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Renters, landlords, and farmland stewardship

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Abstract

Are farmers better stewards of the land they own than the land they rent from others? We answer this question using a data set that identifies Ontario farmers' conservation practices on their own land as well as the land they rent. Using a fixed-effects regression approach, we find that the role of tenure varies for different types of conservation practices. Farmers were found to be just as likely to adopt a machinery-related practice such as conservation tillage on their rented land as that land which they own. On the other hand, farmers were found to be less likely to adopt site-specific conservation practices such as planting cover crops on rented land. However, this effect diminishes as the expected length of the rental relationship increases when the landlord has a farming background.

JEL classifications: Q15, Q24

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1. Introduction

Are farmers better stewards of the land they own than the land they rent from others? The answer to this question matters to many because nonowner farmers manage much of the farmland in North America, nearly 40% in Canada and the United States (Nickerson et al., 2012; Statistics Canada, 2016), and an increasing proportion of land in many developing countries (Jin and Jayne, 2013). Given the widespread extent of rented farmland, an affirmative answer to this question has implications for soil and water quality and for future agricultural productivity. Agricultural policy in Canada, Europe, and the United States sets out to achieve enhanced environmental outcomes through conservation production practices on working farmland.[1] The role of tenure in farmland stewardship therefore has implications for the assessment and design of agrienvironmental policy.

In this article, we examine the impact of several dimensions of tenure, including the expected length of the rental relationship and the landlord type, on adoption of agricultural conservation practices.[2] Previous empirical research on the relationship between land tenure and the adoption of conservation practices yields conflicting results. Belknap and Saupe (1988) and Lynne et al. (1988) find that owner-operators are more likely to adopt conservation practices than tenants. Several other studies find no differences in use of conservation practices between owner-operators and tenants (Lee and Stewart, 1983; Norris and Batie, 1987; Rahm and Huffman, 1984).[3] More recently, Soule et al. (2000) find that owner-operators and share-renters are more likely than cash-renters to adopt conservation tillage, a conservation practice that potentially reduces costs in the short term. The same study also finds that cash and share-renters are less likely than owner-operators to adopt conservation practices that generate benefits only in the long run, such as grassed waterways, strip cropping, and contour farming.

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[1] See Lichtenberg (2014) for a discussion of agrienvironmental policy within the U.S. Farm Bill, Rajsic et al. (2012) for a discussion of environmental aspects of Canada's Growing Forward policies, and Laukkanen and Nauges (2014) for a discussion of agrienvironmental programs in the EU.

[2] Studies on the more general question of why farmers adopt best management practices (BMPs) have been summarized by Baumgart-Getz et al. (2012). Their study provides a quantitative summary of 46 studies from 1982 to 2007 examining the adoption of agricultural BMPs. In addition to studies that address land tenure, they identify a host of factors that should be considered when empirically examining this issue.

[3] The conflict in the literature might be due to the ambiguity in defining the appropriate measure for the adoption of conservation practices. For instance, Lynne et al. (1988) use the number of conservation practices adopted by farmers as a proxy for their conservation effort, while Norris and Batie (1987) use total expenditures on conservation practices. Other studies (Lee and Stewart, 1983; Rahm and Huffman 1984) use a dichotomous choice model to examine the adoption of a specific conservation practice.

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Our analysis addresses two specific limitations of the existing literature on the impact of tenure on farmland stewardship. First, the previous literature examines the application of conservation practices to rented land under an implicit assumption that tenure security is equal on all rented land (see Soule et al., 2000). We relax this assumption by including a measure of the length of time a farmer expects to rent in a parcel of land. This allows us to assess, for example, whether a farmer who expects to rent a parcel of land for the short term is just as likely to apply conservation practices as a farmer who expects to rent for the long term.

The importance of this additional dimension of tenure—that is, the expected rental length—will depend on the time horizon over which the conservation practice is expected to generate positive net returns. If the conservation practice generates short-term returns, variation in the expected rental length may be less likely to influence the decision to adopt. For this reason, we suspect that the expected rental length does not influence the decision to adopt conservation practices that generate positive net returns in the short term, such as conservation tillage. However, the expected rental length is more likely to matter for the adoption of conservation practices such as the use of cover crops that are costly in the short term, but have the potential to generate positive net benefits in the medium to long term. For instance, in a review of the literature on the adoption of cover crops, the American Farmland Trust (2013) identifies short-term rental contracts as one potential barrier to the adoption of conservation practices. More recently, Bergtold et al. (2017) survey the literature to assess the economic motivations for the adoption of cover crops. One conclusion of their assessment is that negative short-term outcomes due to cover crops are traded off against positive long-term outcomes.

Our second contribution is to formally assess the influence of landlord type on adoption of conservation practices. While longer term rental contracts are expected to influence a tenant's decision to adopt conservation practices, landlords may also influence whether a tenant applies conservation practices. Lichtenberg (2007) emphasizes the importance of landlords in determining soil conservation investments. Given considerable heterogeneity in the character of farmland owners (farmers, nonfarmers, investors, etc.), the role of landlords is likely to vary considerably. If some landlords are more aware of the benefits of conservation investments, then they may take steps (e.g., communicating with renters, monitoring, and screening renters) that increase the likelihood that farmers adopt conservation practices.

Despite the diversity of landlord types, the influence of landlord type on the adoption of conservation practices has received little attention in the previous literature (Bryan et al., 2015). A recent publication by Gottlieb et al. (2015) examines investments on preserved farmland, including conservation activities. They find that nonoperators report fewer investments—that is, conservation practices, buildings, equipment, and irrigation—than operators. However, unlike our analysis, their empirical approach does not differentiate between conservation practices, and they sample landowners that had preserved farmland.

In a series of publications that derive results from a survey of Iowa landlords and farmers, Arbuckle (2010) identifies several issues that are relevant to our effort to differentiate landlords and recognize differences with respect to the specific conservation practice. In their survey, both landlords and operators agree that the decision to use tillage is primarily up to the tenant. Specifically, nearly 89% of the landlords indicate that tillage practices are decided by the operators; a distribution of responsibilities that is confirmed by the separate responses of farmers. This stands in sharp contrast with decisions regarding the establishment of "conservation practices," which appear to be distributed in relatively greater proportion to the landlord; only 48% of landlords indicate that farmers are primarily responsible for conservation practices. Moreover, the survey results also suggest that landlords tend to be relatively uncertain about the benefits and use of cover crops.

Nearly 50% of the rental contracts we examine are between farmers and "nonfarmer" landlords. A popular assertion (see, e.g., Shute and Shute, 2013) is that nonfarmer landlords are less interested in farming and may actually discourage some farming activities. This perception influences contemporary policy. For example, the Vermont Land Trust now includes legal language in their purchase of agricultural preservation easements to ensure that the farmland to which easements apply remains under the ownership of farmers, rather than nonfarm families.[4] More recently, a strong majority in North Dakota voted against a measure that would have reduced restrictions on nonfarmer ownership of farmland (Ortiz and Plume, 2016). Similarly, Strom (2016) suggests that farmers renting from "absentee" landlords have less incentive to adopt cover crops. Our data set allows us to empirically assess whether landlord type influences the likelihood of conservation practices on farmland. Arbuckle and Ferrell (2012) study Iowa farmers and find that most farmers believe that cover crops provide agronomic and environmental benefits, and that their belief is strengthened by their knowledge of cover crops. If farmer landlords understand the benefits of cover crops more than nonfarmer landlords, tenants renting from farmers may be more likely to plant cover crops on rental land relative to tenants that rent from nonfarmers. There is a great deal of future research to be done in gaining greater insight into the effects of landlord heterogeneity. In this regard, an additional contribution of this article is our empirical examination of whether a farmer who applies conservation practices on their own land is just as likely to adopt these practices on rented land if the landlord is a nonfarmer.

Our detailed survey of Ontario farmers enables an empirical approach that assesses the use of conservation tillage and cover crops on land that a farmer owns, and land that the same famer rents. This approach contrasts with the existing empirical studies that identify the impact of tenure on conservation practice adoption based on the share of each farmer's total acreage that

[4] See, for example, https://www.vlt.org/farm/.

is rented (Belknap and Saupe, 1988; Lynne et al., 1988; Norris and Batie, 1987). In these studies, farmers who rent a greater share of their total acreage are expected to be less likely to adopt conservation practices, particularly those practices that have longer payback periods. In contrast, our survey data document adoption of conservation practices on rented land and owned land for the same farmer; hence, we are able to control for unobserved farmer characteristics.

Several interesting results emerge from our analysis. We find that the influence of tenure security varies with the type of conservation practice. Farmers are just as likely to use conservation tillage on the land they rent as the land they own. On the other hand, farmers are less likely to plant cover crops on the land that they rent compared to the land that they own. Both these findings are expected given differences in the investment horizon. Also, the landlord type appears to influence whether a farmer treats rented farmland like owned farmland. Specifically, even when farmers have long-term expectations regarding rental length, farmers are less likely to plant cover crops on rented land when their landlord is a nonfarmer. However, when the landlord is a farmer, farmers tend to treat the farmland like their own (with respect to cover crops) when they expect to rent the farmland in the medium to long term. Hence, the expected rental length is a necessary but not a sufficient condition for the adoption of conservation practices.

The remainder of the article is organized as follows. Section 2 provides a brief overview of the conceptual framework used for the study. This is followed by a discussion of the empirical model in Section 3 and data in Section 4. Results are presented in Section 5 and the final section provides concluding remarks.

2. Conceptual framework

McConnell (1983) and Soule et al. (2000) present two-period models to demonstrate the effect of tenure security on the decision to adopt conservation practices. Besley (1995) also uses a two-period model to demonstrate that investment does not occur on land held by farmers who cannot capture future returns due to lack of tenure security. The following discussion draws from Soule et al. (2000). Consider a farmer who grows a single crop via a production practice that influences current profitability and can have longer term effects on land productivity and land value. The farmer chooses from a set of production practices. Some production practices trade-off current profitability for greater future returns, when compared to an alternative production practice. A farmer who is able to capture or has internalized future returns is more likely to adopt production practices that sacrifice current profitability but improve future land productivity and land value. Following Soule et al. (2000), the farmer seeks to maximize the present value of net benefits from adoption of production practice:

$$\max PV_i = \pi_i + \gamma V_i, \quad (1)$$

where π_i is the current net return due to use of practice i and V_i is the discounted stream of future net returns, as reflected in land productivity and land value, due to the current use of practice i.[5] Discounted future net returns are weighted by $\gamma \in (0, 1)$, which indicates the extent to which the farmer expects to capture future net returns associated with current use of production practice.

When assessing alternative production practices, a lower expectation of capturing future net returns diminishes incentives to adopt production practices that sacrifice returns in the current period for greater returns in the future period. Consider a farmer choosing between a conventional production practice ($i = c$) and a conservation production practice ($i = g$). The farmer chooses the conservation production practice if it increases the present value of net benefits relative to the conventional production practice:

$$\pi_g + \gamma V_g > \pi_c + \gamma V_c. \quad (2)$$

It is clear from Eq. (2) that a conservation production practice that increases (decreases) both current and future net benefits is adopted (not adopted), independent of the expectation of capturing future returns. The choice between these two practices is less clear when use of the conservation practice increases future returns, but sacrifices profitability in the current period. Rearranging Eq. (2) yields the following expression:

$$\gamma(V_g - V_c) > \pi_c - \pi_g. \quad (3)$$

Eq. (3) suggests that a farmer chooses the conservation production practice, g, when the expected increase in future net returns, $\gamma\ (V_g - V_c)$, exceeds the short-run decrease in current returns, $\pi_c - \pi_g$.

The farmer weights future net returns by γ. A conventional interpretation of γ is that it is an indicator of tenure security: the farmers' subjective expectation that he or she will be in a position to capture future returns (Soule et al., 2000). Under this interpretation of γ, both ownership and expected rental length are hypothesized to influence tenure security. Tenure security on owned land, γ_o, is expected to be greater than tenure security on rented land, γ_r; however, the difference in tenure security between owned and rented depends on the expected rental length, k. These expected relationships are summarized as follows: $\gamma_o \geq \gamma_r$; $\gamma_r \to \gamma_o$ as $k \to \infty$. Put simply, as the expected rental length increases, a farmer's tenure security on rented land approaches that level of tenure security experienced on owned land.

In the case of a rented land, the landlord type might also influence adoption of conservation practices. As noted by Soule et al. (2000), landlords can provide renters with incentives to adopt conservation practices; in the context of Eq. (3), this will reduce the short-run decrease in current returns, $\pi_c - \pi_g$, due to the use of the conservation practice and will increase likelihood of adoption. Landlords can also require the use of conservation

[5] In a two-period model, discounted future net returns, V_i, is expressed as $V_i = V_i/(1 + r)$, where r is the discount rate.

practices through formal or informal terms of rental contracts. This implicitly increases the weight the farmer places on future returns, such that the renter behaves like an owner. The use of rental contracts to incentivize the adoption of conservation practices will give rise to monitoring and enforcement costs; landlords will vary in their ability to incentivize and monitor the use of conservation practices. For example, Soule et al. (2000) suggest that landlords with a farming background are better able to minimize these transaction costs and have a greater awareness of the benefits of conservation practices.

Renters might also derive long-term nonpecuniary benefits from the use of conservation practices, which are tied to the renter's reputation as a good land steward. In the context of Eq. (3), future nonpecuniary benefits can be interpreted as an increase in the weighted future returns, $\gamma\ (V_g - V_c)$, realized by the renter due to current adoption of the conservation practice. For instance, farmers who rent from landlords with stronger social ties to other landlords in the farming community are more likely to benefit from the reputational effects of conservation practice adoption.

3. Empirical model

We define a latent variable $y^* = \pi_g - \pi_c + \gamma(V_g - V_c)$, which represents the expected present value of net benefits of adopting the conservation production practice relative to the conventional production practice. If $y^* > 0$ the conservation practice is adopted and $y = 1$. If $y^* \leq 0$, the conservation practice is not adopted and $y = 0$. The net benefit of adopting the conservation practice is a function of farmland, farmer, and farm operation attributes and the tenure status of the farmer. The probability that farmer j uses conservation practice g on plot l can therefore be written as:

$$\Pr(y_{jl} = 1) = \alpha X_{jl} + \beta T_{jl} + \delta_j + \varepsilon_{jl} \quad (4)$$

where α and β are vectors of unknown parameters to be estimated; X_{jl} denotes observed plot-level characteristics, including physical features of the land and cropping history; T_{jl} denotes measures associated with tenure status; δ_j denotes farmer-specific characteristics; and ε_{jl} captures idiosyncratic shocks. We investigate the influence of tenure security in several ways. First, we examine the overall impact of tenure on the use of two conservation practices. In this case, T_{jl} takes on a value of one if the farmer is renting the plot and takes on a value of zero if the farmer owns the plot. This is the most basic definition of tenure security and is the one that has been used in the previous literature.

Second, we allow tenure security to vary by the renters' subjective expectations about the length of the future rental relationship. The longer the expected rental relationship, the greater the tenure security. We enter two dummy variables. The first is a short-term rental arrangement indicator, which takes on a value of 1 if the farmer is renting the plot and expects to rent the plot for five or less additional years, and is equal to 0 otherwise. The second is a long-term rental arrangement indicator that takes on a value of 1 if the plot is rented and the renter expects to rent for six or more additional years.

Third, we assess the effect of landlord type—that is, farmer landlords versus nonfarmer landlords—on the farmer's decision to adopt conservation practices on rented land. Each of the rented plots is classified as having a farmer landlord or a nonfarmer landlord. The farmer landlord variable takes on a value of 1 if the farmer is renting the plot from a landlord with a farming background, and the nonfarmer landlord variable takes on a value of 1 if the farmer is renting the plot of land from a landlord with no farming background. We define current farmers, retired farmers, and spouses of farmers as landlords with a farming background.

There are several potential threats to successfully identifying the role of tenure in the adoption of conservation practices. First, farmer-specific characteristics might be correlated with tenure security and the likelihood of adopting conservation practices. The second threat to identification might arise due to the characteristics of owned and rented land that are systematically correlated with the likelihood that a plot of land is rented versus farmed by the owner-operator. Finally, the fixed-effect model could lead to biased results if unobserved farmer characteristics vary across rented and owned land—a violation of the assumption that the farmer fixed effect is constant across owned and rented land. Supporting Information Appendix 1 provides a detailed discussion of our approach to these identification issues.

4. Data

We use data from a telephone survey of farmers in Ontario and Manitoba, carried out over a two-week period in April 2013. Our survey questionnaire was conducted through Ipsos Agriculture and Animal Health, a division of Ipsos-Reid. In order to use the fixed-effects approach outlined in our empirical model, we restrict our sample to 198 farmers in Ontario that operate on both owned and rented land. For each farmer, the survey collects detailed plot-specific information about the largest plot of owned land operated by the farmer and the largest plot of rented land operated by the farmer.[6] The following discussion focuses on data documenting conservation practices, tenure type, and landlord type. Table 1 presents definitions of the variables used in this analysis. A more detailed discussion of the survey and the data documenting plot-level characteristics is provided in Supporting Information Appendix 2.

[6] We restricted attention to the largest plots of owned and rented land in order to keep the length of time it took to complete the survey to under 20 minutes. Focusing on one owned and one rented plot allowed us to collect very detailed information on each plot.

Table 1
Variable definitions

Variable	Definition
Conservation practices	
Conservation tillage	1 if conservation tillage used on the field
Cover crops	1 if cover crops were planted on the field
Rented	1 if field is rented
Tenure length	
Short-term rental	1 if respondent expects to rent the land for five years or less
Long-term rental	1 if respondent expects to rent the land for more than five years
Landlord type	
Farmer landlord	1 if landlord classified as having a farming background
Nonfarmer landlord	1 if landlord classified as not having a farming background
Productivity	
Poor	1 if the respondent classified the field as poor
Good	1 if the respondent classified the field as good
Very good	1 if the respondent classified the field as very good
Excellent	1 if the respondent classified the field as excellent
Hilly	1 if field is characterized as having a hilly topography
Coarse	1 if field is characterized as having a coarse soil texture
Drainage	1 if the field is drained by surface or tile drainage
Irrigated	1 if the field is irrigated
Plot size	Size of the field in acres
Corn planted in 2012	1 if corn was planted on the field in 2012
Soybean planted in 2012	1 if soybean was planted on the field in 2012
Winter wheat planted in 2012	1 if winter wheat was planted on the field in 2012

4.1. *Data: conservation practices*

We focus on two conservation practices: conservation tillage and cover crops. We ask farmers if they used conventional tillage, minimum tillage, or no till in 2012. A farmer is defined as using conservation tillage if minimum tillage or no till is used as the primary means to prepare the land. Conservation tillage provides on-farm medium- to long-term benefits through reduced soil erosion, and short-term benefits due to improved soil moisture availability (Schoengold et al., 2015). Conservation tillage systems also generate short-term benefits in terms of fuel and labor savings associated with fewer field operations (Zentner et al., 2002). A conservation tillage system typically requires an up-front investment in modifications to planting equipment. This up-front investment can be recovered quickly due to improved soil moisture and reduced variable costs. Most importantly, from the perspective of our analysis, once a farmer modifies planting equipment for her own land, the same equipment can be used on rented land. Hence, with respect to conservation tillage, after controlling for farm parcel attributes farmers are likely to treat the land they rent similar to the land they own. Moreover, since conservation tillage generates short-term net returns, expectations regarding rental length are unlikely to be an important factor in determining whether a farmer treats rented land differently from owned land.

Farmers may face incentives to treat rented land differently than their own when it comes to the decision to adopt cover crops. In our survey, farmers indicated if they planted a cover crop on the land they rented and owned in 2012. Farmers reported planting red clover, alfalfa, oats, and barley as cover crops; their identification of cover crops is consistent with the Ontario Ministry of Agriculture, Food, and Rural Affairs definition of cover crops (Verhallen et al., 2001). It is important to note that the key planting decisions occurred in 2012, which was indeed a high-priced year. This may have influenced the adoption rate of cover crops, but should not affect our cross-sectional assessment of differences in adoption practices by farmers.

Cover crops are frequently promoted as a practice that can maintain or increase soil productivity by reducing soil erosion and building soil organic matter over the long term (Creamer and Baldwin, 2000; Snapp et al., 2005). That said, the adoption of cover crops remains low; see Bergtold et al. (2017) for a detailed characterization of the economic factors that may influence the low adoption rate in the United States, which was approximately 4% in 2011. The research that examines adoption from an economic standpoint suggests that there are substantial direct and indirect up-front costs due to cover crops, but uncertain benefits—primarily arising out of longer term soil productivity improvements (Schnitkey et al., 2016). The costs of cover crops are due to (1) direct establishment and maintenance costs, (2) indirect costs due to cover crop management problems and delayed establishment of the subsequent cash crop, and (3) opportunity costs due to foregone income from high return cash crops (Snapp et al., 2005). In production regions, such as Ontario, cover crops often require farmers to forego a more profitable summer cash crop therefore imposing short-term, field-specific costs on farmers. The benefits of cover crops tend to be longer term and are difficult to assess (Snapp et al., 2005). Some literature suggests that some cover crops increase nitrogen availability, which can reduce fertilizer costs in the short term (Lichtenberg et al., 1994). However, the benefits of reduced input costs in the short run may be more than offset by the short-term costs of establishing a cover crop such as red clover (Roberts et al., 1998).

The trade-off between long-term soil productivity gains and short-term opportunity costs imply that cover crops are unlikely to generate positive net benefits in the short term. This has two implications for our analysis. First, farmers have a financial incentive to treat the land they own differently from the land they rent if they are less tenure secure on rented land. Second, we expect these incentives to diminish if the farmer expects to rent the land for a long time. In other words, with respect to cover crops, we expect that farmers will be less likely to plant cover crops on the land they rent than the land they own. However, if they expect to rent the land for a long time, then

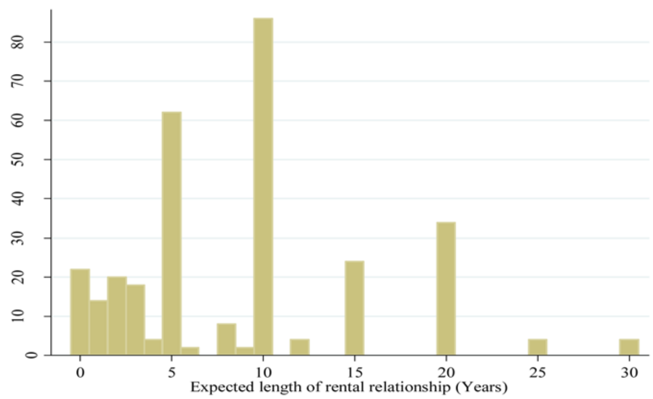

Fig. 1. Distribution of expected length of rental relationship [Color figure can be viewed at wileyonlinelibrary.com]

farmers will be in a position to capture the long-term net benefits and will therefore treat owned and rented land similarly.

4.2. Data: length of rental relationship

For the plot of land the farmer rented, the survey documents several aspects related to tenure security.[7] We ask each survey respondent, "How long do you expect to rent this land from this landlord?"[8] We therefore capture a subjective expectation of tenure that we believe is important to the decision to adopt conservation practices that are costly in the short term but provide longer term benefits. Fig. 1 presents the distribution of the expected rental lengths, which we use to guide our definition of short-term rental contracts. On average, farmers in our sample expect to continue to rent for approximately eight years.[9] Survey respondents tended to report in five-year increments.[10] For this reason, there are a large number of farmers who expect to rent their land for an additional 5, 10, 15, or 20 years. Given the discrete increments in the expected rental length, we differentiate the short and long term using five years as a cutoff. As a result, farmers who expect to rent for an additional five years or less are classified as being in "short-term" rental arrangements, and farmers who expect to rent for more than five years are considered as being in "long-term" rental arrangements.[11]

4.3. Data: landlord type

Farmers were also asked to classify the type of landlord they rent land from. Landlords who were identified as active farmers, retired farmers or the spouse of a deceased farmer were classified as being "farmer" landlords. Landlords who were identified as nonfarmers and who were primarily holding the land as an investment opportunity were classified as "nonfarmer landlords."

5. Results and discussion

In this section we present the regression results from several different specifications. The first set of results examines the impact of tenure—that is, rented or owned—on the adoption of conservation tillage and cover crops. The second set of results expands the character of land tenure in a manner that allows us to assess the impact of the expected rental length on the adoption of conservation practices. Finally, we discuss the results from specifications that allow the impact of tenure security to vary by landlord type. For each of the specifications, we begin with a presentation of the conservation tillage results followed by the cover crop results.

All results presented are based on farmer fixed-effects linear probability model specifications. Standard errors are clustered at the farmer level in all regressions. This allows for general patterns of heteroscedasticity, and for arbitrary correlation in the error terms within each farmer. Clustering at the farmer level assumes independent errors across higher levels of aggregation, such as county. This assumption may not be valid, for instance, if there are county-level determinants of the adoption of conservation practices due to variation in extension efforts, climate, or historical acceptance of conservation practices. In general, the more conservative approach is to cluster at a higher level of aggregation. In our application this could be at the county level. However, we face a couple of limitations associated with clustering at the county level. First, there are only 20 counties in the study area; a small number of clusters can

[7] Soule et al. (2000) examine differences between cash and share renters and find evidence that owners and share renters are more likely than cash renters to adopt conservation tillage. We do not examine differences between cash and share renters because only 15% of renters in our survey are in share rental arrangements.

[8] The exact wording of the question is "How long do you expect to rent this land from this landlord?" A potential concern is that the expected rental length reported by a farmer might be influenced by the age of the farmer such that older farmers report a shorter expected rental length despite having very strong tenure security. The correlation between the age of the respondent and the expected length of the rental relationship is −0.143. For this reason, we do not believe that the age of the respondent is entangled with perceptions of rental length. Moreover, we use a discrete measure for expected length; the correlation between this discrete measure and age is −0.079.

[9] Several prior studies find that landlord–tenant relationships in agriculture are long-lived. Kirwan and Roberts (2016) report an average rental duration of 10.2 years, Allen and Lueck (1992) report an average length of 11.5 years, and Sotomayor et al. (2000) report an average duration of 14.4 years.

[10] Approximately 65% of the respondents are grouped at either 5, 10, 15, or 20 years.

[11] The measure and meaning of expected rental length is an important issue. Anticipating our forthcoming discussion of results, we empirically assess our measure of expected rental length and the associated categorical measures of time horizons as either "short-term" or "long-term." As the discussion next explains more fully, an important empirical finding is that the expected tenure length does not influence the decision to use conservation tillage but it does affect the use of cover crops. However, with respect to the latter effect, we find that the effect of expected rental length is nonlinear such that a continuous measure of expected rental length is not statistically significant. Instead, we find a "threshold" expected rental length (i.e., five years) below which farmers are less likely to adopt cover crops.

lead to small standard errors and therefore overstate the precision of estimated coefficients (Cameron and Miller, 2015).[12] Second, the numbers of observations in our county-level clusters are unbalanced, ranging from a minimum of 2 to a maximum of 28 observations in a county cluster. As pointed out in Carter et al. (2017), unbalanced clusters reduce the effective number of clusters. In our application this implies that the effective number of county clusters is less than 20. As a robustness check, in Supporting Information Appendix 4 we report estimates from a series of regressions that cluster at the county level. These findings suggest that our results are not sensitive to our choice of cluster.

5.1. Tenure type

Approximately 66% of farmers use conservation tillage on rented land and 64% of farmers use conservation tillage on land that they own. The difference in the adoption of cover crops is stark, with approximately 15% of farmers planting cover crops on rented land compared to 26% of farmers planting cover crops on owned land. We present detailed summary statistics and normalized differences in means (or frequencies) between the two subsamples (owned vs. rented land) in Supporting Information Appendix 3, Table A3.1.

Table 2 presents the results from the tenure model. The rent variable does not have a statistically significant effect on the likelihood that farmers will adopt conservation tillage. Hence, farmers appear equally likely to use conservation tillage on land that they own and the land they rent. This is consistent with the notion that conservation tillage generates short-term benefits and, once the fixed investment in machinery modifications is made, farmers are just as likely to use conservation tillage on rented land as on owner-operated land.

The results in Table 2 imply that tenure does influence the adoption of cover crops. Farmers are 9.9% less likely to plant cover crops on land they rent compared to the land they own. Conservation tillage can generate short-term net benefits, whereas cover crops typically require a longer period of time to produce positive net benefits. Farmers appear to take this into account, and are more reluctant to plant cover crops if they may not be in a position to realize the medium-term returns arising from the up-front investment. Several site-specific characteristics influence the use of conservation tillage and cover crops. Farmers are more likely to use conservation tillage on plots with coarse soils, consistent with the fact that coarse soils are more likely to suffer moisture deficits and conservation tillage conserves moisture. Farmers on hilly land are more likely to adopt conservation tillage, possibly due to concerns about soil and water erosion. Conservation tillage is more likely on larger plots of land. We find that farmers are less likely to use conservation tillage on land that is currently planted to corn, possibly due to the thick residue associated with this crop. Finally, land planted in soybeans in 2012 is more likely to be in conservation tillage. The crop grown on the property influences the use of cover crops. Plots planted to soybeans in 2012 are 10.8% less likely to be planted to cover crops. On the other hand, plots that were used to grow winter wheat in 2012 are 27.9% more likely to plant cover crops, which is consistent with the fact that cover crops like red clover are often under seeded with winter wheat.[13]

Table 2
Impact of tenure on use of conservation practices

	Conservation tillage		Cover crops	
	Coefficient	Standard error	Coefficient	Standard error
Rented	−0.018	0.033	−0.099***	0.035
Good productivity	0.033	0.110	0.153	0.115
Very good productivity	−0.030	0.117	0.069	0.125
Excellent productivity	−0.088	0.134	0.135	0.158
Hilly	0.088	0.100	0.032	0.103
Coarse	0.206***	0.067	−0.037	0.075
Plot size (thousand acres)	0.249	0.178	−0.155	0.132
Drainage	−0.022	0.064	0.072	0.070
Irrigation	−0.338	0.179	0.258	0.223
Corn planted in 2012	−0.177***	0.050	−0.063	0.053
Soybean planted in 2012	0.075*	0.042	−0.108**	0.048
Winter wheat planted in 2012	0.021	0.052	0.279***	0.064
Constant	0.671***	0.114	0.143	0.117
R^2 within	0.177		0.214	
R^2 between	0.003		0.126	
R^2 overall	0.022		0.154	
Observations	396		396	
Number of farmer clusters	198		198	

Notes: Standard errors adjusted for farmer clusters.
***Statistical significance at 1%; **statistical significance at 5%; *statistical significance at 10%.

5.2. Expected length of rental relationship

Regression results from the expected rental length model are presented in Table 3. We restrict the sample in this model to only those respondents who provided an estimate of their expected length of rental contract. (Summary statistics and normalized differences for this restricted sample are presented in

[12] As discussed in Cameron and Miller (2015), the estimated variance–covariance matrix is an average over the number of clusters. If the number of clusters is small, then the estimated variance–covariance matrix can be a poor estimate of the true variance–covariance matrix. Essentially, a small number of clusters with many observations per cluster will have less bias, but greater variance.

[13] Farmers who grow corn and soybeans on rented land may not have access to the land over the winter due to the terms of their rental contract, and may therefore be less likely to plant a cover crop. On the other hand, farmers who rent land to grow winter wheat have access to the land over the winter. To address this possible concern, we examined the influence of tenure on the decision to plant winter wheat, which is a less profitable crop than corn and soybeans, but builds soil organic matter in the long term. We restrict our attention to farmers who had access to the same rented plot for at least three years. We find that farmers are less likely to plant winter wheat on rented land than on their own land, consistent with the results in the cover crop equation.

Table 3
Impact of the expected length of rental relationship on the use of conservation practices

	Categorical measure of expected tenure length				Categorical and continuous measure of expected tenure length			
	Conservation tillage		Cover crops		Conservation tillage		Cover crops	
	Coefficient	Standard error	Coefficient	Standard error	Coefficient	Standard error	Coefficient	Standard error
Expected rental length (years)					0.005	0.010	−0.006	0.007
Short-term rental	−0.010	0.044	−0.115**	0.054	−0.023	0.055	−0.099*	0.055
Long-term rental	−0.041	0.045	−0.055	0.043	−0.103	0.117	0.025	0.101
Good productivity	0.072	0.129	0.153	0.115	0.071	0.131	0.154	0.114
Very good productivity	0.038	0.134	0.129	0.133	0.035	0.136	0.132	0.132
Excellent productivity	−0.110	0.154	0.240	0.152	−0.117	0.157	0.249	0.152
Hilly	0.071	0.099	0.110	0.076	0.071	0.100	0.110	0.077
Coarse	0.201**	0.078	0.037	0.075	0.205***	0.078	0.033	0.075
Plot size (thousand acres)	−0.045	0.109	−0.227*	0.123	−0.051	0.107	−0.220*	0.128
Drainage	0.034	0.079	−0.001	0.074	0.044	0.073	−0.014	0.078
Irrigation	−0.313*	0.173	0.279	0.203	−0.314*	0.169	0.280	0.203
Corn planted in 2012	−0.165***	0.048	−0.071	0.048	−0.165***	0.048	−0.071	0.048
Soybean planted in 2012	0.113**	0.049	−0.115**	0.050	0.112**	0.049	−0.114**	0.050
Winter wheat planted in 2012	0.012	0.056	0.152**	0.074	0.015	0.056	0.149**	0.074
Constant	0.617***	0.124	0.164	0.122	0.611***	0.122	0.172	0.123
R^2 within	0.215		0.172		0.217		0.176	
R^2 between	0.009		0.116		0.008		0.110	
R^2 overall	0.035		0.128		0.035		0.125	
Observations	308		308		308		308	
Number of farmer clusters	154[a]		154		154		154	

Notes: Standard errors adjusted for farmer clusters. We define a short-term rental arrangement as less than or equal to five years and a long-term rental arrangement as greater than five years. The number of observations in Table 3 is less than Table 2 due to the omission of respondents who do not provide rental length information. ***Statistical significance at 1%; **statistical significance at 5%; *statistical significance at 10%.

Supporting Information Appendix 3, Table A3.2.) We present two sets of results; the first model includes the two categorical measures of the expected tenure length—that is, short and long-term rental. The second model includes the two categorical measures as well as a continuous measure of the expected tenure length. We find that, in both models, the variables that measure variation in the expected future length of the rental arrangement are not statistically significant factors influencing the decision to adopt conservation tillage. Farmers appear to be behaving as if the net benefits of using conservation tillage are positive in the very short run. As discussed earlier, it might also be the case that, once the investment in machinery modifications has been made, it is easier to use one production system across all land independent of tenure status on individual plots of land.

As presented in the first model, the expected length of rental arrangement is associated with the use of cover crops. Our results suggest that renters who expect to rent the land for an additional five years or less are 11.5% less likely to use cover crops on their rented land compared to owned land. Importantly, longer term renters appear equally as likely to plant cover crops on rented land as they are to plant cover crops on the land that they own. This is an interesting result: farmers in long-term rental arrangements expect to reap more of the medium- to long-term benefits associated with cover crops and are therefore more likely to make the short-term investment, whereas farmers in short-term rental arrangements are not. In this model, farmers appear to behave as though the net benefits associated with cover crops are positive after five or more years.

As presented in Table 3, including the continuous measures of the expected rental length in the cover crop model does not influence our key findings. Specifically, the qualitative insights are unchanged if we include a continuous measure of the expected rental length along with the categorical measures (short and long term). In this case, the coefficient of the expected rental length (measured in years) is statistically and economically insignificant. These findings suggest that while cover crops may have some beneficial effect on soil health in the short run, continued application (as part of a long-standing rotation) is needed to generate economic advantage that justifies the cost. Given the grouping exemplified in Fig. 1 and our empirical results, five years appears to be a general threshold used by farmers to identify whether the net benefits of cover crops justify adoption.

Supporting Information Appendix 4 provides further sensitivity analysis to assess the alternative ways of specifying the expected rental length. Irrespective of how we define the expected rental length, the decision to adopt conservation tillage is not influenced by the expected rental length. Conceptually and empirically, our measure of the expected rental length matters more for the cover crop adoption decision. Using categorical variables that (1) differentiate the long from the short term using terciles of the expected rental length, or (2) define short term as less than or equal to 10 years leads to similar results to the baseline results we report here: that is, statistically significant effects that indicate that short-term renters are less likely to adopt cover crops on rented land than on their own land. However, defining short term as less than five years (e.g., less than or equal to 4) does not generate statistically significant results.

5.3. Farmer and nonfarmer landlords

We examine the influence of landlord type on the adoption of conservation practices with a model that interacts the landlord type dummy variable with the expected rental length dummy variable.[14] We restrict the sample in this model to only those respondents who chose to classify their landlord according to one of the provided options, and also provided an expectation of the length of their rental contract.[15] Summary statistics and normalized differences for this sample are presented in Supporting Information Appendix 3, Table A3.3. The results from this model are presented in Table 4. As expected, we find that adoption of conservation tillage on rented versus owned land is independent of landlord type. However, landlord type does influence the adoption of cover crops. Farmers are less likely to plant cover crops on nonfarmer-owned farmland in both short and long term. Indeed, irrespective of the expected rental length, farmers do not appear to treat nonfarmer landlords' farmland as if it were their own. Both variables that characterize nonfarmer landlords (*Nonfarmer landlord × Short rental* and *Nonfarmer landlord × Long rental*) have coefficients with a negative sign and both are statistically significant. However, farmers' cover crop planting decisions on land owned by a farmer appear to depend on the expected rental length. In the short run, farmers do not treat farmland owned by farmers as if it were their own. In Table 4, the coefficient on the *Farmer landlord × Short rental* variable is negative and statistically significant. Interestingly, and consistent with our earlier discussion of the influence of the expected rental length, the coefficient on the *Farmer landlord × Long rental* is statistically insignificant. Hence, in the long run, with respect to cover crops, farmers appear to treat farmland rented from other farmers as if it were their own.

These results suggest that the expected length of rental contract influences the adoption of cover crops for those farmers renting from a farmer landlord. The higher level of tenure security associated with longer expected rental lengths fails to incentivize the adoption of cover crops on land rented from nonfarmer landlords. One potential explanation is that farmer landlords are more experienced with, and knowledgeable of, the benefits of cover crops.

Table 4
Impact of landlord type and expected rental length on use of conservation practices

	Conservation tillage		Cover crops	
	Coefficient	Standard error	Coefficient	Standard error
Nonfarmer landlord × Short rental	0.008	0.053	−0.142*	0.078
Nonfarmer landlord × Long rental	−0.051	0.061	−0.137**	0.065
Farmer landlord × Short rental	−0.064	0.079	−0.151**	0.067
Farmer landlord × Long rental	−0.016	0.064	0.008	0.057
Good productivity	−0.036	0.094	0.121	0.122
Very good productivity	−0.054	0.110	0.093	0.141
Excellent productivity	−0.215	0.132	0.177	0.159
Hilly	0.050	0.101	0.097	0.078
Coarse	0.215*	0.083	0.046	0.076
Plot size (thousand acres)	−0.032	0.126	−0.252**	0.113
Drainage	0.021	0.082	0.005	0.073
Irrigation	−0.387*	0.199	0.310	0.227
Corn planted in 2012	−0.171***	0.052	−0.063	0.046
Soybean planted in 2012	0.130**	0.054	−0.131**	0.053
Winter wheat planted in 2012	0.022	0.058	0.172**	0.075
Constant	0.696***	0.105	0.209	0.131
R^2 within	0.255		0.219	
R^2 between	0.013		0.135	
R^2 overall	0.046		0.154	
Observations	284		284	
Number of farmer clusters	142[a]		142	

Notes: Standard errors adjusted for farmer clusters. We define a short-term rental arrangement as less than or equal to five years and a long-term rental arrangement as greater than five years. We define current farmers, retired farmers, and spouses of farmers as landlords with a farming background. All other types of landlords are classified as nonfarmer landlords. The number of observations in Table 4 is less than Table 3 due to the omission of respondents who do not provide information on landlord type (i.e., nonfarmer, farmer). Clusters are distributed between the landlord type and rental expectations as follows: Nonfarmer landlord × Short rental = 38; Nonfarmer landlord × Long rental = 34; Farmer landlord × Short rental = 29; Farmer landlord × Long rental = 41. ***Statistical significance at 1%; **statistical significance at 5%; *statistical significance at 10%.

[14] Defined $T = 1$ if the plot is rented, $L = 1$ if in a long-term rental relationship, and $F = 1$ if renting from a "farmer" landlord. The typical three-way interaction model is as follows: $y = \beta 1T + \beta 2L + \beta 3F + \beta 4TL + \beta 5TF + \beta 6LF + \beta 7TLF$. Since $L = 1$ and $F = 1$ only when $T = 1$, this implies that $L = TL$, $F = TF$, and $LF = TLF$. The interaction model therefore reduces to $= \beta 1T + (\beta 2 + \beta 4)TL + (\beta 3 + \beta 5)TF + (\beta 6 + \beta 7)TLF$. This is equivalent to the reparameterized equation we estimate: $y = \alpha 1TLF + \alpha 2TLN + \alpha 3TSF + \alpha 4TSN = \alpha 1TLF + \alpha 2TL(1 - F) + \alpha 3T(1 - L)F + \alpha 4T(1 - L)(1 - F) = \alpha 4T + (\alpha 2 - \alpha 4)TL + (\alpha 3 - \alpha 4)TF + (\alpha 1 - \alpha 2 - \alpha 3 + \alpha 4)TLF$, where $S = 1$ if in a short-term rental relationship and $N = 1$ if renting from a "nonfarmer" landlord.

[15] It is possible that contract stipulations influence the use of cover crops. We have no evidence of stipulations directly related to cover crops, but we do observe crop choice stipulations. Just over 5% of the farmers in our sample enter into rental relationships with crop choice stipulations. Dropping these farmers from the sample does not alter our results.

In summary, with respect to conservation tillage, the inclusion of landlord type leads to results that are qualitatively similar to the earlier regression results: that is, farmers are just as likely to adopt conservation tillage on the land they rent as the land they own. However, the results are more nuanced when we introduce landlord type to examine the adoption of a cover crop. With respect to farmer landlords the results are similar: that is, farmers with long-term rental expectations treat rented farmland like their own. However, with respect to cover crop adoption on land rented from nonfarmer landlords, the results differ: that is, farmers are less likely to plant cover crops on rented land regardless of the expected rental length. This suggests that tenure security, as measured by the expected length of the rental relationship, is a necessary but not a sufficient condition for adoption of cover crops. Given the increasing prevalence of nonfarmer landlords and ongoing efforts to enhance conservation adoption, we believe this finding should serve as a basis for future theoretical and empirical studies.

It is also important to note that our results are not structural. While our result is consistent with a general perception that nonfarmer landlords are less aware of conservation practices and are less likely to monitor and enforce their use, we cannot rule out the role of other landlord characteristics that may be correlated with our measure of landlord type. For instance, farmer landlords may have a stronger conservation ethic and are therefore more likely to encourage the use of conservation practices. We estimate a reduced form relationship between landlord type and adoption of conservation practices; the effect we estimate reflects several factors including the conservation attitude of the landlord as well as the landlords' awareness of and ability to enforce and monitor the use of conservation practices. This is certainly a promising area for future research that we expect will be developed in the coming years, for example, by collecting more extensive information on landlord characteristics. Our results are suggestive and we hope that they will help to push this literature forward in a productive manner.

6. Conclusion

This study examines the impact of tenure security on the use of conservation practices. We draw a distinction between conservation practices that payoff quickly, such as conservation tillage, and those that require more time to pay off, such as cover crops. We use plot-level data collected from a sample of farmers in southern Ontario to examine the use of conservation practices on land they rent versus land that they own. Identification of the role of tenure, including both expected rental length and the type of landlord, is based on within-farmer variation, which allows us to control for unobserved farmer characteristics that might influence tenure security and the use of conservation practices.

We find that tenure does not influence the use of conservation tillage, irrespective of the length of rental contract or the type of landlord. This is consistent with the fact that conservation tillage generates positive net returns in the short term and, once adopted, there are incentives to use a one tillage system on both owned and rented land. On the other hand, tenure security matters for the adoption of cover crops, which is a plot-specific conservation practice that generates positive net returns in the medium to long term. We find that farmers are less likely to use cover crops on land they rent compared to land they own, and that the extent of tenure security as measured by the expected length of the rental relationship also matters. Consistent with popular perceptions (Shute and Shute, 2013; Strom, 2016) our results also indicate that landlord type matters. Specifically, farmers renting from nonfarmer landlords are less likely to adopt cover crops on rented land even if they expect to have a long-term rental relationship with their landlord. This suggests that a long-term rental relationship is not sufficient to increase adoption of a medium- to long-term conservation practice such as cover crops. Extension and outreach efforts promoting increased use of conservation practices therefore need to recognize differences among landlords. While extension and outreach efforts are typically oriented to farm operators, recent extension efforts in the United States have targeted nonfarmer landlords (Cox, 2010; Duffy, 2015). Similarly, in Canada such efforts are underway. In Canada, Credit Valley Conservation (an Ontario Conservation Authority) has recently held environmental planning workshops for farm landlords. Our research suggests that such targeting is appropriate.

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Supporting Information

Additional supporting information may be found online in the Supporting Information section at the end of the article.

Table A3.1. Summary statistics by tenure
Table A3.2. Summary statistics by expected length of rental relationship
Table A3.3. Summary statistics by landlord type
Table A4.1. Cover crop fixed-effects regressions with standard errors clustered by county
Table A4.2. Cover crop regressions: alternative tenure length categories