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The Achilles Heels of Carbon Farming: Operational Constraints on the Next Cash Crop

July 2022

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Abstract: Urgent calls for actions to slow climate change have stimulated new interest in actions to harness the potential for carbon sequestration on agricultural lands. The private sector has established corporate goals for reducing contributions to climate change and there has been much decentralized market activity to develop voluntary markets for agricultural soil carbon sequestration to meet this demand from companies and consumers wishing to offset emissions. This brief conducts a critical assessment of the nature of the market opportunity today for farmers and for those who would benefit from the opportunity to incentivize real increases in net carbon sequestered in agricultural lands of the U.S. We discuss how the potential success of these markets is currently limited by important factors related to contract design and land tenure, with suggestions for how to address the challenges and unlock the opportunities.

Keywords: carbon sequestration, agriculture, climate change, offsets, markets, land tenure
JEL Codes: Q15, Q54

[1] Support for this work was provided by the Illinois Farm Bureau. This paper is also based in part on work funded by the USDA-NIFA W4133 Multistate Research Grant #1008843. Authors are listed alphabetically. The findings and conclusions in this report are those of the authors and should not be construed to represent any official USDA or U.S. Government determination or policy.

I. Introduction

Climate change is accelerating, with scientists and policy makers issuing increasingly dire warnings of the consequences for human well-being if serious efforts aren't made quickly to reduce net emissions of greenhouse gasses (Bradshaw et al., January 13, 2021; Ehrenreich, March 18, 2021; IPCC Sixth Assessment, February 27, 2022; Plumer and Fountain, November 11, 2021; Plumer and Zhong, February 28, 2022; Plumer, Zhong and Friedman, February 28, 20022; Zhong, April 4, 2022; Plumer and Zhong, April 4, 2022). Urgent calls for actions to slow climate change have stimulated new interest in actions to harness the potential for carbon sequestration on agricultural lands.

Agriculture's role as both a source and a sink for emissions that influence climate change has long been a component of the national Greenhouse Gas (GHG) inventory maintained by the US EPA.[2] Agriculture in 2020 accounted for 11% of total US GHG emissions split between crop cultivation (54%), livestock (40%) and fuel combustion (6%).[3] Total carbon equivalent emissions sequestered in soils and vegetation are referred to as "carbon sinks," but the ability to sequester depends on land use. For example, forestry is a relatively much larger continuing sink than cropland. Policy proposals to cap GHG emissions using a regulatory approach have failed thus far at the federal level but have been enacted in some US states and other countries. More recently, the private sector has established corporate goals for reducing contributions to climate change and there has been a large amount of decentralized market activity to develop voluntary markets for agricultural soil carbon sequestration to meet this demand from companies and consumers wishing to offset emissions.

Distinct from past efforts to directly regulate emissions or enact "cap and trade" legislation, recent developments are being led by private sector boards of directors to achieve corporate sustainability goals and satisfy growing consumer demand. This represents a significant change in the impetus for the creation of a market for emissions and sequestration of atmospheric carbon in agricultural soils. In the agri-food sector this has included what has become known as "in-setting" by focusing specifically on emissions and sequestration opportunities inside a company's supply chain. A company that purchases grain, for instance, must establish a baseline level of emissions that result from production of the grain that is an input to the company's production process(es). Emissions that result from status quo production practices represent the baseline or starting point for reducing emissions to achieve GHG goals; the same companies are working to understand how changes in farmer management practices can reduce the GHG intensity of crop (or animal) production, and thus lower the GHG footprint of production. Simultaneously, farmers are seeking to determine the same thing while evaluating the private advantages and disadvantages of a growing number of market opportunities to sell carbon that

[2] https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks.
[3] https://cfpub.epa.gov/ghgdata/inventoryexplorer/#agriculture/entiresector/allgas/category/all.

farmland can sequester.

As with any potential new market there are many challenges. Among the most prominent for carbon farming are found at the intersection of these new opportunities with features of existing systems, such as land tenure. If farming to help mitigate climate change is "the next cash crop" there are significant realities that have to be addressed and real operational hurdles to overcome (Wongpiyabovorn et al. 2022; Valiant et al. 2021.) This brief uses recent research and market developments together with economic principles to assess the nature of the market opportunity today for farmers and for those who would benefit from the opportunity to incentivize real increases in net carbon sequestered in agricultural lands of the U.S. We discuss how the potential success of these markets is currently limited by important factors, with potential ideas for addressing the challenges and unlocking the opportunities.

II. Challenges for Viable Carbon Farming Programs

Unattractive carbon contracts

There are several features of the current landscape of carbon farming contracts that are unattractive even to farmers who are owner-operators. As we discuss in this section, the payments for carbon sequestration are relatively low, most carbon contracts involve multi-year commitments, and the future of both private and public options for carbon sequestration or mitigation payments is highly uncertain.

Changes in farm or grazing management practices are required to enhance soil carbon sequestration or reduce carbon equivalent emissions from fertilizer management. These changes are not costless and unless the private benefits of changing practices or the sequencing of practices (e.g. moving fall fertilizer application to spring or post-plant) outweigh these costs there is no reason to expect farmers to supply GHG mitigation to other economic sectors. Payments from voluntary private market initiatives in 2022 continue to be relatively low; Wongpiyabovorn et al. (2022) report that farmers are currently being paid between $10 to $40 per acre for carbon farming practices. However, numbers reported from a 2013 study in Sellars et al. (2021) indicate that carbon prices per metric ton would need to be greater than $30 per metric ton to be worth the costs to farmers of most carbon farming practices.

Private carbon contracts also require multi-year commitments. To the extent that the market seeks to pay a farmer for production practices that capture and store GHG/carbon in the soils, the market will expect that such emissions are held or sequestered in the soils for multiple years. Indeed, Plastina and Wongpiyabovorn (2021) report minimum contract lengths ranging from 5-10 years.

Finally, rapid flux and uncertainty in the future private and public landscape of carbon farming

contracts and policies has a chilling effect on the appeal of current multi-year carbon contracts to farmers. Wongpiyabovorn et al. (2022) discuss how demand for carbon offsets brokered through private carbon markets rests on the credibility of the products, which is undermined by label proliferation and the absence of an independent government standard. At the same time, the USDA is publicly engaged in discussions of federal programs to incentivize carbon farming (Colman et al. 2021). Farmers cannot know how commitments they make to a carbon contract now will interact with future program options. Will credits generated through one system/program/aggregator be verifiable as credits in alternative systems? Will adopters of today's carbon contracts be penalized in future, more-desirable programs because they are early adopters, and thus any new contract they enter into would not be "additional"?

It is not surprising that in this environment, anecdotal evidence abounds of farmers hesitant to commit to any sort of contract under existing options (public or private) due to uncertainty about the future. The economics of irreversible decision making under uncertainty (real options frameworks) indicates that in these conditions, we can expect to see farmers delaying commitment to contracts because there is value to the farmer in waiting to see which market(s) end up prevailing. Prior research has found that farmers have a $10.57/acre option value of not signing a multi-year carbon sequestration contract, and that government sequestration payments are preferred to payments from carbon markets (Gramig and Widmar 2018).

Land tenure and the farm lease challenge

The challenges that face carbon farming contracts are greatly magnified by tenancy issues in the large areas of the Midwest where land is not farmed by the owner of the land but is rented. The typical structure and length of leases used for farmland in the Midwest present challenges in providing appropriate incentives for adoption of practices which sequester carbon.

The proportion of farmland operated under a rental agreement is highest in the major cash-grain production regions of the U.S. such as Illinois. The percent of acreage rented is also higher for larger, commercial farms and for farms managed by younger farm operators (Bigelow et al. 2016). The majority of non-operator landlords are not actively involved with farming. As a result, fixed cash rental agreements are the dominant lease type. Over the past 25 years, the percentage of acres operated under a fixed cash agreement for Illinois FBFM cooperators has increased from less than 30% to more than 50% while the percentage of land owned by the farm operator has remained relatively constant between 20 and 25%. While the majority of lease arrangements involve multi-year relationships between the landowner and farmer tenant, most leases are re-negotiated on an annual basis (Bigelow et al., 2016).

Annual cash rental agreements account for 72 percent of the non-owner operated farmland in the region (Schnitkey et al. Sept. 28, 2021.) This poses arguably the largest barrier to the development of carbon farming and a market for GHG/carbon sequestration. Crop choices and farming practices that would sequester soil carbon are undertaken on an annual basis and most

rented farmland operates under annual leases, which puts at risk any GHG/carbon captured and stored in the soils. If the farmer who adopted a practice to capture GHG/carbon loses the lease the following year, the GHG/carbon stored in the soils is put at risk and depends on the subsequent tenant adopting the same practices or similar practices to maintain the sequestration. Importantly, carbon farming or GHG markets "can only succeed to the extent that tenant-farmers and landowners are willing to engage in this new" market opportunity (Scott and Endres 2014: 101, at 104).

Taking Illinois as an example, the typical cash lease is year-to-year. The annual lease is not workable for a multi-year GHG contract and will limit the potential of this market given the large share of rented farmland. Moreover, State law has significant impacts on farm leases. For example, a tenant farmer must be given four months' notice that the lease will be terminated for that termination to be legally effective. Many leases are not written and operate on the traditional "handshake" agreement. If there is not a written contract, the law defaults to a notice requirement of October 31 and the lease is considered to begin March 1. Additionally, any agreement "that cannot be performed in one year" requires a written contract according to the Statute of Frauds (Uchtmann 2006; Scott and Endres 2014 at 110-11, and footnote 49 and 50 for statutory and other citations).

Qualitative analysis via survey methods and interviews has confirmed a number of the barriers to conservation practice adoption on rented farmland in the Midwest. Farm operators (tenants) identify the typical lease terms – annual renewals, timeline for negotiation, rental rates – as barriers to conservation practice adoption. This implicitly recognizes the initial costs associated with practices that may not provide benefits until multiple years in the future. In contrast, non-operator landowners have been found to identify market factors (i.e. profitability) and lack of knowledge/information on conservation program and farm management practices as primary barriers to conservation practice adoption on the land they rent to farmers (Ranjan et al. 2019). Policy recommendations include better information and education resources, and policy designs, targeted to landowners rather than farm operators.

Survey work with landowners in Iowa shows that adoption of conservation tillage practices is actually more common on rented land, but confirms that adoption of conservation practices with higher initial costs and longer-term periods for potential benefits (cover crops, buffer strips, sediment basins) are less likely to be adopted on rented land (Sawadgo et al. 2019.) The Iowa survey work also suggests that 1) landowners currently renting to farmers engaged in conservation tillage practices might be more likely to consider providing financing assistance to their tenant farmers for adopting cover crop practices, and 2) the majority of landowners would be interested in tax-based incentives for conservation practice adoption (i.e. tax-free cost sharing, or conservation-related tax credits or deductions).

Over the life of a farmland lease, much can happen in terms of the value of leased land, the value of farmland to the owner, market conditions, death or transfer of the property or of the tenant, or that the tenant walks away from the lease. Anecdotally, farm operator tenants have expressed concerns regarding the costs associated with conservation practice adoption that might result in benefits to the land that would largely accrue to the landowner in the future. Specifically, conservation practices may improve soil health and yield potential over time, resulting in positive effects on land values and future increases in rental rates that would offset any gains to the farmer tenant. These realities drastically complicate entering into multi-year leases, let alone the challenges these add to contracts for carbon capture and storage in the field.

III. Possible Solutions

In theory, the benefits of carbon sequestration and mitigation in row-crop farm systems exceed the costs, so it should be possible to craft a set of contracts and policies that improve social well-being through net carbon reductions while yielding financial benefits for farmers. Here we present suggestions for contract features and public policy strategies that can overcome the Achilles heels of the current landscape of carbon farming contracts.

Use stacking to help payments exceed costs

Beyond GHG mitigation opportunities, other markets for environmental or ecosystem services (ES) generated by working agricultural lands could provide additional income streams if farmers are able to combine payments for multiple ES (often referred to as "stacking environmental credits") generated by the same practice or systems of practices. Environmental advocates often raise concerns about letting landowners get paid for multiple services that flow from the same practice out of concern that in some cases, the additional payment for a second service would not have been necessary to incentivize the practice. However, failure to allow stacking can prevent socially optimal levels of investments in practices that produce multiple environmental benefits (Lentz et al. 2014). Specifically, Lankoski et al. (2015) find that payments to farmers for either water or carbon services individually are not enough to induce practice adoption, while credit stacking is a viable option for encouraging farm practices that yield both sets of benefits with sufficient payoff for the farmers.

Government conservation programs that provide cost-share payments to farmers to adopt more environmentally benign practices are payments made by USDA to a farmer to implement practices and are not payments for any specific environmental outcome (i.e. carbon sequestration, nutrient loss mitigation). To the extent that farmers can receive initial support from EQIP, CSP or a related Regional Conservation Partnership Program (RCPP) to implement practices that generate or enhance environmental service flows, existing USDA programs can help offset the cost and in some cases may reduce the risk of changing management practices to receive payments for ES. A simplified example of this would be a farmer who applies for and

receives EQIP funding to implement cover crops; if this farmer is able to reduce fertilizer usage on cover cropped fields to receive GHG reduction credits and simultaneously reduce Nitrogen runoff and leaching that improves water quality, they may be able to stack credits for climate change mitigation and water quality regulation ES and be paid for these services by a carbon market and a water quality trading market operating in their watershed.

Break the barrier of long multi-year contracts

Inflexible long contracts discourage owner-operators from taking part in carbon farming programs and are especially problematic in the context of leased farmland. Creative contract design can allow meaningful participation in short term contracts for carbon farming practices while encouraging multi-year practice adoption that best fosters soil carbon sequestration. Gramig (2012) previously discussed alternative structures for agricultural soil carbon sequestration payments to address the nonlinear time-path of carbon accrual in soils. One option is to pay annually for the small incremental carbon accrual in the soil (or fertilizer emissions avoided/reduced), effectively renting the carbon in the soil as it accumulates until the soil's carbon saturation point is reached and a maintenance payment is made as an annuity after saturation is achieved. Other economic research has called for permanent abatement to be purchased after an initial fixed term sequestration rental contract (Herzog Caldeira and Riley 2003) recognizing the non-permanent nature of soil carbon storage. As these markets mature, contract provisions will be necessary to address other factors such as potential changes in land ownership. For example, if one owner-operator takes payments in exchange for lower profits to sequester carbon in the soil and then sells the land, it needs to be clear how the obligation to that contract (and the "ownership" of the stored carbon) changes with the sale.

The fact that soil carbon storage is not permanent is almost entirely unaddressed in the current voluntary carbon market, and the low prices being paid for soil carbon credits reflect this to a certain extent. The social value of permanent GHG emissions abatement or storage of atmospheric carbon is arguably much higher than the value to society of temporary soil carbon storage. It's possible that creating contracts that are explicit about duration of sequestration could yield payments for long-term storage that are higher than current going rates,

Resolve policy and contract uncertainty

The current landscape has many different contracts and intermediaries that have sprung up in an independent and uncoordinated manner. There are no national standards for defining and verifying carbon offsets, and change happens so quickly in this market that farmers and landowners can't tell whether a better program will come along right after they have made a multi-year commitment to one of today's suppliers. A Federal program through USDA could help by providing a unifying approach to carbon markets and how conservation practices qualify/contribute. A new USDA initiative in this vein is the Biden administration's Partnerships for Climate-Smart Commodities program intended to spur innovation and public-private

partnerships to enhance agricultural resilience to climate change, including through markets for environmental goods and services.[4]

Private companies could also collectively benefit from industry-wide norms for contract provisions that allow farmers to enter into a new contract even if they previously engaged in carbon farming practices with a different company. Such provisions would ease farmer and landowner fears of being penalized in future programs for having been early adopters, and prevent them from avoiding carbon farming contracts entirely now in order to keep the option open to take a better contract that might come along in the following years.

A more fundamental concern about current carbon farming contracts is long-term viability of demand. No public policy, like a cap-and-trade greenhouse-gas emissions program for industrial sources, creates binding demand in the U.S. for soil carbon storage. The current landscape is an entirely voluntary market for soil carbon storage, and the amount of soil sequestration possible greatly exceeds voluntary market demand today. The only obvious sources of value are niche consumer demand for emissions offsets for carbon-intensive activities (i.e. air travel) and corporate or other institutional demand for sequestration credits to offset GHG emissions that count towards achieving environmental performance targets. These sources of demand are unstable, and In both cases the common critique of "off-setting" applies because global emissions may not actually decline enough to reverse the effects of climate change we are already experiencing. If the U.S. were able to establish a meaningful greenhouse gas limitation policy with national constraints on emissions (say, from fossil fuel consumption), then demand for soil carbon storage as an offset would be stabilized at a higher level than the present day.

Facilitating carbon farming contracts for leased farmland

It is difficult to craft strategies that provide appropriate incentives and legal protections for landowners and farmers in the context of carbon farming on leased land. However, these challenges are not unique to carbon farming. For example: organic farms must pass through a three-year transition to achieve certification, and accomplish strict ongoing compliance with organic requirements (Fuller et al. 2021); perennial energy crops (Scott and Endres 2014, 2013a - 2013d; Scott et al. 2013) and agroforestry (Keeley et al. 2019; Chenyang et al. 2021) face limitations from annual rental agreements; wind and solar energy production are working to address tenancy and rental agreement issues (Richardson et al. 2022).

Fortunately, lessons can be learned by studying experiences with other ag-environmental programs that address issues of tenancy and rental agreements when conservation actions have short term costs, long-term benefits, and require multi-year contracts. Existing and emerging voluntary programs contract directly with landowners over multiple years, and then serve as intermediaries/aggregators to contract with farm tenants who agree to operate using conservation

[4] https://www.usda.gov/climate-solutions/climate-smart-commodities

practices. Another strategy would adopt features of federal policy approaches, combining the longer-term nature of CRP with aspects of existing "working lands" programs to rent the land, then contract with farmers to adopt the practices on those lands.

Olson (2021) explains how tenant farmers can still participate in the multi-year Conservation Stewardship Program (CSP.) Legal analyses by Cox (2010, 2011) discuss how to achieve sustainable farming practices on rented land, and Schnitkey et al. (Jul 13, 2021) point out that multi-year ag-environment programs will gain more traction on lands where the operating farmer has a good expectation of a long term relationship with the landowner through informal connections or the nature of the contract. Masuda et al. (2021) analyze factors that yield low take-up of existing government environmental programs on rented lands. They suggest a suite of interventions that could help non-operating landowners and farm operators work together to take advantage of ag-environmental programs, including monitoring service provision and contracts designed to cover both transactions costs and operational costs, reducing risks to both parties. Findings from a broad survey of non-operating landowners by Petrzelka et al. (2021) similarly "suggests is that there is a communication gap rather than a difference in views between the landowner and renter, and that the gap is what has led to reluctance to implement conservation practices on rented land."

IV. Conclusions

The growing climate-change crisis demands policy and market innovations to harness the potential for agricultural lands to sequester carbon. The uncoordinated emergence of private market options for payments to farmers for carbon credits has important limitations. Payments for carbon are low compared to the production and transaction costs of accomplishing sequestration. The dynamic nature of soil-carbon accumulation has produced contracts for carbon farming that have multi-year temporal minimums that farmers prefer to avoid. Uncertainty about the future of private markets and public policy around carbon farming discourages farmers further from committing to a long-term carbon farming agreement, and the nature of farm leases make it particularly challenging for carbon-farming markets to gain traction in areas where non-owner-operated farms are highly prevalent.

Strategic steps could mitigate many of these challenges that are currently stifling uptake of carbon-market opportunities. First, farmers could be allowed to secure payments for multiple ecosystem services that flow from sustainable practices rather than being limited to payment for carbon alone; this will bring benefits into line with costs to farmers. Second, carbon-farming contracts could be developed that do not require long term contracts and aim for permanent carbon storage; renting carbon stored temporarily in soil is still beneficial, and short term contracts may appeal to farmers for whom multi-year commitments are challenging. Third, policy and market uncertainty could be reduced by having the USDA create guidelines and

standards to stabilize the credibility of the carbon credits farmers produce and stop farmers from needing to wonder if a better program will come along the next year. Fourth, carbon markets and programs can use a range of strategies related to communication, contracting, and provision of monitoring services to facilitate involvement non-owner-operating farmers.

These challenges are thorny but not insurmountable. Farmers, farmland owners, and society at large have much to gain from initiatives that address the limitations of the current landscape of markets and policy and unlock the power of carbon-farming programs to help farmers to help the world by slowing the climate crisis.

V. References

Bigelow, Daniel, Allison Borchers, and Todd Hubbs. 2016. *U.S. Farmland Ownership, Tenure, and Transfer*, EIB-161, U.S. Department of Agriculture, Economic Research Service, August 2016.

Chenyang, Lingxi, Andrew Currie, Hannah Darrin, and Nathan Rosenberg. 2021. "Farming with trees: Reforming U.S. farm policy to expand agroforestry and mitigate climate change." *Ecology LQ* 48: 1.

Colman, Zack, Liz Crampton, and Helena Bottemiller Evich. 2021. "Biden mulls giving farmers billions to fight climate change. Even farmers are unsure about the plan." Politico. https://www.politico.com/news/2021/03/29/biden-carbon-bank-proposal-478224.

Cox, Edward. 2010. "A lease-based approach to sustainable farming, Part I: farm tenancy trends and the outlook for sustainability on rented land." *Drake Journal of Agricultural Law* 15: 369.

Cox, Edward. 2011. "A lease-based approach to sustainable farming, part II: Farm tenancy trends and the outlook for sustainability on rented land." *Drake Journal of Agricultural Law* 16: 5.

Fuller, Kate Binzen, Joseph P. Janzen, and B. Munkhnasan. 2021. "Farmland rental rates: Does organic certification matter?." *Land Economics* 97(1): 80-106, http://le.uwpress.org/content/97/1/80.full.pdf.

Gramig, Benjamin M. "Some unaddressed issues in proposed cap-and-trade legislation involving agricultural soil carbon sequestration." 2012. *American Journal of Agricultural Economics* 94(2): 360-367.

Gramig, Benjamin M. and Nicole Widmar. 2018. "Farmer preferences for agricultural soil carbon sequestration schemes." *Applied Economic Perspectives and Policy* 40(3): 502–521. https://doi:10.1093/aepp/ppx041

Herzog, H., K. Caldeira, J. Riley. 2003. "An issue of permanence: Assessing the effectiveness of temporary carbon storage." *Climatic Change* 59(3): 293–310.

Keeley, Keefe O., Kevin J. Wolz, Kaitie I. Adams, Jeannine H. Richards, Erin Hannum, Severine von Tscharner Fleming, and Stephen J. Ventura. 2019. "Multi-party agroforestry: emergent approaches to trees and tenure on farms in the Midwest USA." *Sustainability* 11(8): 2449.

Lankoski, Jussi, Markku Ollikainen, Elizabeth Marshall, and Marcel Aillery. 2015. "Environmental co-benefits and stacking in environmental markets", OECD Food, Agriculture and Fisheries Papers, No. 72, OECD Publishing, Paris, https://doi.org/10.1787/5js6g5khdvhj-en.

Lentz, Adam H., Amy W. Ando, and Nicholas Brozović. 2014. "Water quality trading with lumpy investments, credit stacking, and ancillary benefits." *JAWRA Journal of the American Water Resources Association* 50(1): 83-100.

Masuda, Yuta J., Seth C. Harden, Pranay Ranjan, Chloe B. Wardropper, Collin Weigel, Paul J. Ferraro, Sheila M. Reddy, and Linda S. Prokopy. 2021. "Rented farmland: A missing piece

of the nutrient management puzzle in the Upper Mississippi River Basin?" *Journal of Soil and Water Conservation* 76(1): 5A-9A https://www.jswconline.org/content/76/1/5A.abstract.

Olson, Kalee. 2021. "Applying for CSP on rented land." Center for Rural Affairs. https://www.cfra.org/blog/applying-csp-rented-land.

Petrzelka, Peggy, Matthew J. Barnett, Gabrielle Roesch-McNally, and Jennifer Filipiak. 2021. "Advancing understanding of conservation practices on rented land." *Journal of Soil and Water Conservation* 76(2): 35A-40A https://www.jswconline.org/content/76/2/35A.abstract.

Plastina, Alejandro and Oranuch Wongpiyabovorn. 2021. "How to grow and sell carbon credits in U.S. Agriculture." https://www.extension.iastate.edu/news/comparing-carbon-credit-programs-focus-new-report

Ranjan, Pranay, Chloe B. Wardropper, Francis R. Eanes, Sheila M. Reddy, Seth C. Harden, Yuta J. Masuda, and Linda S. Prokopy. 2019. "Understanding barriers and opportunities for adoption of conservation practices on rented farmland in the U.S." *Land Use Policy* 80: 214-223.

Richardson, Jesse, Peggy Kirk Hall, and Whitney Morgan. "Land Use Conflicts between Wind and Solar Renewable Energy and Agricultural Uses." 2022. WVU College of Law Research Paper. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4042235.

Sawadgo, Wendiam, Wendong Zhang, and Alejandro Plastina. 2019. "Land Tenure and Conservation Practice Use: Evidence from Landowners' Decisions in Iowa." Agricultural and Applied Economics Association Annual Meeting, Atlanta, GA.

Schnitkey, Gary, Krista Swanson, Nicholas Paulson, and Carl Zulauf. 2021. "Impacts of Rental Arrangements on Cover Crop and Conservation Practice Adoption." farmdoc daily (11):106, Department of Agricultural and Consumer Economics, University of Illinois at Urbana-Champaign, July 13, 2021, https://farmdocdaily.illinois.edu/2021/07/impacts-of-rental-arrangements-on-cover-crop-and-conservation-practice-adoption.html.

Schnitkey, Gary, Nicholas Paulson, Carl Zulauf and Krista Swanson. 2021. "Trends in Farmland Leasing." farmdoc daily (11):138, Department of Agricultural and Consumer Economics, University of Illinois at Urbana-Champaign, September 28, 2021, https://farmdocdaily.illinois.edu/2021/09/trends-in-farmland-leasing.html.

Scott, Elise and A. Bryan Endres. 2013a. "The Bioenergy Farm Lease Part 1: Long-Term Leasing Provisions." farmdoc daily (3):120, Department of Agricultural and Consumer Economics, University of Illinois at Urbana-Champaign, June 21, 2013, https://farmdocdaily.illinois.edu/2013/06/bioenergy-farm-lease-1-long-term.html.

Scott, Elise and A. Bryan Endres. 2013b. "The Bioenergy Farm Lease Part 2: Invasion Concerns." farmdoc daily (3):125, Department of Agricultural and Consumer Economics, University of Illinois at Urbana-Champaign, June 28, 2013, https://farmdocdaily.illinois.edu/2013/06/bioenergy-farm-lease-2-invasion.html.

Scott, Elise and A. Bryan Endres. 2013c. "The Bioenergy Farm Lease Part 3: Rhizome Reclamation." farmdoc daily (3):132, Department of Agricultural and Consumer Economics,

University of Illinois at Urbana-Champaign, July 11, 2013, https://farmdocdaily.illinois.edu/2013/07/bioenergy-farm-lease-part-3-rhizome.html.

Scott, Elise, L. Quinn and A. Bryan Endres. 2013. "The Bioenergy Farm Lease, Part 4: Incorporation of Evolving Standards." farmdoc daily (3):224, Department of Agricultural and Consumer Economics, University of Illinois at Urbana-Champaign, November 22, 2013, https://farmdocdaily.illinois.edu/2013/11/bioenergy-farm-lease-4-evolving-standards.html.

Scott, Elise C., and A. Bryan Endres. 2014. "Demanding supply: Re-envisioning the landlord-tenant relationship for optimized perennial energy crop production." *Duke Environmental Law and Policy Forum* 25.

Sellars, Sarah, Gary Schnitkey, Carl Zulauf, Krista Swanson, and Nicholas Paulson. 2021. "What Questions Should Farmers Ask about Selling Carbon Credits?" farmdoc daily (11):59, Department of Agricultural and Consumer Economics, University of Illinois at Urbana-Champaign, April 13, 2021.

Uctmann, Donald L., 2006. "October 31 is 'Notice' Deadline for Many Farm Leases," farmdoc, available: https://farmdoc.illinois.edu/publications/october-31-is-notice-deadline-for-many-farm-leases.

Valliant, Julia CD, Analena B. Bruce, Matthew Houser, Stephanie L. Dickinson, and James R. Farmer. 2021. "Product diversification, adaptive management, and climate change: Farming and family in the US Corn Belt." *Frontiers in Climate*: 52, https://www.frontiersin.org/articles/10.3389/fclim.2021.662847/full?&utm_source=Email_to_authors_&utm_medium=Email&utm_content=T1_11.5e1_author&utm_campaign=Email_publication&field=&journalName=Frontiers_in_Climate&id=662847.

Wongpiyabovorn, Oranuch, Alejandro Plastina, and John M. Crespi. 2022. "Challenges to voluntary ag carbon markets." *Applied Economic Perspectives and Policy.*