19TH CENTURY FARMING AND 21ST CENTURY TECHNOLOGY: The Path to Cleaner Water

Kelly Kennedy*

INTRODUCTION

"From water does all life begin."[1] Frank Herbert's novel *Dune*, published in 1965, underscored the importance of the fundamental element of life: water. Writing of a world where water is scarce—highly valued by all—he emphasized conservation and the use of technology to help people create,

* J.D. Candidate, 2016, Sandra Day O'Connor College of Law at Arizona State University; B.A. Political Science, Minor in Women's Studies, 2013, Point Loma Nazarene University.

1. FRANK HERBERT, DUNE 55 (1984).

retain, and reclaim clean water. Fast-forward fifty years and the technology is now here—technology that can help us conserve and purify our water. But our waters are still polluted. While a variety of factors play a role, one of the leading causes is agricultural pollution. The technology today, however, can help to prevent agricultural pollution. It offers a way toward a world with cleaner water. Equipped with the new technology and utilizing old-fashioned farming techniques, farmers can prevent the run-off coming off their farms.

Farmers are often seen as the backbone of America, not polluters. Advertisements during election season feature the picturesque image of the farmer. The farm ideal is even displayed in the coveted commercial spots of the Super Bowl. Who can forget the 2013 Super Bowl Dodge Ram commercial playing Paul Harvey's speech "So God Made a Farmer"?[2] But what these images and ads do not show us is that famers also pollute our waters. Fertilizer and pesticides used on crops to boost yields, such as atrazine and nitrates,[3] can leach into groundwater and contaminate drinking water.[4] Excess water from rain and irrigation that is not absorbed into the soil, runs off the farm, carrying with it a multitude of pollutants which can enter and infect lakes and rivers.[5] The pollutants can have devastating impacts upon aquatic life, the ecosystem, and the availability of clean water.[6]

Pollution from agricultural sources is difficult to regulate due to the lack of point source (PS) discharges—or easily identifiable points that can be regulated and monitored.[7] The federal Clean Water Act (CWA), the principal program responsible for improving the health of U.S. waterbodies, addresses water pollution from point sources such as wastewater treatment plants and industrial factories by requiring permits to discharge, but nonpoint source (NPS) discharges are exempt.[8] Of course, Section 319 of the CWA does

---

2. Garance Franke-Ruta, *Paul Harvey's 1978 'So God Made a Farmer' Speech*, THE ATLANTIC (Feb. 3, 2013, 10:55 PM), http://www.theatlantic.com/politics/archive/2013/02/paul-harveys-1978-so-god-made-a-farmer-speech/272816/.

3. The chemicals cause adverse health effects. For example, one study found that atrazine and nitrates together in drinking water led to an increased risk for developing Non-Hodgkin Lymphoma. Martha G. Rhoades et al., *Atrazine and Nitrate in Public Drinking Water Supplies and Non-Hodgkin Lymphoma in Nebraska, USA*, 7 ENVTL. HEALTH INSIGHTS 15, 25 (2013).

4. Mary Jan Angelo & Jon Morris, *Maintaining a Healthy Water Supply While Growing a Healthy Food Supply: Legal Tools for Cleaning Up Agricultural Water Pollution*, 62 U. KAN. L. REV. 1003, 1007 (2014).

5. *Id.*

6. *Id.* at 1008–09.

7. *Id.* at 1009.

8. *See* 33 U.S.C. § 1342 (2016) (noting that the National Pollutant Discharge Elimination System applies to "discharge of pollutants"); *id.* § 1362(12) (limiting the definition of "discharge of pollutants" to point sources).

address NPS pollution by requiring states to identify polluted waterbodies and to create plans to control the pollution.[9] But, the primary method used to reduce NPS pollution has been federal and state voluntary incentive programs. This voluntary approach though has been highly criticized for not doing enough to clean up NPS discharges;[10] many call for tougher regulations. Yet, the difficulties in regulating NPS pollution with a lack of a point source to determine causation and apportion liability, and to monitor compliance led to the implementation of voluntary programs.[11] Despite the criticism and calls for greater regulation, voluntary programs can prevent and remedy NPS pollution.[12]

While a push for more direct regulation is warranted, legislators should not ignore the benefits voluntary incentive programs provide in reducing NPS pollution. This article will explore a variety of ways the federal and state governments can improve and incentivize the use of voluntary conservationist practices in order to prevent agricultural pollutant run-off and improve water quality. The voluntary programs should emphasize the practices that have the greatest potential in reducing nonpoint source pollution—a blend of old-fashioned, sustainable farm practices with new agricultural technology. In order to encourage farmers to implement practices that reduce and prevent nonpoint source pollution, incentives are needed. Strengthening and expanding conservation programs, utilizing water quality trading, redirecting Farm Bill subsidies to farmers practicing sustainability, and increasing certification programs for conservation are all methods which can entice farmers to enact conservation practices, and in particular old-fashioned practices coupled with new technology.

Such methods can encourage farmers to participate from a cost-effective, environmental, and profitable approach. While top-down regulatory

---

9. Federal Water Pollution Control Act, Pub. L. No. 107-303, 319 (2002) (codified at 33 U.S.C. § 1329 (2016)).

10. *See* Robin Kundis Craig & Anna M. Roberts, *When Will Governments Regulate Nonpoint Source Pollution? A Comparative Perspective*, 42 B.C. ENVTL. AFF. L. REV. 1, 62 (2015); Douglas R. Williams, *When Voluntary, Incentive-Based Controls Fail: Structuring a Regulatory Response to Agricultural Nonpoint Source Water Pollution*, 9 WASH. U. J.L. & POL'Y 21, 27–28 (2002).

11. *See, e.g.*, *Possible Amendments to the Federal Water Pollution Control Act: Hearings Before the Subcomm. on Water Res. of the Comm. on Pub. Works & Transp.*, 98th Cong., 2629 (1984) (statement of J. Leonard Ledbetter, Director, Environmental Protection Division, State of Georgia) (discussing the difficulties in controlling nonpoint sources); *id.* at 2972 (statement of Neil Sampson, Executive Vice President, National Association of Conservation Districts) (noting that due to the variability of nonpoint source problems states were given flexibliliy in pollution control).

12. *See, e.g.*, Mark Risse & Hillary Tanner, *Effects of Voluntary Agricultural Best Management Practice Implementation on Water Quality* (2009), http://aware.uga.edu/wp-content/uploads/2009/08/Effects-of-Voluntary-BMPs.doc.

approaches where the state or federal government mandates certain actions can work, bottom-up approaches where farmers are encouraged to change can also reach the same goal of clean water. Starting with the farmer—from the point where the pollution begins—creates a prevention strategy and an opportunity to teach and lead current farmers and future farmers to practice and understand the benefits of sustainable farming.

Part I describes the development of modern agriculture and its impact on water sources. Part II discusses the effect of agricultural run-off on water quality. Part III focuses on the past efforts taken to address the pollution. Lastly, Part IV offers a path forward by exploring the ways governments can improve and incentivize voluntary programs to prevent nonpoint source pollution.

I. HOW MODERN AGRICULTURE IMPACTED OUR WATERS

The "Green Revolution"[13] refers to a time period in the 1960s when scientific advances in the field of crop hybridization led to a doubling in grain yields.[14] With urbanization, a growing population, and famines around the world, the Green Revolution was an answer to what was seen as a food crisis.[15] In the United States the population was quickly rising, jumping from 100 million in 1917 to 200 million fifty years later in 1967.[16] Thomas Malthus, an economist in the 1800s, theorized that resources are scarce and the tendency of humans is to grow exponentially.[17] According to Malthus' population theory, if population growth is left unchecked, living standards will decline to a level just sufficient for subsistence.[18] In order to thwart Malthusian fear, the Green Revolution tackled the increasing population problem by using technology to increase the amount of resources, in this case

13. The name came from a speech given by William Gaud, then head of the United States Agency for International Development, who said that the "world was witnessing 'the makings of a new revolution. It is not a violent red revolution like that of the Soviets, nor is it a white like that of the Shah of Iran, I call it the green revolution.'" CHRISTIAN ANTON SMEDSHAUG, FEEDING THE WORLD IN THE 21ST CENTURY: A HISTORICAL ANALYSIS OF AGRICULTURE AND SOCIETY 187 (2010).

14. INT'L FOOD POL'Y RES. INST., GREEN REVOLUTION: CURSE OR BLESSING? 2 (2002), http://oregonstate.edu/instruct/css/330/three/Green.pdf.

15. *Id.* The crisis came as the world's population was growing and famine and malnutrition were widespread, creating concern about the current food supply being able to meet the needs of the population. *Id.*

16. THOMAS ROBERTSON, THE MALTHUSIAN MOVEMENT: GLOBAL POPULATION GROWTH AND THE BIRTH OF AMERICAN ENVIRONMENTALISM 7 (2012).

17. AHMED M. HUSSEN, PRINCIPLES OF ENVIRONMENTAL ECONOMICS 201 (2d ed. 2004).

18. *Id.* at 202.

the food supply. Society could produce more food using the same amount of land and could farm land previously unsuitable for agriculture. Key to this demand for greater yields was crop hybridization and chemical fertilizer and pesticides.[19]

The rise of industrial fertilizer came with the development of the Harbor-Bosch method in 1909—"[o]ne of the most important single events" of modern agriculture.[20] The method made it possible to synthesize ammonia, creating a source of nitrogen for plants.[21] This was truly a revolutionary discovery; nitrogen is one of the key nutrients plants need to grow. Farmers could now buy nitrogen fertilizer produced from this method to increase their yields.[22] Capitalizing on the discovery, the United States after World War II ushered in the use of fertilizer, largely a byproduct of military manufacturing.[23] Fertilizer is composed of phosphorus and ammonium nitrate—the principal ingredient used in explosives.[24] After the war, the United States Department of Agriculture (USDA) promoted the use of leftover stockpiled ammonium nitrate as fertilizer.[25]

Prior to the Green Revolution's utilization of chemical fertilizer, plants received nutrients from a variety of sources. In nutrient-rich soils, fertilizer was unnecessary for crop production. In nutrient-deficient soils, animal waste, plant compost, crop rotation, cover cropping, and nitrogen-fixing legume crops provided supplemental nutrients.[26] The Green Revolution changed the nature of farms, however. The natural methods of enriching the soil subsided as industrial fertilizer promised to deliver high yields with a seemingly simple, but toxic composition.

The Revolution also helped buttress farming on a larger scale, pushing the smaller farms out of operation.[27] The influx of food ultimately resulted in overproduction and decreased crop prices.[28] While small farms struggled to stay afloat, large farms were able to sustain the crisis.[29] They exploited the

---

19. INT'L FOOD POL'Y RES. INST., *supra* note 14, at 2.
20. SMEDSHAUG, *supra* note 13, at 179.
21. *Id.*
22. HUGH S. GORMAN, THE STORY OF N: A SOCIAL HISTORY OF THE NITROGEN CYCLE AND THE CHALLENGE OF SUSTAINABILITY 3 (2013).
23. MICHAEL POLLAN, THE OMNIVORE'S DILEMMA: A NATURAL HISTORY OF FOUR MEALS 41 (2006).
24. *Id.*
25. *Id.*
26. Angelo & Morris, *supra* note 4, at 1006.
27. William Eubanks, *A Rotten System: Subsidizing Environmental Degradation and Poor Public Health with Our Nation's Tax Dollars*, 28 STAN. ENVTL. L.J. 213, 222 (2009).
28. *Id.*
29. *Id.*

smaller farms by "purchasing foreclosed farms at below-market rates and by joining forces with other large farms and food processors to create the first agribusiness lobby."[30]

The federal administration in the 1970s continued to push the American landscape into the large industrial megafarms we know today.[31] Particularly, Earl Butz, appointed by President Nixon to serve as the USDA Secretary, transformed agriculture into a commercialized industry.[32] Butz adopted the policy of "Go Big or Get Out,"[33] telling small farms to "'adapt or die' by expanding into large operations reliant on industrial pesticides, herbicides, and fertilizers."[34] He even urged farmers to "plant fencerow to fencerow," neglecting to consider the environmental ramifications.[35] Thus, farmers tore out the shelterbeds, windbreaks, filter strips, and contours that prevent water and soil run-off.[36]

The industrial agricultural system also made way for the development of large Concentrated Animal Feeding Operations (CAFOs). High-yielding corn became a substantial source of animal feed and still is; in 2012, about forty percent of American corn produced was fed to animals.[37] Farmers began feeding livestock corn instead of grass—a more cost effective and less land intensive practice.[38] CAFOs became popular without the need for land flush with grass to feed the animals;[39] farmers could place the animals in tight corridors. The tight corridors though threaten water quality from the manure and urine produced.[40] CAFO operators attempt to concentrate the waste into lagoons, intending to recycle the waste later.[41] However, the lagoons can leak or spill over into water sources, thereby bringing nutrients and pathogens into the waterbodies and causing elevated biological oxygen demand, meaning the oxygen is being depleted in the water source.

---

30. *Id.*
31. *Id.* at 224.
32. *Id.* at 223–24.
33. *Id.* at 224.
34. *U.S. Agriculture Secretary Ousted Over Racist Joke*, L.A. TIMES (Feb. 3, 2008), http://articles.latimes.com/2008/feb/03/local/me-butz3.
35. Eubanks, *supra* note 27, at 224.
36. *Id.*
37. NAT'L CORN GROWERS ASS'N., WORLD OF CORN. UNLIMITED POSSIBILITIES. (2013), http://www.ncga.com/upload/files/documents/pdf/WOC%202013.pdf.
38. Eubanks, *supra* note 27, at 259.
39. *Id.*
40. ROBERT PAARLBERG, FOOD POLITICS: WHAT EVERYONE NEEDS TO KNOW 147 (2d ed. 2013).
41. *Id.*

For example, in 1995 "an eight-acre hog-waste lagoon in North Carolina burst, spilling 25 million gallons of manure into the New River."[42] About ten million fish were killed and 364,000 acres of coastal wetlands had to be closed, preventing shellfishing operations.[43] The aquatic species were harmed through the effects of eutrophication. Eutrophication is an over-enrichment of a waterbody characterized by excessive plant and algae growth.[44] Algae blooms limit sunlight, ultimately reducing plant growth and disrupting aquatic species' ability to hunt.[45] The process can also deplete dissolved inorganic carbon and raise the water's pH.[46] Additionally, when the algae blooms die the decomposition depletes the dissolved oxygen needed to sustain life.[47] As can be seen, the pollution running off farms causes serious repercussions. While the Green Revolution was successful in that it increased crop yields, it also caused a series of adverse environmental impacts like the pollution of our waters.

II. AGRICULTURAL RUN-OFF

"The world's strongest man opening and dumping bag after bag of nitrogen fertilizer into the Mississippi River could not begin to keep up with the stream of nitrogen flowing this spring . . . ," writes Orlan Love in *The Gazette*, over the run-off flowing from Iowa to the Gulf of Mexico's dead zone in 2014.[48] Agricultural run-off remains a current and pressing concern. In 2000, the Environmental Protection Agency's (EPA) National Water Quality Inventory reported that agricultural NPS pollution is a leading source of negative impacts on surveyed rivers and lakes, is "the second largest source of impairments to wetlands, and [is] a major contributor to contamination of surveyed estuaries and ground water."[49] In 2009, the State-EPA task group reported that nitrogen and phosphorous pollution may "become one of the costliest, most difficult environmental problems we face

42. *Id.*

43. *Id.*

44. Michael F. Chislock et al., *Eutrophication: Causes, Consequences, and Controls in Aquatic Ecosystems*, NATURE EDUC. KNOWLEDGE (2013), http://www.nature.com/scitable/knowledge/library/eutrophication-causes-consequences-and-controls-in-aquatic-102364466.

45. *Id.*

46. *Id.*

47. *Id.*

48. Orlan Love, *Farm Fertilizer Runoff Wreaking Havoc*, THE GAZETTE (Mar. 28, 2014, 6:35 PM), http://thegazette.com/2013/08/04/farm-fertilizer-runoff-wreaking-havoc/.

49. *Protecting Water Quality from Agricultural Runoff*, EPA (Mar. 2005), http://www.epa.gov/sites/production/files/2015-09/documents/ag_runoff_fact_sheet.pdf.

in the 21st century" as drinking water, inland waters, and coastal estuaries are negatively impacted.[50] The task group found nutrient pollution directly linked to the impairment of twenty percent of river and stream miles, twenty-two percent of lake acres, and eight percent of bay and estuarine square miles in waterbodies surveyed.[51] A number of agricultural activities cause NPS pollution, including waste from CAFOs, overgrazing, overplowing, and excessive or poorly timed application of fertilizer, pesticides, and irrigation water.[52]

Pollutants from farming that impact water quality come from fertilizer, pesticides, sediment, and manure. Fertilizer contains salts, nitrogen, phosphorus, and potassium.[53] Farmers' use of fertilizer has increased rapidly over the decades. In 2011, farmers used around 12.8 million tons of nitrogen fertilizer—over four and a half times the amount used in 1960.[54] And in 2011, farmers used around 4.3 million tons of phosphate compared to 2.5 million tons in 1960.[55] When the nutrients from fertilizer exceed the plants' needs or farmers apply fertilizer right before it rains, the fertilizer can run off or seep into water sources.[56] When infants ingest nitrate (a form of nitrogen) it can cause low oxygen levels in the blood leading to methemoglobinemia ("blue baby" disorder), a potentially fatal condition.[57] Nitrates may also increase the risk of cancer.[58] Pesticides are another deadly source of run-off. Indeed, some pesticides were developed as nerve gases during World War II.[59]

The pollutants in fertilizer and pesticides harm aquatic species and fishing communities through algae growth. As mentioned, the overgrowth of algae, or eutrophication, can ultimately deplete oxygen, block sunlight, and lead to

---

50. STATE-EPA NUTRIENT INNOVATIONS TASK GRP., AN URGENT CALL TO ACTION: REPORT OF THE STATE-EPA NUTRIENT INNOVATIONS TASK GROUP 1 (2009), http://www.epa.gov/sites/production/files/documents/nitgreport.pdf.

51. *Id.* at 5.

52. EPA, *supra* note 49.

53. *See id.*

54. *Table 1—U.S. Consumption of Nitrogen, Phosphate, and Potash, 1960–2011*, USDA, http://www.ers.usda.gov/data-products/fertilizer-use-and-price.aspx#26718 (last updated July 12, 2013). Notably, the acreage of land in farms in 1960 was close to 1,200 million of acres and in 2012 close to 914 million acres. USDA, 2012 CENSUS OF AGRICULTURE 17 tbl.9 (2012), http://www.agcensus.usda.gov/Publications/2012/Full_Report/Volume_1,_Chapter_1_US/usv1.pdf; U.S. DEPT. OF COMMERCE, U.S. CENSUS OF AGRICULTURE: 1959 pt. 2, at 4 (1959), http://usda.mannlib.cornell.edu/usda/AgCensusImages/1959/02/01/1959-02-01.pdf.

55. USDA, *supra* note 54.

56. EPA, *supra* note 49.

57. Bernard Nolan et al., *Probability of Nitrate Contamination of Recently Recharged Groundwaters in the Conterminous United States*, 36 ENVTL. SCI. & TECH. 2138, 2138 (2002).

58. *Id.*

59. POLLAN, *supra* note 23.

the death of aquatic life.[60] A well-known case of eutrophication caused largely from nutrient run-off from agriculture is the "dead zone" in the Gulf of Mexico, which currently measures 5,052 square miles or roughly the size of Connecticut.[61] Algae blooms can also contain toxic or harmful metabolites that poison fish as well as those who later ingest the species containing the toxin.[62] In April 2014, toxic algae blooms in Monterey Bay caused the California Public Health Department to issue a warning not to eat parts of anchovy, sardines, or crab caught in the Monterey Bay.[63] Later, seabirds were found dead on the beach, likely from eating fish contaminated with domoic acid—a toxin produced from a type of algae.[64] The toxin caused the seabirds' nervous systems to fail and started to affect the sea lions, which became disoriented and veered from their migratory route.[65]

Sediment and manure are other sources of water pollution. Rain and excess irrigation water can cause soil to wash off the fields and into nearby lakes or streams.[66] This sediment can cloud the water and reduce the sunlight necessary for aquatic plants to live.[67] It can also "clog the gills of fish or smother fish larvae"[68] and disrupt riffle/run habitats by lowering the pH of the water and increasing heavy metal and salinity contents.[69] Furthermore, the soil can carry fertilizer, pesticides, and heavy metals into waterbodies, which in turn contaminate drinking water and cause algae blooms.[70] Finally, animal manure can run off into waterbodies. With manure in CAFOs concentrated in small spaces, deadly bacteria can grow.[71] In 2006, E. coli

60. Donald Anderson et al., *Harmful Algal Blooms and Eutrophication: Nutrient Sources, Composition, and Consequences*, 25 ESTUARIES 704, 705 (2002).

61. NAT'L OCEANIC ATMOSPHERIC ADMIN., *NOAA-, EPA-Supported Scientists Find Average but Large Gulf Dead Zone*, NOAA NEWS (Aug. 4, 2014), http://www.noaanews.noaa.gov/stories2014/20140804_deadzone.html.

62. Anderson et al., *supra* note 60.

63. Tom Miller, *Toxic Algae Blooms Killing Sea Birds, Threaten Humans*, KSBW (April 30, 2014, 12:03 AM), http://www.ksbw.com/news/toxic-algae-blooms-killing-sea-birds-threaten-humans/25729808.

64. *Id.*

65. *Id.*

66. EPA, *supra* note 49.

67. *Id.*

68. *Id.*

69. Chang Zhang et al., *Effects of Sediment Geochemical Properties on Heavy Metal Bioavailability*, 73 ENV'T INT'L 270, 275–76 (2014).

70. EPA, *supra* note 49. Sediment can cause other problems such as decreased water levels and reservoir capacity and increased flooding. Eubanks, *supra* note 27, at 257.

71. Eubanks, *supra* note 27, at 279.

outbreaks were traced to spinach grown in California with contaminated manure being a possible source of the bacteria.[72]

As shown, farming practices can lead to a whole host of problems for water quality. Problems may be obvious, such as animal waste leaking from lagoons, to barely noticeable, such as excess fertilizer sinking into groundwater. The pollutants themselves are also different from one farm to the next. Remedying NPS pollution requires a complex approach that starts with identifying the pollutant running off, finding the source amongst acres of land, and then developing the best plan to solve the problem.

III. PRIOR ACTIONS TAKEN TO ADDRESS WATER QUALITY

A. Clean Water Act

The Clean Water Act (CWA) is an expansive piece of legislation aimed at improving water quality. The CWA has been successful in improving the nation's waters with water quality standards and permitting requirements.[73] The EPA estimates its point source program reduces conventional pollution discharges by 108 million pounds annually and toxic discharges by 24 million pounds annually.[74] However, the Act has not adequately addressed water quality issues stemming from NPS pollution.

The Act's most notable program is the National Pollutant Discharge Elimination System (NPDES). The CWA prohibits the discharge of any pollutant into navigable waters from a point source unless an NPDES permit is obtained.[75] A point source is any "discernible, confined and discrete conveyance."[76] Yet, though the Act specifies "any pollutant," it specifically excludes run-off from agriculture; it exempts agricultural storm water discharge and return flows from irrigation.[77] The CWA does not fully address agricultural run-off because of the difficulty in regulating when there are a

72. Sabin Russell et al., *Spinach E. Coli Linked to Cattle/Manure on Pasture Had Same Strain as Bacteria in Outbreak*, SFGATE (Oct. 13, 2006, 4:00 AM), http://www.sfgate.com/health/article/Spinach-E-coli-linked-to-cattle-Manure-on-2550111.php.

73. The Act reduced lead, fecal bacteria, and biological oxygen demand loads. Corey Longhurst, *Where is the Point? Water Quality Trading's Inability to Deal with Nonpoint Source Agricultural Pollution*, 17 DRAKE J. AGRIC. L. 175, 179 (2012).

74. *Id.*

75. 33 U.S.C. § 1311(a) (2016).

76. *Id.* § 1362(14) (2016).

77. *Id.* (defining point source to exclude "agricultural stormwater discharges and return flows from irrigated agriculture").

multitude of diffuse sources and generally no pipe discharge to pinpoint as the cause.[78] Notably, the Act lists Concentrated Animal Feeding Operations (CAFO) as a point source and hence subjects them to permits and regulations.[79] The program is effective at controlling the flow of pollutants from point sources, but since the permits do not apply to nonpoint sources, most NPS polluters are not subject to federal discharge limitations.

The CWA also requires each state to establish Water Quality Standards (WQS) and Total Maximum Daily Loads (TMDLs) for its waterbodies. For WQS, the states must establish the designated use of each waterbody, develop water quality criteria for particular pollutants, and create antidegradation standards.[80] For waters that will not meet water quality standards for particular pollutants, states must establish priority rankings for impaired waters and develop TMDLs.[81] TMDLs set the amount of a certain pollutant that a particular waterbody can assimilate without violating the water quality standards.[82] Once states complete the complex scientific task of setting the TMDLs,[83] they then have to allocate them among both the point source and nonpoint source dischargers.[84] Most nonpoint source discharges are not monitored or quantified. This leaves states with insufficient information as to how many or what pollutants are discharged and is why most states have not applied the TMDL program to farms.[85]

Due to the lack of federal efforts to address NPS pollution, Congress amended the CWA in 1987 to establish the Nonpoint Source Management Program, or Section 319.[86] The program requires that states identify waters impaired by nonpoint sources and develop plans to control and reduce the pollution.[87] The states are to submit management plans that include best management practices (BMPs), a program to implement the BMPs, and sources of funding.[88] A few incentives for states to comply are a cost-sharing grant program and a section that requires the federal department and agency to accommodate the concerns of the state.[89] The EPA is responsible for

78. Angelo & Morris, *supra* note 4, at 1009.

79. JOSEPH J. BERNOSKY, OVERVIEW OF ENVIRONMENTAL LAWS AND REGULATIONS: NAVIGATING THE GREEN MAZE 44 (2011).

80. Angelo & Morris, *supra* note 4, at 1012.

81. BERNOSKY, *supra* note 79, at 47.

82. Angelo & Morris, *supra* note 4, at 1013.

83. *See id.* at 1014 (explaining the process for setting the TMDLs).

84. *Id.*

85. *Id.* at 1015.

86. BERNOSKY, *supra* note 79, at 52; Williams, *supra* note 10, at 72.

87. 33 U.S.C. § 1329(a)(1)(B)–(C) (2016).

88. *Id.* § 1329(b)(2).

89. *Id.* § 1329(k).

ensuring that states submit the required reports and management plans. If a state fails to submit a report or if the EPA does not approve a plan, the EPA can promulgate one.[90] Despite some success,[91] the program has a number of limitations. The EPA cannot prepare and implement a management plan for states that opt not to develop one.[92] It lacks funding to subsidize costs.[93] Additionally, it does not have clear performance standards to ensure that grants are being used effectively in the states.[94] The CWA has helped to clean up the nation's waters, but agricultural water pollution remains a pressing concern that often falls through its reach.

B. Groundwater Regulation

Agricultural water pollution is also addressed through groundwater regulation, as groundwater and agriculture are closely linked. Indeed, "agriculture is largely responsible for toxic contamination of groundwater."[95] At the federal level, the Safe Drinking Water Act (SDWA) protects public drinking water supplies. The Act has requirements of wellhead programs, sole source aquifer designation programs, and underground injection well programs.[96] At the state level, classification systems for groundwater are often adopted. An example of a classification is designating an aquifer for drinking water. The classification system helps the state set quality standards, permit requirements, and land-use controls, among other features.[97] States may also set groundwater quality standards in order to specify a maximum concentration of a contaminant, describe an acceptable level, or define a permissible level.[98] States can then use the standards in implementing permits or monitoring requirements.

Recently, states began "to require more systematic efforts to prevent contamination by agricultural operations."[99] Montana, for example, has the

---

90. *Id.* § 1329(d)(3).

91. *See Nonpoint Source Success Stories*, EPA, http://www.epa.gov/polluted-runoff-nonpoint-source-pollution/nonpoint-source-success-stories (last visited Jan. 16, 2016).

92. 33 U.S.C. § 1329(e) (2016).

93. Williams, *supra* note 10, at 75.

94. *Id.* at 75–76.

95. LINDA A. MALONE, ENVIRONMENTAL REGULATION OF LAND USE § 9:17 (2014).

96. *Id.*

97. KENNETH A. MANASTER & DANIEL P. SELMI, STATE ENVIRONMENTAL LAW § 20:11 (2014).

98. *Id.*

99. *Id.* § 20:37.

Agricultural Chemical Ground Water Protection Act.[100] The Act first authorizes the Department of Health and Environmental Sciences to adopt rules setting agricultural chemical groundwater standards.[101] Then the department implements a general and specific management plan to protect groundwater from agricultural chemicals.[102] The general plan includes implementing best management practices and the specific plan includes targeting certain chemicals in a defined groundwater area.[103] The department can enforce the plan with compliance orders, injunctions, and penalties.[104]

Of course, groundwater quality regulation does not ensure protection. Recent litigation in Wisconsin over groundwater contamination likely from CAFOs called into question the state's regulatory efforts. The court found the state's efforts lacking and called for the state to place tougher restrictions on an industrial dairy farm in the region.[105] Many factors affect whether the regulations will be tough enough to succeed in protecting groundwater from agricultural activities. Weak programs, resource limitations, or even general unwillingness to regulate farms more heavily all can prevent the government's regulation from succeeding.

C. Best Management Practices

Agricultural run-off has largely been addressed through voluntary and incentive-based programs. Both the federal government and states offer incentives to farmers who voluntarily participate in best management practice (BMP) programs or undertake pollution reduction measures. Agricultural BMPs are activities designed to conserve soil and water and reduce run-off. BMPs include implementing irrigation and water management practices[106] and minimizing "the transport of nutrients by using cover crops, conservation tillage and contour farming to limit erosion, and by planting buffer strips and managing riparian zones to trap nutrients and disperse run-off."[107]

---

100. MONT. CODE ANN. § 80-15-101 to -414 (2016). Another example is Arizona's Pesticide Groundwater Quality Protection Program, see ARIZ. REV. STAT. ANN. § 49-301 (2016).

101. MONT. CODE ANN. § 80-15-201 (2016).

102. *Id.* §§ 80-15-211 to -212.

103. *Id.*

104. *Id.* §§ 80-15-403, -404, -412, -414.

105. Ron Seely, *Judge Blames Toxic Kewaunee County Wells on 'Massive Regulation Failure'*, WISCONSINWATCH.ORG (Oct. 30, 2014), http://wisconsinwatch.org/2014/10/judge-blames-toxic-kewaunee-county-wells-on-massive-regulatory-failure/.

106. Angelo & Morris, *supra* note 4, at 1018.

107. *Id.*; *see infra* Part IV.A. for more information on these practices.

In order to encourage farmers to adopt BMPs, both the federal government and states have adopted conservation programs. Conservation programs in the federal government come out of the Farm Bill reauthorizations—a bill one may think only shapes American food policy, but in fact also considerably affects our water policy. Congress recently reauthorized the Farm Bill in February 2014.[108] Farm Bill programs are voluntary and many receive mandatory funding;[109] indeed, the Farm Bill is one of the largest sources of conservation funding.[110] The primary program, the Environmental Quality Incentives Program (EQIP), with a budget of eight billion dollars for the period 2014–2018,[111] provides financial and technical assistance to farmers. For example Sarah Woutat, who owns a vegetable farm in Minnesota, applied for financial assistance from EQIP to help her build high tunnel and field borders.[112] These tunnel and plants lining the borders reduce nutrient run-off and decrease the use of pesticides.

Another program, the Conservation Stewardship Program (CSP) helps and rewards farmers who maintain conservation activities through financial and technical support.[113] Farmers must meet a set number of priority resource concerns by the end of a five-year contract; in exchange, these farmers receive annual payments based on their performance.[114] Additionally, the Regional Conservation Partnership Program (RCPP), newly established in 2014, provides assistance in regional or watershed-based concern areas through partnerships with a variety of organizations.[115] This program's enactment in the Farm Bill emphasizes how agriculture and water quality are inexorably linked.

Modeled after the federal programs, states have enacted voluntary programs to incentivize farmers to adopt management practices.[116] Incentives for farmers include education programs, technical assistance, and cost-

---

108. MEGAN STUBBS, CONSERVATION PROVISIONS IN THE 2014 FARM BILL (P.L. 113-79) 1 (2014), http://nationalaglawcenter.org/wp-content/uploads//assets/crs/R43504.pdf.

109. *Id.* at 4.

110. Lisa Schulte Moore, *Farm Bill Politics May Prove Devastating to the Environment*, SCI. AM. (July 11, 2013), http://www.scientificamerican.com/article/farm-bill-politics-may-prove-devastating-environment/.

111. STUBBS, *supra* note 108, at 8.

112. Julie MacSwain, *Minnesota Farm Uses Conservation to Make Each Acre Count*, USDA: USDA BLOG (Mar. 20, 2014), http://blogs.usda.gov/2014/03/20/minnesota-farm-uses-conservation-to-make-each-acre-count/#more-50694.

113. STUBBS, *supra* note 108, at 8.

114. *Id.*

115. *Id.* at 12.

116. JAMES S. SHORTLE & DAVID GERRARD ABLER, ENVIRONMENTAL POLICIES FOR AGRICULTURAL POLLUTION CONTROL 136 (2001).

sharing.[117] Recently though, states have begun to move toward more enforceable mechanisms due in part to immediate needs or improved assessment abilities.[118] Though the laws vary, many include the enforcement of BMPs.[119] However, few states target agricultural NPS pollution in a comprehensive manner, rather they focus on individual pollutants.[120]

While governmental efforts at the federal and state level have used voluntary programs in addition to regulation to achieve a reduction in NPS pollution, a voluntary incentive-based approach to NPS pollution truly offers a number of advantages over command-and-control regulation. For example, when the cause of pollution varies among sources, an approach that can take into account the differences in agriculture across the United States—and even in states and counties themselves, with varying soil type and climate—may be more effective in reducing water pollution because it can meet the needs of the locale. And while command-and-control may cause a reduction in pollution, some farmers are apt to reduce their pollution only to the minimum necessary to comply; they have no incentive to reduce their pollution further. Economic incentives can provide that encouragement to reduce pollution levels beyond the minimum required. More command-and-control regulation to reduce NPS pollution may come in the future, but for now, emphasizing and working with voluntary programs that are already there, that are already working, can help to tackle the pollution currently plaguing U.S. waters.

IV. THE PATH FORWARD: UTILIZING VOLUNTARY CONSERVATION PROGRAMS WITH 19TH AND 21ST CENTURY PRACTICES

Voluntary programs[121] can and do work to prevent agricultural run-off.[122] Indeed, the "conservation literature suggests that with regard to the privately

117. *Id.*

118. *Id.* at 136, 138; s*ee also* Longhurst, *supra* note 73, at 183–85.

119. SHORTLE & ABLER, *supra* note 116, at 136.

120. *Id.* at 137.

121. Voluntary programs can be termed "pay for performance," "green payments," and "incentive-based." Voluntary programs with cost-sharing, subsidies, or other incentives are all part of a broader framework of payments for ecosystem services (PES), defined as payments to individuals or communities to undertake actions that increase levels of desired ecosystem services. Kelsey B. Jack et al., *Designing Payments for Ecosystem Services: Lessons from Previous Experience with Incentive-Based Mechanisms*, 105 PROC. NAT'L ACAD. SCI. U.S. 9465, 9465 (2008).

122. *See*, *e.g.*, Risse & Tanner, *supra* note 12 (Dr. Mark Risse and Hillary Tanner at the University of Georgia Department of Biological and Agricultural Engineering conducted a literature review and found that voluntary programs can be effective at reducing nutrient pollution). A cautionary note to PES policies is that they can make it profitable in the long-term

held land base of the United States, voluntary (in contrast to command-and-control) programs are not only becoming more prevalent in environmental policy, but offer significant benefits over traditional regulatory approaches."[123] Benefits include increasing economic returns, enhancing decision-maker flexibility in meeting multiple goals, and increasing farmers' willingness to accept the practices.[124]

While voluntary programs may not wholly solve the NPS pollution problem, they can help to reduce it. As many voluntary conservation programs are already in place, the stage is set for improving upon them rather than creating policy from scratch. The National Institute of Food and Agriculture (NIFA) looked at and asked farmers what motivated them to adopt conservation programs.[125] It found factors such as profit increases, trusted name-brand technology, and networks of support all affect the chance that a farmer will adopt conservation practices.[126] Insights from studies like these can shape the way future policies and programs are created in order to increase farmers' willingness to enact the practices.

Specifically, a voluntary approach blending conservationist farm practices with agricultural technology can prevent agricultural run-off, clean our water supply, and ultimately lead to a sustainable agricultural future. While some of the practices can be fairly budget-friendly like tilling, other practices, such as the use of drones that can monitor crop health with sensors, cost much more.[127] This is where conservation programs come into play—they provide technical assistance and help lower the cost to the farmer in implementing the technology that can reduce NPS pollution. And though some may be wary of pouring more money into conservation programs, the clear benefit of addressing NPS pollution and thereby limiting toxins in the water should weigh against the concern. At any rate, whether money is allocated to the farmer to develop prevention strategies or after the fact to clean up pollution with restoration efforts, the pollution will continue to cost money. A variety

---

to enter or stay in the industry because they can make an environmentally harmful activity profitable and hence undermine any environmental effectiveness. Jack et al., *supra* note 121, at 9468. Therefore, agencies must take care to ensure that this does not occur.

123. KATE E. ROSENBERG, AIMING FOR THE RIGHT TARGET: THE RELATIONSHIP BETWEEN AGRICULTURAL VOLUNTARY INITIATIVES AND WATER QUALITY IMPAIRMENT 7 (UMI Dissertation Publ'g 2013).

124. *Id.*

125. D. HOAG ET AL., LESSONS LEARNED FROM THE NIFA-CEAP: HOW FARMERS AND RANCHERS MAKE DECISIONS ON CONSERVATION PRACTICES 2 (2012), http://content.ces.ncsu.edu/how-farmers-and-ranchers-make-decisions-on-conservation-practices.

126. *Id.*

127. *See infra* Part IV.B. for a discussion of the use of drones.

of sustainable farming practices, from those developed hundreds of years ago to some just in the early stages of development, can help decrease the agricultural run-off that is polluting the waters.

A. 19th Century Methods

Sometimes called "old-fashioned methods," practices used in the 19th century are seeing a comeback, driven in part by the sustainable agriculture movement.[128] These methods prevent agricultural run-off in addition to improving the health of the farm. For example, many lessen the need for fertilizer and pesticide applications. A variety of natural fertilizer methods keep the soil fertile. Farmers can till, which consists of "plowing, turning and airing the soil."[129] They can use organic matter like manure, alfalfa meal, and wood ash.[130] Integrated pest management reduces the need for large amounts of pesticide. Farmers can monitor and identify pests to see which ones are causing damage to the crops and then spray targeted areas rather than cover the whole field in pesticides. Farmers can also plant pest resistant crops.[131] A practice in tune with pest management is attracting beneficial animals and insects.[132] Bats and birds are insects' natural predators so farmers could build houses to attract them to their fields.[133] And keeping certain types of insects around, such as ladybugs, beetles, green lacewing larvae, and fly parasites, helps crops because the creatures feed on pests.[134] Another method, which reduces pesticide use, is crop diversity because it reduces the amount of food available to one pest and limits its population growth.[135] Crop rotation reduces

---

128. Adherents of the movement question the techniques and practices used in industrial agriculture. The movement has three goals: environmental health, economic profitability, and social and economic equity. Gail Feenstra et al., *What is Sustainable Agriculture?*, U.C. DAVIS AGRIC. SUSTAINABILITY INST., http://asi.ucdavis.edu/programs/sarep/about/what-is-sustainable-agriculture (last visited Dec. 14, 2015).

129. Diana Bocco, *Top 10 Sustainable Farming Practices*, DISCOVERY, http://www.discovery.com/tv-shows/curiosity/topics/10-sustainable-farming-practices.htm (last visited Oct. 22, 2015).

130. *Id.*

131. *Id.* Genetically modified organisms are a controversial topic at the moment but will not be discussed in this paper.

132. Steve Graham, *Landscaping: Attracting Beneficial Animals*, NETWORX (May 12, 2011), http://www.networx.com/article/landscaping-attracting-beneficial-anima.

133. *Id.*

134. Bocco, *supra* note 129. Diana Bocco writes, "[l]adybugs are not just pretty additions to your garden—they also eat harmful insects." *Id.*

135. *See Healthy Farm Practices: Crop Diversity and Rotation*, UNION CONCERNED SCIENTISTS, http://www.ucsusa.org/food_and_agriculture/solutions/advance-sustainable-agriculture/crop-diversity-and-rotation.html#.VnOi7RUrLIU (last visited Dec. 17, 2015).

both fertilizer and pesticide use.[136] This is a technique where different crops are planted after another crop in order to replenish the nutrients of the soil.[137] It also prevents the transmission of disease, for "[b]acterial tilt, crown rot, tan spot and a number of pests, such as septoria, scab and phoma, can be deterred easily by rotating crops."[138]

Other practices include planting cover crops and changing animal feed. Cover crops are crops planted to revitalize the soil and help with "insect management, soil quality, fertility, pest control, and water conservation."[139] For example, planting clover helps with water filtration, suppresses weeds, controls erosion, and prevents ground freezing.[140] The right amount and quality of protein fed to an animal reduces the amount of nitrogen in manure.[141] This means that if run-off or seepage does occur, less nitrogen enters the water.[142] Many of the practices discussed above are all relatively budget-friendly and simple to implement. Furthermore, they prevent water pollution by reducing the chemical inputs and stopping the flow of pollutants coming off the farm.

Nevertheless, concerns do arise in the switch from conventional to sustainable farming. One concern cited is that with an increasing population sustainable practices will fail to meet the high yield demand of the future. Notably, the switch to sustainable farming may temporarily cause lower yields than conventional agriculture, but it does not mean that sustainable farming cannot meet the world's food demand. Take for instance organic agriculture, a type of sustainable farming that uses practices like crop rotation and refrains from using synthetic fertilizer or pesticides. During the transition to organic farming, crop yields decline.[143] However, after five years or more

---

Furthermore, a mix of different species reduces the chance of a disease or pest affecting all of the crops. *Id.* With the increasing homogeneous global food supply, food security is a major concern as pests and diseases could wipe out large tracts of crops and lead to a loss of adequate nutritious food needed to sustain a community. *See* Tim Radford, *Pests Pose Increasing Risk to Food Security*, CLIMATE CENT. (Aug. 31, 2014), http://www.climatecentral.org/news/pests-pose-increasing-risk-to-food-security-17964.

136. Bocco, *supra* note 129.

137. *Id.*

138. *Id.* Deterrence is due to the fact that diseases and pests often affect a specific type of crop and not others. *Id.*

139. *Id.*

140. *Id.*; *see* SUSTAINABLE AGRIC. RESEARCH & EDUC., MANAGING COVER CROPS PROFITABLY 9–11 (Andy Clark ed., 3d ed. 2007).

141. C.A. Rotz, *Management to Reduce Nitrogen Losses in Animal Production*, 82 J. ANIMAL SCI. E119, E121 (Supp. 2004).

142. *Id.*

143. *Toward a Sustainable Agriculture*, CTR. FOR INTEGRATED AGRIC. SYS., http://www.cias.wisc.edu/curriculum/modV/secd/modVsecD.htm (last visited Nov. 19, 2015).

the yields recover "to the same level or sometimes higher levels than when the same fields were under conventional management."[144] The initial decline may occur because it takes years to cultivate a healthy soil and population of beneficial organisms and for the famer to learn how to best manage the farm.[145] The answer to the increasing population problem does not have to be more conventional farming practices. A mix of measures designed to meet the needs of the future can be used such as increasing yields on less productive farmlands, using resources more efficiently, shifting diets, and reducing waste.[146]

Another concern in the switch away from conventional farming is the impact on food security for the poor, but in fact sustainable agricultural practices can positively contribute to food security.[147] Studies indicate "sustainable farming practices are in fact the best hope for hungry people in the poorest and most densely populated areas of the world."[148] This is because of the varied positive effects sustainable practices can have. Consider climate change. Global changes can have devastating impacts on the poor.[149] For example, in poor countries where the economy is dependent on sectors like agriculture, the temperature increase can damage the agricultural sector which is sensitive to climate.[150] Recognizing the consequences, the International Assessment of Agricultural Knowledge, Science and Technology for Development (IAASTD) contends that there "is a need to develop agricultural policies that both reduce emissions and allow adaptation to climate change."[151] Such policies the IAASTD put forth echo sustainable farming practices. Researchers have also hypothesized that sustainable

144. *Id.*

145. *Id.* Of course, some crops like cranberries do not yield the same amount as conventional farming does. *Id.* But over time, organic farming may close the gaps in crops grown organically from those grown conventionally. Sarah Yang, *Can Organic Crops Compete with Industrial Agriculture?*, BERKELEY NEWS (Dec. 9, 2014), http://newscenter.berkeley.edu/2014/12/09/organic-conventional-farming-yield-gap/.

146. *See* Jonathan Foley, *A Five-Step Plan to Feed the World*, NAT'L GEOGRAPHIC, http://www.nationalgeographic.com/foodfeatures/feeding-9-billion/ (last visited Nov. 19, 2015).

147. UNITED NATIONS GLOB. COMPACT, SCALING UP: GLOBAL FOOD SECURITY AND SUSTAINABLE AGRICULTURE 32 (2012), https://www.unglobalcompact.org/docs/issues_doc/agriculture_and_food/Scaling_Up_Food_Ag.pdf.

148. John Ikerd, *The Future of Food: Sustainable Agriculture is Not Optional*, UNIV. MO. (April 24, 2012), http://web.missouri.edu/ikerdj/papers/Pennsylvania%20University%20-%20Future%20of%20Food.htm#_ednref26.

149. INT'L ASSESSMENT OF AGRIC. KNOWLEDGE, SCI. & TECH. FOR DEV., AGRICULTURE AT A CROSSROADS: SYNTHESIS REPORT 18 (2009).

150. *Id.* at 46–52.

151. *Id.* at 50.

farming can provide food security for the future. Niels Halberg at the Danish Institute of Agricultural Sciences conducted a study using an algorithm developed by the World Bank to predict whether a large-scale conversion to organic farming in Europe and North America would "reduce yields, increase world food prices, or worsen hunger in poorer nations."[152] The study found no substantial impact on world food prices and even had hunger-plagued countries exporting food surpluses.[153]

Sustainable farming can offer a number of advantages while achieving high yields. David Pimentel studied the growth of corn and soybeans on an organic farm and conventional farm and found that the organic farm produced the same yields and used no pesticides and thirty percent less energy and water.[154] The shift away from conventional farming may be more beneficial to society. Even though a conventional farm may produce more yields per acre on certain crops, it does so at the cost of degrading the environment.[155] The "benefits of the higher yield may be offset by the cost of environmental cleanup," which society will ultimately pay.[156] Even if the price is higher, the cost may merely reflect the true social cost in terms of environmental harm, such as water pollution, and thus warrant the cost. As Douglas Gayeton writes, "[a]t some point we have to recognize that what we pay for food at the supermarket counter is not the true cost."[157] These practices that reflect sustainable agriculture do "not mean a return to either the low yields or poor farmers that characterized the 19th century" they instead adopt an approach that maintains "high yields and farm profits without undermining the resources on which agriculture depends."[158]

---

152. Brian Halweil, *Can Organic Farming Feed Us All?*, WORLDWATCH INST., http://www.worldwatch.org/node/4060 (last visited Nov. 19, 2015).

153. *Id.*

154. Susan S. Lang, *Organic Farms Produce Same Yields as Conventional Farms*, CORNELL CHRON. (July 13, 2005), http://www.news.cornell.edu/stories/2005/07/organic-farms-produce-same-yields-conventional-farms.

155. Leo Horrigan et al., *How Sustainable Agriculture Can Address the Environmental and Human Health Harms of Industrial Agriculture*, 110 ENVTL. HEALTH PERSP. 445, 453 (2002).

156. *Id.*

157. Philip Hanes, *Lexicon of Sustainability Defines True Cost Accounting*, FOODTANK (Sept. 30, 2014), http://foodtank.com/news/2014/09/lexicon-of-sustainability-defines-true-cost-accounting.

158. Jay G. Varshney & K.K. Barman, *Can Butachlor be a Component of Sustainable Rice Farming? An Indian Perspective*, *in* INTERNATIONAL CONFERENCE ON 21ST CENTURY CHALLENGES TO SUSTAINABLE AGRI-FOOD SYSTEMS 315, 316 (P.G. Chengappa et al. eds., 2007).

B. 21st Century Technology

A picture of a farmer and her pitchfork is as classic as Norman Rockwell. But a farmer and her smartphone? Living up to its reputation as being omnipresent, technology has expanded into the agricultural sector, creating innovative ways to not only increase crops yields, but also help conservation efforts. In the future, technology may even change the horizontal nature of farms and prevent some of the environmental problems we face today.[159] For now, with NPS pollution pouring into U.S. waterways, technology is here to help prevent and remedy the problem. Chiefly, technological innovations mixed with basic conservation farming practices can significantly reduce agricultural run-off.

One technological innovation is the tail-water recovery system, a system that reuses irrigation water that runs off the farm.[160] First, the flow of run-off water is designated into a sedimentation pond.[161] After an allowance of time for the sediment to settle out, the water is returned to the irrigation system.[162] The system decreases water waste, allows for reapplication of some nutrients (swept away in the water previously), and prevents contamination of nearby surface waters.[163] It also can increase profits and reduce groundwater dependence.[164] Reservoirs and tail-water recovery systems have the capability of collecting eighty percent of the potential sediment loss from a farm.[165] They prevent sediment from running off into the stream carrying with it harmful pollutants.

Bioreactor chips and purification programs provide other methods of reducing agricultural run-off. Farmers can build a subsurface trench and fill

---

159. *See* Lisa Chamberlain, *Skyfarming*, N.Y. MAG. (Oct. 24, 2007), http://nymag.com/news/features/30020/. The future of farming may be in vertical farms. *Id.* Crops are grown in vertical structures allowing the water to collect at the bottom and be recycled. *Id.* In a controlled environment, vertical farming can allow food to be grown "organically, without herbicides, pesticides, or fertilizers, eliminating agricultural runoff." *Id.*

160. C.C. Shock & T. Welch, *Tailwater Recovery Using Sedimentation Ponds and Pumpback Systems*, 134 ORE. ST. U., DEPT' CROP & SOIL SCI. EXT/CRS, July 2011, at 1, http://www.cropinfo.net/pdf/extension/ExtCrs134-TailwaterRecovery.pdf.

161. *Id.*

162. *Id.*

163. *Id.*

164. JENNIE POPP ET AL., ASSESSING THE BENEFITS OF ON-FARM RESERVOIRS AND TAIL-WATER RECOVERY SYSTEMS 2 (2004), http://ageconsearch.umn.edu/bitstream/20210/1/sp04po03.pdf.

165. *Id.* at 10.

it with a carbon source like wood chips.[166] The rain and irrigation water running off the farm will go through pipes and then into a pile of wood chips that absorb nitrogen.[167] Hence, the nitrates are removed before the water enters other waterbodies. Still in the early stages of development, a water recycling pilot program in San Francisco is experimenting with solar water purification.[168] The program works by capturing heat from the sun which in turn evaporates and condenses pure water from agricultural drainage.[169] Polluted water turns into clean water, ready for reapplication.

Furthermore, irrigation techniques such as drip irrigation and center-pivot systems conserve water and reduce run-off. Drip irrigation, available over and under ground, consists of using tubes to deliver water in small amounts straight to the plants' roots minimizing the risk of evaporation and run-off.[170] Farmers can expect water savings—up to fifty percent over traditional furrow irrigation (water flown down through trenches).[171] Farmers can experience yield increases, due to the plant receiving the right amount of water, and energy savings.[172] Of course, some disadvantages to the system are the initial cost of installation and technical use.[173] Over time though, farmers can become familiar with the systems. Center pivot irrigation is a moving system that rotates around a fixed point. Center pivots are widely used on farms—in 2010 eighty-three percent of sprinkler irrigated land used center pivots.[174] Such widespread use is due in part to the high efficiency of the systems, minimal labor input, and ability to operate on rough topography.[175]

Unfortunately, the center pivot irrigation systems can create run-off with high application rates, but a few measures can prevent this.[176] As the systems

166. *What is a Woodchip Bioreactor?*, PURDUE UNIV. https://engineering.purdue.edu/watersheds/conservationdrainage/bioreactors.html (last visited Nov. 19, 2015).

167. *Id.*

168. Meagan Clark, *Solar Water Purification Technology Recycles Ag Runoff*, INT'L BUS. TIMES (July 14, 2014), http://www.ibtimes.com/solar-water-purification-technology-recycles-ag-runoff-1627236.

169. *Id.*

170. *Working with Our Suppliers to Manage Water Use*, UNILEVER, https://www.unilever.com/sustainable-living/the-sustainable-living-plan/reducing-environmental-impact/water-use/using-water-wisely-in-agriculture/working-with-our-suppliers-to-manage-water-use/ (last visited Nov. 19, 2015).

171. *Id.*

172. *Id.*

173. *Id.*

174. P. Nakawuka et al., *Efficacy of Boom Systems in Controlling Runoff Under Center Pivots and Linear Move Irrigation Systems*, 30 APPLIED ENGINEERING AGRIC. 797, 797 (2014).

175. *Id.*

176. *Id.*

are widely used, implementing a few tools to help potential run-off is important in order to protect water quality.[177] One method is to combine the systems with the use of electromagnetic soil mapping.[178] The electromagnetic sensor coupled with a global positioning system can provide a picture of the conductivity of the soils and the water holding capacity.[179] One can identify management zones and depths of irrigation (amount of water that needs to be applied) for each zone. Then, using precision variable rate irrigation, which controls valves along an irrigator, the right amount of irrigation can be applied to match soil and crop requirements.[180] Additionally, placing booms on the sides of the center pivot prevents run-off.[181] Booms work by placing applicators farther from towers. This lowers the water application rate by applying water to a larger area and allowing the water to infiltrate the soil more slowly.[182] Applying the right amount of water to prevent evaporation and run-off is an essential component to preventing water pollution. Equipped with the right irrigation systems, farmers can not only prevent run-off, but also conserve water, energy, and increase yields.

Drones, already used in Japanese farming, are making their way to American farms.[183] Drones range in cost from $2,000 to $160,000, making them an expensive option, but one well worth the price.[184] Some farmers even recover their investments within a year.[185] They have infrared cameras and sensors to "scan crops for health problems, monitor nutrient uptake and hydration, and locate disease or insect outbreaks."[186] They enable farmers to evaluate crops with their high resolution radiometer, thermal camera to track plant temperature and hydration, and laser scanner to measure plant height.[187] Instead of spraying pesticides uniformly over their crops, farmers can look at

177. *Id.*

178. Stu Bradbury et al., *Precision Irrigation as a Tool to Reduce Nutrient Leaching and Runoff*, *in* ACCURATE AND EFFICIENT USE OF NUTRIENTS ON FARMS 1, 2 (L.D. Currie & C.L. Christensen eds., 2013), http://www.massey.ac.nz/~flrc/workshops/13/Manuscripts/Paper_Bradbury_2013.pdf.

179. *Id.*

180. *Id.* at 3–4.

181. P. Nakawuka et al., *supra* note 174, at 798.

182. *Id.*

183. Christopher Doering, *Growing Use of Drones Poised to Transform Agriculture*, USA TODAY (Mar. 23, 2014, 7:18 AM), http://www.usatoday.com/story/money/business/2014/03/23/drones-agriculture-growth/6665561.

184. *Id.*

185. *Id.*

186. Tanner Ehmke, *Unmanned Aerial Systems for Field Scouting and Spraying*, 58 CSA NEWS, Dec. 2013, at 4, 5–6, https://dl.sciencesocieties.org/publications/csa/pdfs/58/12/4.

187. *Id.*

an aerial survey and selectively spray plants that need attention.[188] Plus, since the drones can fly just a few feet above the crop and spray, more of the spray goes on the plants not the ground.[189] In essence, drones allow for precision agriculture: tailoring the use of pesticides, herbicides, and fertilizer on an as-needed basis. The potential impacts of the use of drones are overwhelming. The U.S. does not currently allow drones for commercial use except in limited cases, but in February 2015, the Federal Aviation Administration (FAA) proposed rules to integrate unmanned aircraft systems into the airspace.[190] The Association for Unmanned Vehicle Systems International said that drones will have a $13.6 billion impact on the U.S. economy in the first three years of implementation, with most of that growth in precision agriculture.[191]

Though drones may not be on U.S. farms yet, a number of sensors and monitoring devices are available to promote precision agriculture. Sol Chip produces wireless sensors that collect information on soil water availability, soil fertility, and plant water status, among other data.[192] Ag Leader Technology's crop sensor measures and records information on crops "in real-time using the reflectance of light shined on growing plants."[193] Positively, investments in precision agriculture products like sensors are on the rise. In 2014, a fifty million dollar venture fund was created to support companies invested in food and agricultural technology.[194] Indeed, the federal government even has its foot in the precision agriculture door. The Precision Farming Incentive under EQIP has been implemented in a few states to "encourage the adoption of variable-rate application of nutrients and pesticides and promote the use of GPS-enabled precision agricultural technology and equipment."[195] Such precision and data from sensors allows farmers to better manage their water usage and chemical inputs and ultimately reduce the run-off from their farms.

---

188. *Id.*

189. *Id.*

190. Aaron Cooper, *FAA Proposes to Allow Commercial Drone Use*, CNN (Feb. 15, 2015, 3:00 PM), http://www.cnn.com/2015/02/15/politics/drones-faa-rules-commercial-flights.

191. Ehmke, *supra* note 186, at 4–5.

192. Shahnaz Mahmud, *The Skinny on Sensors*, GLOBAL AGINVESTING (Dec. 8, 2014), http://www.globalaginvesting.com/news/blogdetail?contentid=4955.

193. *Id.*

194. *Id.*

195. *Partnership Initiative with ACES for Precision Farming 2012*, USDA NRCS, http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/about/?cid=nrcs141p2_022695 (last visited Nov. 11, 2015).

Although technology offers clear benefits, public sentiment remains mixed. Some see technology as a negative, as the cause of the Green Revolution and a part of the environmental degradation America now faces.[196] Yet technology can also be seen as an answer—a tool to help improve the Earth's resources. Certainly implementing technology into farms has its hindrances. The innovations are expensive and require technical knowledge. Until the cost of the technology is matched with consumers' ability to pay, cost-sharing programs are necessary along with technical and educational assistance for farmers. Logan Handsaker, a product specialist at Ag Leader Technology, notes that the crop sensor industry faces an "uphill battle" as the implementation of sensors requires developing management practices around farmers and "many producers are set in their ways."[197]

Despite the battles, coupling the use of technology with old-fashioned farming techniques can significantly improve agricultural run-off. The "tried-and-true approaches—such as no-till farming; planting cover crops; and installing buffers, catch basins, and other structures or devices to slow the flow—are still vital."[198] Technology can even make conservation practices more effective by giving farmers and researchers data. Sensors and monitors collect, document, summarize, and analyze field, plant, and water conditions. Such information helps farmers choose the best BMP, like cover crops if the data suggests an unhealthy soil. The sensors can also pinpoint areas where pollution concentration is greatest and allow for precision conservation.[199] Furthermore, data from sensors can improve NPS pollution models, helping farmers "better identify critical points in the watershed for management, and facilitate the development of smart farms that increase nutrient use efficiency and minimize environmental impacts."[200] Together, traditional conservation practices and new technology can provide an incredibly effective means for preventing NPS pollution.

---

196. *See* Prabhu L. Pingali, *Green Revolution: Impacts, Limits, and the Path Ahead*, 109 PROC. NAT'L ACAD. SCI. U.S. 12302, 12303–05 (2012).

197. Mahmud, *supra* note 192.

198. John Carey, *Precision Conservation*, CONSERVATION MAG. (Sept. 9, 2013), http://conservationmagazine.org/2013/09/precision-conservation.

199. *See infra* Part IV.C.I (discussing precision conservation).

200. CTR. FOR ENVTL. POL'Y AM. UNIV., EXPERT WORKSHOP ON WATER TECHNOLOGIES SUMMARY REPORT 5 (2014), http://www.american.edu/spa/cep/projects/upload/Summary-Report_Expert-Workshop_7-24-14_FINAL.pdf. They can even help improve the measurements used by the USDA Natural Resource Conservation Service programs. The Center for Environmental Policy at American University writes, "[s]ensors could provide a means of better quantifying variable impacts, so that static practice-based measurements and model assumptions that are often used in these program[s] can be refined by site-specific performance-based measures." *Id.*

While the information and technology are there to help reduce the run-off from agricultural farms, the question remains of how to encourage farmers to voluntarily implement these practices—practices that go back to the 19th century coupled with the high-tech tools of the 21st century. In order for farmers to voluntarily implement such practices they need adequate incentives. Four ways to encourage farmers to adopt conservation practices are: strengthened conservation programs, water quality trading, subsidies, and certification.

C. Incentives to Enact Conservation with 19th and 21st Century Practices

1. Strengthen and Expand Current Conservation Programs

Conservation programs at the federal, state, and local level should be expanded and strengthened in order to reduce NPS pollution. Studies have "documented the effectiveness of conservation practices in reducing pollutant export from farmland and rangeland at the plot, practice, and/or field scales."[201] Conservation programs should aim to reduce NPS pollution more effectively and provide the necessary incentives to get farmers involved.

NPS pollution can be greatly reduced through conservation programs that target conservation practices to critical source areas—known as precision conservation. Precision conservation requires experts to find impaired waters and identify critical source areas, and then to evaluate programs based on the amount of pollution that enters waterways.[202] Precision conservation dovetails with precision agriculture by using technology like yield sensors, GPS-equipped tractors, and controlled sprayers. The technology helps "spot and eliminate pollution hotspots with surgical accuracy."[203]

An example of precision conservation is found in a project in Wisconsin. The water pollution situation was dire with rotting algae on the beaches "so thick . . . that the town had to dig paths th[r]ough the sludge with backhoes before boats could be launched for a fishing derby."[204] The natural resource agency tried to solve the problem by asking the legislature to require all

201. SOIL & WATER CONSERVATION SOC'Y, HOW TO BUILD BETTER AGRICULTURAL CONSERVATION PROGRAMS TO PROTECT WATER QUALITY: THE NATIONAL INSTITUTE OF FOOD AND AGRICULTURE—CONSERVATION EFFECTS ASSESSMENT PROJECT EXPERIENCE 3 (Deanna L. Osmond et al. eds., 2012).

202. Carey, *supra* note 198.

203. *Id.*

204. *Id.*

farmers to install buffer strips, but the idea was rejected.[205] Pete Nowak, a professor of environmental studies at the University of Wisconsin-Madison, ended up bringing together farmers, government conservationists, and environmental groups and scientists to create the Wisconsin Buffer Initiative.[206] Funded in part by a federal grant from the Natural Resources Conservation Service through the Cooperative Conservation Partnership, Nowak's team ranked the state's polluted watersheds and aimed to target the farms where most of the run-off was occurring.[207] Ten farms were chosen. Incentivized with federal, state, and nonprofit dollars, in addition to improved efficiency and environmental benefits, nine of the ten farmers agreed to make changes.[208] So far, the farmers have undertaken no-till practices and installed barnyard run-off systems, fencing, cattle crossings, and monitoring devices.[209] The implementation measures are still ongoing, but researchers expect to find phosphorus levels drop by twenty-five percent or more.[210]

Precision conservation is advantageous in that, when conservation practices are chosen, they are specifically selected to help treat the pollutants and pollutant sources causing the most harm. That concept implemented into all conservation programs aimed at improving water quality can truly reduce a large percentage of pollution. Such precision is needed because, otherwise, conservation efforts may have a minuscule impact.[211] The type of pollutant, characteristics of the land, and scale of harm, among other factors, affect what conservation measures will target the pollution most effectively. What works for one area of the country or watershed may not work most effectively in another. Furthermore, precision conservation exemplifies the benefits of mixing 19th and 21st century practices. Using both methods together is key; high resolution imagery from satellites and light detection and ranging systems can map the topography and soil type of an area, allowing analysts to pinpoint where most of the run-off is occurring and then target those areas with old-fashioned conservation techniques.[212]

---

205. *Id.*
206. *Id.*
207. *Id.*
208. *Id.*
209. *Id.*
210. *Id.*
211. For instance, the National Institute of Food and Agriculture (NIFA) found that "watershed studies implemented conservation practices that targeted erosion and sediment abatement, even when the principal water quality impairment was nutrients, herbicides, or bacteria." SOIL & WATER CONSERVATION SOC'Y, *supra* note 201, at 161.
212. The Chesapeake Conservancy uses these technologies to map and target critical source areas in the Nanticoke River watershed. Carey, *supra* note 198.

While conservation programs offer a number of advantages, they cannot work without funding. Farmers may care about the environment, but they care more about making enough money to stay afloat. One farmer said, "Conservation competes with the time he could be using to make money."[213] Farmers are concerned about returns and sunk investment costs.[214] Thus, conservation has to be cost effective. The National Institute of Food and Agriculture (NIFA) found that "[m]ost people expressed the need for the government to offer cost-sharing that covered a significantly larger share of the installation or implementation cost than was currently available."[215] Certainly, a call for increased cost-sharing will always be sought for any program where there is uncertainty about future benefits, but nevertheless sharing the cost is critical in order to encourage farmers to even try a practice. Of note is that there may be a downside to continually providing the opportunity for farmers to sign up for the programs. Murat Isik found that "cost-share subsidy policies are most effective in inducing technology adoption when they are immediately offered to farmers and guaranteed that they will be removed soon."[216] Possibly, an approach to solving the problem Isik found is to offer a larger cost-sharing arrangement for early adopters when the benefits are uncertain and a smaller cost-sharing agreement for those that adopt later.

Cost-share incentives bring the price of technology into a more feasible range for farmers. In the future, precision farming can travel the same course as other technologies that were previously economically infeasible but were later modified to become more wallet-friendly.[217] Taxes on fertilizer and pesticides could supplement current funding sources. Florida implemented a tax on pollutants for those who produce or import pollutants.[218] Even though producers may transfer the cost to the farmers buying the products, it can help to caution farmers before they spread massive applications onto their farms.[219] Additionally, NIFA suggested programs seek funding from creative

---

213. SOIL & WATER CONSERVATION SOC'Y, *supra* note 201, at 22.

214. Murat Isik, *Incentives for Technology Adoption Under Environmental Policy Uncertainty: Implications for Green Payment Programs*, 27 ENVTL. & RES. ECON. 247, 248 (2004).

215. SOIL & WATER CONSERVATION SOC'Y, *supra* note 201, at 22.

216. Isik, *supra* note 214, at 261.

217. K.R. KRISHNA, PRECISION FARMING: SOIL FERTILITY AND PRODUCTIVITY ASPECTS 159 (2013).

218. *Florida's Pollutants Tax*, MY FLORIDA, http://dor.myflorida.com/dor/forms/current/gt800032.pdf (last visited Dec. 15, 2015).

219. Kathleen Segerson and Dan Walker write: "[i]nput and output decisions of producers are driven to a large extent by prices, and over-production or over-use can result when those prices do not reflect all of the associated impacts on society." Kathleen Segerson & Dan Walker,

sources.[220] For example, in the Cannonsville Reservoir in New York, watershed programs developed relationships with the end users or municipalities that supplied the water, which in turn led to funding opportunities.[221]

Of course, cost is not the only factor that predicts whether a farmer will implement conservation practices.[222] Time management, flexibility, and ease of management and adoption, among a whole host of other factors, affect a farmer's decision.[223] Allowing flexibility and input from the farmer can lead to a willingness to invest.[224] Continuing technical assistance is also important to train the farmer and ensure sustained effectiveness.[225]

In order to actually reach the farmer, education is of utmost importance. NIFA found that some farmers had negative perceptions about certain practices,[226] and insufficient or incorrect education can prevent farmers from applying conservation measures. The "spread of precision farming techniques ha[s] been relatively slow in many parts of the world" partly because of inadequate education.[227] These farmers are not yet convinced that precision techniques are "easy to handle and economically feasible and even profitable."[228] Precision agriculture's accuracy, yield improvement, fertilizer use efficiency, and environmental benefits need to be highlighted.[229] Education can not only help with the uncertainty farmers experience in deciding whether or not to implement a practice, but also help improve the perception of conservation programs. Outreach efforts like meeting personally with farmers and developing a network of early adopting farmers[230] can bolster a program's success.[231]

Nutrient Pollution: An Economic Perspective, 25 ESTUARIES 797, 797–98 (2002). They found that the large increase in fertilizer use over the last sixty years was driven largely by the "low cost and high contribution to agricultural productivity." *Id.* at 798. Farmers over-use fertilizer because they make decisions about fertilizer use based upon their net gains. *Id.* The low cost and high output prices from fertilizer cause them to use more and more. *Id.*

220. SOIL & WATER CONSERVATION SOC'Y, *supra* note 201, at 163.

221. *Id.*

222. Some farmers given the option of 100% cost-share were not interested in conservation practices. *Id.* at 48.

223. *Id.* at 162.

224. *Id.*

225. *Id.*

226. *Id.* at 34.

227. KRISHNA, *supra* note 217, at 159.

228. *Id.*

229. *Id.*

230. Farmers often learn from other farmers nearby.

231. SOIL & WATER CONSERVATION SOC'Y, *supra* note 201, at 161–62.

Conservation programs can be strengthened by the implementation of precision conservation, more flexibility and education, and above all by adequate funding. The mix of conservation techniques and technological innovations works together to reduce the most critical NPS pollution areas. Programs like the Cooperative Conservation Partnerships[232] should be expanded in order to effectively target NPS pollution. And other programs that provide incentives for conservation on a more individual farmer level, such as the Environmental Quality Incentives Program, can be improved by following similar techniques. All farmers who want to implement practices that reduce run-off should be given support. NPS pollution will continue even if the largest polluters reduce their run-off.

2. Trading Programs

Well known in the acid rain or carbon emission debates, trading programs are another method to encourage farmers to voluntarily reduce NPS pollution. The programs have even received federal encouragement. In 2003, the EPA created a National Water Quality Trading Policy, setting the parameters a state trading program must follow in order to receive EPA support.[233] The purpose of the policy was to "encourage states, interstate agencies and tribes to develop and implement water quality trading programs for nutrients, sediments and other pollutants where opportunities exist to achieve water quality improvements at reduced costs."[234] Trading programs work by allowing a polluting source to purchase pollution reductions from another source in order to meet its regulatory obligations.[235] By reducing one's pollution, one generates credits to sell and gain revenue. The main advantages of the programs are flexibility and innovation for one can choose how to achieve reductions.[236] Economically, the trading programs aim to reduce individual pollution abatement costs, making the programs more attractive than options like treatment plant upgrades. They also promote a coordinated effort among point and nonpoint sources, regulatory agencies, and the public,

232. This was discussed above as the program researchers in Wisconsin entered into. The Cooperative Conservation Partnerships are now rolled into the Regional Conservation Partnership Program in the 2014 Farm Bill.

233. *Water Quality Trading Policy*, EPA (Jan. 13, 2003), http://water.epa.gov/type/watersheds/trading/upload/2008_09_12_watershed_trading_finalpolicy2003.pdf.

234. *Id.*

235. Juliana Corrales et al., *Water Quality Trading Programs Toward Solving Environmental Pollution Problems*, 62 IRRIGATION & DRAINAGE 72, 73 (2013).

236. *Id.*

providing the potential for greater participation and ultimately pollution reduction.[237]

Nutrient trading programs have great potential to reduce NPS agricultural pollution in a cost-efficient manner. The premise of the trading programs is that "PS polluters have been regulated to a point where any additional abatement will require sophisticated, costly techniques."[238] The aim is thus to achieve pollution reduction through NPS polluters who can implement less costly abatement techniques. The NPS polluter or farmer implements a technique, such as cover crops, and decreases their discharge. They then can turn around and sell the credit generated to a PS polluter so that the PS polluter can meet their obligations.

Several states have implemented or are working on developing water quality trading programs, such as the states in the Chesapeake Bay Watershed. In the Chesapeake Bay Watershed, which spans across six states and the District of Columbia, only twenty-nine percent of the Bay and its tidal waters meet water quality standards.[239] NPS pollution contributes to about three-quarters of the pollution.[240] In fact, agriculture is the single largest source of nutrient and sediment pollution entering the Bay.[241] In 2010, the EPA set a multi-state TMDL for nitrogen, phosphorus, and sediment in the Bay.[242] The states then had to create Watershed Implementation Plans in order to detail how they planned to meet the TMDL.[243]

In the effort to tackle the Bay problem, Virginia, Maryland, and Pennsylvania established nutrient trading programs addressing point and nonpoint sources. For example, in Pennsylvania the program, initiated in 2005, is voluntary and provides incentives for pollutant reductions beyond compliance requirements.[244] Trading may take place between any combination of point sources, nonpoint sources, and third parties.[245] The

---

237. *Id.*

238. Angelo & Morris, *supra* note 4, at 1022.

239. SEUNG AH BYUN, A COMPARATIVE EVALUATION OF STATE POLICIES AND PROGRAMS FOR NONPOINT SOURCE POLLUTION CONTROL IN THE CHESAPEAKE BAY WATERSHED 55 (2014).

240. *Id.*

241. *Agriculture*, CHESAPEAKE BAY PROGRAM, http://www.chesapeakebay.net/issues/issue/agriculture#inline (last visited Dec. 15, 2015).

242. *Chesapeake Bay Total Maximum Daily Load (TMDL)*, EPA, http://www2.epa.gov/chesapeake-bay-tmdl (last visited Nov. 14, 2015).

243. *Id.*

244. 25 PA. CODE § 96.8 (2016); BYUN, *supra* note 239, at 229.

245. *Phase 2 Watershed Implementation Plan Nutrient Supplement*, PA. DEP'T ENVTL. PROT., 1 (Jun. 18, 2015) http://files.dep.state.pa.us/Water/BPNPSM/NutrientTrading/NutrientTradingSupplementToPhase2WIP.pdf.

program allows trading for the following nutrients: nitrogen, phosphorus, and sediment.[246] The Pennsylvania Department of Environmental Protection first specifies the watershed and determines or concurs on the maximum aggregate discharge allowance of the nutrient or sediment.[247] Before generating credits, sources must gain certification by the department and have the pollutant activity verified and registered.[248] The department is also in charge of approving the calculation of credits.[249] Credits can be traded in an auction system or on the market.[250] The program has had some success in selling credits; the number of credit buyers increased from forty-nine in 2013 to sixty-two in 2014.[251]

To be sure, water quality trading programs face a number of challenges. The programs have experienced a lack of consistent support, possibly due to the fact that federal and state agencies have not invested enough time and resources into educating the public about the programs and their economic benefits.[252] Therefore, agencies must focus more attention on educating industries and farmers in order to encourage them to partake in the programs. Another concern is "pollution hot spots." Pollution hot spots occur when water quality equivalence has not been taken into account in order to ensure that one unit of NPS discharge reduction is equivalent to offsetting one unit of PS discharge.[253] Analysts must take care to ensure that the trading ratios take into account factors like "geographic and hydrologic complexity of the watershed" and the "properties of the pollutant" to prevent the creation of hot spots.[254] Additionally, the difficulty in measuring NPS pollution prevents NPS polluters from participating in trading programs. However, the advancing technology that allows for greater precision can overcome this challenge.[255]

---

246. 25 PA. CODE § 96.8 (2016).

247. *Id.*

248. *Id.*

249. *Id.*

250. BYUN, *supra* note 239, at 230.

251. *Compare 2013 Nutrient Buyers Registry: Nutrient Credit Registry*, PA. DEP'T ENVTL. PROT., http://files.dep.state.pa.us/Water/BPNPSM/NutrientTrading/NutrientCreditRegistry/2013_Buyers_Total.pdf (last updated Nov. 30, 2013), *with 2014 Nutrient Buyers Registry: Nutrient Credit Registry*, PA. DEP'T ENVTL. PROT., http://files.dep.state.pa.us/Water/BPNPSM/NutrientTrading/NutrientCreditRegistry/2014_Nutrient_Buyers_Summary.pdf (last updated Nov. 30, 2014).

252. Corrales et al., *supra* note 235, at 76.

253. *Id.*

254. *Id.*

255. *See id.* at 76–77 (discussing the technology and capabilities to reduce uncertainty and lower measurement costs).

Water quality trading programs offer an innovative approach to reducing agricultural water pollution. Trading provides flexibility and cost-effectiveness. Most of the trading programs in the United States include point and nonpoint sources, providing the potential for agricultural reductions to play a large role.[256] The programs, by providing a revenue stream, can offer farmers the encouragement necessary to implement conservation practices.

3. Subsidies

Another way to encourage farmers to adopt conservation practices is through subsidies. The Farm Bill provides subsidies to large corporations and megafarms for crops that are not in demand.[257] Seventy-five percent of "total subsidies go to the biggest 10 percent of farming companies, including Riceland Foods Inc., Pilgrims Pride Corp., and Archer Daniels Midland."[258] Even "farmers" who are only partly involved in farming enterprises, such as Bruce Springsteen, Jon Bon Jovi, and Jimmy Carter receive subsidies.[259] The Bill gives subsidies to agribusinesses in multitudes. In 2005, "when pretax farm profits were at a near-record $72 billion, the federal government handed out more than $25 billion in aid, almost 50 percent more than the amount it pays to families receiving welfare."[260] Congress should take subsidies away from large agribusiness and place them in the hands of farms operating sustainable agricultural methods. Sustainable agriculture includes the implementation of practices like no-till farming, cover cropping, crop rotation, and precision fertilizer. Providing subsidies to sustainable farms can mitigate the damage caused by industrial agriculture.

"[F]armers will farm wherever the money is;" [261] thus, if Congress gives subsidies for sustainable agriculture, farmers will undertake the practices. Data suggests that farmers want to maintain their communities and conserve their natural ecosystems, but have been pressured to farm commodity crops like corn because that is where they will be able to make money to support

256. JAMES S. SHORTLE, WATER QUALITY TRADING IN AGRICULTURE 41 (2012).

257. Eubanks, *supra* note 27, at 227.

258. *Farm Subsidies: A Welfare Program for Agribusiness*, WEEK (Aug. 10, 2013), http://theweek.com/article/index/248078/farm-subsidies-a-welfare-program-for-agribusiness.

259. *Id.*

260. Dan Morgan et al., *Farm Program Pays $1.3 Billion to People Who Don't Farm*, WASH. POST (July 2, 2006), http://www.washingtonpost.com/wp-dyn/content/article/2006/07/01/AR2006070100962.html.

261. Eubanks, *supra* note 27, at 304.

themselves.[262] Although the Farm Bill of 2014 moved away from direct subsidies and instead moved the funds into a Price Loss Coverage and Agricultural Risk Coverage Program, the payments are still going toward commodity crops (corn, grain, oilseeds).[263]

The Farm Bill does actually have a program providing "green payments." The Conservation Stewardship Program, first authorized in the 2002 Farm Bill, rewards producers for conservation performance across the farm. The program has continuous enrollment and nationwide eligibility with an acreage cap of ten million per year.[264] All states must first identify at least five priority resource concerns.[265] To apply for the program, the farmer must address at least two resource concerns.[266]

While the "green payments" program is promising, it is underfunded. According to the Environmental Working Group, twenty-eight percent of farmers who want to enroll in the program have been denied federal assistance over the last seven years (2005–2012) due to the lack of funding.[267] In the 2014 Farm Bill, the program's funding was further reduced by over two billion dollars.[268] In order for the program to work—to implement sustainable practices that can prevent agricultural run-off—it must have the necessary funding. By redirecting the subsidies given to farms currently polluting waters to farmers implementing sustainability, more farmers can sign up either for programs like the Conservation Stewardship Program or others that provide green payments.

Moving beyond just paying farmers the redirected subsidies, John Ikerd, a professor emeritus of agricultural and applied economics, would pay farmers and also institute a special farm tax rate. His plan is to provide a tax

---

262. BRADLEY LUBBEN ET AL., THE 2007 FARM BILL: U.S. PRODUCER PREFERENCES FOR AGRICULTURAL, FOOD AND PUBLIC POLICY v–viii (Nat'l Pub. Policy Educ. Comm. 2006).

263. *Crop Commodity Programs*, USDA ECON. RES. SERV., http://www.ers.usda.gov/agricultural-act-of-2014-highlights-and-implications/crop-commodity-programs.aspx (last updated April 11, 2014). The Price Loss Coverage allows farmers to receive payments if prices dive below a certain level and the Agricultural Risk Coverage allows farmers to recover losses not covered under crop insurance deductibles. *Id.*

264. DEFENDERS OF WILDLIFE, A GUIDE TO THE FARM BILL CONSERVATION PROGRAM 7–9 (2014), http://www.defenders.org/sites/default/files/publications/a-guide-to-farm-bill-conservation-programs.pdf.

265. *Id.* at 9.

266. *Id.* at 8–9.

267. Marni Salmon, *Many Farmers Seeking Conservation Help Get Turned Away*, ENVTL. WORKING GROUP (May 13, 2013), http://www.ewg.org/agmag/2013/05/many-farmers-seeking-conservation-help-get-turned-away.

268. *House Subcommittee Passes 2015 Agriculture Funding Bill*, NAT'L SUSTAINABLE AGRIC. COALITION (May 20, 2014), http://sustainableagriculture.net/blog/house-subcommittee-approps/.

credit for each family farm demonstrating progress toward sustainability.[269] Farmers approved for the tax credit would also have an alternative tax rate on net farm income.[270] Ikerd proposes that as the "net farm income increases, the advantage of the alternative 'tax rate' and 'tax credit' would diminish."[271] He provides an example of a $20,000 tax credit and an alternative farm tax rate at fifty percent of total net farm income. Fifty percent of a net farm income of $40,000 would offset the $20,000 tax credit. On the other hand, at an income of $60,000, it would be advantageous to the farm to give up the special farm tax credit and be taxed the same as other businesses. The end product is that as the farms become more productive and profitable government assistance will subside. His suggestion provides support for the fact that sustainable agriculture is a serious and worthy cause—one worth changing the subsidized nature of the Farm Bill.

The problem is that these subsidies are a "tough sell" to Congress. Large agricultural businesses will claim that the prices of their crops will fall devastatingly low should a subsidy withdrawal happen and will lobby to keep their subsidies. The large agricultural businesses will exhibit what is called rent-seeking behavior—the activity of influencing the political process to obtain a favorable outcome for themselves or avoid an unfavorable one.[272] Politicians may align with the businesses if it is in their best interest.[273] Small farms stand less of a chance of winning unless they work together and pool their resources—a difficult task. As public choice theory explains, "individuals are self-interested utility maximizers . . . not likely to pursue collective interests."[274] Furthermore, politics often call for "give and take." Even if certain members of Congress want to redirect subsidies, such a decision may fail for the overall desire to pass a bill or gain another provision that will only happen if the member dismisses the subsidy idea. It is a feat that seems unlikely, but as NPS pollution continues to pollute water sources and gather more public attention, the government may feel the need to truly change the Farm Bill.

---

269. John Ikerd, *Redirecting Government Policies to Ensure Agricultural Sustainability*, UNIV. MO., http://web.missouri.edu/~ikerdj/papers/ASASFarmPolicy.htm#_ftn (last visited Dec. 15, 2015).

270. *Id.*

271. *Id.*

272. ANDREW SCHMITZ ET AL., AGRICULTURAL POLICY, AGRIBUSINESS, AND RENT-SEEKING BEHAVIOUR 45 (2d ed. 2010).

273. *Id.*

274. 2 ENCYCLOPEDIA OF GOVERNMENT AND POLITICS 657 (Mary Hawkesworth & Maurice Kogan eds., 2004).

Another hurdle is that the American public seems to be clamoring more and more for the end of subsidies.[275] But, by touting the change as a *redirection* of funds already used to subsidize farms, the proposal may be more acceptable, especially as it calls for a positive end goal: sustainable farming.[276] Of course, even those in favor of moving toward sustainability might criticize the fact that the government would be paying the polluters to stop, rather than having them come to their own realization of the need for sustainability. Even so, the benefits of creating more sustainable farms, more clean water may outweigh the fact that farmers are being paid not to pollute. It is possible that at least for a temporary time the end may justify the means.

Redistributing subsidies away from large agriculture "would facilitate employment within the farming sector and help keep family farmers on the land, support vibrant rural economies, assist with soil conservation, and support the urgently-needed transition to a sustainable food system - one that reflects the realities of 21st Century agriculture."[277] The subsidies currently used to support farms polluting our waters could find a new purpose in promoting clean water among other worthy causes. Ikerd writes that "Congress must somehow find the courage to focus agricultural programs of the future on using 'public funds,' to produce 'public benefits.'"[278] Clean water is a public benefit that cannot be ignored.

4. Certification

Certification of products or practices is a growing development,[279] and is now used for sustainable farming practices. As such, it provides the potential to be used to target "discharges at the source" and incentivize "polluters to stop discharging."[280] First, a body formulates a set of standards. The standards are based on the practices that have been most successful in reducing NPS pollution. Certification requires testing and verification, both necessary to

---

275. *See, e.g.*, James B. Stewart, *Richer Farmers, Bigger Subsidies*, N.Y. TIMES (July 19, 2013), http://www.nytimes.com/2013/07/20/business/richer-farmers-bigger-subsidies.html?_r=0.

276. Of course, critics could point to the fact that higher food prices for consumers may result if large agricultural businesses fail to receive subsidies and pass their increased costs onto consumers.

277. *Financing the Global Sharing Economy, Part Three (6): End Support for Agribusiness*, SHARE (Oct. 1, 2012), http://www.sharing.org/information-centre/reports/financing-global-sharing-economy-part-three-6-end-support.

278. Ikerd, *supra* note 269.

279. Think of the dolphin-safe tuna label or the USDA Organic label.

280. Kyle W. Robisch, *Getting to the (Non)Point: Private Governance as a Solution to Nonpoint Source Pollution*, 67 VAND. L. REV. 539, 565 (2014).

ensure compliance. Certification can work on the product side—allowing farmers to achieve the standards and sell goods with a label announcing their certification. Or certification can work on the overall farming production side—enticing farmers to implement approved practices in order to receive the benefits that come with certification such as regulatory certainty.

On the product side, the certification differentiates between goods produced in a manner that reduces "nonpoint source pollution during production, manufacturing, growing, or shipping" and those that do not take water-friendly practices into account (at least publicly with certification).[281] The certification incentivizes consumers to buy the products that promote the protection of drinking water, recreation activities, and animal habitats. As consumer demand for such products increases, other farmers are encouraged to reduce their pollution and enter the certification process. Examples of products where certification is creating demand and supply are fair-trade coffee and sustainably harvested fish.[282] Certification can open the door to more business opportunities by creating market access, access to credit, and technical assistance.[283]

Product-side certification is not without its problems. One concern is that farmers will pass the increased costs to themselves onto consumers, and there is conflicting research on consumers' willingness to pay the increased price.[284] Instead of focusing on getting businesses to lower costs, one avenue may be to promote more consumer awareness in order to encourage consumers to actually buy the product.[285] Another problem is that it would be difficult to devise specific standards for individual goods. But working with other organizations that have already developed standards or consulting with organizations knowledgeable in water quality can ease the administrative burden. A third potential problem is greenwashing, where consumers are confused with multiple labels and claims. Claims of greenwashing arose in a dispute between Water and Sanitation Health (WASH), a Seattle nonprofit, and Chiquita, which claims to produce bananas in a sustainable manner.[286]

---

281. *Id.*

282. Notably, "[b]y the end of 2011, 7 percent of wild landings of fish for human consumption . . . and 17 percent of coffee produced globally were certified." STEERING COMM. OF THE STATE-OF-KNOWLEDGE ASSESSMENT OF STANDARDS & CERTIFICATION, TOWARD SUSTAINABILITY ES-4 (2012).

283. *Id.* at 61 fig.3.2.

284. *Id.* at 50 box 2.9.

285. *Id.* at app. A-189.

286. Sarah Shemkus, *Better Bananas: Chiquita Settles Lawsuit over Green Marketing, but the Legal Battle Isn't Over*, THE GUARDIAN (Dec. 19, 2014, 04:10 PM),

WASH claimed that Chiquita's farms in Guatemala contaminated drinking water with fertilizer and fungicides and air-dropped pesticides close to schools and homes.[287] The suit has now been settled, but WASH has filed an additional suit against the Rainforest Alliance, who certified the Chiquita farms as sustainable.[288] The dispute remains as to whether the bananas are grown under sustainable conditions. In order to prevent greenwashing, one method is to partner with the EPA, USDA, or similar local government organizations in order for the certification to gain more legitimacy.

On the overall farming production side, the program works by rewarding farmers who implement conservation practices on their farms. The farms which implement and maintain approved farm management practices can obtain certification status and receive additional benefits such as regulatory certainty for a period of years, priority status for technical and financial assistance, and less time-consuming inspections. Maryland has a Farm Stewardship Certification and Assessment Program, established in 2010.[289] When a farmer volunteers, the state evaluates the farm for nutrient management, soil conservation, and water quality to assess whether the farm meets the program's standards.[290] To qualify, the farmer must have implemented a nutrient management plan that meets state requirements and a soil conservation and water quality plan that prevents significant sources of pollution from running off the farm.[291] As of December 2015, the program has 119 certified farms.[292]

Michigan also has a voluntary conservation program for farms. The Michigan Agriculture Environmental Assurance Program requires a farmer to go through three phases before verification. First, farmers attend an education session updating them on agriculture regulations.[293] Second, an on-farm risk assessment evaluates environmental risks and devises viable solutions.[294] Lastly, the farmer receives verification after steps one and two are completed, the state's management practices are followed, and specific

---

http://www.theguardian.com/sustainable-business/2014/dec/19/chiquita-lawsuit-green-marketing-bananas-water-pollution.

287. *Id.*

288. *Id.*

289. *Maryland Farm Stewardship Certification and Assessment Program*, MD. ASS'N SOIL CONSERVATION DISTS., http://www.mascd.net/FSCA/ (last visited Jan. 18, 2016).

290. *Id.*

291. *Id.*

292. *Certified Agricultural Conservation Stewards*, MD. ASS'N SOIL CONSERVATION DISTS., (Dec. 15, 2015), http://mascd.net/FSCAP/farm_list.html.

293. *Michigan Agriculture Environmental Assurance Program (MAEAP)*, MICHIGAN.GOV (2010), http://www.michigan.gov/mdard/0,4610,7-125-1599-12819--,00.html.

294. *Id.*

practices for either the livestock, farmstead, or cropping system are implemented.[295] In return, farmers receive recognition and access to incentives.[296] Signed into law in 2011, the program currently has over 2,300 verifications.[297]

The Minnesota Agricultural Water Quality Certification Program is another voluntary opportunity for farmers to implement practices that promote clean water.[298] The certification process involves an assessment that evaluates physical field characteristics, nutrient management factors, tillage, pest management, irrigation and tile drainage, and conservation practices.[299] Those who implement and maintain the practices set forth by the state can achieve certification, allowing them to obtain regulatory certainty for ten years.[300] The farmers also can use the status to promote their business as a protector of water quality and obtain priority access to technical and financial assistance.[301] After its approval by the legislature in 2013, the program was initially piloted in four watersheds and then expanded statewide in 2015, with 47 certified farms so far.[302]

One difficulty is that these programs are state-run and thus require a sufficient and steady revenue stream that is not always available or stable due to budget appropriations. Partnering with non-governmental organizations can help prevent the programs from faltering during state budget cuts. Another problem is the potential perception by farmers that the programs are a means of more government control. The hope is that with education focused on the benefits farmers can receive by voluntarily cooperating, such as increased business and regulatory certainty, the farmers may see the benefits outweighing the burden of oversight by the state.

The certifications are still in their early stages of development, but these programs can work to prevent NPS pollution by enticing farmers with

---

295. *Id.*

296. *Id.*

297. *About the Michigan Agriculture Environmental Assurance Program*, MICH. AGRIC. ENVTL. PROGRAM, http://www.maeap.org/about (last updated Feb. 17, 2015).

298. *Minnesota Agricultural Water Quality Certification Program*, MINN. DEP'T AGRIC., http://www.mda.state.mn.us/awqcp (last visited Jan. 18, 2016).

299. *Minnesota Agricultural Water Quality Certification Program Overview*, MINN. DEP'T AGRIC., http://www.mda.state.mn.us/~/media/Files/protecting/waterprotection/mawqcpoverview.pdf (last visited Jan. 18, 2016).

300. *Id.*

301. *Id.*

302. *Water Quality Certification Expands to Farms Across Minnesota*, MINN. DEP'T AGRIC., (July 23, 2015), http://www.mda.state.mn.us/en/news/releases/2015/~/media/Files/news/2015releases/nr20150723-mawqcp.pdf.

incentives such as gaining a niche market of consumers who want to buy from farmers practicing sustainability. And in return for implementing conservation practices, the farmers receive decreased regulation, access to financial resources, and good publicity. Certification can lead the way in encouraging farmers to implement the best management practices all without a heavy command-and-control approach.

CONCLUSION

Dead zones. Toxic algae. Cancer-causing chemicals. Nonpoint source pollution is a *big deal*. As nonpoint source pollution continues to flow down our lakes and rivers into the ocean or seep into our groundwater, the need for action continues. Even as calls for greater command-and-control regulation occur, improving the problem through programs already available and already working to clean up the waters should continue to be emphasized. Federal and state voluntary conservation programs can reduce agricultural pollution. The key is to focus on advocating and incentivizing the practices that have the greatest impact on reducing pollution such as precision conservation and precision agriculture. These practices utilize old-fashioned farming methods with new technology. Indeed, farming practices used in the 19th century are still viable and an effective means for preventing run-off. Mixed with the new 21st century technology, these practices can help farmers stop pollution at its source before it enters the groundwater and streams. Of course, farmers have to be incentivized to implement these practices. Utilization and development of conservation programs, trading programs, subsidies given to farms practicing sustainability, and certificates for conservation are all ways that federal and state governments can incentivize farmers to voluntary adopt conservation measures. Together, governments and farmers working cooperatively can prevent agricultural run-off. Conservationist practices and technology can help bring us one step closer to the belief in *Dune* where water is not to be polluted, but to be preserved, to be purified, and to sustain life.