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A Return to the Crossroads: Farming, Nutrient Loss, and Conservation

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A RETURN TO THE CROSSROADS: FARMING, NUTRIENT LOSS, AND CONSERVATION

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I. INTRODUCTION

Through its seasons and markets, farming is cyclical; political history appears mimetic in its own way, not repeating so much as recycling.[1] Thanks largely to expanded production around World War I, American agriculture suffered twin disasters in the 1930s with the Great Depression and the Dust Bowl. In response, Congress created policies to assist and support farmers; efforts that included assistance and support for conserving soil resources. Farming subsequently underwent difficult adjustments under the new federal policies and an unprecedented technological revolution.[2] American agriculture returned to crisis in the 1980s when another round of debt-fueled expansion resulted in farm financial problems, depressed crop prices, and raised concerns about the impact of agricultural production on natural resources and the environment. Roughly thirty years has passed since the 1980s crisis; technological advances and federal policies have again altered the physical and political landscape of American agriculture. Farmers are currently experiencing relatively low crop prices since the records of 2012, along with increasing concerns about the consequences of modern farming on natural resources and the environment. The 1980s crisis repeated neither the financial nor environmental calamities of the Thirties; instead, it recycled elements of them. Whether the same can be said for the current situation remains to be seen. Featured prominently this time is the application of nutrients to grow crops, a significant percentage of which are being lost from farm fields, impacting water quality.

Previous themes for the topics of farming and conservation invoked their metaphorical crossroads, and this article recycles that theme for this

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1. *See, e.g.,* Fredrik Logevall & Kenneth Good, *Why Did We Stop Teaching Political History?*, N.Y. TIMES (Aug. 29, 2016), https://www.nytimes.com/2016/08/29/opinion/why-did-we-stop-teaching-political-history.html?=&_r=1; Graham Allison & Niall Ferguson, *Why the U.S. President Needs a Council of Historians*, ATLANTIC (Sept. 2016), https://www.theatlantic.com/magazine/archive/2016/09/dont-know-much-about-history/492746/.

2. *See, e.g.,* Pete Daniel, *The Crossroads of Change: Cotton, Tobacco, and Rice Cultures in the Twentieth Century South*, 50 J. OF S. HIST. 429 (1984).

discussion of current challenges.[3] Part II reviews the issue of nutrients lost from farming. It summarizes the science and research while reviewing some of the history that runs underneath. Part III discusses responses to nutrient loss in terms of regulation and litigation. Part IV provides a limited discussion of federal farm policy, including conservation policy, briefly reviewing the interconnected history and development of these policies to add perspective to the nutrient loss discussion. Finally, Part V looks to the intersection of nutrient loss, precision agricultural technology, and federal policy to map a potential path forward.

II. TOWARDS AN UNDERSTANDING OF NUTRIENT LOSS AND FARMING

Commercial row-crop farming has long been subjected to criticism, concern, and commentary regarding its environmental implications, much of it regarding water quality degradation.[4] Soil erosion has traditionally been the issue of greatest concern; as a result, significant effort and funding has been invested in combating soil erosion, with noticeable results.[5] Many

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3. *See, e.g.,* Linda A. Malone, *Conservation at the Crossroads: Reauthorization of the 1985 Farm Bill Conservation Provisions*, 8 VA. ENVTL. L. J. 215, 228 (1989); Ralph E. Heimlich & Roger Claassen, *Agricultural Conservation Policy at a Crossroads*, 27 AGRIC. & RESOURCE ECON. REV. 95, 95–101 (1998); Daniel, *supra* note 2, at 454–55.

4. Admittedly, much criticism also involves livestock production and, in particular, large-scale confined animal feeding operations. By necessity, the scope of this article is limited to the environmental issues involved in modern, commercial row-crop farming. *See, e.g.,* Craig L. Williams, *Soil Conservation and Water Pollution Control: The Muddy Record of the United States Department of Agriculture*, 7 B.C. ENVTL. AFF. L. REV. 365, 396 (1979) [hereinafter *Soil Conservation*]; J.B. Ruhl, *Farms, Their Environmental Harms, and Environmental Law*, 27 ECOLOGY L. Q. 263, 280 (2000); Douglas R. Williams, *When Voluntary, Incentive-Based Controls Fail: Structuring a Regulatory Response to Agricultural Nonpoint Source Water Pollution*, 9 WASH. U. J. OF L. & POL'Y 21, 44–45 (2002) [hereinafter *Structuring a Response*]; John H. Davidson, *Factory Fields: Agricultural Practices, Polluted Water and Hypoxic Oceans*, 9 GREAT PLAINS NAT. RESOURCES J. 1, 11 (2004); William S. Eubanks II, *A Rotten System: Subsidizing Environmental Degradation and Poor Public Health with Our Nation's Tax Dollars*, 28 STAN. ENVTL. L. J. 213, 255 (2009); Linda Breggin & D. Bruce Myers, Jr., *Subsidies with Responsibilities: Placing Stewardship and Disclosure Conditions on Government Payments to Large-Scale Commodity Crop Operations*, 37 HARV. ENVTL. L. REV. 487, 492–93 (2013); Jan G. Laitos & Heidi Ruckriegle, *The Clean Water Act and the Challenge of Agricultural Pollution*, 37 VT. L. REV. 1033, 1035–36 (2013); Robin Kundis Craig & Anna M. Roberts, *When Will Governments Regulate Nonpoint Source Pollution? A Comparative Perspective*, 42 B.C. ENVTL. AFF. L. REV. 1 (2015); Margot J. Pollans, *Drinking Water Protection and Agricultural Exceptionalism*, 77 OHIO STATE. L. J. 1195, 1208–09 (2016).

5. *See, e.g.,* MEGAN STUBBS, CONG. RESEARCH SERV., R42459, CONSERVATION COMPLIANCE AND U.S. FARM POLICY 1, 11 (2016), http://nationalaglawcenter.org/wp-content/uploads/assets/crs/R42459.pdf (reporting that farmers reduced erosion by 41 percent from 1982 to 2010 and acres eroding above soil loss tolerance rates have dropped from 175 million acres to 101 million acres).

states have recently prioritized reducing water quality impairments that can result from the loss of fertilizers and chemicals used in modern farming.[6] Nutrients lost from farming are classified as nonpoint source pollution and are exempt from direct regulation under the Clean Water Act because they are from diffuse sources that are generally outside the control of humans.[7] As such, the discussion in this article will focus on nutrient losses from row-crop farming, in particular nitrogen from fertilizers.

A. Why Farming Loses Nutrients

Excess nitrate-nitrogen (N) and total phosphorus (P) in water can degrade water quality. There are multiple potential sources of both nutrients, including point-source polluters, agricultural nonpoint sources, and urban

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6. *See, e.g.,* ILL. ENVTL. PROTECTION AGENCY, ILLINOIS NUTRIENT LOSS REDUCTION STRATEGY IMPLEMENTATION (Aug. 2017), http://www.epa.illinois.gov/topics/water-quality/watershed-management/excess-nutrients/nutrient-loss-reduction-strategy/index; IOWA STATE UNIV., IOWA NUTRIENT REDUCTION STRATEGY 1, 5 (Sept. 2016), http://www.nutrientstrategy.iastate.edu/documents/INRSfull161001.pdf; IND. STATE DEP'T OF AGRIC., INDIANA'S NUTRIENT REDUCTION STRATEGY, http://www.in.gov/isda/files/Indiana%20Nutrient%20Reduction%20Strategy_Final%20Version%204.pdf; OHIO ENVTL. PROT. AGENCY, OHIO NUTRIENT REDUCTION STRATEGY, http://epa.ohio.gov/dsw/wqs/NutrientReduction.aspx#146064466-nutrient-strategy; MINN. POLLUTION CONTROL AGENCY, NUTRIENT REDUCTION STRATEGY, https://www.pca.state.mn.us/water/nutrient-reduction-strategy.

7. *See* Craig & Roberts, *supra* note 4, at 2 ("In the United States, nonpoint source pollution is well-recognized to be one of the last major barriers to achieving state and national water quality goals . . . agriculture is often a locally and regionally significant source of water pollution that is frequently exempt"); Breggin & Myers, *supra* note 4, at 492 ("A byproduct of the production of commodity crops is pollution . . ." and ". . . agricultural activities that cause nonpoint source pollution. . .[a] key harm caused by the large-scale production of commodity crops results from nutrient pollution entering surface water and groundwater"); *Structuring a Response*, *supra* note 4, at 22 ("The gist of the nation's current water quality problems is the absence of effective measures to control nonpoint source pollution . . . [a]gricultural activities are deeply implicated in this problem" and "agricultural nonpoint source pollution is now considered the nation's most persistent and most difficult water quality problem"); Mary Jane Angelo, *Corn, Carbon, and Conservation: Rethinking U.S. Agricultural Policy in a Changing Global Environment*, 17 GEO. MASON L. REV. 593, 602 (2010) ("With regard to the natural environment, high-production industrialized agriculture has contributed to topsoil depletion, contamination of surface and ground water, loss of biodiversity, and harm to protected species."); Laitos & Ruckriegle, *supra* note 4, at 1033, 1037 ("One of the last great intractable problems of environmental law is the pollution of America's waterways caused by agriculture . . . [t]he most pervasive nonpoint agricultural pollutants are nutrients and sediment."); s*ee also* Cory G. Walters, C. Richard Shumway, Hayley H. Chouinard & Philip R. Wandschneider, *Crop Insurance, Land Allocation, and the Environment*, 37 J. OF AGRIC. AND RESOURCE ECON. 301, 301 (2012) ("soil erosion caused by agricultural production represents the leading cause of negative water quality impacts on rivers and lakes in the United States").

storm-water runoff.[8] Research has concluded that of all potential sources, farming is "the most important factor" when it comes to the impairment of rivers and lakes by these nutrients.[9] Commercial fertilizers applied in crop production likely constitute "the primary agricultural nonpoint source of nitrogen and phosphorus," although animal manure may be the largest contributor of phosphorus.[10] In total, farming has been estimated to account for "60 percent of the biologically-active N from anthropogenic sources" on the planet.[11]

Fertilizers help make today's high levels of farm productivity possible.[12] For example, nitrogen is "the most limiting nutrient for corn production in the Corn Belt" and most of the nitrogen fertilizer recommendations made to farmers since the 1970s have been based on yield goals.[13] Fertilizer

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8. *See* ILL. ENVTL. PROTECTION AGENCY, ILLINOIS NUTRIENT LOSS REDUCTION STRATEGY 1-1, http://www.epa.illinois.gov/Assets/iepa/water-quality/watershed-management/nlrs/nlrs-final-revised-083115.pdf; Mark B. David, Gregory F. McIsaac, Gary D. Schnitkey, George F. Czapar & Corey A. Mitchell, *Science Assessment to Support an Illinois Nutrient Loss Reduction Strategy*, BIOCHEMISTRY LABORATORY 1, 1 (May 6, 2014), http://biogeochemistry.nres.illinois.edu/Biogeochem_lab/Science_documents/Illinois_Science_Assessment_Report_May_6.pdf [hereinafter, David et. al., INLRS Science Assessment]; *see also* Todd Royer, Mark B. David & Lowell E. Gentry, *Timing of Riverine Export of Nitrate and Phosphorous from Agricultural Watersheds in Illinois: Implications for Reducing Nutrient Loading to the Mississippi River*, 40 ENVTL. SCI. & TECH. 4126, 4126 (2006) ("Nitrogen and P enrichment from nonpoint sources and resulting eutrophication is a main cause of poor water quality and biotic impairment in many streams and rivers in the United States").

9. Larry J. Puckett, *Identifying the Major Sources of Nutrient Water Pollution*, 29 ENVTL. SCI. & TECH. 408A, 408A (1995).

10. *Id.* (explaining that this is largely due to the "supply and transport properties" of the two nutrients: nitrogen is highly mobile in soils and groundwater, while phosphorus is frequently transported by surface water runoff and is most prevalent in animal manure); Richard B. Alexander, Richard A. Smith, Gregory E. Schwarz, Elizabeth W. Boyer, Jacqueline V. Nolan & John W. Brakebill, *Differences in Phosphorus and Nitrogen Delivery to the Gulf of Mexico from the Mississippi River Basin*, 42 ENVTL. SCI. AND TECH. 822, 826 (2006) ("[A]griculture is the predominant nutrient source to the Gulf" and that 52 percent of total nitrogen (N) and 25 percent of total phosphorus (P) delivered to the Gulf of Mexico can be attributed to corn and soybean crops in the region).

11. Laurie E. Drinkwater & S.S. Snapp, *Nutrients in Agroecosystems: Rethinking the Management Paradigm*, 92 ADVANCES IN AGRONOMY 163, 164 (2007).

12. G. Philip Robertson & Peter M. Vitousek, *Nitrogen in Agriculture: Balancing Cost of an Essential Resource*, 34 ANN. REV. OF ENVTL. RESOURCES 97, 101 (2009) (farmers add nitrogen because today's corn yields "would make dependency on N from stored organic matter (SOM) even less sustainable" than it was in the early 1900s, but that only about 50 percent of applied N is taken up by the crop).

13. *See* John Sawyer, Emerson Nafziger, Gyles Randall, Larry Bundy, George Rehm & Brad Joern, *Concepts and Rational for Regional Nitrogen Rate Guidelines for Corn*, Iowa State University—University Extension 1, 6 (2005), http://publications.iowa.gov/3847/1/P/M2015.pdf at 6 (indicating that "maximum accumulation of approximately 275 lb N/acre is reached by physiological maturity for high-yielding corn"); Robertson & Vitousek*, supra*

is a significant input cost for farmers — one that has more than tripled in the last twenty-five years[14] — but nitrogen fertilizer is relatively inexpensive in relation to its ability to improve yields.[15] Given the significant risks in producing a crop, applying extra N fertilizer represents, for many farmers, a form of insurance and risk management regardless of the potential for high losses.[16] A challenge for policymakers is that the very nutrients "essential to crop growth and yields," when not used by crops, "can become an environmental pollutant."[17] Ultimately, risk and profit are at the forefront of farmer decision making.[18]

From those basic facts, many have beaten a well-worn path to the conclusion that the over-application of nitrogen fertilizers by farmers leads to nutrient losses, nonpoint source pollution, water-quality impairment, and hypoxia in the Gulf of Mexico.[19] While generally accurate, this conclusion

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note 12, at 112; s*ee also* Malden C. Nesheim, A FRAMEWORK FOR ASSESSING EFFECTS OF THE FOOD SYSTEM 336 (Malden C. Neisheim et al. eds., 2015), https://www.ncbi.nlm.nih.gov/books/NBK305171/ (corn has large nutrient requirements, especially nitrogen); Alexander et al., *supra* note 10, at 825.

14. *See* Gary Schnitkey & Sarah Sellars, *Growth Rates of Fertilizer, Pesticide, and Seed Costs Over Time*, FARMDOC DAILY (6):130 (July 12, 2016), http://farmdocdaily.illinois.edu/2016/07/growth-rates-of-fertilizer-pesticide-seed-costs.html (indicating that for high productivity farms in central Illinois the cost per acre of fertilizer has grown from $53 in 1990 to $166 in 2015).

15. *See* Robertson & Vitousek, *supra* note 12, at 102 (noting that adding an additional 10 kg of N fertilizer cost $4.90 per hectare (or about 2.5 acres) in 2000 and $13.50 in 2008, but needed to increase yield by only 2.5 to 2.7 bushels to cover that cost); Stan Daberkow, Marc Ribaudo & Otto Doering, *Economic Implications of Public Policies to Change Agricultural Nitrogen Use and Management*, AGRONOMY MONOGRAPH NO. 49, 883, 885 ("[T]here are compelling economic reasons why producers use the amounts of N that they do" including its "high value" as compared to its cost).

16. *See* Daberkow et al., *supra* note 15, at 889 ([E]xtra fertilizer might help farmers capture better yields with good weather but can be lost if it is too wet and that "the high value of N in crop production and its low cost make special efforts to avoid N losses in crop production one of the least valuable uses of management time and effort").

17. *Id.* at 884.

18. *See id.* (noting that farmers "are rational profit maximizers" but also respond to "other stimuli, such as risk aversion, health concerns, altruism, and so forth" but that "risk preferences may play a key role with respect to their adoption of N management practices").

19. *See* Breggin & Myers, *supra* note 4, at 492; Ruhl, *supra* note 4, at 288–89; s*ee also* T.S. Bianchi, S.F. DiMarco, J.H. Cowan Jr., R.D. Hetland, P. Chapman, J.W. Day & M.A. Allison, *The Science of Hypoxia in the Northern Gulf of Mexico: A Review*, 408 SCI. OF THE TOTAL ENV'T 1471, 1472 (2010); Joshua D. Woodard, *Integrating High Resolution Soil Data into Federal Crop Insurance Policy: Implications for Policy and Conservation*, 66 ENVTL. SCI. & POL'Y 93, 98 (2016) ("[S]ome research suggests that agricultural producers may in fact over-utilize nitrogen-based fertilizers as a physical form of production 'insurance,' leading to reduced energy efficiency and unfavorable environmental outcomes"); Puckett, *supra* note 9, at 408A–09A ("farmers may apply 24 to 38 percent more fertilizers than crops require because of uncertainties associated with weather and soil nutrients").

may be somewhat oversimplified.[20] It is, at least, only part of the story. More important is the other part of that story because it contains key implications for policies seeking to help reduce nutrient loss.

Nitrogen loss involves a complex chemical and biological process but is the result of factors that are largely uncertain, of which weather and rainfall are the most important contributors to actual losses.[21] The process by which nutrients are exported from Midwestern farm fields to the Mississippi River and the Gulf of Mexico is "primarily hydrological," that is, "driven by precipitation and drainage of the agricultural landscape."[22] The role of rain in nutrient loss cannot be overstated.[23] The form of nitrogen that is used for fertilizer is very mobile; it easily dissolves in water and moves quickly through the soil by the process of leaching.[24] Rain is such an important factor in nitrogen loss because it determines how much water is flowing through soil, leaching nitrogen, and taking it to the drainage system for the field. Therefore, the more rain, the more nitrogen that can be lost.[25] For ex-

20. *See, e.g.,* Glenn Sheriff, *Efficient Waste? Why Farmers Over-Apply Nutrients and the Implications for Policy Design*, 27 REV. OF AGRIC. ECON. 542 (2005).

21. *See* Daberkow et al., *supra* note 15, at 895.

22. Royer et al., *supra* note 8, at 4126.

23. G.W. Randall, J.A. Vetsch & J.R. Huffman, *Nitrate Losses in Subsurface Drainage from a Corn-Soybean Rotation as Affected by Fall and Spring Application of Nitrogen and Nitrapyrin*, 34 J. OF ENVTL. QUALITY 590, 596 (2005) ("annual precipitation and temporal distribution of precipitation" impact nitrogen loss); Lowell E. Gentry, Mark B. David, Karen M. Smith & David A. Kovacic, *Nitrogen Cycling and Tile Drainage Nitrate Loss in a Corn/Soybean Watershed*, 68 AGRIC., ECOSYSTEMS AND ENV'T 85, 92 (1998) (Nitrate leaching is "controlled by complex interactions between inorganic N pools, and frequency and magnitude of high flow events" from precipitation, making estimates of export variable and dependent upon site-specific conditions"); S.J. Kalkhoff, L.E. Hubbard, M.D. Tomer & D.E. James, *Effect of Variable Annual Precipitation and Nutrient Input on Nitrogen and Phosphorus Transport from Two Midwestern Agricultural Watersheds,* 559 SCI. OF THE TOTAL ENV'T 53, 59 (2016) (Nitrogen applied to farm fields is lost due to rain); E.J. Kladivko, G.E. Van Scoyoc, E.J. Monke, K.M. Oates & W. Pask, *Pesticide and Nutrient Movement into Subsurface Tile Drains on a Silt Loam Soil in Indiana*, 20 J. OF ENVTL. QUALITY 264, 264 (1991) ("[L]eaching of nitrates and pesticides is of greatest concern on sandy soils under high rainfall"); E.J. Kladivko, J. Grochulska, R.F. Turco, G.E. Van Scoyoc & J.D. Eigel, *Pesticide and Nitrate Transport into Subsurface Tile Drains of Different Spacings*, 28 J. OF ENVTL. QUALITY 997 (1999) (nutrient export varies considerably depending on precipitation and the amount of rainfall).

24. *See* Robertson & Vitousek, *supra* note 12, at 108.

25. *See* Mark B. David, Lowell E. Gentry, David A. Kovacic & Karen M. Smith, *Nitrogen Balance in and Export from an Agricultural Watershed*, 26 J. OF ENVTL. QUALITY 1038, 1047 (1997); Daberkow et al., *supra* note 15, at 895 (most of it takes place "during extremely heavy rain events"); K.C. Cameron, H.J. Di & J.L. Moir, *Nitrogen Losses from the Soil/Plant System: A Review*, 162 ANNALS OF APPLIED BIOLOGY 145, 147 (2013) (small differences in weather and soil moisture can have significant impacts on the amount of nitrogen lost); Royer et al., *supra* note 8, at 4127 (nitrogen losses can more than double depending on precipitation, finding a range from 20 to 50 kilograms per hectare per year); Kalkhoff et al., *supra* note 23, at 57 (the concentrations of nitrogen in rivers varies in relation to the amount of rain).

ample, research has found that nitrogen losses can be as much as ten times higher in years with high precipitation.[26]

The timing of rain is also an important contributor because it can leach nitrogen before any crop can take it up, greatly limiting the farmer's ability to prevent losses.[27] From the perspective of both the farmer and the policymaker, these "[n]oncontrollable factors" such as rain and the makeup of the soils "have a greater impact on" nitrogen loss, complicating efforts to control or reduce it.[28] Therein lies the more complex conclusion; unused or excess nitrogen may not be a problem unless/until rainwater carries it through soil and into waterways, a process which is expedited by subsurface drainage systems or tiles.[29]

Another important factor regarding nutrient loss is how it operates within typical farming practices. Corn and soybean crops are planted in the spring and harvested in the fall; the vast majority of nitrogen is lost in the months between harvest and the next season's growing crop.[30] Research demonstrates that nitrogen losses are concentrated during the fallow season from November to March, which produces as much as 70-80 percent of an-

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26. *See* Randall et al., *supra* note 23, at 593 (Over seven years of a study, the results "dramatically show the strong effect of precipitation" noting losses that ranged from 5 kilograms per hectare per year to 50 kilograms per hectare per year in the wettest year of the study).

27. David et al., *supra* note 25, at 1043 ([I]f an "intense rainfall occurs before the crop can use the applied fertilizer, large amounts can be leached in short time periods."); Anne M. Struffert et al., *Nitrogen Management for Corn and Groundwater Quality in Upper Midwest Irrigated Sands*, 45 J. OF ENVTL. QUALITY, 1557, 1560–61 (2016) ("excess water results in leaching losses" and nitrogen leaching "amount closely followed cumulative water drainage amounts in every year, indicating that water transport greatly affects N loss").

28. E.J. Kladivko, J.R. Frankenberger, D.B. Jaynes, D.W. Meek, B.J. Jenkinson & N.R. Fausey, *Nitrate Leaching to Subsurface Drains as Affected by Drain Spacing and Changes in Crop Production System*, 33 J. OF ENVTL. QUALITY 1803, 1803–1809 (2004) (contrasting soils with low organic matter (1.3 percent) and those with high organic matter such that on higher organic matter soils, it "may not be possible to grow corn and soybean" and "consistently maintain [nitrate] concentrations below 10 [milligram per liter of water], even with the best management practices currently available"); Mark B. David, Laurie E. Drinkwater & Gregory F. McIsaac, *Sources of Nitrate Yields in the Mississippi River Basin*, 39 J. OF ENVTL. QUALITY 1657, 1663 (2010) (loss results from "the combination of the most productive soils (high in organic matter) that are tile drained and heavily cropped."); Cameron et al., *supra* note 25, at 146 (even "small differences in weather conditions and initial soil moisture content [can have] a significant effect on the size of" fertilizer nitrogen losses).

29. *See infra* notes 39–40.

30. *See* Kladivko et al., *supra* note 23, at 270 ("[M]ost of the nitrates that reached the drain arrived during the fall, winter, and early spring of the following year when most of the drainflow occurred"); Drinkwater & Snapp, *supra* note 11 (this period reduces carbon and soil organic matter stocks and leaves unused additions of inorganic nitrogen more vulnerable to losses).

nual nitrate load.[31] This is a further challenge for preventing losses because a "large amount of drainage also coincides with the time of fertilizer application."[32] Major rain events in the spring will cause spikes in drainage and large increases in nitrogen loss.[33] In fact, just a "few days of high flow events" in early spring "can lead to most of the annual loss of [nitrogen] from a tile-drained field in some years."[34] This is especially the case if a wet spring follows a dry crop year with poor yields because it can increase nitrogen losses significantly.[35]

Reducing or controlling nutrient loss begins with avoiding excess nitrogen in the soil when it rains in early spring.[36] Heavy rainfall however, may have a much greater effect than some conservation practices intended to control drainage and reduce nitrogen losses, while variations in weather

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31. Kladivko, *supra* note 28, at 1811; Struffert et al, *supra* note 27, at 1563 (most of the water "was from precipitation" even on irrigated farms and that"[d]uring May and June, 41 percent of the total water . . . was received, and 75 percent of the total drainage and 73 percent of the total [nitrogen] leaching occurred"); Randall et al., *supra* note 23, at 593 (as much as 77 percent of the nitrogen lost to drainage is lost between April and June for corn).

32. Struffert et al., *supra* note 27, at 1561.

33. *See* Randall et al., *supra* note 23, at 594–95 ([T]he worst case scenario is an "extended warm fall and early warm and wet spring" that "encouraged rapid nitrification of fall-applied ammonia and degradation of the [nitrogen inhibitor] before the three-month period where substantial drainage occurred.").

34. David et al., *supra* note 25, at 1047 ("[h]igh flow events led to large exports of N in tiles and in the river"); Gentry et al., *supra* note 23, at 95 (nitrogen loss or export is "closely associated" with large rain events, especially in the early spring before any crops are growing); Randall et al., *supra* note 23, at 593 (because annual nitrogen losses are "the product of water flow multiplied" by nitrate-nitrogen concentrations, they are "affected substantially by growing season precipitation"); Struffert et al., *supra* note 27, at 1558 ("Nitrogen application timing is important because excess precipitation and peak N loss typically occur early in the growing season").

35. Gentry et al., *supra* note 23, at 93 (greatest N losses found "in tile drainage to occur after a dry growing season" with low corn yields that leave behind "high inorganic N pool" in the soil; "late planting date, high temperatures at pollination, and low rainfall in July"); Randall et al., *supra* note 23, at 595 (explaining that the combination of dry years followed by wet years increase losses because the dry years produce minimal drainage and limit corn crop growth (nitrogen uptake and usage) which leaves behind large carryovers of residual nitrogen in the soils that is leached out with the subsequent precipitation); Kladivko et al., *supra* note 28, at 1809 ("year-to-year variations in loads occurred as a result of variation in weather and crop yields"); s*ee also* K.A. Congreves, B. Dutta, B.B. Grant, W.N. Smith, R.L. Desjardins & C. Wagner-Riddle, *How does Climate Variability Influence Nitrogen Loss in Temperate Agroecosystems Under Contrasting Management Systems?*, 227 AGRIC. ECOSYSTEMS AND ENV'T 33, 34 (2016) ("a cooler/wetter than normal period could enhance leaching" of nitrogen due to "[s]ub-optimal crop growth and production" which would reduce nitrogen use efficiency by the crop).

36. *See, e.g.,* Randall et al., *supra* note 23, at 590 (farmers must minimize the amount of excess nitrogen "in the root zone when the soil is vulnerable to leaching by excess rainfall, usually spring and fall").

can increase losses more than a farmer's attempts to reduce them.[37] The consequences expected from climate change might further complicate the farmer's ability to control or reduce nutrient losses, as heavier rains and warmer temperatures can potentially reduce the mitigation impact of conservation and best management practices.[38]

B. The Role and History of Subsurface Tile Drainage

Climate and weather are difficult to predict and impossible to control, making them important factors to consider when seeking to address nutrient loss. Field conditions and soil types are also important because they impact how fast water and nitrogen move through them, particularly if they are drained by subsurface tiles.[39] Poorly-drained soils can be incredibly productive for row-crop farming, but they generally require subsurface tile drainage.[40] These are the soils of the Midwestern Corn Belt. The same drainage infrastructure that helps make these fields productive, by draining excess water, also expedites the export of nitrogen leached from the soils and dissolved in the drained water.[41]

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37. *See* Krishna P. Woli, Mark. B. David, Richard A. Cooke, Gregory F. McIsaac & Corey A. Mitchell, *Nitrogen Balance in and Export from Agricultural Fields Associated with Controlled Drainage Systems and Denitrifying Bioreactors*, 36 ECOLOGICAL ENG'G 1558, 1561 (2010).

38. The basic concern about climate change in this context is if it produces a wetter climate it will likely cause higher nitrogen losses from Midwestern row-crop farming. It could also impair the ability of best management and conservation practices to help reduce losses, in part due to expectations that it will produce more high intensity rain events. *See* Struffert et al., *supra* note 27, at 1558 ("Application timing might become increasingly more important because this pattern of wetter springs is expected to intensify"); Congreves et al., *supra* note 35, at 34, 38 (finding higher nitrogen losses "associated with warmer daily temperatures, greater total precipitation, and more frequent precipitation events" and concluding that "the effectiveness of conservation practices in controlling large N loss events via [nitrogen] leaching may decrease in the future as more variable climate with intense precipitation events ensues").

39. *See* David et al., *supra* note 28, at 1663 (fertilizer is not the only thing producing nitrate losses but also "the combination of the most productive soils (high in organic matter) that are tile drained and heavily cropped"); Cameron et al., *supra* note 25, at 151 ("Nitrate leaching losses are generally greater from poorly structured sandy soils than from clay soils because of the slower water movement and the greater potential for denitrification to occur in the clay soils").

40. *See* Randall et al., *supra* note 23, at 590 (subsurface tile drainage is "a common water management practice in highly productive agricultural areas with poorly drained soils that have seasonally perched water tables or shallow ground water").

41. *Id.* (tile drainage transports "substantial amounts" of nitrogen "from the landscape to surface waters" and "[n]itrate concentrations in the Mississippi River are generally greatest in tributaries where artificially drained soils planted to corn and soybeans dominate the landscape"); Royer et al., *supra* note 8, at 4126, 4130 ("[a]rtificial drainage through under-field tiles is clearly a mechanism by which [nitrate-nitrogen] entered the streams" because it "pro-

The consensus of extensive research on this topic is that drainage tiles contribute substantially to the nitrogen loads in rivers and waterways.[42] Moreover, research has indicated that surface concentrations of nitrogen in the Midwest increased with fertilizer use and application rates during the 1960s and 1970s.[43] The footprint for tile-drained farmland is immense, with as many as forty-nine million acres in the Mississippi River Basin and almost ten million acres in Illinois alone.[44] Drainage carries a long history that dates to before the Civil War, a legacy steeped in settlement, farming, public health, and the railroads.[45]

A prime example of this is Illinois. Central Illinois, now considered "an agricultural Canaan," was once "a dangerous, disease-ridden swamp" known for its "sticky 'black gumbo' that horses would sink in up to their bellies."[46] Settlers considered the swamps to be hazardous to public health at a time when malaria was the top cause of death in Illinois.[47] At the time, drainage was considered "a moral imperative and the best means to realize productive potential of the soil and eliminate the source of diseases such as

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vides a mechanism by which water and dissolved nutrients can bypass groundwater flow paths and move rapidly from fertilized cropland to streams and rivers").

42. *See, e.g.*, David et al., *supra* note 25, at 1043, 1046 ("the source of most of the [nitrogen], with river concentrations responding directly to tile flow" and that the overall pattern of concentrations of nitrogen "in the tiles was similar to that in the river"); Woli et al., *supra* note 37, at 1558–66 ("about 49 percent of the field inorganic N pools was leached through tile drains and seepage and was exported to the nearby river").

43. Gentry et al., *supra* note 23, at 85–86.

44. Royer et al., *supra* note 8, at 4126 (finding that approximately 49 million acres of cropland in the Mississippi River Basin "are artificially drained by under-field (tile) systems, particularly intensively farmed and fertilized areas such as Iowa, Illinois, Indiana, and Ohio"); ILL. ENVTL. PROTECTION AGENCY, INLRS Science Assessment, at 3-1, 3-20 (finding that of the roughly 22 million acres of cropland in Illinois (equal to 60 percent of the state's total land area) almost 10 million of those acres are drained by tile).

45. *See* Charles D. Ikenberry, Michelle L. Soupir, Keith E. Schilling, Christopher S. Jones & Anthony Seeman, *Nitrage-Nitrogen Export: Magnitude and Patters from Drainage Districts to Downstream River Basins*, 43 J. OF ENVTL. QUALITY 2024, 2024 (2014) ("[w]idespread agricultural drainage projects were facilitated by the federal Swamp Land Act enacted in the middle of the 19th century to encourage drainage and development of wetlands for agricultural purposes").

46. Michael A. Urban, *An Uninhabited Waste: Transforming the Grand Prairie in Nineteenth Century, Illinois, USA*, 31 J. OF HIST. GEOGRAPHY 647, 648, 652 (2005) (stating that prior to the building of the Illinois Central railroad in the late 1850s, this Grand Prairie region was "one of the largest contiguous areas of tallgrass/wet prairie east of the Mississippi River"); *Id.* at 661 ("[w]hat was once unbroken stretches of tallgrass prairie is today widely regarded as some of the most fertile, productive agricultural land in the world").

47. *See id.* at 652–53; Mary R. McCorvie & Christopher L. Lant, *Drainage District Formation and the Loss of Midwestern Wetlands, 1850-1930*, 67 AGRI. HIST. 13, 25–26 (1993) (noting that many blamed swamp gases until it was discovered that the diseases were spread by mosquitoes, which find the swamps to be good breeding grounds).

malaria."[48] Advocates pushed Congress to act, and members from the Mississippi Valley region led the effort to pass legislation.[49] Although it took twenty years, Congress eventually passed the Swamp Lands Act in 1850, providing authority to transfer land to settlers who would improve it, including through drainage of the land.[50] Under the law, the federal government donated (deeded) these swamp lands to the states which, in turn, deeded the lands for the purpose of converting them to productive lands and improving sanitation and health.[51] In response, the State of Illinois turned over the swamp lands to counties for drainage in 1852.[52] This also coincided with construction of the Illinois Central Railroad.[53] Cheap land drove settlement in a region quickly becoming known as a good place for farming.[54]

Drainage proved difficult and was expensive. It began with simple excavation by hand, but technology and mechanization advanced rapidly between 1850 and 1900.[55] Subsurface, clay drainage tiles were introduced in central Illinois by 1858.[56] Local manufacturing lowered the cost of subsurface tiling, and installation of tile accelerated with mechanical innovations such as ditching machines pulled by horses.[57] The Illinois Central Railroad also pushed advertisers to promote the lands and gave away cash prizes for designing ditching equipment.[58] Drainage tiles were followed by changes to streams and ditches to move the water faster, including straightening, dredging, and widening stream channels.[59]

Subsequently, Illinois passed the Levee Act and the Farm Drainage Act in the 1870s, which provided for the legal organization of drainage districts with powers to assess landowners in the district whose lands would benefit from drainage.[60] Because the cost of drainage was high and the capital re-

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48. Urban, *supra* note 46, at 661.

49. *Id.* at 659.

50. *Id.*

51. *Id.*; McCorvie & Lant, *supra* note 47, at 24–25.

52. Urban, *supra* note 46, at 659.

53. *See* Urban, *supra* note 46, at 656.

54. *See* Urban, *supra* note 46, at 657–58 (the Illinois Central Railroad was constructed beginning in the 1850s and it helped erode the negative perception of the prairie, especially by selling land to farmers along its route for reasonable prices).

55. *See* Urban, *supra* note 46, at 660–61 (Drainage tiles had become the preferred method of drainage by 1870, with peak installation considered to have taken place between 1880 and 1890 as horse-drawn ditching machines came into play); McCorvie & Lant, *supra* note 47, at 28–29.

56. *See* Urban, *supra* note 46, at 660–61; McCorvie & Lant, *supra* note 47, at 28–29.

57. McCorvie & Lant, *supra* note 47, at 29.

58. *See* Urban, *supra* note 46, at 659.

59. *See id.* at 661.

60. *See* D.L. Uchtmann & Bernard Gehris, *Illinois Drainage Law*, U. ILL. URBANA-CHAMPAIGN, COOPERATIVE EXTENSION SERVICE, CIRCULAR 1355, 1, 14–15, http://www.farmdoc.illinois.edu/legal/pdfs/drainage_law1.pdf (drainage districts are public

quired for effective drainage across the local landscape was large, drainage districts helped as special-purpose local governmental units that financed drainage and prevented free riders through assessments.[61] Districts were also instrumental in the creation of a network of drainage rather than haphazard drainage by individual landowners.[62] During the relatively prosperous years before and after World War I, nearly 60 percent of land in drainage districts was organized.[63] The value of farmlands may have increased by as much as 500 percent after the land was drained.[64] In fact, lands that were once wetlands, but have been drained for farming, "often have both the greatest investment in capital improvements and the highest productivity."[65]

The combined federal, state, local, and private efforts had a profound impact on the swamps of places like central Illinois. The number of malaria outbreaks and fatalities fell as settlers increased the amount of drained acreage.[66] The landscape, however, was forever altered. Of the wetlands estimated to have been in existence in the 1850s, 90 percent have been drained, and much of the work was completed before 1900.[67] Wetland acreage fell by more than 95 percent in the Midwestern Corn Belt after the Swamp Land Acts, decreasing from an estimated 28 million acres in 1850 to 1.3 million acres by 1930.[68] Between 1870 and 1967, approximately 124 million acres of land had been drained for agriculture and 99 million drained acres were in a drainage district.[69] It wasn't until the 1970s, however, that science was able to document the value provided by wetlands (swamps); it took even longer to recognize the "hydrological benefits in filtering and processing pollutants and storing flood waters."[70] As late as 1956, USDA was still sub-

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entities that can force uncooperative landowners into the district, which includes paying the assessment and submitting to eminent domain; but only if it can be shown that their lands will benefit from drainage); Urban, *supra* note 46, at 657 (in the late 1870s, state laws were enacted to allow small farmers to organize and create drainage districts so as to help spread the cost of digging ditches and expanding outlets for drained water).

61. *See* McCorvie & Lant, *supra* note 47, at 30–34 ("the establishment of drainage districts must be of benefit to the public health, utility and welfare, and that the cost of the drainage must not exceed the estimated benefits to the properties affected"); *Id.* at 37–38 ("the drainage district, not the farmer, usually owns the ditches and main tile lines that drain his land or to which his own tiles drain").

62. *See id.* at 34, 37.

63. *Id.* at 33.

64. *See id.*

65. McCorvie & Lant, *supra* note 47, at 37–38.

66. *See* Urban, *supra* note 46, at 654.

67. *See id.* at 662.

68. *See* McCorvie & Lant, *supra* note 47, at 25–28.

69. *See id.* at 36–37 (concluding that of the estimated 124 million acres of drained wetlands in the continental U.S., 77.5 million acres were sold and drained based on the Federal Swamp Land Acts and the Graduation Act of 1854).

70. *Id.* at 22–23.

sidizing wetland drainage through cost sharing the expense of subsurface drainage tile.[71] USDA also provided technical assistance for wetland drainage through 1972 and financial incentives through 1977.[72]

C. Regulation, Lawsuits, and the Risks from Nutrient Loss

The above discussion highlights the overwhelming impact of weather and the long history of human activities that complicate agriculture's nutrient loss challenge. They should be important and necessary realities for any attempts to craft policies in response. None of it is intended, however, as absolution for the farmers, especially those over-applying nutrients or failing to adopt best-management practices, because the consequences from nutrient loss are real and significant. Nutrients exported to local rivers and streams are transported to the Mississippi River and then to the Gulf of Mexico, where they contribute to hypoxic, or dead, zones.[73] In addition, nitrates and other nutrients in waterways can impact drinking-water supplies and require significant expenditures to remove the nitrates in order to provide safe drinking water.[74] These are not new issues. The "impacts of nutrient losses from agricultural lands on aquatic ecosystems became apparent in the 1970s."[75]

To date, much of the public response to nutrient loss and water-quality degradation has been regulatory or quasi-regulatory. For example, the Environmental Protection Agency (EPA) has moved forward with regulatory actions under the Clean Water Act that impact farmers across large regions such as the Chesapeake Bay.[76] In Ohio, after the city of Toledo found toxins in the water supply due to harmful algal blooms linked to farm nutrients, the state passed a law restricting fertilizer application in the Western Lake Erie Basin.[77] Additionally, many states have implemented wide-scale strategies to reduce the nutrient loads from both point and nonpoint sources within their borders.[78]

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71. *See id.* at 23.
72. *See id.* at 24.
73. *See, e.g.*, David et al., *supra* note 25; Royer, *supra* note 8.
74. *See, e.g.,* Pollans, *supra* note 4.
75. Drinkwater & Snapp, *supra* note 11, at 165.
76. Lara B. Fowler, Matthew B. Royer & Jamison E. Colburn, *Addressing Death by a Thousand Cuts: Legal and Policy Innovations to Address Nonpoint Source Runoff*, CHOICES, Quarter 3 (2013), http://www.choicesmagazine.org/choices-magazine/theme-articles/innovations-in-nonpoint-source-pollution-policy/addressing-death-by-a-thousand-cuts-legal-and-policy-innovations-to-address-nonpoint-source-runoff; Am. Farm Bureau Fed'n. v. EPA, 792 F.3d 281 (3d Cir. 2015).
77. *See* Clare E. Luddy, *Utilizing Farm Bill 2014 Incentives to Improve Lake Erie Water Quality*, 30 NAT. RES. AND ENV'T 46 (2015).
78. *See supra* note 7.

Recently, litigation has directed even more attention to this issue. On March 16, 2015, Des Moines Water Works (DMWW) filed a citizen enforcement action under the Clean Water Act (CWA) against three Iowa drainage districts upstream from Des Moines.[79] DMWW alleges violations of the CWA due to nitrates in the Raccoon River that constitute pollution from farming via drainage of farmland by the districts.[80] The Iowa Supreme Court held that the drainage districts were immune under Iowa law for monetary damages but did not make any determination regarding the Federal CWA claim.[81] Subsequently, in March 2017, the District Court dismissed the case for lack of standing because the drainage districts, found to be immune, lacked the ability to redress any injury to DMWW.[82] The court did not reach the CWA claims and left unsettled DMWW's novel argument that the drainage infrastructure constitutes a point source, removing it from the agricultural storm-water exemption in the statute.[83]

In brief, DMWW argued that the statute and regulations distinguish between discharges that are runoff from the surface of farm fields and those that are the result of groundwater below the surface.[84] Discharges can be excluded only if they qualify as agricultural storm water and the term "storm water" narrows the exclusion to only surface runoff.[85] DMWW also argued

79. The lawsuit also included state law claims including common law tort claims for nuisance, trespass, and negligence. *See* Complaint, Bd. of Water Works Trs. v. Bd. of Supervisors, No. 5:15-cv-04020 (N.D. Iowa Mar. 16, 2015) [hereinafter, *DMWW* Complaint]; *see also* Bd. of Water Works Trs. v. Bd. of Supervisors, No. 16-0076 (Iowa 2017) (decision of the Iowa Sup. Ct. on questions certified by the Fed. Dist. Ct.) [hereinafter *DMWW*, Iowa Sup. Ct. decision].

80. *See id.*

81. *See DMWW*, Iowa Sup. Ct. decision, *supra* note 79 (drainage districts are immune from lawsuits for monetary damages because they are state entities that have only special, limited powers and duties under Iowa law and the State's Constitution; this limited statutory authority means that drainage districts can only be sued to compel them to carry out their limited purpose and not for other equitable remedies under state law).

82. *See* Bd. of Water Works Trs. v. Bd. of Supervisors, No C15-4020-LTS, 2017 U.S. Dist. LEXIS 39025, 47 ELR 20042 (N.D. Iowa Mar. 2017).

83. *See* 33 U.S.C. §1251(a) (2012) and 33 U.S.C. §1362(14) (2012) (a point source is "any discernible, confined and discrete conveyance, including but not limited to any pipe, ditch . . . does not include agricultural storm water discharges or return flows from irrigated agriculture"); Decker v. Northwest Envt'l Defense Center, 568 U.S. 597, 622 (2013) (Scalia, J., concurring in part and dissenting in part) (asking "are storm water discharges 'natural runoff' when they are channeled through manmade pipes and ditches, and carry with them manmade pollutants?").

84. *See* Brief of Board of Trustees of the City of Des Moines, Iowa in Resistance to Defendants' Motion for Partial Summary Judgment on Counts I & II at 41–47, Bd. of Water Works Trs. v. Bd. of Supervisors, No. 5:15-cv-04020 (N.D. Iowa May 5, 2016) [hereinafter *DMWW*, Brief in Resistance] (water that runs off of the fields is storm water and excluded but once it passes through the soil it becomes groundwater and no longer excluded).

85. *See DMWW*, Brief in Resistance, *supra* note 84, at 42 (pointing to EPA's definition of the term storm water in regulations that does not include subsurface groundwater and that

the Drainage Districts were not farmers; therefore, not protected by the agriculture storm water runoff exemption, making water collected and transported by the Drainage Districts' infrastructure a point source.[86] The Drainage Districts, however, claimed that they were covered by the agriculture storm water exemption.[87]

DMWW's argument was novel in the agricultural drainage context but courts have looked to "the primary cause of the discharge" and whether that primary cause was a natural one such as precipitation.[88] Where human actions are the primary cause of the discharge, the agricultural storm water discharge exemption may not apply.[89] In fact, the Ninth Circuit has concluded that "when storm water runoff is collected in a system of ditches, culverts, and channels and is then discharged into a stream or river, there is a 'discernable, confined and discrete conveyance' of pollutants and there is therefore a discharge from a point source within the meaning of the Clean Water Act's definition of a point source."[90]

With dismissal on the technical matter of standing, the district court did not reach the more significant CWA claims and arguments. The outcome of any challenge to the CWA exemption as applied to tile-drained farmland owners and farmers remains unknown, but any future lawsuits would be

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the word drainage applies only to surface runoff); *id.* at 40 ("the word storm water considerably narrows the scope of the exclusion. . .to flow directly from, and in immediate temporal proximity to a storm event. . .runoff that is not absorbed by the soil, but rather moves across the surface of the land.").

86. *See DMWW*, Brief in Resistance, *supra* note 84, at 48 (districts not engaged in farming but support it in a manner akin to a public utility and compares drainage to urban storm water runoff which is a nonpoint source but is considered a point source under the Clean Water Act when it is collected, transported, and discharged by storm sewers. In other words, "discharges of nitrate by farms and farmers are excluded from regulation, but discharges by Drainage Districts are still required to obtain NPDES permits because they are exactly the kind of large scale infrastructure which is within the heart of the purpose of the NPDES system.").

87. *See* Brief in Support of Motion for Partial Summary Judgment on Counts I and II at 40, Bd. of Water Works Trs. v. Bd. of Supervisors, No. 5:15-cv-04020 (N.D. Iowa April 1, 2016) [hereinafter, *DMWW*, District Brief] ("[b]ecause drainage districts' tile drains and ditches move excess water from the surface and the root zone following precipitation, those flows are exempt from NPDES permitting as 'agricultural storm water discharges.'").

88. *See* Waterkeeper Alliance, Inc. v. EPA, 399 F.3d 486, 508–09 (2d Cir. 2005); Concerned Area Residents for the Env't v. Southview Farm, 34 F.3d 114, 120–21 (2d Cir. 1994).

89. *See Waterkeeper Alliance*, 399 F.3d at 508–09; *Southview Farm*, 34 F.3d at 121; *see also* Catskill Mountains Chapter of Trout Unlimited, Inc., v. the City of New York, 273 F.3d 481, 492 (2d Cir. 2001) (the court looked specifically at whether "water is artificially diverted from its natural course and travels several miles" to be discharged into "a body of water utterly unrelated in any relevant sense . . . .").

90. *See* Northwestern Env't Defense Center v. Decker, 728 F.3d 1085, 1085–86 (9th Cir. 2013) (referring to Northwest Environmental Defense Center v. Brown, 640 F.3d 1063 (9th Cir. 2011), (*rev'd on other grounds* by *Decker*, 568 U.S. at 615.).

expected to face significant hurdles. In Iowa, these hurdles appear insurmountable. Dismissal aside, the lawsuit highlighted the growing challenges for farming due to nutrient losses. It added to a list that includes federal regulations, state laws and regulations, statewide strategies, and criticism from scientists, academics, environmental interests, and the general public.

III. INTERCONNECTED DEVELOPMENT OF FEDERAL FARM AND CONSERVATION POLICIES

The most direct and significant federal role in farming is contained in omnibus legislation that is debated roughly every five years and known as the farm bill.[91] It covers a multitude of federal statutes and programs, but much of the focus remains on the large items of mandatory spending for farm programs, crop insurance, conservation, and the Supplemental Nutrition Assistance Program (SNAP).[92] Federal farm support and conservation policies both began with disasters that hit the farm economy in the 1930s. Commodity support policy was a response to depressed prices and incomes during the Great Depression, while conservation policy was developed in response to the Dust Bowl.[93]

A. Brief Overview of the Evolution of Farm Support Policy

The Agricultural Adjustment Act of 1933 was an emergency response to the Great Depression.[94] Farm support policies were largely emergency response measures during the New Deal years before Congress attempted to create permanent policy in 1938.[95] This permanent policy, known as the

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91. *See* Agricultural Act of 2014, H.R. 2642, 113th Cong. (2014); Jill Lawrence, *Profiles in Negotiation: The 2014 Farm and Food Stamp Deal*, CTR. FOR EFFECTIVE PUB. MGMT. BROOKINGS INST. (Oct. 2015), http://www.brookings.edu/research/papers/2015/10/23-farm-bill-negotiation-lawrence; Neil D. Hamilton, *The 2014 Farm Bill: Lessons in Patience, Politics, and Persuasion*, 19 DRAKE J. OF AGRI. LAW 1–37 (2014).

92. *See* Renee Johnson & Jim Monke, *What is the Farm Bill?*, CONGRESSIONAL RESEARCH SERVICE, CRS REPORT FOR CONGRESS, RS22131 at 6, Figure 3 (Feb. 8, 2017).

93. *See generally* MURRAY R. BENEDICT, FARM POLICIES OF THE UNITED STATES, 1790-1950: A STUDY OF THEIR ORIGINS AND DEVELOPMENT (1953); Harold F. Breimyer, *Agricultural Philosophies and Policies in the New Deal*, 68 MINN. L. REV. 333 (1983); Wayne D. Rasmussen, *New Deal Agricultural Policies after Fifty Years*, 68 MINN. L. REV. 353 (1983); Theodore Saloutos, *New Deal Agricultural Policy: An Evaluation*, 61 J. OF AM. HIST. 394–416 (1974); BILL WINDERS, THE POLITICS OF FOOD SUPPLY: U.S. AGRICULTURAL POLICY IN THE WORLD ECONOMY (2009).

94. *See* Agricultural Adjustment Act of 1933, P.L. 73-10, 48 Stat. 31 (73d Congress, 1st Session, May 12, 1933); Benedict, *supra* note 93.

95. They stood on two interconnected concepts. First, an attempt to control commodity production by limiting the amount of acres farmers could plant to individual crops. Second, crop prices were directly supported through nonrecourse loans at specified loan rates using an

parity system of farm support, was controversial and problematic; it failed to effectively control production or improve prices for nearly four decades.[96] Congress finally revised farm policy in 1973 due to high crop prices and consumer backlash; the resulting legislation combined food stamps with farm-support programs and elevated income supporting deficiency payments over price-supporting loans.[97] Strong crop prices and the design of the payments encouraged farmers to expand production, which they did in many cases by borrowing heavily.[98] Crop prices eventually decreased and many farmers were stuck holding too much debt at a time of stagflation, leading to another farm economic crisis that consumed much of the 1980s and billions in federal outlays.[99] Another price spike helped produce the 1996 Farm Bill, which marks the beginning of the modern era for commodity support policy.[100]

The most notable change in modern farm policy was a move to decouple federal assistance from farming, in particular, planting decisions and market prices. The bill provided fixed payments to assist farmers but with-

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index of prices and costs. *See generally* ORVILLE MERTON KILE, THE FARM BUREAU THROUGH THREE DECADES (1948); BENEDICT, *supra* note 93; UNITED STATES DEPARTMENT OF AGRICULTURE – ECONOMIC RESEARCH SERVICE, HISTORY OF AGRICULTURAL PRICE-SUPPORT AND ADJUSTMENT PROGRAMS, 1933–84, AGRICULTURE INFORMATION BULLETIN, NO. 485 (1984).

96. Conceptually, production controls were expected to increase crop prices, with loan rates as a floor price, and to counter the production incentive created by the loan rates if prices were low. *See generally* WINDERS, *supra* note 93; JOHN MARK HANSEN, GAINING ACCESS: CONGRESS AND THE FARM LOBBY, 1919–1981 (1991); WILLARD W. COCHRANE & MARY E. RYAN, AMERICAN FARM POLICY 1948–1973 (1976).

97. *See* S. REP. NO. 93–173 (1973); Agriculture & Consumer Protection Act of 1973, S. 1888, 93d Cong. (1973); *see also* Claude T. Coffman, *Target Prices, Deficiency Payments, and the Agriculture and Consumer Protection Act of 1973*, 50 N.D. L. REV. 299, 307 (1973-74); John Ferejohn, *Logrolling in an Institutional Context: A Case Study of Food Stamp Legislation, in* CONGRESS AND POL'Y CHANGE 220–63 (Gerald C. Wright, Leroy N. Reiselbach & Lawrence C. Dodd eds., 1986).

98. *See generally* DAVID RAPP, HOW THE U.S. GOT INTO AGRICULTURE AND WHY IT CAN'T GET OUT (1988); KENNETH L. ROBINSON, FARM AND FOOD POLICIES AND THEIR CONSEQUENCES (1989); M.C. HALLBERG, POLICY FOR AMERICAN AGRIC.: CHOICES AND CONSEQUENCES (1992); DAVID ORDEN, ROBERT PAARLBERG & TERRY ROE, POLICY REFORM IN AMERICAN AGRICULTURE: ANALYSIS AND PROGNOSIS (1999).

99. Program expenditures were driven by low crop prices, specifically the difference between market average prices and the target prices fixed in statute that triggered deficiency payments. *See generally* RAPP, *supra* note 98; ROBINSON, *supra* note 98; ORDEN ET AL., *supra* note 98.

100. *See* Federal Agricultural Improvement & Reform Act of 1996, H.R. 2854, 104th Cong. (1996). First, increased export demand pushed commodity prices to record levels. Second, Republicans won a majority in both chambers of Congress for the first time in 40 years in the 1994 mid-term elections and sought to cut spending, balance the Federal budget, and reduce the government's role in the economy. *See generally* LYLE P. SCHERTZ & OTTO C. DOERING III, THE MAKING OF THE 1996 FARM ACT (1999); ORDEN ET AL., *supra* note 98.

out market distortions.[101] When the change was followed by another period of sustained low prices, Congress quickly reinstated price-based support but also revised and expanded crop insurance.[102]

Recent farm bills have provided multiple payment mechanisms for commodity farmers, sometimes layered on top of one another, and at other times designed as choices.[103] These programs have ranged from direct payments to payments that are triggered by fixed prices or revenue.[104] The landscape for farm policy has also witnessed major changes from a setback at the World Trade Organization over cotton payments[105] to the Renewable Fuels Standard's impact on crop prices and production decisions.[106] At the

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101. Known as "Freedom to Farm," it used seven-year contracts providing farmers with fixed annual payments on historic contract acres instead of contingent on whether the farmer planted the crop. At the time, supporters claimed that the 1996 Farm Bill was the most substantial reform of farm commodity policy. *See generally* WINDERS, *supra* note 93; ORDEN ET AL., *supra* note 98.

102. An Asian financial crisis damaged export markets and brought down prices. Congress responded by appropriating tens of billions of dollars to farmers in emergency payments known as Market Loss Assistance. Congress before revising crop insurance policy to increase premium subsidy and expand coverage. *See* WINDERS, *supra* note 93; Joseph W. Glauber, *The Growth of the Federal Crop Insurance Program, 1990-2011*, 95 AM. J. AGRIC. ECON. 482, 483–85 (2013); Joseph W. Glauber, *Crop Insurance Reconsidered*, 86 AM. J. AGRIC. ECON. 1179, 1182 (2004).

103. *Compare* Farm Security & Rural Investment Act of 2002, H.R. 2646, 107th Cong. (2002) (providing direct payments, countercyclical payments, marketing assistance loans and loan deficiency payments), *with* Agricultural Act of 2014, *supra* note 91 (providing election between Price Loss Coverage or Agriculture Risk Coverage, as well as marketing assistance loans and loan deficiency payments).

104. The 2002 Farm Bill reinstated target prices in the form of the counter-cyclical payments program. *See* Farm Security & Rural Investment Act of 2002, H.R. 2646, 107th Cong. (2002). The 2008 Farm Bill continued direct and counter-cyclical payments and marketing loans, but also added new revenue-based policy options for farmers. Revenue-based policies are based on some combination of prices and yields, with payments triggered by a loss of revenue as compared to historical benchmark revenue. The 2008 Farm Bill included two versions of this policy, the Average Crop Revenue Election (ACRE) and Supplemental Revenue Assistance Payments (SURE). *See* Food, Conservation, & Energy Act of 2008, H.R. 6124, 110th Cong. (2008). The 2014 Farm Bill eliminated direct payments and required farmers to choose between programs, one of which triggered assistance on low prices the other on low revenues. *See* Agricultural Act of 2014, *supra* note 91. *See also* Glauber (2013), *supra* note 102.

105. Brazil initiated a dispute against U.S. cotton supports before the World Trade Organization (WTO) and won overwhelmingly. Brazil's WTO victory not only required revisions to cotton supports, it also posed a threat to U.S. farm commodity policy. *See* RANDY SCHNEPF, CONG. RESEARCH SERV., RL32571, BRAZIL'S WTO CASE AGAINST THE U.S. COTTON PROGRAM (2011); Michael J. Shumaker, *Tearing the Fabric of the World Trade Organization: United States—Subsidies on Upland Cotton*, 32 N.C. J. INT'L L. & COM. REG. 547, 579 (2006-2007); William A. Gillon, *The Panel Report in the U.S.-Brazil Cotton Dispute: WTO Subsidy Rules Confront U.S. Agriculture*, 10 DRAKE J. AGRIC. L. 7 (2005).

106. The Renewable Fuels Standard requires domestic transportation fuel suppliers to blend mandated amounts of renewable fuel, which is mostly ethanol produced from corn

same time, commodity payment programs have also been eclipsed by crop insurance after Congress revised the program in 2000.[107]

This brief tour of farm policy history highlights the overriding importance of price risk in policy development; major changes in policy happen almost exclusively when crop prices are increasing, but tend to revert when prices subsequently decline. Recently, federal budget disciplines have come to play a dominant role in the development of farm and conservation policy, increasing conflict, partisanship, and the difficulty for crafting farm bills.[108] If there is a constant in farm policy, it is the commodity loan program. Loans remain coupled to actual production with fixed loan rates set by Congress.[109] The most significant revisions were in the late 1980s and early 1990s.[110] They were intended to prevent forfeitures of commodities under loan and better orient the policy to markets in order to avoid distortions and similar problems that had long plagued the program.[111] Despite these revisions, the marketing assistance loan program remains the most significant link to the New Deal-era parity policies.

B. Brief Overview of the Development of Conservation Policy

With the same New Deal roots and paths that often intertwine, conservation policy has experienced a different development than the commodity programs. In its early iterations, conservation was largely subordinate to price-support goals and used mostly to pay farmers to temporarily hold land out of production in hopes of controlling supplies and increasing prices.[112]

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starch. *See* Jonathan Coppess, *Three Little Words: EPA and the RFS Waiver Authority*, CHOICES, Quarter 1 (2016) http://www.choicesmagazine.org/choices-magazine/submitted-articles/three-little-words--epa-and-the-rfs-waiver-authority; Bruce A. McCarl & Fred O. Boadu, *Bioenergy and U.S. Renewable Fuels Standards: Law, Economic, Policy/Climate Change and Implementation Concerns*, 14 DRAKE J. OF AGRIC. L. 43 (2009).

107. *See* Johnson & Monke, *supra* note 92; Glauber (2013), *supra* note 102.

108. *See* Johnson & Monke, *supra* note 92; Lawrence, *supra* note 91; Hamilton, *supra* note 91. *See also* David Orden & Carl Zulauf, *Political Economy of the 2014 Farm Bill*, 97 AM. J. AGRIC. ECON. 1298 (2015).

109. *See* U.S. DEP'T. OF AGRIC., ECON. RES. SERV., FARM PROGRAM EFFECTS ON AGRICULTURAL PRODUCTION: COUPLED AND DECOUPLED PROGRAMS, https://www.ers.usda.gov/webdocs/publications/41708/30381_aer838b_002.pdf?v=41271.

110. Renamed the Marketing Assistance Loan (MAL) program, it permitted farmers to repay loans at lower rates and keep the difference (marketing loan gain). In addition, Congress added Loan Deficiency Payment (LDP) provisions in lieu of taking out a loan on the crop and if prices were below the loan rate at time of sale the farmer would collect the difference in a direct payment. *See* Food Security Act of 1985, H.R. 2100, 99th Cong. (1985); Food, Agriculture, Conservation, & Trade Act of 1990, S. 2830, 101st Cong. (1990).

111. *See generally* WINDERS, *supra* note 93; ORDEN ET AL., *supra* note 96.

112. *See*, *e.g.,* Soil Conservation and Domestic Allotment Act of 1936, S. 3780, 74th Cong. (1936) (Congress declared the policy to include preservation of soil resources and the reestablishment of farmer purchasing power); Agricultural Act of 1956, H.R. 10875, 84th

Conservation policy faded during World War II and again when crop prices spiked in the 1970s; the 1985 Farm Bill marks the beginning of modern conservation policy that is designed predominantly to address conservation challenges.[113] Seventies farm expansion recycled soil erosion and other environmental issues which, by 1985, collided with an environmental coalition empowered by legislative and political victories.[114] Conservation policy and federal conservation expenditures have grown since 1985. The policy has branched in three different directions: (1) eligibility for farm program payments and crop insurance, known as conservation compliance; (2) reserve or retirement programs that remove land from production; and (3) working lands programs that provide cost-share assistance for practices or for conservation improvements. The following provides a summary of these policies, their history, and their development.

1. Conservation Compliance

Conservation compliance was created by the landmark conservation title of the Food Security Act of 1985 out of New Deal concepts that did not gain traction until the 1970s and 1980s.[115] Conservation compliance is not a

Cong. (1956) (included the Soil Bank and a Congressional Declaration of Policy that "the production of excessive supplies of agricultural commodities depresses prices and income of farm families; constitutes improper land use and brings about soil erosion, depletion of soil fertility, and too rapid release of water from lands where it falls.").

113. *See, e.g.,* Angelo, *supra* note 7; Malone, *supra* note 3. *See also* David A. McGranahan, Paul W. Brown, Lisa A. Shulte & John C. Tyndall, *A Historical Primer on the U.S. Farm Bill: Supply Management and Conservation Policy*, 68 J. OF SOIL AND WATER CONSERVATION 67A (2013); Zachary Cain & Steven Lovejoy, *History and Outlook for Farm Bill Conservation Programs*, CHOICES, Quarter 4 (2004), http://www.choicesmagazine.org/2004-4/policy/2004-4-09.htm; Jonathan Coppess, *The Next Farm Bill May Present Opportunities for Hybrid Farm-Conservation Policies*, CHOICES, Quarter 4 (2017), http://www.choicesmagazine.org/choices-magazine/theme-articles/looking-ahead-to-the-next-farm-bill/the-next-farm-bill-may-present-opportunities-for-hybrid-farm-conservation-policies.

114. Notably, the Clean Air Act and the Clean Water Act victories impacted the 1985 Farm Bill as Congress placed an emphasis on conserving natural resources and addressing environmental concerns. *See* Linda A. Malone, *A Historical Essay on the Conservation Provisions of the 1985 Farm Bill: Sodbusting, Swampbusting, and the Conservation Reserve*, 24 U. KAN. L. REV. 577, 581–82 (1985-1986) (discussing a 1983 report by the Comptroller General that indicated Federal soil conservation programs were inadequate and not meeting potential, coupled with a 1985 USDA report that put the spotlight on farming highly erodible land and a need for better conservation policy. It indicated that over 3.8 million acres of "fragile land" had been converted between 1976 and 1982, which were losing an estimated 15-20 tons per acre); s*ee also* Food Security Act of 1985, H.R. 2100, 99th Cong. (1985).

115. In 1984, the House and Senate were moving forward with legislation that required limited forms of compliance known as "sodbuster" and conditioned farm payments on not plowing highly erodible land that had not recently been in production. *See* Randall A. Kramer & Sandra S. Batie, *Cross Compliance Concepts in Agricultural Programs: The New Deal to*

program that provides assistance to farmers or landowners; rather, it establishes eligibility requirements for federal farm support based on farmer practices and natural resource issues.[116] Farmers and landowners can lose program eligibility if they fail to comply with restrictions for farming on highly erodible land and wetlands.[117] First, a farmer can lose eligibility for assistance for producing "an agricultural commodity on a field on which highly erodible land is predominate" without a plan to control or minimize erosion.[118] The second part of compliance pertains to wetlands such that any person "who in any crop year produces an agricultural commodity on converted wetland" or converts a wetland for production is ineligible for federal support.[119]

Much of the original design for compliance has survived subsequent farm bills. Failure to comply can result in lost payments and, potentially, a requirement that the farmer repay any federal assistance received while he or she was out of compliance.[120] After 1985, Congress initially expanded both conservation compliance and exemptions to it that were based on the farmer's actions.[121] By the 1996 Farm Bill, Congressional perspectives had

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the Present, 59 AGRIC. HIST. 307, 316–17 (1985) (crediting passage of the Soil and Water Resource Conservation Act of 1977 as a significant turning point, followed by the efforts of John Block, Secretary of Agriculture under President Ronald Reagan who, in 1981, "declared himself in favor of the basic concept of cross compliance because it appeared to be a low cost method of achieving more effective soil conservation . . . [and] introduced some consistency in government programs so that the federal government did not simultaneously reward and penalize conservation behavior"). *See also* Heimlich & Claassen, *supra* note 3, at 98; Malone, *supra* note 3, at 215; McGranahan et al., *supra* note 113, at 71; Cain & Lovejoy, *supra* note 113, at 39–40.

116. *See* McGranahan et al., *supra* note 113, at 71 ("[c]onservation compliance made eligibility for commodity programs contingent on conservation practices to prevent production and conservation programs from working against each other" by requiring "implementation of conservation plans for highly erodible land").

117. This provision was commonly referred to as the sodbuster program which was generally intended to preclude government subsidies from encouraging the conversion of fragile lands to intensive production. *See* Malone, *supra* note 114, at 584.

118. If a farmer has highly erodible land, she or he can avoid ineligibility under this provision if they are "applying a conservation plan" or an approved conservation system designed to control or minimize soil erosion. *See* Food Security Act of 1985, H.R. 200, 99th Cong. (1985); 16 U.S.C. § 3811 (2012); 16 U.S.C. § 3812 (2012).

119. Unlike highly erodible lands, however, production on prior-converted wetlands may be grandfathered depending on date of conversion and earlier conversions may not result in ineligibility. *See* Food Security Act of 1985, § 1222; 16 U.S.C. § 3821 (2012); 16 U.S.C. § 3822 (2012).

120. *See* STUBBS, *supra* note 5, at 7.

121. In 1990, Congress also expanded ineligibility to cover conversion of a wetland and provided a more technical definition as to what constituted a wetland: a "predominance of hydric soils"; whether the land is "inundated or saturated by surface or groundwater at a frequency and duration sufficient to support a prevalence of hydrophytic vegetation"; and supports such vegetation under normal circumstances. Food Agriculture, Conservation, and

changed and the bill removed crop insurance from conservation compliance.[122] This perspective changed again in the debate for the 2014 Farm Bill and Congress re-attached compliance to crop insurance.[123]

2. *Acreage Retirement or Reserve Programs*

Conservation programs that seek to retire production cropland acres or place them in a long-term reserve include the Conservation Reserve Program (CRP) and the easement programs. CRP combined cropland acreage reductions with an explicit focus that environmentally-sensitive and highly-erodible lands should be retired from production.[124] Specifically, CRP uses long-term contracts with landowners to help them "conserve and improve the soil, water, and wildlife resources" of environmentally-sensitive lands with a cropping history.[125] Congress added easement policies in 1990 to ad-

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Trade Act of 1990, *supra* note 110, at § 1421 ("draining, dredging, filling, leveling or any other means for the purpose, or to have the effect, of making the production of an agricultural commodity possible"); *see* H.R. REP. NO. 101–916, at 909–910 (1990) (stating that all three criteria must be met to be considered a wetland and that designation not be due to only one; the criteria are to be evaluated and met based on normal conditions or circumstances within basic realities of farming and farmland).

122. It also revised the definition of conservation plans on highly erodible lands and conservation systems for use in the plan to reduce or control erosion, expanded the exemptions to ineligibility for failure to comply with highly erodible lands and wetlands requirements, added good faith exemptions and expanded the exemptions from ineligibility for wetlands compliance, revised the mitigation provisions and added authority for mitigation banking regarding converted wetlands. *See* Federal Agriculture Improvement and Reform Act of 1996, *supra* note 100, at § 321.

123. Specifically, the 2014 Farm Bill applied compliance to the portion of crop insurance premiums covered by the Federal Crop Insurance Corporation and commonly referred to as premium subsidy. *See* Agricultural Act of 2014, *supra* note 91, at § 2611; *see also* Jonathan Coppess, *Conservation Compliance and Crop Insurance in the New Farm Bill*, FARMDOC DAILY (May 2, 2014), http://farmdocdaily.illinois.edu/2014/05/conservation-compliance-and-crop-insurance-in-farm-bill.html.

124. Like compliance, CRP highlighted the significant shift in conservation policy in 1985 even though the program was an updated version of the 1956 Soil Bank. Notably, both were created in the depths of the Eighties farm crisis and involved attempts to help farmers recover by recycling components from the New Deal and Eisenhower eras. *See* Malone, *supra* note 114, at 582–83; Roger Claassen, Andrea Cattaneo & Robert Johansson, *Cost-Effective Design of Agri-Environmental Payment Programs: U.S. Experience in Theory and in Practice*, 65 ECOLOGICAL ECON. 737, 742 (2008) ("CRP was the first U.S. land retirement program to base eligibility on resource conditions or potential environmental damage"); Cain & Lovejoy, *supra* note 113, at 6; and McGranahan et al., *supra* note 113, at 71A.

125. Only certain land is eligible for CRP contracts, beginning with cropland that "if permitted to remain untreated could substantially reduce the agricultural production capability for future generations" or that is considered Highly Erodible Land that can be farmed with a conservation plan to control erosion. *See* 16 U.S.C. § 3831 (2012); 7 C.F.R. § 1410.3(c) (2017) (objectives include "reduce water and wind erosion, protect the Nation's long-term

dress environmental concerns about wetlands.[126] The Wetlands Reserve Program (WRP) was designed to "assist owners of eligible lands in restoring and protecting wetlands" through USDA's purchase of an easement on the property that removed a portion from production and returned it to a functioning wetland.[127] Congress also created an easement program to provide authority for USDA to ensure "the continued long-term protection of environmentally sensitive lands . . . [and] water quality" on farms and ranches.[128] The 2002 Farm Bill expanded conservation easements by creating the Grassland Reserve Program (GRP) with a goal of enrolling two million acres of "restored or improved grassland, rangeland, and pastureland" that could, unlike CRP, be used for "common grazing purposes" and other production uses such as haying, mowing, or harvesting for seed production.[129]

Since 1985, Congress has reauthorized CRP in each farm bill and expanded the program's purposes. Notably, Congress has increased or decreased the program's acreage cap in subsequent bills, coinciding with low or high crop prices (respectively).[130] Easement programs have received simi-

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capability to produce food and fiber, reduce sedimentation, improve water quality, create and enhance wildlife habitat, and other objectives.").

126. The George H.W. Bush Admin. pushed for a more environmentally-focused farm policy and for farmers to improve stewardship; the goal was to head off calls by environmental groups for stronger regulations on farming. At the time, wetlands loss received significant, critical attention from environmental and conservation interests and an increasingly concerned public. *See Congress Enacts Lean Farm Package*, CQ ALMANAC, 1990, at 1, 17–18, http://library.cqpress.com/cqalmanac/cqal90-1112689.

127. Easements could be permanent, for 30 years or for the maximum duration permitted by State law to "create and record an appropriate deed restriction in accordance with applicable State law to reflect the easement" and to "provide a written statement of consent to such an easement signed by those holding a security interest in the land." *See* Food, Agriculture, Conservation, and Trade Act of 1990, *supra* note 110, at § 1438. The goal of the program was to "restore and protect converted and farmed wetlands, achieving as significant an increase in wetland functions and values as are possible and practical" on as many as a million acres. *See* H.R. Rep. No. 101–916, *supra* note 121, at 931.

128. This was designed to place an easement on land that had been in the CRP or other cropland that contained riparian corridors, is "an area of critical habitat for wildlife," or contains "other environmentally sensitive areas" that production on it could cause problems for the farmer in terms of complying with environmental goals. *See* Food, Agriculture, Conservation and Trade Act of 1990, *supra* note 110, at § 1440 (known as the "Environmental Easement Program," it also involved permanent easements or the maximum term permitted by the State).

129. The GRP made use of both long-term rental agreements or a permanent easement (or one up to the maximum permitted by the State) and land eligible included grasslands (including improved range or pasture) and those "located in an area that has been historically dominated by grasslands," with the potential to serve as wildlife habitat. *See* Farm, Security, and Rural Investment Act, *supra* note 103, at § 2401 (40 percent of the funds were for rental agreements while 60 percent of the funds were available for easements).

130. *See* Farm, Agriculture, Conservation, and Trade Act of 1990, *supra* note 110, at § 1431 (setting the acreage cap at between 40 and 45 million acres; authorized continuous sign-

lar treatment depending on price levels: the 2014 Farm Bill, for example, combined all easement authorities into a single program.[131] This Congressional action reflects a difficult reality for land reserve or retirement programs: pressure to reduce acres in the program when prices and land rents are strong, but reverse pressure to return acres to the programs when they are weak.[132] This exposes one of the conflicts inherent in the policy between earning a return from the land and protecting natural resources.

3. *Working Lands Programs*

Congress has added to conservation policy with what are known as working lands programs, most notably the Environmental Quality Incentives Program (EQIP), created by the 1996 Farm Bill to provide financial and technical assistance to farmers and ranchers.[133] This could have been, in part,

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up and a special Conservation Reserve Enhancement Program); Federal Agriculture Improvement and Reform Act (FAIR) of 1996, *supra* note 100, at § 332 (acreage cap reduced to 36.4 million acres and authorized early termination for some contracts after five years); Farm, Security, and Rural Investment Act (FSRA), *supra* note 103, at § 2101 (increased the cap to 39.2 million acres, added a pilot program for enrollment of certain wetland and buffer acreage contiguous); Food, Conservation, and Energy Act (FCEA), *supra* note 104, at §§ 2103, 2106, 2108 (lowered the acreage cap to 32 million acres, revised the pilot program for wetlands and buffer acreage, permit enrollment of certain flooded farmland, permitted wind turbines and provided for a transition incentive program); and Agricultural Act of 2014, *supra* note 91, at § 2001 (reduced the acreage cap from 27.5 million acres in fiscal year 2014 to 24 million acres in fiscal year 2018, and added to the list of eligible lands certain grasslands that had previously been eligible for the Grasslands Reserve Program).

131. The 1996 Farm Bill reduced the limit on acres that could be enrolled, but the 2002 Farm Bill expanded them. *See* Federal Agriculture Improvement and Reform Act of 1996, Pub. L. No. 104–127, *supra* note 100, at § 333 (reduced WRP enrollment cap to 975,000 acres); Farm Security and Rural Investment Act of 2002, *supra* note 103, at § 2202 (WRP expanded to 2.275 million acres with a goal of 250,000 acres added each year). The 2008 Farm Bill expanded the enrollment cap to just over 3 million acres. *See* Food Conservation and Energy Act of 2008, *supra* note 104, at § 2202. The 2014 Farm Bill program, the Agricultural Conservation Easement Program (ACEP), combined grasslands, farmlands, and wetlands easement authorities and funding. *See* Agricultural Act of 2014, *supra* note 91, at §§ 2301, 2601 (grasslands and farmlands are now called Agricultural Land Easements; the combined funding was set at $400 million for fiscal year 2014, increasing to $500 million in fiscal year 2017 before falling to $250 million in fiscal year 2018).

132. *See* Claassen et al., *supra* note 124, at 741 (noting that "episodes of land retirement have followed severe downturns in crop prices" (citation omitted)).

133. EQIP combined the functions of existing program authorities into a single program. *See* FAIR Act of 1996, *supra* note 100, at § 334 (programs included the Agricultural Water Quality Incentives Program (AWQIP), the Agricultural Conservation Program, the Great Plains Conservation Program and the Colorado River Basin Salinity Control Program. Farmers applied for cost-share (not more than 75 percent) and incentive payments "in an amount and at a rate determined by the Secretary to be necessary to encourage a producer to perform 1 or more land management practices"). The 1990 Farm Bill created AWQIP to reduce "agricultural pollutants" as "an important goal of the programs and policies of the Department of

a response to some of the shortcomings with reserve policy discussed above. EQIP was created "to promote agricultural production, forest management, and environmental quality as compatible goals and to optimize environmental benefits" by assisting farmers with the installation and maintenance of conservation practices that will help them comply with, or avoid, environmental regulations.[134] The program covers a broad category of eligible land and seeks to prioritize assistance to achieve conservation benefits in the most cost-effective and efficient manner.[135] Cumulatively, EQIP has impacted the most acres of any conservation program, while consuming a smaller share of the conservation budget than CRP.[136]

In addition to EQIP, Congress has created and revised a complicated working-lands program known as the Conservation Stewardship Program (CSP), intended as a green payment policy that rewards farmers who practice high levels of environmental stewardship in their crop production.[137]

Agriculture." FACT Act of 1990, *supra* note 110, at § 1439 (providing assistance to farmers "in environmentally sensitive areas" with three-to-five-year contracts with farmers to voluntarily "implement a water quality protection plan" in return for annual incentive payments, cost share assistance, and technical assistance).

134. The program is intended to provide "flexible assistance" to farmers in the form of sharing the cost for installing and maintaining specific conservation practices. *See* 16 U.S.C. § 3839aa(3) (2012) (by promoting and optimizing the program would "avoid[], to the maximum extent practicable, the need for resource and regulatory programs by assisting producers in protecting soil, water, air, and related natural resources and meeting environmental quality criteria . . . ."). *Id.* at § 3839aa(2).

135. Applications for assistance are to be prioritized based on "overall level of cost-effectiveness to ensure that conservation practices and approaches proposed are the most efficient means of achieving the anticipated conservation benefits," as well as "how effectively and comprehensively the project addresses the designated resource concern." 16 U.S.C. §3839aa(b)(1) - (2). Consideration is also to be given to those that "improve conservation practices or systems in place on the operation at the time the contract offer is accepted or that will complete a conservation system" indicating at least some priority for those already undertaking conservation on their farms. 16 U.S.C. §3839aa(b)(4). *See* Claassen et al., *supra* note 124, at 743 (EQIP "[p]ayments are made when practices have been completed and approved" and for some practices producers can "receive annual incentive payments"; notably the 2002 Farm Bill altered the program both by increasing its funding but also "bidding on financial assistance was eliminated in favor of a flat 50% rate of cost-sharing for structural practices and a (locally) fixed rate of payment for management practices" as "Congress abandoned the statutory requirement to maximize environmental gain while eliminating bids for financial assistance").

136. *See* UNITED STATES DEPARTMENT OF AGRICULTURE, USDA FY2017 BUDGET SUMMARY at 61–62, http://www.obpa.usda.gov/budsum/fy17budsum.pdf ("2017 Conservation Budget" chart showing CRP at 30 percent and EQIP at 25 percent; "Farm Bill Conservation Programs Cumulative Acres Enrolled" chart showing over 284 million for EQIP compared with 96 million in CSP and 24 million CRP).

137. It was first called the Conservation Security Program and Congress overhauled it in the 2008 Farm Bill, renaming it the Conservation Stewardship Program. *See* FSRI Act of 2002, *supra* note 103, at § 2001; FCEA of 2008, *supra* note 104, at § 2301 (to "encourage producers to address resource concerns in a comprehensive manner" by "undertaking addi-

Generally, it requires a certain level of conservation activity to be eligible and ties annual contract payments to improving conservation and adding practices; payments are partially determined by the costs of conservation activities, income forgone, and expected environmental benefits.[138] CSP is not designed to introduce farmers to conservation, but rather is for those farmers who have already been implementing conservation on their farms.[139] The intent is towards enhancing conservation efforts already undertaken.

Congress has continued to innovate and expand the suite of working lands programs, including by adding acres to, and funding for, these programs.[140] This intent is most evident in CSP, where Congress has repeatedly emphasized a policy of adding millions of acres to it each year.[141] According to USDA-NRCS, at seventy million acres, CSP is the largest conservation program in the country.[142]

Innovation is also evident in the 2014 creation of the Regional Conservation Partnership Program (RCPP), which not only consolidated various conservation policies into a single authorization, but also sought coordina-

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tional conservation activities" as well as "improving, maintaining and managing existing conservation activities."); Tadlock Cowan, CONG. RESEARCH SERV., RS21740, CONSERVATION SECURITY PROGRAM: IMPLEMENTATION AND CURRENT ISSUES (2008), http://nationalaglawcenter.org/wp-content/uploads/assets/crs/RS21740.pdf; Debra Owen, *Legislative History of Conservation Security Program*, 9 GREAT PLAINS NAT. RESOURCES J. 36 (2004).

138. *See* FCEA of 2008, *supra* note 104, at § 2301; Agricultural Act of 2014, *supra* note 91, at § 2101 (codified as amended in 16 U.S.C. §3838d *et seq.*) (contract offer to USDA must demonstrate that the producer "meets or exceeds" a stewardship threshold for each resource concern — a threshold based on science and established by USDA — for "at least 2 priority resource concerns" plus "at a minimum, meet or exceed the stewardship threshold for at least 1 additional priority resource concern" and land brought into production after the 2014 Farm Bill that was not devoted to crop production in at least four of the six years prior to it is not eligible). The policy looks to the "degree to which the conservation activities will be integrated across the entire agricultural operation for all applicable priority resource concerns over the term of the contract." 16 U.S.C. §3838g(d)(2) (2012).

139. *See* UNITED STATES DEPT. OF AGRIC. - NAT. RESOURCES CONSERVATION SERV., CSP-LEARN MORE, https://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/national/programs/financial/csp/?cid=nrcseprd1288524 [hereinafter USDA-NCRS].

140. Mandatory funding for EQIP went from $400 million in 2002 to $1.3 billion by fiscal year 2007, but 60 percent was to be reserved for livestock, while the 2014 Farm Bill also increased funding. *See* FSRI Act of 2002, *supra* note 103, at § 2701; Agricultural Act of 2014, *supra* note 91, at § 2201, 2601 (from $1.35 billion in fiscal year 2014 to $1.75 billion by fiscal year 2018; 60 percent of the funds remain dedicated to livestock producers and practices).

141. The 2008 Farm Bill instructed USDA to enroll an additional 12.769 million acres each fiscal year, but manage it to achieve a national average of $18 per acre enrolled; while the 2014 Farm Bill instructed USDA to add 10 million acres to the program each fiscal year at the same per-acre cost. *See* FCEA of 2008, *supra* note 104, at § 2301; Agricultural Act of 2014, *supra* note 91, at § 2101 (codified as amended in 16 U.S.C. §3838g(c) (2012)).

142. *See* USDA-NRCS, *supra* note 139.

tion across multiple programs and on a regional scale.[143] Congress explained that it wanted to push innovation and advance efforts to integrate practices and approaches across multiple programs on a regional scale.[144] Unlike previous conservation programs, RCPP is unique in that it requires matching assistance from non-federal-entity partners to leverage private funding for region-wide conservation outcomes.[145]

Looking at the growth and expansion of working-lands policies in recent farm bills, coupled with reductions in the reserve programs, gives the appearance of a trend in policy preference. RCPP might also represent a further shift away from one program, one farm, isolated practices to a coordinated, regional approach across multiple farms. It may well reflect some frustration on the part of Congress and influential constituencies that the existing patchwork of programs, policies, and practices are not achieving a desired level of conservation.[146] A contrary view might be that these reflect policy preferences when prices are trending upward that could be reversed with lower prices.

IV. MAPPING INITIAL STEPS ON A PATH AWAY FROM THE IMPASSE AT THE CROSSROADS

On the map of this particular crossroads, nutrient loss comes from one direction bearing the long legacy of subsurface drainage and the difficult vagaries of weather. From the other direction is more than eighty years of bifurcated federal farm policy; one ostensibly focused on the risks to a

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143. The program also prioritizes regional conservation challenges, for example, the Mississippi River Basin and water quality degradation caused by excess nutrients, pesticides, and sediment. The specific programs used by RCPP are the Agricultural Conservation Easement Program (ACEP); the Environmental Quality Incentives Program (EQIP); the Conservation Stewardship Program (CSP); and the Healthy Forests Reserve Program (HFRP). *See* Agricultural Act of 2014, *supra* note 91, at §§ 2401, 2601.

144. *See* H.R. REP. NO. 113-333, at 410–13 (2014) (Conf. Rep.); Jonathan Coppess, *Dead Zones & Drinking Water, Part 1: RCPP and Review*, FARMDOC DAILY (Feb. 25, 2016), http://farmdocdaily.illinois.edu/2016/02/dead-zones-drinking-water-part1.html.

145. For example, private partners accept a significant responsibility such as defining the scope of projects, planning and implementing them; partners are to be the lead on conservation practices and activities involved in the project, the potential operations affected, the geographic area covered, and outreach and assessment. *See id.*; H.R. REP. NO. 113-333, at 116 (2014).

146. *See, e.g.,* Eubanks, *supra* note 4, at 247, 304 (criticizing conservation as an underfunded, "ineffective structure" and that many farmers "genuinely want to . . . conserve their natural ecosystems, but they have been pressured to farm corn and other commodity crops because that is where past profits could be garnered"); Craig Cox, *Data Show Farmers Must Do More to Protect the Environment, Public Health*, AGMAG (Oct. 13, 2016), http://www.ewg.org/agmag/2016/10/new-ewg-database-details-30-billion-spent-us-farm-conservation-programs (arguing that $29.8 billion paid to farmers over 10 years may have "produced no lasting change").

farmer's business and operation, the other a shifting patchwork of programs that either take land out of production or encourage adoption of conservation practices. The critical regulatory and litigation responses to modern row-crop farming pose tough but inescapable questions for both farmers and policy. What would constitute an effective direction to address challenges that are landscape in scale and scope, given the realities of the thousands of independent operators competing against each other under constant risk from volatile markets and unpredictable weather?[147]

Federal farm policy offers an enticing option, but one diminished by the harsh lights of reality and history. For one, this "ready-made tool" lacks focus given the various programs with little coordination, longstanding conflicts, and significant complexities all likely to defy simple solutions.[148] The policies are compartmentalized behind strong institutional barriers that exist in spite of serving largely the same farm population, while from a nutrient-loss perspective conservation lags behind in important ways.[149] History counsels that any path will be long and difficult, requiring incremental policy changes that may initially be opposed or dismissed. Policy is not sufficient on its own, and generally requires something else that is consequential directly to farmers. This has frequently been a role played by technological advances. Accordingly, a path forward could well be shaped by a combination of precision-agriculture technology and new policies that begin to break down long-standing institutionalized barriers.

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147. Adding further complications, many of the farmers who will be the most necessary to achieve conservation goals come with political baggage in the eyes of some. *See* Breggin & Myers, *supra* note 4, at 520 (USDA data indicate that "large-scale commodity crop operations (corn, soybean, and wheat farms with total annual sales of $500,000 or more) received 39.4 percent of all conservation subsidy dollars that went to those commodity crops").

148. *Id.* at 522 (calling the farm bill a "ready-made tool for achieving almost immediate reductions of pollution generated by large-scale commodity crop operations without requiring an increase in federal subsidy payments" and arguing for "for attaching conditions to federal payments to ensure that the dollars are used wisely and in a manner that is not counter to other public policy priorities").

149. One measure is an acreage comparison which, using USDA data, indicates that 259 million acres are covered by FSA commodity programs each year and that 397 million acres were insured in 2014. By comparison, NRCS reports that 58 million acres were under active conservation contracts in 2015. *See* Coppess, *supra* note 113; s*ee also* USDA, FY2017 BUDGET SUMMARY, *supra* note 136 (indicating that cumulative acres were 284 million for EQIP compared with 96 million in CSP and 24 million CRP). Another measure is Federal spending with farm program outlays in fiscal year 2016 topping $5.6 billion and crop insurance at $4.9 billion; conservation outlays were nearly $4.6 billion. *See* CONG. BUDGET OFFICE, CBO'S JANUARY 2017 BASELINE FOR FARM PROGRAMS (2017), https://www.cbo.gov/sites/default/files/recurringdata/51317-2017-01-usda.pdf.

A. Precision Agriculture Technology and Conservation

The winds of technological-driven change continue to alter the agricultural landscape, recently, in the form of precision technologies.[150] Precision agriculture technology encompasses a broad range of systems, data, and analytical tools which generally include global positioning systems (GPS), remote sensing (RS), and geographic information systems (GIS).[151] It also features sophisticated modeling and computer programs using mapped data, spatial analysis, surface modeling, and spatial data mining.[152] Data and, in particular, high-resolution data often referred to as "Big Data" is at the center and is "rapidly increasing our capacity to analyze large sets of information in space and time."[153]

Precision-agriculture technology has progressed significantly from computer mapping in the 1970s that focused on displaying information, to spatial data management in the 1980s that focused on data structure and management with the ability to link digital maps to "attribute databases for geo-query."[154] In the 1990s, GIS modeling analysis provided "the groundwork for whole new ways of assessing spatial patterns and relations" as well as precision agriculture.[155] More recently, GIS and precision technology have focused on multimedia mapping, data structure, and analysis, and moving towards geo-registered map layers as building blocks for "dynamic flows modeling that tracks movement over space and time in a three-dimensional geographic space."[156]

Not surprisingly, the farmer's decision to adopt precision technology is largely an economic and financial one, part of the chase for profitability and better risk management.[157] The technology holds incredible potential for

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150. The larger, more sophisticated farmers currently have the highest adoption rates, which can also vary significantly across the different technologies. *See* DAVID SCHIMMELPFENNIG, FARM PROFITS AND ADOPTION OF PRECISION AGRICULTURE, U.S. DEPT. OF AGRICULTURE, ECONOMIC RESEARCH SERVICES, ECONOMIC RESEARCH REPORT NO. 217 at III (2016).

151. *See* JORGE A. DELGADO & JOSEPH K. BERRY, ADVANCES IN PRECISION CONSERVATION, ADVANCES IN AGRONOMY 98, at 2 (2008).

152. *Id.* at 2–4.

153. *See* Woodard*, supra* note 19; *see* Delgado & Berry, *supra* note 151, at 4–8 (comparing the new capabilities to traditional statistics that were "nonspatial and analyzed data set by fitting a numerical distribution . . . to generalize the central tendency of the data").

154. Delgado & Berry, *supra* note 151, at 10.

155. *Id.*

156. *Id.*

157. *See* Anne Mims Adrian, Shannon H. Norwood & Paul L. Mask, *Producers' Perceptions and Attitudes Toward Precision Agriculture Technologies*, 48 COMPUTERS AND ELECTRONICS IN AGRIC. 256, 257–268 (2005) ("profitability was the biggest motivating factor in using precision agriculture tools" and the "economic benefit was the deciding factor for adopting precision agricultural tools. The authors further note that farmers see value in the

conservation outcomes as interest in adapting and adopting precision technology for that purpose grows.[158] This could be vital to feeding a growing world population from a shrinking base of arable land, which demands more intensive production and further stresses natural resources such as water.[159] Where precision technological advancements may provide the greatest promise is helping to make sure that "improved agricultural productivity is not mutually exclusive with improved sustainability" and conservation.[160]

To begin with, conservation-focused precision technologies can build strategies that improve both conservation and production, in part by planning conservation practices to fit production and using the practices effectively.[161] It can begin with simply making better use of data and information to "detect hot spots for implementation of preferred management options such as spatially distributed BMPs."[162] User-friendly planning tools can provide mapping and data to develop a better understanding of fields and watersheds.[163] This includes the connections between various land uses and

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information provided and its use to support decision-making including reducing risks and decisions regarding environmental issues but they also found a steep learning curve and challenges due to cost).

158. *See* Delgado & Berry, *supra* note 151, at 9 (advocating for "Precision Conservation" as a "new way to use advanced technologies to integrate thousands of data points and multiple layers of information contained in maps for management and conservation of the agricultural and natural areas . . . to identify those management landscape combinations that produce or receive significant impact"); Woodard, *supra* note 19, at 93 ("increased interest in exploring opportunities to employ high-resolution data in large scale policy applications to improve sustainability of the agricultural system, which previously were impractical or impossible").

159. *See* Delgado & Berry, *supra* note 151, at 1 (noting population estimates of 10 billion by 2050 and the need for more intensive production while also needing to conserve natural resources with less arable land); Mark D. Tomer, Sarah A. Porter, David E. James, Kathleen M.B. Boomer, Jill A. Kostel & Eileen McLellan, *Combining Precision Conservation Technologies into a Flexible Framework to Facilitate Agricultural Watershed Planning*, 68 J. OF SOIL AND WATER CONSERVATION 113A, 113A (2013) (discussing demands on agriculture for more intensive production while further stressing natural resources such as water quality).

160. Woodard, *supra* note 19, at 99 (adding that "precision agriculture and improved practices also have a large role to play in both intensification and conservation").

161. *See* Tomer et al., *supra* note 159, at 113A (technology can provide the "basis for developing watershed-specific strategies to improve environmental conditions and agricultural production" such as locating conservation practices "where they can be most effective" and that this "approach holds to the idea that individual voluntary conservation can better enable natural resources to serve wider society if these voluntary efforts are informed by precision conservation technologies").

162. Delgado & Berry, *supra* note 151, at 24 (involve "using multiple models and GIS to increase [scientists'] ability to process several layers of information to assess transport and pollution levels" to generate predictions).

163. *See* M.D. Tomer, S.A. Porter, K.M.B. Boomer, D.E. James, J.A. Kostel, M.J. Helmers, T.M. Isenhart & E. McLellan, *Agricultural Conservation Planning Framework: 1. Developing Multipractice Watershed Planning Scenarios and Assessing Nutrient Reduction Potential*, 44 J. OF ENVTL. QUALITY 754, 755 (2015) (input data from "soil survey information, and high-resolution digital elevation models (DEMs) derived from LiDAR (light

conservation practices coupled with better analysis of water flows to, for example, reduce soil erosion.[164]

Much of the power of, and potential for, precision technology involves the capability to integrate complex, variable information about land and field conditions, along with weather and hydrology, to help guide farm management.[165] For example, conservation could look to the current adoption of precision technology to vary production inputs such as seed rates and fertilizers as a model for varying conservation practices to match erosion reduction outcomes as well as productivity.[166] Managing complex systems for farming and conservation will benefit from modeling and technology around soils data, precipitation, evapotranspiration, crop growth, leaching, water drainage and other hydrological matters, as well as the landscape scales needed to address natural resource challenges.[167]

For nutrient loss and nitrate-nitrogen leaching, precision technology could help analyze impacts from changes in soils and soil types across individual fields, multiple fields, and entire watersheds, but the technology could also help analyze the subsurface flow dynamics that are so important

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detection and ranging) survey data" and "soil characterization data from the NRCS Web Soil Survey" with "publicly available USDA field boundaries datasets" to generate "a suite of possibilities for placement of conservation practices from which planning scenarios can be developed and compared for their potential to meet water quality goals"); *id.* at 766 ("demonstrated a system to develop and test watershed-scale conservation planning scenarios using high-resolution, LiDAR-derived DEMS" that could construct map products).

164. Delgado & Berry, *supra* note 151, at 3 ("Precision Conservation connects farm fields, grasslands, and range areas with the natural surrounding areas such as buffers, riparian zones, forest, and water bodies . . . [the goal] is to use information about surface and underground flows to analyze the systems in order to make the best viable decisions for application of management practices that contribute to conservation of agricultural, rangeland, and natural areas"); *Id.* at 16 ("[S]patial assessment of field erosion and the development of maps from the resultant data can be useful to identify highly sensitive areas of the fields . . . used to develop site-specific conservation practices . . . for the site-specific areas that have higher rates of erosion").

165. *See* Delgado & Berry, *supra* note 151, at 6 ("new spatial techniques will contribute to an integrated evaluation of topography, hydrology, weather, management, and other physical and chemical parameters, providing new insight into site-specific Precision Conservation for management of flow-interconnected agricultural and natural resources").

166. *See* Delgado & Berry*, supra* note 151, at 13 ("Different spatial patterns of erosion that will affect yield productivity" in that the more an area of a field erodes, the lower the yields from that area; managing all areas of a field "with similar conservation practices" may not improve matters; precision technology can permit the consideration of "variable conservation" to increase sustainability).

167. *See id.* at 24 (discussing modeling systems that can "estimate spatial water erosion in topographically complex landscapes" and "evaluate the effects of local soil properties and microtopography on changes in soil detachment and deposition across short distances" with capability to "quantify spatial and temporal erosion, deposition, sediment yield, evapotranspiration, soil evaporation, photosynthesis, plant and soil respiration infiltration, drainage (with and without tiles), crop growth, yield, and other parameters").

given the role of tile drainage in nutrient loss.[168] It can further integrate an understanding of what is happening as an individual field connects to others within and across multiple watersheds (landscape scale), while adding economic analysis for farm management.[169] Technology and modeling also advance key aspects of adaptability, especially to variations in weather, soil, and growing conditions, as well as different crops, rotations, and conservation practices.[170] From there, precision technology can be used for conservation practice design, implementation, and management and "help link research, implementation, and evaluation of riparian practices."[171] The possibilities are profound and the applications for conservation are just beginning to be explored.

The potential that such technology and planning can help improve yields and economic returns will be incredibly important for farmer acceptance and adoption.[172] Modeling and mapping coupled with simulation technologies will allow farmers to work through conservation practice scenarios and identify alternatives that meet natural resource goals, such as nutrient loss reduction, while seeking to improve (or not harm) production and profitability.[173] The ability to work easily with large sets of data and information over complex, interrelated and real-world matters, including cost and benefits, could be transformative.[174]

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168. *See id.* at 13–14 and 18 (discussing "a three-dimensional management scheme that accounts for both surface and underground flows").

169. *See id.* at 23 ("models and algorithms that account for spatial erosion variabilities using GIS and Digital Elevation Models (DEMs)" that can be integrated of "layers of information with GIS, remote sensing, and computer modeling" that can facilitate "identification of variable flows and connecting the flows from field to watershed." This can also be used to "assess the effect of management practices across the watershed and how to generate more efficient use of the economical resources to reduce environmental impacts" and "assess hot spots, identify most susceptible locations, and to implement best management practices").

170. *See* Tomer et al., *supra* note 163, at 754 (to "be successful, any general strategy must be adaptable to the array of unique combinations of landscape, farm management systems, and the conservation preferences of individuals who own and/or operate farm businesses across this broad region of agricultural production").

171. M.D. Tomer, K.M.B. Boomer, S.A. Porter, B.K. Gelder, D.E. James & E. McLellan, *Agricultural Conservation Planning Framework: 2. Classification of Riparian Buffer Design Types with Application to Assess and Map Stream Corridors*, 44 J. ENVTL. QUALITY 768, 768 (2015) ("Digital elevation models (DEMs) obtained from LiDAR (light detection and ranging) surveys are a new data resource and are becoming increasingly available" and can be useful for mapping and evaluating "a range of ecosystem services across watersheds").

172. *See* Delgado & Berry, *supra* note 151, at 16 (discussing "Site-Specific Management Zones (SSMZ)" shown to increase yields or keep them stable, while increasing nitrogen use efficiencies and improving economic returns); Adrian, Norwood & Mask, *supra* note 157, at 268.

173. *See* Tomer et al., *supra* note 163, at 760–66.

174. Delgado & Berry, *supra* note 151, at 24 ("GIS, RS, and other models to handle large sets of information that consider spatial and temporal variability and allow the identification

A farmer can assess the costs of improving water quality, and so can the policymaker. This is important because "implementing cost-effective and user-friendly application of these technologies across the breadth of watershed improvement efforts that will be necessary is a daunting task."[175] The power and potential of this technology will benefit policy development and help assess the need for program adjustments. Better data and analysis can improve both conservation and crop support programs, including crop insurance.[176] By bridging the gap between current practices for managing risk and those more "appropriately designed," precision technology can "lead to alignment of incentives and producer adoption of certain conservation practices."[177] Changes to crop insurance will take time and significant data; other policy options might prove more expedient while also generating data and experience to help feed changes in crop insurance.

B. Thinking About a Different Kind of Conservation Policy

Arguably, current federal policies "operate on the outdated premises that conservation and farming are mutually exclusive and that cropland that is not explicitly identified for conservation will not protect natural resources or ecological services."[178] Compliance provisions indicate a one-sided focus on how to make commodity programs or crop insurance more conservation oriented. In light of history, a better question might be to ask why conservation policies do not seek to incorporate matters of farm risk, particularly price-based risk. Doing so would make them more relevant to the farmers

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of variable and temporal flows in the environment [that] informs decisions that can lead to the site-specific implementation of conservation practices that maximize conservation efforts").

175. *See* Tomer et al., *supra* note 163, at 754.

176. Crop insurance, built on concepts of risk and actuarial soundness, may offer a unique policy opportunity if conservation practices improve soils and reduce production risks. *See* Woodard, *supra* note 19, at 93–94 ("well-designed policies are necessary for fostering appropriate production incentives and accommodating innovations in conservation and sustainability" while poorly designed "government insurance policy can lead to adverse incentives regarding which management practices producers adopt, potentially dis-incentivizing conservation-oriented cropping practices"); *Id.* at 96 ("higher-quality soils in a county were found to have a statistically lower risk" and that "higher soil quality is related to lower yield risk . . . [and a] particularly large tail for poor soils"); *Id.* at 99 (discussing further "the foundational nature of soil in evaluating yield risk" and the "direct evidence of the predictive capacity of large-scale, highly available soil data in predicting crop insurance loss rates").

177. Woodard, *supra* note 19, at 98 (farmers "may in fact over-utilize nitrogen-based fertilizers as a physical form of production 'insurance', leading to reduced energy efficiency and unfavorable environmental outcomes" but discussing "cases where they otherwise might not if access to insurance did not exist and/or if available insurance contracts did not properly account for such practices").

178. Angelo, *supra* note 7, at 601.

who are necessary to conservation outcomes, especially if combined with further investments in precision technology. Making specific farm program recommendations can be a hazardous undertaking and the following discussion treads lightly — more thought experiment than proposal.

This thought experiment for a potential new direction begins with simple farm economics. Crop yields determine how many bushels a farmer has to sell and market prices determine what those bushels are worth. Multiplied together, prices and yields produce the crop's revenue or the gross value of production.[179] From here, the farmer pays operating costs, land rent, overhead, and other costs of producing the crop; the remainder is the farmer's profit or loss.[180] The costs of a crop are mostly incurred with its planting but the revenues are not earned until it is harvested and sold. Standing between the costs and returns is the growing season and weather. This is the heart of farm risk: the money sunk in the ground with the seed may not be covered by the crop produced or its value on the market.

Farm risk is inherently relevant for conservation because conservation practices may add operating costs to the farmer and could impact yields. One particular practice, cover crops, will serve as an example for this discussion. Researchers conclude that cover crops are one of the most promising practices for reducing nutrient losses from row-crop farming.[181] Adopting cover crops requires a significant change in the farm's existing management program. Conventional practice for a corn-soybean rotation involves planting in the spring, growth during summer, and then harvest in the fall; it leaves the ground bare and fallow during the rest of the year.[182]As discussed above, this is when the majority of nutrient loss occurs.[183]

Cover crops are planted counter-cyclically to the cash crop rotation. They are established in the fall around harvest and terminated in the spring before or after planting the cash crop. Because they are growing when the field is normally fallow, cover crops have the ability to scavenge and store nitrogen that might otherwise be lost.[184] Cover crops also increase diversifi-

179. *See* U.S. DEP'T OF AGRIC., ECON. RES. SERV., COMMODITY COSTS AND RETURNS, https://www.ers.usda.gov/data-products/commodity-costs-and-returns/commodity-costs-and-returns/#Current Costs and Returns: All commodities.

180. For example, corn farms in the U.S. average about $336 per acre in operating costs in recent years, part of a total cost of production estimated at $643 per acre; revenues have averaged $710 per acre for a $67 per acre profit, but have been lower in 2014 and 2015 with USDA estimating an $87 and $63 per acre loss, respectively. *See id.*

181. *See* David et. al., INLRS Science Assessment, *supra* note 8, at 3-32 and 6-15.

182. *See supra* notes 30, 31.

183. *See supra* notes 30–35.

184. Other research has added that certain cover crops, such as cereal rye, can potentially reduce nitrate leaching from fall-applied nitrogen application. *See, e.g.,* Corey Lacey & Shalamar Armstrong, *The Efficacy of Winter Cover Crops to Stabilize Soil Inorganic Nitrogen After Fall-Applied Anhydrous Ammonia*, 44 J. OF ENVTL. QUALITY 442 (2015); Corey Lacey

cation of the ecosystem and reduce soil erosion.[185] However, farmers have been slow to adopt cover crop practices.[186] Surveys have found that farmers want more information about cover crops, including the potential benefits for their farms and risk factors such as impacts on yields and profitability.[187]

Cover crops also add costs to a farm operation, generally incurred at or near harvest for the cash crop.[188] Intuitively, this would be a barrier to adoption, especially when prices and revenues are down. Moreover, the long history of farm policy demonstrates the importance of price risk to farmers in their evaluation of and demand for policies. Conservation policy's three branches seek to remove acres from production, cover part of the costs of practices such as cover crops, or remove eligibility for other federal assistance. This does appear to support the argument that the policies are outdated and treat farm income risk and farm conservation risk as separate, if not mutually exclusive, matters.[189] By ignoring the fundamental farm risk in

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& Shalamar Armstrong, *In Field Measurements of Nitrogen Mineralization Following Fall Applications of N and the Termination of Winter Cover Crops*, 7 AIR, SOIL, AND WATER RES. 53 (2014); R.W. Malone, D.B. Jaynes, T.C. Kaspar, K.R. Thorp, E. Kladivko, L. Ma, D.E. James, J. Singer, X.K. Morin & T. Searchinger, *Cover Crops in the Upper Midwestern United States: Simulated Effect on Nitrate Leaching with Artificial Drainage*, 69 J. OF SOIL AND WATER CONSERVATION 292 (2014); T.C. Kaspar, D.B. Jaynes, T.B. Parkin & T.B. Moorman, *Rye Cover Crop and Gamagrass Strip Effects on NO3 Concentration and Load in Tile Drainage*, 36 J. OF ENVTL. QUALITY 1503 (2007); S. Snapp, S. Swinton, R. Labarta, D. Mutch & J. Black, *Evaluating Cover Crops for Benefits, Costs and Performance Within Cropping System Niches*, 97 AGRONOMY J. 322 (2005).

185. *See* Snapp et al., *supra* note 184, at 323–24.

186. INLRS Science Assessment in 2015 found, however, that Illinois farmers were planting less than 320,000 acres of cover crops but that the strategy requires adoption of cover crop practices on all 10 million acres of tile-drained farmland. *See* David et. al., INLRS Science Assessment*, supra* note 8, at 6-14.

187. *See* Am. Seed Trade Ass'n, *Annual Report 2015-2016* (2016), http://www.northcentralsare.org/content/download/77965/1347810/2015-2016_Cover_Crop_Survey_Report.pdf?inlinedownload=1.

188. Cost estimates can vary considerably depending on specific practices and the assumptions included in the estimate. *See, e.g.,* Gary Schnitkey, Jonathan Coppess & Nick Paulson, *Costs and Benefits of Cover Crops: An Example with Cereal Rye*, FARMDOC DAILY (2016), http://farmdocdaily.illinois.edu/2016/07/costs-and-benefits-of-cover-crops-example.html (estimating between $20.60 and $25.60 per acre for cereal rye); Laura Christianson, John Tyndall & Matthew Helmers, *Financial Comparison of Seven Nitrate Reduction Strategies for Midwestern Agricultural Drainage*, 2 WATER RESOURCES AND ECON. 30, 39 (2013) (estimating establishment costs at between $58.56 and $115.15 per hectare (2.47 acres) and total costs, including revenue reductions from lost yield at between $594.98 to $800.39 per hectare); David et. al., INLRS Science Assessment, *supra* note 8, 3-36 (showing costs per pound of removed nitrogen for cover crops at $3.21 to $11.02); Sarah S. Roley, Jennifer L. Tank, John C. Tyndall & Jonathan D. Witter, *How Cost-Effective are Cover Crops, Wetlands, and Two-Stage Ditches for Nitrogen Removal in the Mississippi River Basin*?, 15 WATER RESOURCES AND ECON. 43, 47 (2016) (average cost for cover cropping practices over four states (Iowa, Illinois, Indiana and Ohio) estimated at $61 per acre).

189. *See* Angelo*, supra* note 7.

conservation policy, the programs risk irrelevance to the farmers that need to adopt the practices. Any reconsideration of conservation policy might be well-advised to start there.

From a farm program perspective, the marketing assistance loan (MAL) program presents an intriguing opportunity for conservation-based policy reform.[190] Under the program, a farmer takes out a nonrecourse loan on the harvested commodity at the loan rate established by Congress in the statute. The loan term is typically nine months. At repayment, if market prices are below the loan rate, USDA can permit the farmer to repay the loan at the lower rate and keep the difference.[191] In this way, the program helps the farmer cover some operating expenses and may encourage them to store harvested crops instead of having to sell them at the lowest price points. Unlike the payment programs, it has not been decoupled from farm production. Moreover, the price supporting loan concept was one of the earliest policy innovations to help farmers.

Further, the MAL program is relatively inexpensive in terms of federal outlays and costs to the taxpayer.[192] For farm bill purposes, this is beneficial because the Congressional Budget Office estimates low outlays in the ten-year budget baseline, especially corn loans. The program is inexpensive from a federal budget perspective for two reasons. First, it is a loan that farmers are expected to repay. The program would be expected to require federal outlays only in years when prices are exceptionally low by current

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190. *See* Angelo, *supra* note 7, at 652 (referencing and quoting David E. Adelman & John H. Barton, *Environmental Regulation for Agriculture: Towards a Framework to Promote Sustainable Intensive Agriculture*, 21 STAN. ENVTL. L.J. 3, 39–40 (2002)). In the interest of full disclosure, the author would like to note that he is working with IL Farm Bureau on the concept as part of its effort to advocate for changes in the upcoming farm bill.

191. This is known as the marketing loan gain. *See supra* notes 109-111.

192. For example, in 2014 FSA reports loan activity for corn at 11,402 loans made for corn covering 574 million bushels and $1.1 billion in total amount of loan funds. The Congressional Budget Office indicated that for 2014 nearly all of the loans were repaid and that Federal outlays for the program in 2014 were only $40 million. *See* U.S. DEP'T OF AGRIC., FARM SERV. AGENCY, LOAN SUMMARY-NATIONAL LEVEL REPORTS, https://apps.fsa.usda.gov/sorspub/reports.do?command=displayParameters&reportName=loan-all-national&reportCatalogName=public; CONG. BUDGET OFFICE, CBO'S MARCH 2015 BASELINE FOR FARM PROGRAMS, https://www.cbo.gov/sites/default/files/recurringdata/51317-2015-03-usda.pdf (note that CBO indicates for 2014 that $832 million dollars in loans were paid and $792 million were repaid). FSA and CBO data indicate similar numbers for 2015: 14,045 loans made for corn covering over 746 million bushels and $1.4 billion in total loan amount with Federal outlays of $40 million. *See* CONG. BUDGET OFFICE, CBO'S MARCH 2016 BASELINE FOR FARM PROGRAMS, https://www.cbo.gov/sites/default/files/recurringdata/51317-2016-03-usda.pdf (CBO reported $1.1 billion in loans made with $1.07 billion repaid for $40 million in outlays).

standards. This leads to the second reason existing program loan rates for corn are low compared to market average prices.[193]

As such, a first step towards a new direction in conservation policy could involve revising the MAL program, or creating an option within it, to provide a loan to the farmer for conservation purposes. Loan repayment could be tied to economic measures and permit farmers to pay back less than the full loan when prices, incomes, or some similar measure is low relative to a historic average. This would begin to not only strike a new direction for conservation policy, but also offer the potential to reform the MAL program.

For example, the loan rate could be shifted away from using a loan rate that is fixed in statute and does not adjust to recent market prices; the fixed rate could be replaced with one based on a moving average calculation.[194] It could also be further redefined by using a multi-crop revenue calculation or even some form of farm income, net cash, or margin basis. Additionally, to encourage conservation practices, the loan rate could be adjusted higher for specific conservation practice adoption, such as cover crops. The farmer could borrow against the revised loan rate plus the cost of cover crops near the time for establishing the cover crop. This would help provide operating funds better aligned with the conservation practice. At the time for repayment, the same economic factors could be used to calculate repayment rates. If the repayment rates are below the loan rate, repayment could be at the lower rate. However, if prices, income, or cash were strong enough to be above the loan rate, the farmer repays the loan with no cost to the federal government. This would better align conservation and market risk, requiring the farmer to pay for conservation when times are good and sharing the cost when they are not.

Finally, participation in this revised loan program could be coupled with reporting requirements from the borrower-farmer on what practices were actually implemented. Reporting would not only help ensure that the farmer is adhering to the conservation components, but would also provide much needed data that could be used for research and assessment. If coupled

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193. Corn's loan rate is set at $1.95 per bushel. *See* Agricultural Act of 2014, *supra* note 91, at 1202. By comparison, USDA data indicates that corn prices at harvest have ranged from a high of $6.79 per bushel in 2012 to a low of $3.54 per bushel in 2013 for an average (2010-2015) of $4.78 per bushel. *See* USDA-ERS, *supra* note 179. In addition, the low loan rate may be a factor in the low participation rate by farmers with USDA-FSA reporting only 14,045 loans in 2015 on corn covering just over 746 million bushels. *See* USDA-FSA, *supra* note 192. That compares to the total corn production in 2015 of 13.6 billion bushels. *See* U.S. DEP'T OF AGRIC., NATIONAL AGRICULTURAL STATISTICS SERVICE QUICK STATS, https://quickstats.nass.usda.gov/.

194. For example, the ARC-CO program uses the 5-year Olympic moving average of marketing year average (MYA) prices which takes the five most recent years, drops the highest and lowest prices, and averages the remaining three. *See* Agricultural Act of 2014, *supra* note 91, at § 1117.

with investments in precision technology for conservation purposes, the program could make even further progress. In fact, precision technology could help with reporting and data management. More importantly, precision technology could help on-farm management of the new conservation practices while driving further research, education, and outreach.

V. CONCLUSION

The conservation loan concept is meant to advance thinking and discussion on the significant challenges facing row-crop farmers from issues like nutrient loss. Such a concept will not constitute a policy panacea for the challenges and risks of nutrient loss. At most, it could be part of a new direction for policy that, when coupled with other advancements such as precision technology, could help make significant progress for farmers and natural resources. It is a concept rooted in farm risk, particularly price and weather. Weather is a predominant driver of nutrient loss from farming and can greatly impact farm production. Market prices are one of the most relevant components of a farmer's ability to profit from his or her labors and remain in business. The long history of farm policy demonstrates its importance in any policy debate. If nutrient loss represents another crossroads for conservation and farm policy, mapping a direction out of the impasse would seem to require revised policies that break through (or at least erode) existing institutional barriers, along with the technology to help the farmer succeed on the ground where it matters.