Global Development And Environment Institute
Tufts University

Land Value and Soil Quality: An Untapped Incentive Structure

Benjamin Johnson*

Climate Policy Brief
No. 13
June, 2020

Introduction

Agricultural production in the United States is predominantly characterized by large-scale production including high levels of artificial inputs. Lands that are rented or owned by farmers are often valued in relation to historical production. The USDA outlines this farmland valuation method, noting that rental rates are largely determined by the perceived value of production in a given year.

Despite the superficial intuitiveness of this output-focused valuation methodology, it fails to address the wide array of localized benefits provided to farmers and landowners by improved soil quality. While farmers use land for income-generating agricultural production, how they use the land can improve or depreciate the land's longer-term productive potential. This potential should be clearly reflected in the land's value but is omitted in a valuation system based only on current production.

Soil Quality

Soil is a complex aggregate of organic and inorganic compounds formed in array of different structures with different qualities. Accordingly, soil quality can only be defined in relation to the human activities it facilitates. With this in mind, soil quality can be defined (for the purposes of this paper) as the composition of those attributes that promote agricultural production, such as biological diversity, water retention, and plant nutrient formation.

* *Benjamin Johnson is a Research Assistant at GDAE and recent graduate of the Fletcher School of Law and Diplomacy, with a specialization in Law and Development as well as International Environment and Resource Policy.*

One of the most important attributes of soil quality is the presence of soil organic carbon (SOC). Often presented as a soil quality indicator,[2] SOC is closely related to the numerous functions and other attributes of agricultural soil. From the hydraulic attributes of infiltration and retention to creating the structural and environmental conditions for complex biological processes, SOC directly influences plant productivity.[3] In addition, the diversity of organisms contributing to the sustainable availability of plant nutrients is both enabled by the presence of SOC and creates SOC through the decay of plant refuse.[4]

The availability of SOC on agricultural lands is influenced by the productive techniques of farmers. Conventional techniques and regenerative practices are often at odds. Conventional techniques incentivize increasing present yields and investing in artificial inputs that replace attributes of SOC.[5] The conventional use of chemical fertilizer and tilling are associated with both the reduction of SOC content as well as disruption of the conditions necessary for biological activity. Accordingly, conventional intensive techniques that seek to increase seasonal production at the expense of soil organic carbon lead to the degradation of soil quality.[6] By comparing conventional and regenerative techniques, the value of soils and the agricultural land they occupy can be properly understood.

Stewardship and Value

Improving soil quality, also referred to as soil stewardship, provides both public and private goods. In terms of public goods, soil quality improvements can have significant local and global effect including reduced fertilizer and pesticide runoff and flood prevention. Most notably, improved stewardship has been promoted as an important component of climate change mitigation and carbon sequestration.[7] If societies choose to compensate farmers for the public benefit of proper stewardship, this will be a significant factor in its adoption.

While acknowledging the importance of public policies, the primary focus of this document is to evaluate the private benefits to farmers and landowners of engaging in regenerative practices. In a 2015 paper, Pascual et al. established a framework for understanding the value created through soil stewardship in relation to biodiversity (a benefit associated with high SOC content). In their analysis they describe how the total economic value (TEV) of the soil's quality is a product of the soil's natural insurance value (NIV) and the total output cost (TOC) of improving stewardship. The TEV of soil is explained in their analysis as "the sum of… the value of the expected mean flow of ecosystem services plus [TOC] its variance reducing ability [NIV]".[8] As shown in Figure 1 below, the total output value is comprised of values associated with ongoing productivity concerns, while the natural insurance value is comprised of the value of risk mitigation and adaption. Accordingly, the value of stewardship is realized through the yearly changes in output and reductions in inputs, as well as value from mitigating and adaptability to shocks (risk).

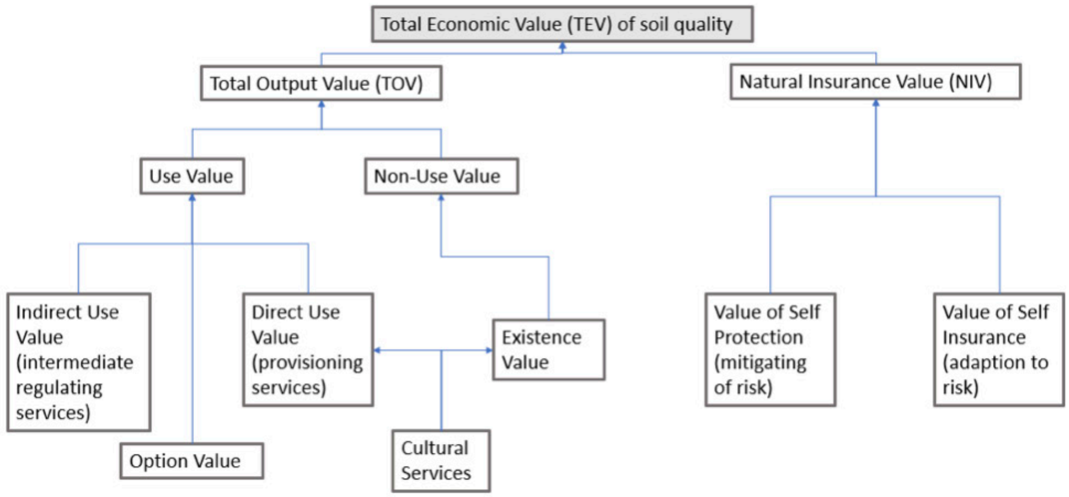

Figure 1: Flow-chart depicting the factors that contribute to soil's Total Economic Value (TEV), the above is a version adapted to soil quality (as opposed to only biodiversity).[9]

The value of the NIV and the TOC are largely expressions of the value derived from the three key soil services of natural infrastructure, productive inputs, and risk mitigation. Encouraging high SOC, first, provides the natural infrastructure necessary to irrigate, store water, and provide the environment for biological activity and nutrient production to take place. Comprised of the continual accumulation of organic waste and previous crop residue, such as root systems and foliage, this service often takes years to realize. Nonetheless, the natural infrastructure services of SOC are integrally connected to soil's capacity to provide productive inputs over the long term and to mitigate the risk of environmental shocks.[10]

Soil's natural insurance value (NIV) refers to its ability to prevent and/or dilute the impact of adverse events and production variability. This can be compared to the services provided by the crop insurance sector. Crop insurance in the United States is largely governed by the Federal Crop Insurance Act of 1980, which provides for a unique public-private insurance arrangement. The Act provides for the government to subsidize private insurers' administrative and operating costs, as well as reinsuring possible losses. All of these subsidies ensure that premiums are affordable, and that participation is high, with the intension of mitigating revenue and catastrophic event risks for farmers. Accordingly, the insurance compensates farmers for the production and price declines, as well as losses associated with natural disasters.[11] However, while both NIV and crop insurance attempt to address the financial losses associated with unforeseen events, the two differ greatly in terms of how the value is eventually realized. Crop insurance focuses upon providing assistance after an event, while the

NIV of soil quality is preventative, avoiding losses through reducing the severity of events and production variability.[12]

Carefully stewarded soils provide a source of risk mitigation and adaptation. The natural infrastructure of soil, from root formation to soil aggregation, can protect crops from unpredictable shocks, such as droughts, floods, and sudden temperature changes.[13] While the magnitude of risk mitigation will be dependent upon numerous local and global environmental influences, promotion of SOC content can reduce the vulnerability of farmland to adverse events.

In contrast with natural methods for protecting crop production, the subsidization of crop insurance prevents farmers from realizing the negative consequences of intensive conventional techniques. On average, farmers pay less than half of the insurance premiums.[14] While definitive research on the effects of crop insurance subsidization on conventional practices is still hotly debated, census data does show an increase in chemical input for corn production coincides with subsidized insurance coverage.[15] This could suggest that subsidized crop insurance and chemical inputs are complements, resulting in an underappreciation of soil quality.

Improved soil quality also includes the provision of productive input services. In comparison to practices that encourage soil with high SOC content, conventional intensive agricultural practices supplement and replace the services of stewarded soil with an array of artificial inputs.[16] Declining chemical fertilizer prices have reinforced incentives to expand yields through increasing these inputs. Nonetheless, chemical fertilizer application is notoriously inefficient, requires yearly application, and promotes additional problems. First, less than half of the nitrogen and phosphorus fertilizer used worldwide is actually utilized by the intended crops.[17] Additionally, artificial fertilizer inputs are not retained in soil, resulting in notably lower rates of bio-available nitrogen, phosphorus, and potassium after harvest.[18] Last, artificial fertilization imposes increasing recurrent costs through the continual degradation of soil quality and increased incidence of pests.[19] In addition to requiring tillage that destroys the soil's aggregate stability, these fertilizers result in increased pest and disease incidence by inhibiting biodiversity.[20] In a vicious cycle, greater vulnerability to pests and disease incentivizes additional inputs of pesticides.

As opposed to chemical fertilizer costs, pesticide costs have increased over the past decade at an average rate of 4%.[21] The increasing costs of pesticides will become increasingly more burdensome for farmers as soil degradation continues. As artificial inputs increase, the natural infrastructure will correspondingly degrade, and may pose increased risk for conventional farmers.

The impact of conventional intensive agriculture on soil quality has been overwhelmingly negative. Research in the past two decades has begun to shed light on how tilling and the provision of artificial inputs have contributed to soil degradation. Reductions in SOC, as well as the accompany attributes caused by conventional practices, have led to the impairment of soil structure, nitrogen mineralization, as well as the ability of soil to retain nutrients and water. [22]

Numerous estimates of the value created by efforts to improve soil quality have been made in order to examine whether the transition towards improved soil stewardship is justified. A Canadian study from almost two decades ago found that the yearly marginal benefit per acre of soil stewardship to be between $2.20 - $0.50. This benefit was more pronounced on farmland with originally poor soil quality. [23] However, these results analyzed the value of stewardship solely through the price of the final product. This limitation is precisely what needs to be addressed.

Increased prices, such as price premiums, are often used to compensate for lower yields found under improved soil stewardship. Nonetheless, increased prices can result in lower sales and cannot overcome the initial cost of transition. Recognizing this issue, and the importance of soil stewardship to the public good, the US government has offered subsidies and grants. An example of the government's interests in improving farmland soil quality is USDA's Natural Resources Conservation Service's Conservation Innovation Grants program, which is provided through participating states.[24]

Despite the efforts to create price premiums, subsidize transition, and the corresponding growth of the organic market, agricultural production remains largely conventional in the US.[25] The failure to transition, despite the long-term advantages of soil stewardship, indicates that the value of stewardship is not sufficiently realized in the market. Improvement in the structure of agricultural real-estate markets, as well as improved public policies, could provide a way for farmers and landowners to realize the value of stewardship and provide better incentives for regenerative practices.

Farmland Valuation and Financial Tools

Proper valuation of soil stewardship would provide farmers with the chance to weigh opportunities and long-term profit potential appropriately. The results of good soil stewardship practices in terms of long-term improvements in soil quality require years to be realized. In the face of these hurdles, intermittent government subsidies and price premiums are inadequate.

Crops are produced by the confluence of both human and natural inputs. Much like investments in other farm assets, a farmer's investment in the soil can act to maintain or increase future wealth by ensuring continuous yields and mitigating risks.[26] By framing soil quality as an investment decision, the land that the soil occupies can be considered as an appreciable or depreciable asset.

Currently, however, soil quality remains a poor determinant of agricultural real-estate values. Utilizing agricultural rent values as a an indicator of land values, a 2007 working paper found that cash rents only increased by approximately $1 per acre for crop-suitability index improvements (CSR, an index that measures soil quality), while a $1 increase in the price of corn increased rents by more than $75 per acre.[27] This discrepancy fails to capture the detrimental effect of increased yields on soil in the long-run. The farmer, in a sense, causes the farmland asset's productive value to depreciate in the pursuit of short-run returns, since longer-term productivity factors are not represented in the land's market value.

Possibly originating from the proclamation made by the first Chief of the Bureau of Soils, Milton Whitney, in which he asserted that soil is an "indestructible" asset that "cannot be exhausted", [28] soil remains poorly factored into land prices. This isn't to say that efforts have not been made to rectify this problem. In the Croatan Institute's report on regenerative agriculture investment, they identify PACE's (Purchase of Agriculture Conservation Easement) extended mortgages and Iroquois Valley Farmland REIT's conditional lending programs as examples of tying soil quality to land values through debt obligations.[29] While many of the programs seeking improved soil stewardship involve a consortium of philanthropic funders providing catalytic investments (by diminishing costs associated with the risk of investment), PACE and Iroquois Valley Farmland REIT have taken advantage public grants to facilitate the transition.[30]

Iroquois Valley Farmland Real Estate Investment Trust (REIT) is a service provided by a public benefit B Corporation. By providing tailored leases and mortgages that decrease initial costs of transition, the trust seeks to facilitate access to small and medium sized plots by new farmers. While attempting to enable change, the company has seen a year of lost revenue which has forced it to recognize the disparity in how land is valued Kevin Egolf, Iroquois Valley's Chief Financial Officer, highlighted that fact in an interview, noting how lower commodity prices have repressed farmland values regardless of soil management practices. [31]

Overall, despite a few examples of companies and programs facilitating the transition to principles of soil stewardship, the agricultural real-estate market has yet to view soil quality as a significant factor in farmland value.

Taxation, Supply Chains and Adverse Incentives for Commodity Consumption

Transitioning to an agricultural real-estate market that values soil quality is limited by many barriers. Important considerations, such as the presence of direct and indirect commodity production subsidies and rigid supply chains, contribute to a distorted land market. Addressing these market factors will be an important step to encouraging improved soil stewardship.

The subsidization of commodity production and the prevalence of crop insurance have had a marked effect on how land is valued. A 2009 article on agricultural subsidies (primarily in the form of crop insurance) and rental rates found that very little of the farm revenue realized by farmers goes to landowners. In a sense the subsidization artificially undervalues the contribution of soil quality by ensuring that value is created by artificial inputs and risk is mitigated through subsidized insurance as opposed to high quality soil.[32] The result is that farmers are protected from experiencing the true costs of improper soil stewardship. The insurance market has been established to compensate for soil's lost resilience by offering a version of a guarantee of sales income and reducing the financial impact of environmental shocks.[33] However, like the vicious cycle imposed by artificial fertilization, insurance of the final crop encourages larger yields that result in increased exposure to the risks of soil degradation.[34]

Recent policies that have been enacted since the increased trade tensions with China have resulted in an economic environment that further entrenches distorted commodity supply chains. For example, the 2019 Market Facilitation Program (MFP) was a subsidy response to compensate farmers for the drop in international demand. The MFP has resulted in ensuring that artificial inputs remain affordable and has created a disproportionate allocation of funding to large conventional farms as opposed to smaller farms that are more likely to transition.[35]

Nonetheless, programs such as the 2015 federal tax incentive for Conservational Easement have provided some public incentives for improved soil stewardship. The Conservational Easement program allows landowners to set aside agricultural land in returned for a decreased property valuation for tax purposes.[36]

Despite the efforts of federal tax incentives, local property taxes play a far more significant role in a farm operation's investment and soil management decisions. In Maine, property valuation for tax purposes is established by the Department of Agriculture, focusing on revenue and other attributable factors within the agricultural market.[37] While Maine's property valuation system appears to be almost entirely dependent on commodity market factors, Ohio and South Dakota have sought to create indices for taxation that are more representative of soil quality. Unfortunately, these indices only consider current and past conditions, omitting the impact of current production techniques on future productivity. Ohio utilizes the Current Agricultural Use Value (CAUV) that reflects past commodity market valuation in addition to general soil conditions. South Dakota has opted for a system of taxation of production valuation that includes soil quality tables that adjust the value to be representative of its current production capacity. Unsurprisingly, both taxation schemes have had unfortunate results incentivizing improved soil stewardship. The Ohio CAUV taxation system is indifferent to farmer planting and harvesting decisions. The South Dakota valuation scheme has resulted in conserved property (under the Conservation Easement program) or less intensely farmed properties with high soil qualities carrying a disproportionate tax burden.[38]

All of the above agricultural property taxation schemes fail to recognize how soil quality contributes to crop production. By basing taxation on valuations of historical production and fixed soil quality indices, they fail to capture the value added by regenerative practices. A possible solution comes from the concept of severance taxes. A severance tax, a tax applied when a natural resource is "severed" from its source,[39] could encourage improved stewardship by placing a larger tax burden on those operations that degrade a soil's quality.

There would be significant public benefits from improved soil stewardship, including erosion and flood prevention, as well as social benefit from a more sustainable agricultural sector. Without efforts to readdress taxation and without appropriate government action to limit involvement in insurance subsidization, the process of relating soil quality to land values will continue to be an uphill battle.

Private sector actors from financial and banking services to major commodity processors have an interest in addressing many of the consequences of soil quality degradation regardless of government action. Farmland loan and mortgage providers should be concerned with how soil quality degradation can increase risk of default or depreciate the value of securities. Supply-chain actors such as machinery producers, distributors, and retailers should be concerned with the sustainability of their business's strategies in the face of the costs associated with soil degradation. Accordingly, private sector actors have economic interests in addressing the consequences of soil management practices in addition to opportunities to profit.

Conclusion

The intent of this policy brief is to highlight how agricultural production, soil quality, and land valuation are intrinsically connected. The conventional strategy of providing artificial inputs, tilling soil, and insuring crop yields have imperfectly supplanted the role of soil quality in the agricultural market. Accordingly, soil has become what Milton Whitney believed it to be, a medium for inputs to be combined, devoid of intrinsic value in agricultural markets, and failing to garner the economic value representative of its quality and productive capacity.

Despite the current real-estate market's undervaluing of land's soil properties, investors, prospective farmland owners, and banking institutions have an opportunity to profit from correcting this undervaluation. The government has a key role to play in sensibly adjusting landowner incentives toward proper stewardship. Decreasing public subsidization of crop insurance and/or redirecting government financial assistance to promote risk-reducing soil stewardship practices could dissuade farmers from relying on conventional techniques and facilitate an agricultural transition. Local public policy actors can promote this transition by ensuring agricultural properties are not taxed based upon market value only, instead adjusting the tax burden to reflect benefits from good stewardship and damages from intensive land use and exploitation. As conventional practices have led to consistent soil degradation, farms with high SOC content and the accompanying ecologically and productively beneficial soil qualities may be well positioned to profit as conventional farms incur higher costs and higher levels of risk.

Endnotes

[1] Benjamin Johnson is a Research Assistant at GDAE and recent graduate of the Fletcher School of Law and Diplomacy, with a specialization in Law and Development as well as International Environment and Resource Policy.

[2] Volchko, Yevheniya, Norrman, Jenny, Bergknut, Magnus, Rosen, Lars, and Soderqvist, Tore. "Incorporating the Soil Function Concept into Sustainability Appraisal of Remediation Alternatives." Journal of Environmental Management 129 (2013): 368.

[3] Belcher, K. W., M. M. Boehm, and R. P. Zentner. "The Economic Value of Soil Quality under Alternative Management in the Canadian Prairies." Canadian Journal of Agricultural Economics/Revue Canadienne D'agroeconomie 51, no. 2 (2003): 176.

[4] Pascual, U., Termansen, M., Hedlund, K., Brussaard, L., Faber, J.H., Foudi, S., Lemanceau, P., and Liv-Jørgensen, S. "On the Value of Soil Biodiversity and Ecosystem Services." Ecosystem Services 15 (2015): 14; and see Six, J., Elliot, E. T., & Paustian, K. (2000). Soil macroaggregate turnover and microaggregate formation: A mechanism for C sequestration under no-tillage agriculture. Soil Biology and Biochemistry, 32(140), 2099-2103. https://doi.org/10.1016/S0038-0717(00)00179-6

[5] Parman, Bryon. 2019. "Farmers Encouraged to Plan and Budget for High Fertilizer Prices." North Dakota State University - Extension Services. May 2019. https://www.ag.ndsu.edu/news/newsreleases/2019/may-13-2019/farmers-encouraged-to-plan-and-budget-for-high-fertilizer-prices.

[6] Six, J., et al. (2000). 2099-2103. Ozlu, Ekrem & Arriaga, Francisco. (2018). Intercorrelation in Mechanisms of Soil Aggregate Formation and Carbon Stabilization in Midwest Soils, USA.; and see Naba Kumar Mondal, Jayanta Kumar Datta, and Arnab Banerjee. "Integrated Effects of Reduction Dose of Nitrogen Fertilizer and Mode of Biofertilizer Application on Soil Health under Mung Bean Cropping System." Communications in Plant Sciences 5, no. 1-2 (2014): 20.

[7] Bai, Xiongxiong, Yawen Huang, Wei Ren, Mark Coyne, Pierre-Andre Jacinthe, Bo Tao, Dafeng Hui, Jian Yang, and Chris Matocha. "Responses of Soil Carbon Sequestration to Climate-smart Agriculture Practices: A Meta-analysis." Global Change Biology 25, no. 8 (2019): 2591-606.; and see Sperow, M. (2016). Estimating carbon sequestration potential on U.S. agricultural topsoils. Soil and Tillage Research, 155, 390-400. https://doi.org/10.1016/j.still.2015.09.006

[8] Pascual, U., Termansen, M., Hedlund, K., Brussaard, L., Faber, J.H., Foudi, S., Lemanceau, P., and Liv-Jørgensen, S. "On the Value of Soil Biodiversity and Ecosystem Services." Ecosystem Services 15 (2015): 13-4.

[9] Ibid et al., 14.

[10] Basche, A. D. & Edelson, O. F. (2017). Improving water resilience with more perennially based agriculture. Agroecology and Sustainable Food System, 41(7). https://doi.org/10.1080/21683565.2017.1330795; and see Six, J., Elliot, E. T., & Paustian, K. (2000). Soil macroaggregate turnover and microaggregate formation: A mechanism for C sequestration under no-tillage agriculture. Soil Biology and Biochemistry, 32(140), 2099-2103. https://doi.org/10.1016/S0038-0717(00)00179-6

[11] United States. Government Accountability Office, Author. Crop Insurance, Opportunities Exist to Improve Program Delivery and Reduce Costs : Report to the Honorable Dianne Feinstein, U.S. Senate. 2017. 7-8.

[12] Miranda, Mario, and Dmitry V. Vedenov. "Innovations in Agricultural and Natural Disaster Insurance." American Journal of Agricultural Economics 83, no. 3 (2001): 650-55.; and see Pascual, U., et al. (2015). 17.

[13] Bommarco, R., Kleijn, D., & Potts, S. G. (2013). Ecological intensification: harnessing ecosystem services for food security. Trends in Ecology & Evolution, 28(4), 230-238. https://doi.org/10.1016/j.tree.2012.10.012; and see Belcher, K. W., et al. (2003). 191.

[14] Woodard, Joshua D., Gary D. Schnitkey, Bruce J. Sherrick, Nancy Lozano-Gracia, and Luc Anselin. "A Spatial Econometric Analysis of Loss Experience in the U.S. Crop Insurance Program." Journal of Risk and Insurance 79, no. 1 (2012): 262.

[15] Roberts, Michael, Erik O'Donoghue, and Nigel Key. "Chemical And Fertilizer Applications In Response To Crop Insurance: Evidence From Census Micro Data." IDEAS Working Paper Series from RePEc, 2003, IDEAS Working Paper Series from RePEc, 2003.

[16] Schnitkey, Gary. 2018.

[17] Adesemoye, A.O., Kloepper, J.W. Plant–microbes interactions in enhanced fertilizer-use efficiency. Appl Microbiol Biotechnol 85, 1–12 (2009). https://doi-org.ezproxy.library.tufts.edu/10.1007/s00253-009-2196-0

[18] Karasawa, Toshihiko, Masako Takebe, Fumio Sato, Michio Komada, Kazunari Nagaoka, Makoto Takenaka, Yasufumi Urashima, Seiichi Nishimura, Shigeru Takahashi, and Naoto Kato. "Trends of Lettuce and Carrot Yields and Soil Enzyme Activities during Transition from Conventional to Organic Farming in an Andosol." Soil Science and Plant Nutrition 61, no. 2 (2015): 303.; and see Naba Kumar Mondal, et al. (2014). 21.

[19] Adesemoye AO, Kloeppe JW (2009) "Plant-microbes interactions in enhanced fertilizer-use efficiency." Appl Microbiol Biotechnol 85:1–12.

[20] Tamburini, Giovanni, Serena De Simone, Maurizia Sigura, Francesco Boscutti, and Loren-

zo Marini. "Soil Management Shapes Ecosystem Service Provision and Trade-offs in Agricultural Landscapes." Proceedings. Biological Sciences 283, no. 1837 (2016): 20161369-20161369. 5-6.

[21] Schnitkey, Gary. (2018).

[22] Edmondson, Jill L., Davies, Zoe G., Gaston, Kevin J., Leake, Jonathan R. "Urban cultivation in allotments maintains soil qualities adversely affected by conventional agriculture." Journal of Applied Ecology 51, no. 4 (2014): 880,7.; Dungait, Jennifer A.J, Laura M Cardenas, Martin S.A Blackwell, Lianhai Wu, Paul J.A Withers, David R Chadwick, Roland Bol, Philip J Murray, Andrew J Macdonald, Andrew P Whitmore, and Keith W.T Goulding. "Advances in the Understanding of Nutrient Dynamics and Management in UK Agriculture." Science of the Total Environment 434 (2012): 39-50.; Lal, R. "Soil Carbon Sequestration Impacts on Global Climate Change and Food Security." Science (Washington) 304, no. 5677 (2004): 1623-627.; and see Loveland, P., and J. Webb. "Is There a Critical Level of Organic Matter in the Agricultural Soils of Temperate Regions: A Review." Soil & Tillage Research 70, no. 1 (2003): 1-18.

[23] Belcher, K. W., et al. (2003). 191.

[24] Schilling, K. E. et al. (2014). The potential for agricultural land use change to reduce flood risk in a large watershed. Hydrological Process, 28(8), 3315-3325. https://doi.org/10.1002/hyp.9865; Iowa Conservation Innovation Grants Heavy on Soil Health." Targeted News Service (Washington, D.C.), 2013.; and see "Conservation Innovation Grants | NRCS." 2020. United States Department of Agriculture, Economic Research Service. 2020. https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/cig/.

[25] "Organic Market Overview." 2019. United States Department of Agriculture, Economic Research Service. 2019. https://www.ers.usda.gov/topics/natural-resources-environment/organic-agriculture/organic-market-overview/.

[26] Pascual, U., et al. (2015). 12.

[27] Du, Xiaodong, David Hennessy, and William Edwards. "Determinants of Iowa Cropland Cash Rental Rates: Testing Ricardian Rent Theory." IDEAS Working Paper Series from RePEc, 2007, IDEAS Working Paper Series from RePEc, 2007. 36.

[28] Nygren, Joshua M. 2015. "Soil, Water, and the State: The Conservation-Industrial Complex and American Agriculture since 1920." Order No. 3708159, University of Kansas. 41. https://login.ezproxy.library.tufts.edu/login?url=https://search-proquest-com.ezproxy.library.tufts.edu/docview/1696068933?accountid=14434.

[29] Electris, Christi, Joshua Humphreys, Kristin Lang, David LeZaks, and Jaimie Silverstein. 2019. "Soil Wealth: Investing in Regenerative Agriculture across Asset Classes." Croatan In-

stitute. 28, 46. http://croataninstitute.org/.

[30] Electris, Christi, et al. (2019). 28, 31-32, 46.

[31] Mesesan, Claire. 2019. "If We Want to Change Our Food System, We Need to Change Our Finance System." Medium. October 23, 2019. https://bthechange.com/if-we-want-to-change-our-food-system-we-need-to-change-our-finance-system-3b67c4d2a59f.; and see Reiss, Dawn. 2017. "The U.S.'s First Organic Farm REIT Is Based in Evanston." Crain's Chicago Business. February 4, 2017. https://www.chicagobusiness.com/article/20170204/ISSUE01/170209917/iroquois-valley-farms-is-u-s-s-first-organic-reit.

[32] Kirwan, Barrett E. "The Incidence of U.S. Agricultural Subsidies on Farmland Rental Rates." Journal of Political Economy 117, no. 1 (2009): 142, 159. Accessed June 9, 2020. doi:10.1086/598688.

[33] Miranda, Mario, and Dmitry V. Vedenov. "Innovations in Agricultural and Natural Disaster Insurance." American Journal of Agricultural Economics 83, no. 3 (2001): 650-55.; and see Pascual, U., et al. (2015). 17.

[34] Mahul, Olivier. "Optimal Insurance Against Climatic Experience." American Journal of Agricultural Economics 83, no. 3 (2001): 593-604.

[35] Smith, Eric Belasco, Vincent H. 2019. "How the Biggest Farms Are Getting More per Acre in Trade-War Subsidies." MarketWatch. December 11, 2019. https://www.marketwatch.com/story/how-the-biggest-farms-are-getting-more-per-acre-in-trade-war-subsidies-2019-12-11.

[36] Electris, Christi, et al. (2019). 50.

[37] "Current Land Use Programs, Property Tax." 2018. Department of Administrative and Financial Services: Maine Revenue Services. 2018. https://www.maine.gov/revenue/propertytax/propertytaxbenefits/current_use.htm.

[38] Dinterman, Robert, and Ani L Katchova. "Property Tax Incidence on Cropland Cash Rent." Applied Economic Perspectives and Policy, 2019, Applied Economic Perspectives and Policy, 04/01/2019. 4-5.; and see Lowrey, Nick. 2019. "Reform of Agricultural Land Taxation Could Help Farmers but Shift Burden to Homeowners and Businesses." Argus Leader. November 11, 2019. https://www.argusleader.com/story/news/2019/11/11/south-dakota-land-taxation-agriculture-taxes/2563137001/.

[39] "State Oil and Gas Severance Taxes." 2018. National Conference of State Legislatures. September 6, 2018. https://www.ncsl.org/research/energy/oil-and-gas-severance-taxes.aspx.; and see "Mineral Interests and Severance Taxes." 2011. Center for Agricultural Law and Taxation. 2011. https://www.calt.iastate.edu/article/mineral-interests-and-severance-taxes.