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Naveen Adusumilli
LSU Agricultural Center

Hua Wang
Louisiana State University

agriculture

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Conservation Adoption Among Owners and Tenant Farmers in the Southern United States

Naveen Adusumilli [1,*] and Hua Wang [2]

[1] Louisiana State University Agricultural Center Department of Agricultural Economics 230 Martin D. Woodin Hall, Baton Rouge, LA 70803, USA

[2] Center for Natural Resource Economics & Policy Louisiana State University Department of Agricultural Economics 254B Woodin Hall, Baton Rouge, LA 70803, USA; hwang23@lsu.edu

* Correspondence: nadusumilli@agcenter.lsu.edu; Tel.: +01-225-578-2727

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Abstract: This study investigates owner and tenant characteristics and differences between these two groups in their participation in federal conservation initiatives. Bivariate probit model analysis, based on a 2016–2017 Louisiana row-crop producer's survey show that owners, relative to tenant farmers, are more likely to adopt conservation in early years of ownership. The results emphasize the need for mechanisms for tenants in short-term contracts to invest in long-term conservation. Moreover, conservation initiatives should be tailored, as tenant farmers are increasingly farming more land and policies should carefully account for this growing group of farmers.

Keywords: conservation; voluntary adoption; conservation incentives; policy; outreach; tenant

1. Introduction

National soil and water health initiatives have focused on promoting the adoption of several conservation practices among farmers as a measure to address nonpoint source pollution, weathering farming against extreme events such as drought and heavy rainfall, pest and disease suppression, etc. Adoption of conservation on the ground is influenced by social, individual, and economic characteristics. A vast amount of literature has analyzed these factors on various scales [1–4]. Among variables affecting adoption of conservation, ownership plays an important role in voluntary conservation adoption in the United States and other parts of the world [5].

Ownership variable plays an important role in land management decisions. The author of [6] stressed that ownership is directly linked to better land management decisions. He emphasized that private landowners are more likely to conserve their land and natural resources tied to that land. With growing input costs, coupled with an aging farmer population serving as principal farm operator, more land is now leased but ownership is still retained, as land is considered wealth. In such cases, where it was previously thought that tenancy is associated with poorer adoption of land conservation measures [7], there is a need to increase knowledge about ownership and motivation that drives conservation adoption of working lands and how conservation is perceived among these groups of farmers.

The existing literature has identified characteristics such as age, gender, education [1,8]; other studies have shown that income and access to credit [3,9] affect adoption of conservation technology. But there has not been much evaluation done of ownership factors affecting conservation adoption. In addition, length of ownership, i.e., how long the land is either owned or leased affects conservation adoption because it is assumed that the longer the connection to the land, there is a greater understanding of the resource concerns of the land and the need to address those concerns through conservation implementation. Aligning production with conservation practices is warranted when intensive agricultural production could exacerbate the issue of non-point pollution. Agriculture is considered one of the major contributors to non-point source pollution. Inefficient use of inputs, mainly nutrients and irrigation, to agricultural lands can result in runoff of nutrients and sediments from croplands to neighboring bodies of water. In addition, some of the agricultural lands are naturally prone to losing nutrients and sediments. As a result, understanding the land and its inherent characteristics is key to the management of inputs applied and their consequent removal through anthropogenic as well as natural factors. Therefore, the decision to adopt conservation depends on the need to address these concerns and is dependent on various factors indicated above, including ownership.

Improved varieties, new technology, and policy changes have prompted some landowners to consider leasing out land as one of the ways to maintain ownership but accumulate wealth. On the other hand, tenant farmers are willing to farm more acres, which could be linked to either younger generation of farmers replacing the aging principal farm operators and/or tenant farmers willing to increase total acres in their enterprise to accommodate increasing land rents, as larger farm size can provide overall higher profits due to economies of scale. Nevertheless, it is reasonable to assume that both groups, full owners (principal farm operators that own 100% of the land they farm) and tenant farmers (principal farm operators that rent 100% of the farmland as well as those who rent part of the farmland) would react similarly to growing demand for agricultural products as a consequence of increasing global population, i.e., adopt methods and technology to improve production but each groups' intent to mitigate resource use vis-a-vis overuse can significantly differ as the decision can be a profit-maximizing problem and/or utility-maximizing problem [10].

These dynamics need careful evaluation because the utility gained from conservation adoption can differ among these two groups; hence, investigating the differences among these groups can provide useful insights on what drives conservation adoption and what role previous participation in conservation programs plays in participation in national conservation initiatives, as the purpose to own and/or lease the land can be different among these groups. The objectives of the study are to evaluate whether ownership and length of ownership affect conservation adoption, the factors that differentiate the owner from tenant farmers in adopting conservation practices and programs.

When benefits, both monetary and nonmonetary, accrue form adoption of conservation technologies, there might be region-wide benefits [11], which could include overall nutrient runoff reduction in a body of water, and can also promote adoption as a result of peer- influence, which can have implications for overall farm profits [12] and resource conservation in the long run [13]. Therefore, understanding characteristics that influence conservation adoption, aimed to mitigate nonpoint source pollution, is the cornerstone to promote sustainable agriculture and bolster the argument for the programs to be funded appropriately to achieve those long-term goals.

With recent policies such as regional conservation partnership program, aimed at implementing conservation strategies, across watersheds, understanding the differences in adoption behavior, if present, will conclude whether the interests of the full-owners and tenants are aligned with conservation objectives. Moreover, when production and conservation occur simultaneously on working lands, understanding adopting behavior by these two groups can lead to adjustments in current policies that can enable designing conservation strategies that can be implemented with minimal changes to current practices.

2. Economic Motivation

According to the United States Department of Agriculture's Farms and Land in Farms report, the average farm size in Louisiana increased from 142 acres to 144 acres among full owners from 2002 to 2012, whereas the average farm size increased from 536 acres to 586 acres among tenant farmers. Together, tenants farmed a total of 5.2 million acres in Louisiana in 2012 compared to 2.7 million acres by full owners. In addition, there has been a 19% increase in tenant farmers in Louisiana farming 2000 acres or more from 2007 to 2012. Conversely, full owners decreased by 7% [14] during the same time.

These numbers illustrate that tenant farmers are farming relatively more acres and their number is trending upward in Louisiana, while full owners are decreasing in number and are farming fewer acres.

As noted earlier, ownership can profoundly impact conservation adoption on the ground; however, literature that examined the impact of ownership on conservation adoption found little consensus on the impact of ownership and indicated that these differences among tenant farmers and full owners in conservation adoption are shifting over time [15]. The same study that looked into one specific conservation practice, conservation tillage, have shown that full-owners are more likely to adopt conservation tillage [15], whereas other studies have found that tenant farmers were less likely to adopt conservation tillage or any other long-term conservation practices [2,4]. However, Tosakana [16] indicated that, with respect to buffer strips, leasing was not a deterrent to adoption. Since there are previous studies that have included the minimum tillage variable in the general context of adoption but not specifically related to tenure along with cover crop practices, we build upon the earlier attempts in literature analyzing ownership relation to conservation adoption by providing a closer look for tenant and full owners conservation adoption within the same analysis and analyzing the differences among these two groups in a regional setting.

Understanding this link between tenure and conservation choices in Louisiana is critical because the state is at the tail-end of the discharge of major river basins, the Mississippi and the Red-River, which ultimately discharges into the Gulf. Conservation on working lands can influence nutrient discharge and mitigate non-point source pollution. Attention to the link between tenure and conservation adoption, at this juncture, is critical when conservation programs are often constrained by budget availability, consolidation into fewer programs with various objectives, increase in extreme weather events [17], farm profits being impacted by inefficient input use [10], and elevated nutrient loadings in waterways [18]. Our research examines the connection between tenure and cover crops and conservation tillage adoption, seeking information through reliable sources, and participating in federal conservation programs using information from a producer survey that was conducted in Louisiana in December 2016 to January 2017. In the following sections, we introduce the survey, describe the economic model used to evaluate the responses, and discuss the results and their implications.

3. Survey and Data

The study analyzes row crop and pasture farmer's decisions concerning the adoption of recommended soil management practices but more specifically the implementation of cover crops practices, tillage practices, and those decisions being influenced by ownership, information sources, participation in working-lands programs, and other conservation practices in use. A stratified random sample organized farmers in the Louisiana Master Farmer Program database according to three major row crops (corn/maize, soybeans, and cotton) and/or pasture farmers, farms over 350 acres (141 ha) in active production, and actively engaged in farming. The final group as a result of the above criteria consisted of 754 farmers from a total of 3820. However, out of the 754, only 500 of them had contact information listed in the database. As a result, the survey questionnaire was sent to those 500 farmers through email. Extension agents, research and extension faculty of the LSU AgCenter, and Soil and Water Conservation District Board members volunteered to test the survey for validity. The questionnaire was approved by the LSU AgCenter Institutional Review Board (IRB) prior to the initiation of the online survey.

The survey was designed and implemented using [19] a tailored design method. An initial notification/announcement was provided to farmer groups at producer meetings, field days, and certification meetings about the upcoming survey. This was followed by a pre-notification to the 500 farmers, who eventually received the survey link in the email in December 2016. A reminder email was sent two weeks later to those that have not responded to the survey. Survey respondents did not receive any incentives to complete the survey. Table 1 presents a summary of some management characteristics of the farmers surveyed in the region.

Table 1. General Farm-Management Characteristics of Farmers.

Description	Full Owner (n = 99)		Tenants (n = 157)	
	Percent (%)	Cumulative Percent (%)	Percent (%)	Cumulative Percent (%)
Farmers who used cover crops practice	46.34	46.34	46.88	46.88
Farmers who do not use cover crops practice	53.66	100	53.13	100
% acres under conservation tillage				
1–25%	50	50	18.6	18.6
26–50%	9.09	59.09	27.91	46.51
51–75%	4.55	63.64	9.3	55.81
76–100%	36.36	100	44.19	100
% acres enrolled in Conservation Stewardship Program (CSP)				
1–25%	14.29	14.29	16.67	16.67
26–50%	14.29	28.57	16.67	33.33
51–75%	0	28.57	25	58.33
76–100%	71.43	100	41.67	100
% acres enrolled in Environmental Quality Incentives Program (EQIP)				
1–25%	28.57	28.57	35.48	35.48
26–50%	14.29	42.86	25.81	61.29
51–75%	0	42.86	19.35	80.65
76–100%	57.14	100	19.35	100
Technical assistance and research support				
LSU AgCenter Research or Extension	52.63	52.63	42.37	42.37
Natural Resource Conservation Services (NRCS)	15.79	68.42	15.25	57.63
Crop consultant	5.26	73.68	25.42	84.75
Dealers/distributors	5.26	78.95	6.78	91.53
Other growers	7.89	86.84	1.69	93.22
Internet or Web-based resources	13.16	100	8.47	100

The survey consisted of sections that request information about adoption of 13 different soil management practices, participation in cost-share programs to implement those practices, land ownership structure, and intent to continue adoption based on the availability of cost-share programs. Sociodemographic information is also gathered in the survey. A total of 256 partially or fully completed surveys were returned. For the purpose of the study, responses with respect to cover crops adoption and conservation tillage, by both full-owners and tenant farmers, were included in the analysis. The survey response rate is above the 10% margin of sampling error, which was calculated using a minimum response rate guidance provided by [20] (Dillman provides the following formula for estimating desired response rate: $Ns = Np(1 - p)/((Np - 1)(B/C)^2 + p(1 - p))$, where Ns is the response rate needed for the corresponding level of error, Np is the size of the population (~500 in our research), B is the acceptable amount of sampling error (we assume 10%), C is the statistical certainty usually set at the 95% confidence level (1.96), and p is the estimated level to be investigated, usually a $p = 0.5$ is chosen. These parameters yielded a required response rate of 81). The respondents were categorized as “full-owners” and as “tenants”.

4. Variables

Explanatory variables used in the regression model are described in this section. Descriptive statistics of these variables are given in Table 2. Within the literature on conservation agriculture, location-specific assessments of financial and other factors that influence farmers’ decision to adopt conservation practices are conducted [8,21], which provide useful insights of the independent variables, explain adoption, and facilitate policy argument to improve conservation on working lands [22]. The factors included in this analysis are described below:

Table 2. Variable Definitions and Descriptive Statistics.

Variable	Description	Full Owner (n = 99)		Tenants (n = 157)	
		Mean	Standard Deviation	Mean	Standard Deviation
	Response Variable				
COVER_CROP	Farmer adopts cover crop practices = 1; Else = 0	0.46	0.50	0.47	0.50
MIN_TILL	Farmer uses minimum till practices = 1; Else = 0	0.54	0.51	0.67	0.47
	Explanatory Variables				
	LENGTH OF OWNERSHIP				
YEAR_1	Less than 5 years	0.15	0.36	0.03	0.18
YEAR_2	5-10 years	0.15	0.36	0.09	0.29
YEAR_3	11-15 years	0.10	0.30	0.03	0.18
YEAR_4	16-20 years	0.05	0.22	0.06	0.24
YEAR_5	Greater than 20 years	R	R	R	R
SOIL_MGMT	Farmer who adopts at least two other soil management practices = 1; Else = 0	0.32	0.47	0.44	0.50
AGE	40 years or younger = 1; Else = 0	0.17	0.38	0.17	0.38
FARM_SIZE	Farmers that farm greater than 500 acres = 1; Else = 0	0.41	0.50	0.45	0.50
CSP_EQIP	Enrolled in CSP and/or EQIP = 1; Else = 0	0.22	0.42	0.56	0.50
TA_LSUNRCS	Technical assistance from LSU AgCenter and/or NRCS = 1; Else = 0	0.63	0.49	0.53	0.50

R: Reference group.

The variable *Length of Ownership* is categorized into five groups: (1) Less than five years; (2) five to 10 years; (3) 11 to 15 years; (4) 16 to 20 years; and (5) greater than 20 years. The effect of length of ownership has been examined in a number of adoption studies [4,15,23–26] as ownership plays a crucial role in participation in federal conservation programs. It is often argued that renters that have a short-term connection to land are less likely to implement conservation practices [4]; however, it is not very clear about tenant farmers that are in long-term contracts with landowners. Categorizing the ownership variable into the length of ownership can provide useful insights on conservation adoption strategies among tenants.

Among management variables, soil-management practices, *SOIL_MGMT* was coded 1 if a farmer adopted at least two of the three most commonly recommended soil management practices and 0 otherwise. The three common practices include soil-test, crop rotation, and grassed waterways/ vegetative buffers. While previous studies accounted for this behavior of adoption of soil management practices as for whether or not each of the practice is adopted, the variable in this analysis reflects the adoption of a package of practices, often encouraged by conservation agencies (Farm-specific conservation plan, often called a Resource Management System (RMS) Plan, implemented by farmers with the help of NRCS, is a similar approach where farmers implement a suite of site-specific conservation practices to address natural resource concerns on the farm. Having such a plan is perceived as farmer intent to implement long-term conservation. The soil management variable is believed to capture the effect of long-term conservation strategy among full owner and tenant farmers). These practices are often considered a part of a long-term conservation strategy. Tenant farmers might perceive adoption of these practices as not being able to provide immediate benefits to their overall net returns and might not consider adoption; however, there is evidence that tenant farmers are equally concerned about soil health [27]. The argument behind the latter is that tenant farmers intend to continue to farm the same land through longer rental contracts and/or anticipate to negotiate better contract rates by being better advocates of soil management.

The variable *CSP_EQIP* represents farmer's current or past participation in the CSP and the EQIP, two most popular federal conservation working-lands programs. The variable is coded 1 if a farmer currently participates in CSP/EQIP and 0 otherwise. Both programs currently support cover crop practices and conservation tillage through national initiatives providing annual incentives if implemented for at least three to five years. Although studies have shown that current or previous participation can influence participation in national conservation initiatives [10], differences among tenants and owners have not been evaluated; however, [28] found that government payments for technical assistance did not impact investment in soil conservation practices. About 70% owners had 50% or more acres in these programs while about 40% of the renters have more than 75% of acres in CSP and about 35% renters have less than 25% of acres in EQIP.

The *AGE* variable was coded 1 if a farmer was 40 years or younger and 0 otherwise. In Louisiana, the average age of a principal operator in Louisiana is 58.5 [14], higher than the national average. Hence, there is more emphasis on the need for individuals to enter crop production enterprises to replace the aging farming population and keep agriculture and associated industries viable in the state; however, those entering as decision-makers in the owners or tenant farmers category can have different priorities and strategies to maximize profits. In addition, those entering farming at a much younger age than 40 years old, often seen in many family farms, do not necessarily make farm decisions because the older generation is still very much involved in farming. Those young individuals are only introduced into farming business as a way to initiate transition from one generation to another. As a result, the categorical variable of 40 or older is picked based on expert local farmer advice. Literature has examined this variable only in terms of the influence of age on conservation adoption [29,30] but not from an owner or tenant perspective. Therefore, it is important to understand the decision-making mechanism of that sub-group of farmers, who would be potentially replacing the aging principal farm operators in the region.

Conservation agencies, land-grant universities through their extension program, and independent crop consultants play a major role in the dissemination of information to farmers with respect to management practices, policy changes regarding programs, and research-based performance of management practices in mitigation of natural resource use. Such information is often used to make informed decisions by farmers. The variable *TA_LSUNRCS* represents whether farmers have received technical assistance from various groups, staff, and research faculty, among others. To include in the analysis, the variable was coded 1 if the farmer obtained technical assistance and research support from LSU AgCenter and/or Natural Resource Conservation Services and 0 otherwise. Several programs currently implemented by land-grant universities and conservation agencies can strongly influence conservation adoption; however, if owners and tenants perceive this information differently, it might help explain adoption differences.

5. Empirical Model

According to utility theories [31,32], a farmer's behavior is characterized by a set of attributes (e.g., physical characteristics of the property and socioeconomic characteristics of the farmer). The farmer assesses his/her utility for each attribute on the choice to participate in a conservation program. The overall evaluation is based on a weighted combination of the utilities. The choice that produces the greatest utility is chosen. Thus, the probability that farmers who participate adopt a certain practice can be written as a function of a set of attributes [12]. The estimation of bivariate probit function is based on the method of maximum likelihood and the log-likelihood function can be expressed as:

$$lnL = \sum_{i=1}^{n}\{y_i ln\Phi(\beta' X) + (1-y_i)ln[1-\Phi(\beta' X)]\} \quad (1)$$

where β' is a vector of coefficients to be estimated; X is a vector of explanatory variables.

Often, unobserved factors such as one's attitude toward conservation can influence the adoption of conservation practices. As a result, in the current analysis, adoption of conservation tillage, cover crops, and any other soil management practices can be influenced by this unobservable factor(s), indicating a potential existence of endogeneity that can yield inconsistent results [33]. The problem can be tackled through a good instrument variable(s). Use of instrument variable(s) can estimate causal interactions and at the same time estimate whether the independent variable correlates with the error term.

Test for endogeneity was carried out (using ivprobit command in STATA), which produced the Wald test that examines whether the error terms in the structural equation and the reduced form equation for the potentially endogenous variable are correlated [34]. The endogeneity effect of adoption of common soil management practices on cover crop and conservation tillage adoption was investigated. The reliability of each instrument used against the instrumented in the iv-estimation was also tested.

In general, the parameter estimates of the bivariate probit model rarely have any direct interpretation besides indicating the significance of the explanatory variable and the direction of its influence on the dependent variable. The economic interpretation frequently focuses on the analysis of the marginal effects of regressors on the expected value of y_i for limited dependent variable models [35]. To fully understand the magnitude of the relationship between the explanatory and dependent variables, the marginal effects using the maximum likelihood results obtained from the estimated model are calculated and can be expressed as [36]:

$$\begin{aligned} \Delta X_{ki} Prob(Y_i &= 1|X_{1i}, \ldots X_{ki}; \beta_0, \ldots, \beta_k) \\ &= \{\beta_k \varnothing(\beta_0 + \sum_{l=1}^{k-1} \beta_l X_{ki} + \beta_k + \sum_{l=k+1}^{k} \beta_l X_{ki})|X_{ki} = 1\} - \{\beta_k \varnothing(\beta_0 \\ &+ \sum_{l=1}^{k-1} \beta_l X_{ki} + \beta_k + \sum_{l=k+1}^{k} \beta_l X_{ki})|X_{ki} = 0\} \end{aligned} \quad (2)$$

where $\varnothing(\cdot)$ is the standard normal probability density function (pdf), the discrete change in a regressor of X_{ki} that takes the values [33] is given by the above equation. The marginal effects are interpreted similarly to those of binary probit models, but the effect is on the joint probability of the two outcomes. The marginal effects sum up to zero across the joint probabilities.

6. Results and Discussion

The marginal effects of the analysis are presented in Table 3. For each group of farmers, full-owners and tenant farmers, three decisions are analyzed. Those that have adopted only cover crops and no minimum tillage (CC = 1, MT = 0), those that have adopted minimum tillage but not cover crops (CC = 0, MT = 1), and those that have adopted both practices (CC = 1, MT = 1).

Table 3. Marginal effects for the joint probabilities of full owners and tenant farmers.

Variable	P (CC = 0, MT = 1)	P (CC = 1, MT = 0)	P (CC = 1, MT = 1)	P (CC = 0, MT = 1)	P (CC = 1, MT = 0)	P (CC = 1, MT = 1)
	Full Owners			Tenant Farmers		
LENGTH OF OWNERSHIP						
<5 yrs	−0.38 ***	0.07	0.93 ***	0.23	−0.05	−0.02
5–10 yrs	−0.15	0.05	0.58 ***	−0.25	0.20	−0.30
11–15 yrs	−0.38 ***	0.76 ***	0.01 ***	−0.11	0.07	−0.19
16–20 yrs	0.08	0.09	0.13	−0.58 ***	−0.05	−0.37 **
SOIL_MGMT	0.25	−0.21	0.65 ***	−0.02	−0.03	0.27 *
AGE_40	0.38	−0.33	−0.33 **	0.00	−0.02	0.14
CSP_EQIP	0.49 **	0.42 ***	−0.05	−0.16	−0.03	0.44 *
TA_LSUNRCS	−0.24	0.21	0.34 **	−0.23	0.05	0.05

CC: Cover crop; MT: Minimum Till. Note: <1% level ***; <5% level **; <10% level *.

For variable, length of ownership, among full owners who adopted both practices, individuals with less than 10 years of ownership of land have adopted both cover crops and conservation tillage more than that of those with ownership of greater than 20 years; however, among full-owners that have adopted only conservation tillage, those with less than 15 years of ownership are less likely to adopt conservation tillage than the reference group. One of the reasons for such difference in adoption between two important soil management practices could be that tillage-related practices require a modification to equipment to enable conservation tillage. Those that have recently acquired land might consider this requirement as an additional expense and would prefer to adopt a practice that would fit with existing production practices as well as equipment. Moreover, the existing cost-share programs do not cover any expense to change or modify equipment to allow conservation practice implementation, which could be one of the other reasons for adopting less conservation tillage. On the other hand, among tenant farmers, even those that have leased the land for more than 15 years are less likely to adopt conservation tillage and cover crop practices compared to the reference group. With land rents on the rise, any additional expense might be a deterrent to adoption of a new practice on the farm. It is also likely that tenants might not be able to communicate properly the benefits of these conservation programs to their landowners to obtain approval of conservation practice adoption ultimately not being able to take advantage of the cost-share programs.

In the instrumental variable regression, adoption of common soil management practices is statistically significant with cover crop and conservation tillage adoption, which indicates that there is exogeneity of adoption of common soil management practices with cover crop and conservation tillage adoption. The Wald test results indicated that the instrumental variables are not endogenous to the dependent variable. As a result, the variable *SOIL-MGMT* was included in the final analysis. The variable *SOIL_MGMT* is positive among both full-owners and tenant farmers; albeit, only among those that have adopted both practices. The result is consistent with literature that owners tend to implement conservation strategies relatively more (more likely) than tenants as some of the practices might require a change to current production practices and might not provide immediate net returns, which could lead to less adoption among tenants [37].

The variable *AGE*, indicating the age of farmer to be less than 40 years old or less, is significant and negative among full owners with respect to the adoption of cover crop practices and conservation tillage. Research has shown that young farmers are more likely to adopt conservation practices [3]; however, the effect is opposite with respect to cover crop and conservation tillage practices among full-owners. It is reasonable to assume that irrespective of the age, the adoption decision is dominated by ownership of land. This might not be the case for other conservation practices.

The variable *CSP_EQIP* is both positive and significant among owners and renters. In the full-owner category, the effect is positive among those adopting one of the other practice; whereas, in the renters' category, the effect is positive and significant among those adopting both practices. It is reasonable to assume that renters once provided approval from landowners might take full advantage of participation in conservation programs that provide both cost-share payments and environmental benefits of the conservation practices; hence, a positive and significant effect among those adopting both practices. Whereas among full-owners, the decision to adopt conservation practices is not tied to requiring any approval but rather a practice that best meets their current needs with an assumption that more practices can always be added at a later time, unlike in the case of renters where decisions could be tied to contract length. Shorter the length of the contract, one would find it less economical to invest in additional conservation practices that might not provide benefits within the contract time. Finally, full owners tend to use the information from extension agencies, land-grant university extension, to make decisions regarding implementation of both cover crops and conservation tillage practices. It is likely that renters tend to rely on other sources of information such as crop consultants, seed and fertilizer suppliers, to make some on-farm decisions.

7. Conclusions

Although adoption behavior is strongly linked to economic constraint paradigm, where farmers are more likely to adopt conservation practices, if the profitability from adoption is higher than the status-quo, there is also a strong rationale to adopt additional practices to achieve long-term conservation benefits, often non-tangible such as improvement in soil-water holding capacity, weed suppression, improvement in organic matter, among others, eventually providing environmental and economic benefits into the distant future. This behavior is evident in both full-owners and tenants adopting common soil management practices and adopting both cover crops and conservation tillage.

A large number of studies analyzed adoption behavior and suggested several determinants, including attitudes, costs, natural resources, and ownership to explain the role of these variables in the decision-making process; however, only a few studies accommodate circumstances that explain the differences in adoption decisions between owners and renters. Our results show that owners, irrespective of their length of ownership, are more willing to participate in conservation programs. Tenants, on the other hand, are less likely to implement conservation. Although there might be a blend of economic factors at play, one may be linked to not being able to attain the benefits of the conservation within the contract time for tenant farmers.

While studies have shown that tenant farmers participate more in some conservation programs than owners [38], our study found that certain conservation practices are adopted at a smaller rate among tenant farmers during early years of their contracts. Moreover, as studies showed that participation in conservation programs is not consistent among tenants and owners [39], we find that both groups utilize these programs to implement conservation on working lands; however, tenants tend to adopt multiple practices if they historically participated in cost-share programs. While owners utilize information from conservation agency staff and extension agents to make conservation decisions on the farm, tenants seem to rely more on other sources for information in conservation decisions.

The analysis supports arguments that secure land tenure leads to better adoption of conservation, in other words, short-term lease contracts do not contribute to investments in soil conservation [2]. As a result, long-term investments in conservation are not just tied to the availability of programs and associated incentives but to some extent on land tenure. As data provides some evidence of long-term leases on conservation adoption, the analysis sheds light on conservation behavior of farmers in short-term leases. As results show, there is a great need to provide opportunities for tenant farmers in short-term contracts to invest in long-term conservation. As some full-owners are willing to sacrifice short-term economic returns for long-term conservation benefits, owners preferring short-term contracts should support rental agreements that account for the benefits of conservation implementation and provide a way to share the expense of soil conservation practices with the lessee as a method to ensure sustainability of land use. The use of such decision-making can be tied into policy where landowner and lessee in such an arrangement can be evaluated whether they would qualify for a higher-ranking when allocating cost-share incentives, depending on the characteristics of the cropland, and/or qualify for implementing a mechanism to compensate for the difference in short-term vs long-term lease payment. Some of these alternatives should be of considerable interest to policymakers to substantiate how a public program can provide incentives to invest in a public good generation even when land-tenure is not secured and the benefits of implementation cannot be reaped in the short-run.

Although some of the results are tentative as they are based on smaller number of observations, possibly resulting in measurement error, the results suggest that promoting alternatives to invest in long-term conservation among those in short-term contracts can be an efficient way for wide-scale adoption of soil conservation initiatives. Finally, the results are useful from a policy perspective when certain programs are affected by funding availability that have implications for both owners and tenants, albeit differently; the success of such programs heavily relies on recognizing how these groups would respond to program changes. Moreover, there is ongoing development of various economic instruments to include environmental objectives but the success of the policy instruments is often tied to political as well as economic conditions. On a broader level, as economic theory predicts that security in lease contracts can result in investments in soil conservation, the results from the current analysis can be useful for several sources that communicate with farmers, full-owners and tenant farmers, to implement long-term conservation to address resource concerns.

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References

1. Alam, M.; Islam, M.; Salahin, N.; Hasanuzzaman, M. Effect of tillage practices on soil properties and crop productivity in wheat-mungbean-rice cropping system under subtropical climatic conditions. *Sci. World J.* **2014**, *2014*, 437283. [CrossRef] [PubMed]
2. Fraser, E.D. Land tenure and agricultural management: Soil conservation on rented and owned fields in southwest British Columbia. *Agric. Hum. Values* **2004**, *21*, 73–79. [CrossRef]
3. Prokopy, L.S.; Floress, K.; Klotthor-Weinkauf, D.; Baumgart-Getz, A. Determinants of agricultural best management practice adoption: Evidence from the literature. *J. Soil Water Conserv.* **2008**, *63*, 300–311. [CrossRef]
4. Soule, M.J.; Tegene, A.; Wiebe, K.D. Land Tenure and the Adoption of Conservation Practices. *Am. J. Agric. Econ.* **2000**, *82*, 993–1005. [CrossRef]
5. Sklenicka, P.; Molnarova, K.J.; Salek, M.; Simova, P.; Vlasak, J.; Sekac, P.; Janovska, V. Owner or tenant: Who adopts better soil conservation practices? *Land Policy* **2015**, *47*, 253–261. [CrossRef]
6. Timmons, J. Farm ownership in the United States: An appraisal of the present situation and emerging problems. *J. Farm Econ.* **1948**, *30*, 78–100. [CrossRef]
7. Maddox, J.G. The bankhead-Jones farm tenant act. *Law Contemp. Probl.* **1937**, *4*, 434–455. [CrossRef]
8. Westra, J.V.; Olson, K.D. *Farmers' Decision Processes and Adoption of Conservation Tillage*; University of Minnesota: St. Paul, MN, USA, 1997.
9. Baumgart-Getz, A.; Prokopy, L.S.; Floress, K. Why farmers adopt best management practice in the United States: A meta-analysis of the adoption literature. *J. Environ. Manag.* **2012**, *96*, 17–25. [CrossRef]
10. Adusumilli, N.; Wang, H. Analysis of soil management and water conservation practices adoption among crop and pasture farmers in humid-south of the United States. *Int. Soil Water Conserv. Res.* **2018**, *6*, 79–86. [CrossRef]
11. Just, R.E.; Zilberman, D.; Rausser, G.C. A putty-clay approach to the distributional effects of new technology under risk. In *Book Operations Research in Agriculture and Water Resources*; North Holland Publishing Company: New York, NY, USA, 1980.
12. Rahm, M.R.; Huffman, W.E. The adoption of reduced tillage: The role of human capital and other variables. *Am. J. Agric. Econ.* **1984**, *66*, 405–413. [CrossRef]
13. Adusumilli, N.; Lee, T.; Rister, M.E.; Lacewell, R.D. The economics of mitigation of water pollution externalities from biomass production for energy. *Resources* **2014**, *3*, 721–733. [CrossRef]
14. National Agricultural Statistics Service. In *Book Agricultural Statistics*; United States Department of Agriculture: Washington, DC, USA, 2017.
15. Varble, S.; Secchi, S.; Druschke, C.G. An examination of growing trends in land tenure and conservation practice adoption: Results from a farmer survey in Iowa. *Environ. Manag.* **2016**, *57*, 318–330. [CrossRef]
16. Tosakana, N.S.P.; Van Tassell, L.W.; Wulfhorst, J.D.; Boll, J.; Mahler, R.; Brooks, E.S.; Kane, S. Determinants of the adoption of conservation practices by farmers in the northwest wheat and range region. *J. Soil Water Conserv.* **2010**, *65*, 404–412. [CrossRef]
17. Intergovernmental Panel on Climate Change, I. Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. In *Book Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*; Cambridge University Press: Cambridge, UK, 2014.

18. Howarth, R.W.; Sharpley, A.; Walker, D. Sources of nutrient pollution to coastal waters in the united states: implications for achieving coastal water quality goals. *Estuaries* **2002**, *25*, 656–676. [CrossRef]
19. Dillman, D.A. *Mail and Internet Surveys: The Tailored Design Method—2007 Update with New Internet, Visual, and Mixed-Mode Guide*; John Wiley & Sons: Hoboken, NJ, USA, 2011.
20. Dillman, D.A.; Phelps, G.; Tortora, R.; Swift, K.; Kohrell, J.; Berck, J.; Messer, B.L. Response rate and measurement differences in mixed-mode surveys using mail, telephone, Interactive Voice Response (Ivr) and the Internet. *Soc. Sci. Res.* **2009**, *38*, 1–18. [CrossRef]
21. Uri, N. Conservation Tillage and Input Use. *Environ. Geol.* **1997**, *29*, 188–201. [CrossRef]
22. Knowler, D.; Bradshaw, B. Farmers′ adoption of conservation agriculture: a review and synthesis of recent research. *Food Policy* **2007**, *32*, 25–48. [CrossRef]
23. Abdulai, A.; Owusu, V.; Goetz, R. Land tenure differences and investment in land improvement measures: Theoretical and empirical analyses. *J. Dev. Econ.* **2011**, *96*, 66–78. [CrossRef]
24. Oostendorp, R.H.; Zaal, F. Land acquisition and the adoption of soil and water conservation techniques: A duration analysis for kenya and the philippines. *World Dev.* **2012**, *40*, 1240–1254. [CrossRef]
25. Paudel, K.P.; Gauthier, W.M.; Westra, J.V.; Hall, L.M. Factors influencing and steps leading to the adoption of best management practices by louisiana dairy farmers. *J. Agric. Appl. Econ.* **2008**, *40*, 203–222. [CrossRef]
26. Zeng, D.; Alwang, J.; Norton, G.; Jaleta, M.; Shiferaw, B.; Yirga, C. Land ownership and technology adoption revisited: Improved maize varieties in ethiopia. *Land Policy* **2018**, *72*, 270–279. [CrossRef]
27. Caswell, M.; Fuglie, K.O.; Ingram, C.; Jans, S.; Kascak, C. Adoption of Agricultural Production Practices: Lessons Learned from the US Department of Agriculture Area Studies Project. In *Book Adoption of Agricultural Production Practices: Lessons Learned from the US Department of Agriculture Area Studies Project*; United States Department of Agriculture, Economic Research Service: Washington, DC, USA, 2001.
28. Nielsen, E.G.; Miranowski, J.A.; Morehart, M.J. *Investments in Soil Conservation and Land Improvements*; United States Department of Agriculture, Economic Research Service: Washington, DC, USA, 1989.
29. Daberkow, S.G.; Mcbride, W.D. Farm and operator characteristics affecting the awareness and adoption of precision agriculture technologies in the US. *Precis. Agric.* **2003**, *4*, 163–177. [CrossRef]
30. Mango, N.; Makate, C.; Tamene, L.; Mponela, P.; Ndengu, G. Awareness and adoption of land, soil and water conservation practices in the chinyanja triangle, Southern Africa. *Int. Soil Water Conserv. Res.* **2017**, *5*, 122–129. [CrossRef]
31. Keeney, R.L.; Raiffa, H. *Decisions with Multiple Objectives: Preferences and Value Trade-Offs*; Cambridge University Press: Cambridge, UK, 1993.
32. Von Winterfeldt, D.; Edwards, W. Costs and Payoffs in Perceptual Research. *Psychol. Bull.* **1982**, *91*, 609. [CrossRef]
33. Stock, J.H.; Wright, J.H.; Yogo, M. A survey of weak instruments and weak identification in generalized method of moments. *J. Bus. Econ. Stat.* **2002**, *20*, 518–529. [CrossRef]
34. Wooldridge, J.M. *Econometric Analysis of Cross Section and Panel Data*; MIT Press: London, UK, 2010.
35. Jones, A.M.; Yen, S.T. A Box—Cox Double-Hurdle Model. *Manch. Sch.* **2000**, *68*, 203–221. [CrossRef]
36. Yen, S.T.; Jensen, H.H. Determinants of household expenditures on alcohol. *J. Consum. Aff.* **1996**, *30*, 48–67. [CrossRef]
37. Lynne, G.D.; Shonkwiler, J.S.; Rola, L.R. Attitudes and farmer conservation behavior. *Am. J. Agric. Econ.* **1988**, *70*, 12–19. [CrossRef]
38. Kraft, S.E.; Lant, C.; Gillman, K. WQIP: An assessment of its chances for acceptance by farmers. *J. Soil Water Conserv.* **1996**, *51*, 494–498.
39. Reimer, A.P.; Prokopy, L.S. Farmer participation in US farm bill conservation programs. *Environ. Manag.* **2014**, *53*, 318–332. [CrossRef]