
Number of observations	336	164	103
Panel B Rest of the country (48 percent of total production, measured in thousands of bushels)			
STIR value	77.01	80.39	102.27***
Cover cropping rate (percent)	NA	NA	NA
Number of observations	361	221	56

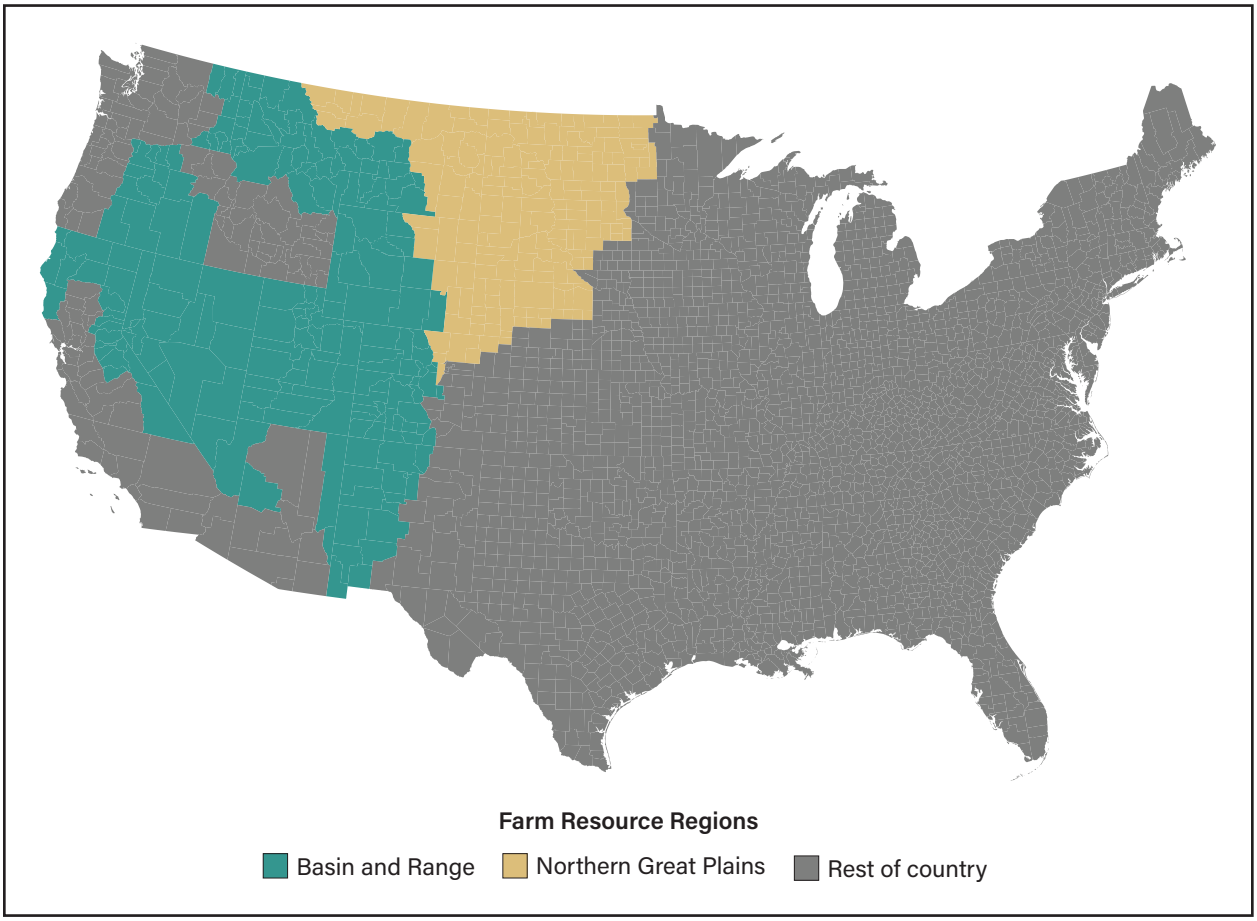
Statistical significance levels: *** = 1 percent.

STIR = Soil Tillage Intensity Rating. NA = not available.

Note: Groups are selected based on approximate production shares, as calculated with USDA, National Agricultural Statistics Service (NASS) county-level statistics. The asterisks indicate if the averages for cash- or share-rented fields are statistically different from the averages for owner-operated fields.

Source: USDA, Economic Research Service using 2011 Agricultural Resource Management Survey (ARMS) Phase II data and USDA's NASS county-level crop production statistics.

Figure C.2
U.S. barley-growing fields by USDA Farm Resource Region, 2011



USDA, Economic Research Service Farm Resource Regions do not include Alaska and Hawaii.

Source: USDA, Economic Research Service.

Table C.3

Regional patterns in conservation adoption rates among sorghum production, 2011

	Owner-operated	Cash-rented	Share-rented
Panel A Prairie Gateway region (66 percent of total production, measured in thousands of bushels)			
STIR value	52.25	34.59*	45.39
Cover cropping rate (percent)	NA	NA	NA
Number of observations	184	74	142
Panel B Rest of the country (34 percent of total production, measured in thousands of bushels)			
STIR value	76.77	162.47**	120.31**
Cover cropping rate (percent)	NA	NA	NA
Number of observations	66	43	35

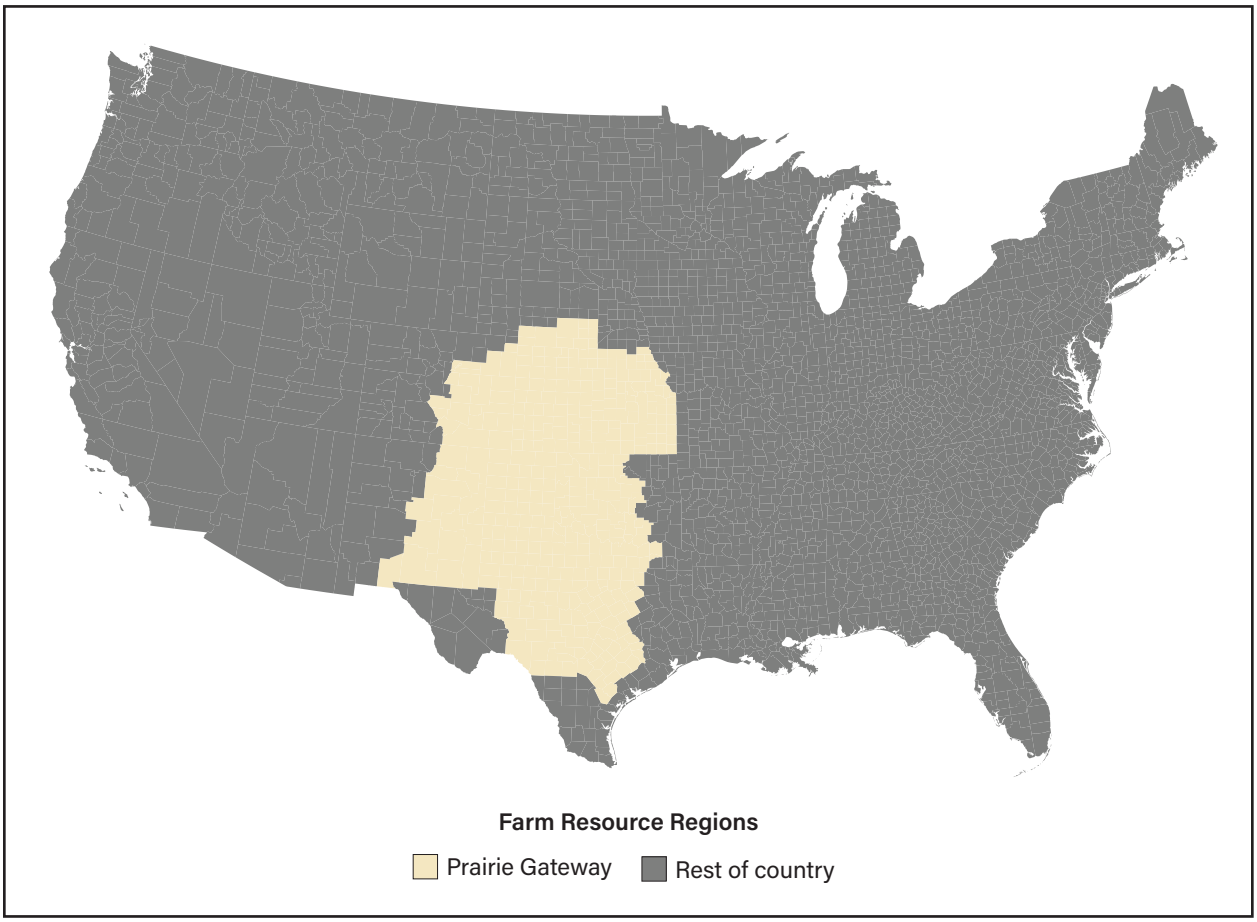
Statistical significance levels: ** = 5 percent, * = 10 percent.

STIR = Soil Tillage Intensity Rating. NA = not available.

Note: Groups are selected based on approximate production shares, as calculated with USDA, National Agricultural Statistics Service (NASS) county-level statistics. The asterisks indicate if the averages for cash- or share-rented fields are statistically different from the averages for owner-operated fields.

Source: USDA, Economic Research Service using 2016 Agricultural Resource Management Survey Phase II data and USDA's NASS county-level crop production statistics.

Figure C.3
U.S. sorghum-growing fields by USDA Farm Resource Region, 2011



USDA, Economic Research Service Farm Resource Regions do not include Alaska and Hawaii.

Source: USDA, Economic Research Service.

Table C.4

Regional patterns in conservation adoption rates among soybean production (2012 USDA's Agricultural Resource Management Survey (ARMS))

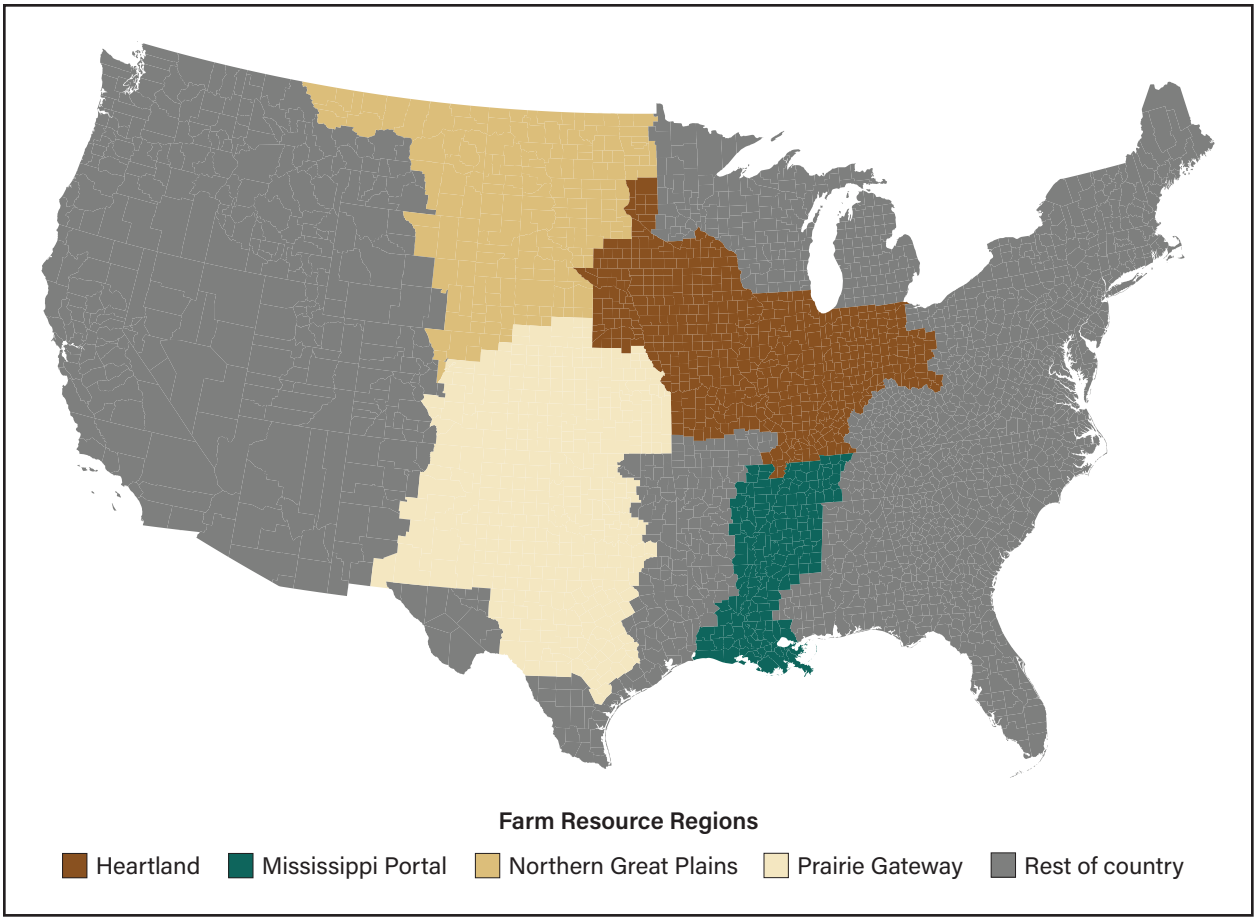
	Owner-operated	Cash-rented	Share-rented
Panel A Heartland region (58 percent of total production, measured in thousands of bushels)			
STIR rate	47.06	50.76	38.79
Cover cropping rate (percent)	NA	NA	NA
Number of observations	566	47	217
Panel B Northern Great Plains and Prairie Gateway regions (16 percent of total production, measured in thousands of bushels)			
STIR rate	46.31	54.78	29.04***
Cover cropping rate (percent)	NA	NA	NA
Number of observations	182	154	79
Panel C Mississippi Portal region (10 percent of total production, measured in thousands of bushels)			
STIR rate	83.04	78.93	93.48
Cover cropping rate (percent)	NA	NA	NA
Number of observations	124	107	130
Panel D Rest of the country (16 percent of total production, measured in thousands of bushels)			
STIR rate	43.62	40.21	21.60**
Cover cropping rate (percent)	NA	NA	NA
Number of observations	245	227	27

Statistical significance levels: *** = 1 percent, ** = 5 percent.

STIR = Soil Tillage Intensity Rating. Groups are selected based on approximate production shares, as calculated with USDA, National Agricultural Statistics Service (NASS) county-level statistics. The asterisks indicate if the averages for cash- or share-rented fields are statistically different from the averages for owner-operated fields.

Source: USDA, Economic Research Service using 2018 Agricultural Resource Management Survey (ARMS) Phase II data and USDA's NASS county-level crop production statistics.

Figure C.4
U.S. soybean-growing fields by USDA Farm Resource Region, 2012



USDA, Economic Research Service Farm Resource Regions do not include Alaska and Hawaii.

Source: USDA, Economic Research Service.

Table C.5

Regional patterns in conservation adoption rates among cotton production, 2015

	Owner-operated	Cash-rented	Share-rented
Panel A Mississippi Portal and Southern Seaboard regions (50 percent of total production, measured in thousands of bushels)			
STIR value	46.54	47.92	88.12**
Cover cropping rate (percent)	19.63	24.02	S
Number of observations	210	233	97
Panel B Prairie Gateway and Fruitful Rim regions (44 percent of total production, measured in thousands of bushels)			
STIR value	210.01	176.72	139.39
Cover cropping rate (percent)	7.17	8.19	7.98
Number of observations	105	90	95

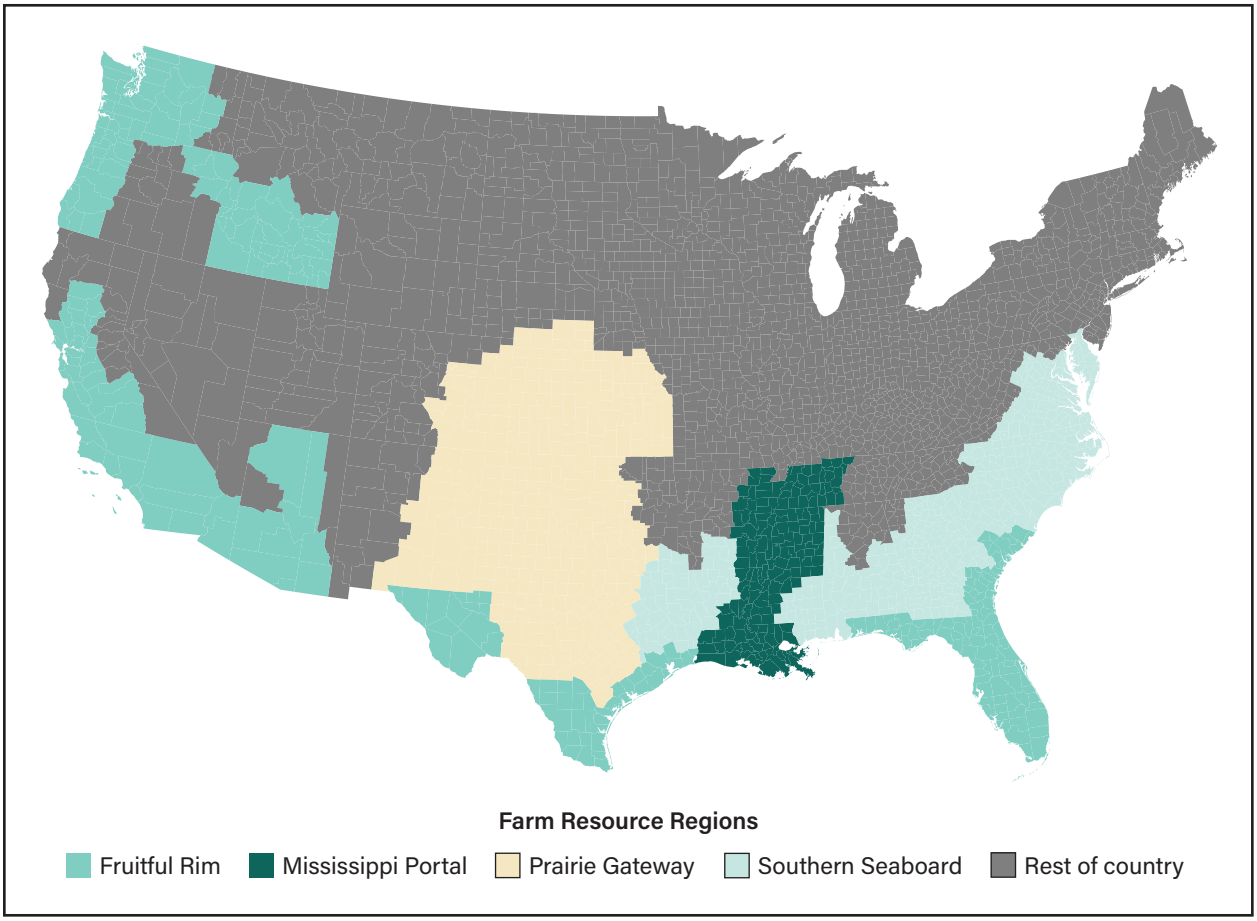
Statistical significance levels: *** = 1 percent, ** = 5 percent.

STIR = Soil Tillage Intensity Rating.

Note: Groups are selected based on approximate production shares, as calculated with USDA, National Agricultural Statistics Service (NASS) county-level statistics. The asterisks indicate if the averages for cash- or share-rented fields are statistically different from the averages for owner-operated fields. The marker "S" identifies estimates that cannot be disclosed due to insufficient sample size, exceedingly low adoption rates, or other disclosure concerns.

Source: USDA, Economic Research Service using 2015 Agricultural Resource Management Survey (ARMS) Phase II data and USDA's NASS Census of Agriculture county-level crop production statistics.

Figure C.5
U.S. cotton-growing fields by USDA Farm Resource Region, 2015



USDA, Economic Research Service Farm Resource Regions do not include Alaska and Hawaii.

Source: USDA, Economic Research Service.