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**ADVANCES IN NORTH CAROLINA'S PORK INDUSTRY
ARE RESULT OF INNOVATION ON FARMS
AND ACROSS VALUE CHAIN**

J. ANDREW CURLISS*

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In mid-September 2018, a powerful Hurricane Florence, with winds that would exceed 140 mph and rainfall amounts as deep as a yard stick, took direct aim at the coast of North Carolina.¹

When it did, activist groups that oppose modern livestock agriculture took aim at the state's hog farmers, generating and spreading thousands of articles, broadcast reports, social media posts, and blogs.² They predicted, in alarming fashion, that the storm would unleash devastation on the environment in a region that includes the state's largest pig-producing counties.³

The director of the North Carolina Environmental Justice Network, as one example, warned that in the aftermath of such a hurricane "[e]verything is toppled over and dumped out into the environment and into the rivers and streams and just running through the communities, and so you have all this—nothing but feces and urine in the waterways, and dead animals."⁴

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1. See Jonathan Drew, *'Threat Becomes Reality': Florence Begins Days of Rain, Wind*, WCJB (Sept. 13, 2018, 8:30 PM), <https://www.wcjb.com/content/news/Hurricane-Florence-winds-and-rain-begin-lashing-Carolinas-493142021.html>.

2. See Arelis R. Hernandez et. al., *Factory Farming Practices Are Under Scrutiny Again in N.C. After Disastrous Hurricane Floods*, WASH. POST (Oct. 16, 2018), https://www.washingtonpost.com/news/capital-weather-gang/wp/2016/10/16/factory-farming-practices-are-under-scrutiny-again-in-n-c-after-disastrous-hurricane-floods/?utm_term=.00ae07b971af.

3. See Rachel Siegel et. al., *After Florence North Carolina Grapples With the Floods, Outages and Endless Water*, WASH. POST (Sept. 18, 2018), https://www.washingtonpost.com/national/after-florence-north-carolina-grapples-with-floods-outages-and-endless-water/2018/09/18/c00b170a-bb68-11e8-9812-a389be6690af_story.html?noredirect=on&utm_term=.d5a14d2ee44f.

4. *NC Lagoons Hold Billions of Gallons of Hog Feces. The Hurricane May Blast That Waste Into Waterways*, DEMOCRACY NOW, (Sep. 13, 2018), https://www.democracynow.org/2018/9/13/nc_lagoons_hold_billions_of_gallons (quoting Naeema Muhammad).

Hurricane Florence delivered a punishing blow to North Carolina.⁵

But, in contrast to the predictions and in keeping with documented science from previous historic storms, hog farms did not unleash devastation.⁶ Instead, for those who look closer, what the storm revealed was an industry that embraces common-sense regulation, and one that continuously improves its farming practices with a clear eye on ensuring environmental protections and a sustainable future in the production of safe and affordable food products for a growing population.⁷

North Carolina juts into the Atlantic Ocean, and the most significant pig producing counties are in the southern coastal plain.⁸ Hurricanes draw attention to the industry's practice of using an anaerobic lagoon treatment system, a system also used by some municipalities and other businesses.⁹ An anaerobic lagoon allows a farmer to collect and store manure from barns within a containment basin, where beneficial bacteria break down and treat the manure.¹⁰ This natural process creates an organic fertilizer that is then applied to a crop at agronomic rates.¹¹ There are approximately 3,300 active hog lagoons in North Carolina.¹²

Hurricane Florence crawled for three days along the border of North Carolina and South Carolina, dumping an estimated 8 trillion gallons of rainwater on the state, and 11 trillion gallons in the

5. See Siegel et. al., *supra* note 3.

6. See JoAnn Alumbaugh, *Disaster Averted by North Carolina Pig Farmers*, PORK (Sept. 15, 2018), <https://www.porkbusiness.com/article/disaster-averted-north-carolina-pig-farmers> (citing *Hurricane Florence's Impact on NC Hog Farms*, NC PORK COUNCIL (Oct. 10, 2018), <https://www.ncpork.org/florenceimpact/>).

7. *Id.*

8. The flooding that followed swelled rivers to record heights. Many rivers remained at major flood stage nearly two weeks after the storm made landfall. *NC Hogs by County* ARCGIS (June 19, 2014), <https://www.arcgis.com/home/item.html?id=4b157863c26f4a95bfc0134850417a7c>

9. See North Carolina Pork Council, *Hog Farms and Hurricanes: A Primer on Lagoons and Flooding*, PORK (Sept. 11, 2018), <https://www.porkbusiness.com/article/hog-farms-and-hurricanes-primer-lagoons-and-flooding>.

10. See Parimal Pal, *Biological treatment Technology*, in *INDUSTRIAL WATER TREATMENT PROCESS TECHNOLOGY* 65–144 (2017), <https://www.sciencedirect.com/science/article/pii/B9780128103913000035?via%3Dihub>.

11. *Turning Manure Into Fertilizer*, SMITHFIELD FOODS, <https://www.smithfieldfoods.com/responsible-operations/environment/turning-manure-into-fertilizer>, (last visited Feb. 23, 2019) (describing the process the company uses to turn manure into fertilizer). See generally *Appendix I – Agronomic Nutrient Application Rate*, U.S. ENVTL. PROTECTION AGENCY, https://www3.epa.gov/npdes/pubs/cafo_manure_guidance_appendixi.pdf [<https://perma.cc/3YT7-MVZY>] (defining agronomic rate as the appropriate application rate of nutrients from animal waste and the crops nutrient requirements).

12. See *Animal Facility Map*, N.C. DEPT OF ENVTL. QUALITY, <https://deq.nc.gov/about/divisions/water-resources/water-resources-permits/wastewater-branch/animal-feeding-operation-permits/animal-facility-map> (last visited Apr. 29, 2019) [hereinafter *Animal Facility Map*].

region.¹³ The storm measured in some locations as a 1,000-year event.¹⁴ The flooding that followed swelled rivers to record heights.¹⁵ Many rivers remained at major flood stage nearly two weeks after the storm made landfall.¹⁶

Hurricane Florence caused \$17 billion in damage in North Carolina,¹⁷ and is responsible for the deaths of 48 people.¹⁸ More than 74,500 structures were flooded,¹⁹ 1,100 roads and highways were closed or impassable²⁰, and more than 2,200 people were rescued or evacuated.²¹ Large swaths of major cities and towns—and all that was in them—were inundated. Approximately 140,000 North Carolinians registered for disaster aid.²² FEMA confirmed at least 10 dams and levees breached in the Carolinas.²³ Across agriculture, the damage was profound, with possibly more than \$1 billion in reported crop losses.²⁴ Like the rest of eastern North Carolina, the record rains forced hog farmers to face extraordinary

13. Lucia I. Suarez Sang, *Florence Dropped and Estimated 8 Trillion Gallons of Rain Over North Carolina*, FOX NEWS (Sept. 18, 2018), <https://www.foxnews.com/us/florence-dropped-an-estimated-8-trillion-gallons-of-rain-over-north-carolina>.

14. See Jason Samenow, *Florence was another 1,000-year rain event. Is this the new normal as the planet warms?*, WASH. POST (Sept. 18, 2018), https://www.washingtonpost.com/weather/2018/09/18/florence-was-another-year-rain-event-is-this-new-normal-planet-warms/?utm_term=.dadbb6a9b3ef; see also Brian Ries et al., *North Carolina Governor Calls Florence a 1,000-year Rain Event*, CNN (Sept. 11, 2018, 8:11 AM), https://www.cnn.com/us/live-news/hurricane-florence-dle/h_4bad7086a2e32d8ee2f67c48e3a514d0.

15. See Francis S. Sellers, *Hurricane Florence Set At Least 28 Flood Records, According to New USCG Report*, WASH. POST (Nov. 13, 2018), https://www.washingtonpost.com/national/hurricane-florence-set-at-least-28-flood-records-according-to-new-usgs-report/2018/11/13/6e23b922-e766-11e8-a939-9469f1166f9d_story.html?noredirect=on&utm_term=.8e73715ecac9.

16. Dennis Mersereau, *Hurricane Florence's Flooding Continues More Than Two Weeks After Landfall*, FORBES (Sept. 29, 2018, 11:35 AM), <https://www.forbes.com/sites/dennismersereau/2018/09/29/hurricane-florences-flooding-continues-more-than-two-weeks-after-landfall/#dcdc199500d6>.

17. *Hurricane Florence Damage in North Carolina Reaches \$17B*, INSURANCE J. (Nov. 2, 2018), <https://www.insurancejournal.com/news/southeast/2018/11/02/506414.htm>.

18. Sean Breslin, *Hurricane Florence Kills 48*, WEATHER CHANNEL (Sept. 28, 2018), <https://weather.com/storms/hurricane/news/2018-09-27-hurricane-florence-impacts-carolinas>.

19. See *Hurricane Florence: September 14, 2018*, NAT'L WEATHER SERV. (Mar. 29, 2019), <https://www.weather.gov/film/HurricaneFlorence> [hereinafter *Hurricane Florence*, NAT'L WEATHER SERV.]

20. Siegel et. al., *supra* note 3.

21. Chuck Burton & Martha Waggoner, *North Carolina Gov Pleads With Storm Evacuees to be Patient*, WEATHER BUG (Oct. 7, 2018, 3:18 PM), <https://www.weatherbug.com/news/North-Carolina-Gov-Pleads-With-Storm-Evacuees-to-b>.

22. See *Hurricane Florence*, NAT'L WEATHER SERV., *supra* note 19.

23. *FEMA Briefing on Hurricane Florence*, C-SPAN (Sept. 13, 2018), <https://www.c-span.org/video/?451431-1/fema-officials-provide-update-hurricane-florence-preparations>.

24. See *Ag losses from Hurricane Florence top \$1.1 billion in NC*, AGWEEK WIRE REPORTS (Oct. 3, 2018, 10:50 AM), <https://www.agweek.com/business/agriculture/4508112-ag-losses-hurricane-florence-top-11-billion-nc>.

circumstances. Thousands of animals were moved to higher ground in advance and during the onset of the storm for their protection.²⁵ Losses of animals on hog farms were isolated, and no single barn lost all of its animals. Many farmers relied on portable generators and animal feed delivered by boat to keep their animals safe in the storm's aftermath.²⁶ And the lagoons? Most of them—more than 98 percent—experienced minimal impact.²⁷ North Carolina hog farmers have seen about 20 hurricanes over the past 20 years, and have gained deep experience in managing lagoons throughout the course of each year, especially in advance of hurricane season. The summer of 2018 was dry, and lagoons were well managed heading into September.²⁸

The record rains from Hurricane Florence did impact six lagoons with some form of structural damage to a containment wall, ranging from a full breach that released liquid contents in two instances to other instances of “cracking” in the dike wall or less significant impacts.²⁹ Some 28 farms had lagoons that filled up with the rainwater to the point that some liquid overflowed.³⁰

Context is crucial. The amount of rain that fell is understandably incomprehensible to an ordinary person. The rainfall amount, for example, equates to about 900,000 gallons of water for every single pig in North Carolina—and it equals nearly 4 billion gallons of water for every hog farm.³¹ Studies have concluded that human waste, in flooding events, is far more concerning than livestock waste for its potential effect on human health.³² Studies

25. *Hurricane Florence's Impact on NC Hog Farms*, NC PORK COUNCIL (Oct. 10, 2018), <https://www.ncpork.org/florenceimpact>.

26. *See Florence Update*, NC PORK COUNCIL (Sept. 19, 2018), <https://www.ncpork.org/advisory8/>.

27. *See Hurricane Florence*, *supra* note 23.

28. *See Climate North Carolina – Charlotte*, U.S. CLIMATE DATA, <https://www.usclimatedata.com/climate/north-carolina/united-states/3203>. Elizabethtown set the state record for rainfall during Florence, but prior had 9 inches below normal. Greenville and Clinton both had total rainfall for the months of June, July and August some inches below normal.

29. *See Animal Operations – Swine Lagoon Facilities*, NC ENV. QUALITY DEPT. (Oct. 9, 2018), <https://deq.nc.gov/news/deq-dashboard#animal-operations---swine-lagoon-facilities>; *see also Hurricane Florence*, *supra* note 23.

30. *See Animal Operations*, *supra* note 27.

31. The total number of hogs in North Carolina in 2018 was 9,100,000. *See 2018 State Agriculture Overview – North Carolina*, UNITED STATES DEP'T OF AGRIC. (2018), https://www.nass.usda.gov/Quick_Stats/Ag_Overview/stateOverview.php?state=NORTH%20CAROLINA. 8 trillion gallons of water was dumped on North Carolina by Hurricane Florence. Dividing that total gallons by the 9,100,000 hogs and 2,100 hog farms results in the allocation denoted above. For data on the total rainfall, see *Jason Samenow*, *supra* note 14. For an estimate as to the number of hog farms in North Carolina, see *Animal Facility Map*, *supra* note 12.

32. Jeffrey A. Soller, et. al., *Estimated human health risks from exposure to recreational waters impacted by human and non-human sources of fecal contamination*, 44 WATER

after previous record-breaking hurricanes, in 1999 and 2016, did not find impacts to the environment from hog farms.³³ After Hurricane Floyd in 1999, for example, widespread predictions of large fish kills caused by a variety of pollutants, including hog farms, were made. But they were proven to be incorrect. “(T)he massive fish kills never happened,” one post-storm assessment concluded, “and in fact, the shrimp fishery had its best year since the state began keeping such records in 1972”³⁴

After historic Hurricane Matthew in 2016, the NC Department of Environmental Quality (NC DEQ) conducted multiple rounds of surveys and sampling at multiple sites.³⁵ NC DEQ concluded:

After reviewing the data collected, and comparing that to precipitation amounts, river levels and known areas of flooding, the overall impacts of Hurricane Matthew on surface water quality were initially minimal and temporary, and the long-term effects appear to be similar to previous storms and long term historical conditions. While many eastern North Carolina areas were inundated by floodwaters and incidents of spills, breaches or waste facility shutdowns were reported, the amount of water discharged into the river basins resulted in a diluting effect, which primarily resulted in lower than normal concentrations of various pollutants.³⁶

Municipal waste plants often discharge raw human sewage directly into the waters of the state, in both periodic rain events and more significant storms.³⁷ These circumstances are the result of sanitary sewer overflows or direct bypasses of the treatment system itself.³⁸ It is generally expected that, in a hurricane with significant

RESEARCH J. 4674, 4674–91 (Sept. 2010), <https://www.sciencedirect.com/science/article/pii/S0043135410004367?via%3Dihub>.

33. See generally Joseph Luczkovich et. al., *The Effects of the Flood on the Water Quality and the Fishes of the Pamlico River Estuary*, in *FACING OUR FUTURE: HURRICANE FLOYD AND RECOVERY IN THE COASTAL PLAIN* 235–45 (John R. Maiolo et al. eds., 2001).

34. See David Herring, *Hurricane Floyd's Lasting Legacy: Assessing the Storm's Impact on the Carolina Coast*, NASA EARTH OBSERVATORY (Mar. 1, 2000), <https://earthobservatory.nasa.gov/features/FloydIntro> [<https://perma.cc/2VM7-B4KL>] “the massive fish kills never happened, and in fact, the shrimp fishery had its best year since the state began keeping such records in 1972.”

35. See NC ENV. QUALITY DEPT., *SURVEY OF SURFACE WATER QUALITY ASSOCIATED WITH HURRICANE MATTHEW, OCTOBER 2016 1* (2017).

36. *Id.* at 4.

37. See Mary Anna Evans, *Flushing the Toilet Has Never Been Riskier*, ATLANTIC (Sept. 17, 2015), <https://www.theatlantic.com/technology/archive/2015/09/americas-sewage-crisis-public-health/405541/>.

38. See Jennifer A. Dlouhy and Ari Natter, *Cities Swimming in Raw Sewage as Hurricanes Overwhelm Systems*, GOVERNMENT TECHNOLOGY: EMERGENCY MANAGEMENT

rainfall, there will be a discharge from such systems in the area impacted by the hurricane.³⁹ But it is not a certainty that a hog farm lagoon will release any contents into the waters of the state during a hurricane. By design and by law, farmers must maintain a “freeboard” of roughly 19 inches, precisely to protect the structural integrity of the lagoon and to absorb significant rain events.⁴⁰ In practice, lagoons are managed more conservatively. Moreover, if a hurricane is so severe that it is causing impacts to multiple hog farm lagoons, public officials and authorities understand that many municipal plants, affecting large populations of people, would in those circumstances also be experiencing severe difficulty in containing and treating human waste.

In Matthew, for example, about 15 farm lagoons were impacted.⁴¹ In contrast, the municipal systems experienced discharges of approximately 150 million gallons of raw sewage to the surface waters of the state.⁴² In Florence, NC DEQ reported that more than 200 wastewater treatment systems across the state were compromised, releasing at least 121 million gallons of sewage that flowed into streets, fields and waterways.⁴³

This is why, in the aftermath of Florence, NC DEQ Secretary Michael Regan said: “We are really focused on our wastewater treatment facilities because there are probably orders of magnitude more human waste that has escaped these wastewater treatment facilities than what has escaped these hog lagoons.”⁴⁴ In a briefing to state lawmakers, the director of the NC DEQ Division of Water Resources likewise emphasized that impacts from hog lagoons were minimal, characterizing discharges as consisting of mostly water from the storm while also emphasizing the enormous amount of rainwater that fell. “I am not sure why there is so much focus (on

(Sept. 13, 2017), <http://www.govtech.com/em/disaster/Cities-Wwimming-in-Raw-Sewage-as-Hurricanes-Overwhelm-Systems.html>.

39. *See id.*

40. *See Advisory on Hurricane Florence – Sept. 17 at 9 P.M.*, NC PORK COUNCIL (Sept. 17, 2019), <https://www.ncpork.org/advisory5/>.

41. *Hurricane Florence’s Impact on NC Hog Farms* (Oct. 10, 2018), <https://www.ncpork.org/buyout/>; *Hurricane Florence’s Impact on NC Hog Farms*, NC PORK COUNCIL (Oct. 10, 2018), <https://www.ncpork.org/buyout/>.

42. Kirk Ross, *Gauging Matthew’s Environmental Damage*, COASTAL REVIEW ONLINE (Dec. 2, 2016), <https://www.coastalreview.org/2016/12/gauging-matthews-environmental-damage/>.

43. John Murawski, *Hurricane Florence Bathed North Carolina in Raw Sewage. New Figures Show It Was Even Worse Than We Thought*, GOVERNMENT TECHNOLOGY: EMERGENCY MANAGEMENT (Sept. 13, 2017), <http://www.govtech.com/em/disaster/Hurricane-Florence-Bathed-North-Carolina-in-Raw-Sewage-New-Figures-Show-it-was-Even-Worse-than-we-Thought.html> (subsection titled “Emergency Management”).

44. Dan Way, *Municipal Sewage Overflows from Florence Dwarfed Hog Waste Discharges*, CAROLINA JOURNAL (Oct. 15, 2018, 2:08 AM), <https://www.carolinajournal.com/news-article/municipal-sewage-overflows-from-florence-dwarfed-hog-waste-discharges>.

animal facilities),” division director Jim Gregson told lawmakers in a November 2018 briefing. “Looks bad, but primarily what you’re seeing on inundated farms is storm water.”⁴⁵

The positive outcome for the farms under the severe stress of a record-breaking hurricane illustrates a disconnect between experts who have conducted evaluations, and the activist groups and mass media, which have tended to ignore science or offer distortions in advancing political goals and outcomes. It is instructive, then, to also understand that there is indeed a “past, present and future” of hog farming—which was an appropriate title for a recent panel discussion held at Florida State University’s College of Law.⁴⁶

I. THE NC PORK INDUSTRY: A BRIEF HISTORY LESSON

Farmers have been raising pigs in North Carolina since the earliest settlers arrived.⁴⁷ Today, North Carolina ranks second in the nation in pork production, raising approximately nine million pigs a year.⁴⁸ It wasn’t always that way.

Agriculture is a cornerstone of North Carolina’s economy—it still ranks as the state’s leading industry.⁴⁹ And tobacco was the leading driver, a cash crop that boosted the state’s fortunes for many generations, from markets in the East to factories and skyscrapers in the Piedmont. Churches, hospitals, universities, banks and all manner of civic infrastructure benefitted from tobacco production. Tobacco’s subsequent decline had serious implications for the North Carolina economy.⁵⁰ North Carolina leaders looked for ways to transform, leading to an emphasis on technology projects, but also a focus on livestock as a way to sustain economic conditions and agriculture in rural regions. One of those solutions was to foster a commercial swine industry and all its components: with grains grown in state, pig production on farms, and in-state processing

45. Statements by Jim Gregson in briefing the N.C. General Assembly on Nov. 23, 2018. Also see Sen. Andy Wells, co-chairman of Senate Appropriations Committee on Agriculture, Natural, and Environmental Resources, *Shooting at the Wrong Target*, ANDYWELLS.ORG (Dec. 10, 2018), <http://andywells.org/shooting-at-the-wrong-target/>.

46. *Hog Farming: Past, Present, and Future*, FLA. ST. UNIV. COLL. OF L., <https://law.fsu.edu/event/hog-farming-past-present-and-future> (last visited Feb. 6, 2019).

47. James R. Jones, *Hog Farming*, ENCYCLOPEDIA OF NORTH CAROLINA, (Jan. 1, 2006) <https://www.ncpedia.org/hog-farming>.

48. *Get the Facts*, NC FARM FAMILIES, <https://ncfarmfamilies.com/get-the-facts> (last visited Feb. 6, 2019).

49. *What Are North Carolina’s Major Industries?*, REFERENCE, <https://www.reference.com/geography/north-carolina-s-major-industries-edce40399877fadf> (last visited Feb. 6, 2019).

50. Ashita Gona, *Tobacco to Tomatoes: The Reinvention of North Carolina’s Agriculture*, ENVIRONMENTAL STORYTELLING (Dec. 9, 2014), <http://jomc565.web.unc.edu/2014/12/09/tobacco-to-tomatoes-the-reinvention-of-north-carolinas-agriculture>.

facilities. State leaders, especially Gov. Luther Hodges, who would later serve as U.S. Commerce Secretary under President Kennedy, as well as the N.C. Department of Agriculture and North Carolina State University,⁵¹ were instrumental in spurring the industry's growth. University leaders turned to science, technology and innovation to develop and foster new methods of hog farming. The goal was to successfully improve animal welfare and housing, address and enhance on-farm sanitation practices, improve food quality and safety, and to continue to feed a growing population. When Swift and Co. opened a processing facility at Wilson, N.C., in 1959, Hodges and a broad range of state leaders celebrated in person at the plant.⁵² At one point, Hodges stamped his feet into wet cement to commemorate the "footsteps of progress" underway.⁵³ The newspaper in nearby Rocky Mount, N.C., described the outpouring of interest as having "evoked more response from eastern North Carolina citizens than has ever before been given private enterprise."⁵⁴ Thousands stood in lines to tour the plant in an open house.⁵⁵ "The foundation for significant economic advancement has been laid," the governor told a large crowd. He noted there was "rejoicing" that the world's largest meat processing company had decided to build its largest processing plant in eastern North Carolina.⁵⁶

"The job now," Hodges said, "is to build on that foundation – to ensure that no facet of this opportunity is overlooked, to make absolutely certain that both the company and the people who stand to benefit from its presence here, take maximum advantage of the opportunity that is now available."⁵⁷ Leaders in the state did build. N.C. State University constructed swine units and showcased ways to improve animal housing and welfare, with indoor barns, and to better treat manure with the innovative lagoon system. A series of trials and studies, reflective of the innovative process, were undertaken. Log books show that thousands of farmers and community leaders toured the demonstration units. In the 1970s, amid implementation of the Clean Water Act provisions, the U.S.

51. Luther Hodges, *Commerce Secretary and North Carolina Governor, Dead*, N.Y. TIMES (Oct. 7, 1974), <https://www.nytimes.com/1974/10/07/archives/luther-hodges-commerce-secretary-and-north-carolina-governor-dead.html>.

52. Jim Nichols, *New Meat Processing Plant Holds Open House in Wilson*, ROCKY MOUNT TELEGRAM, Apr. 19, 1959, at 1A.

53. *Id.* at 2A.

54. *Id.* at 1A.

55. *Id.*

56. Luther Hodges, *Address at Swift and Company Plant Dedication*, N.C. ST. LIBRARY 147 (Apr. 18, 1959), https://archive.org/stream/messagesadresse03hodg/messagesadresse03hodg_djvu.txt.

57. *Id.*

Environmental Protection Agency verified the lagoon system as a non-discharge treatment system, meaning no waste from the farms is released into local rivers or streams.⁵⁸ The systems in use on farms today continue to be permitted as non-discharge systems.⁵⁹ From the late 1960s to the end of the 1980s, the standing stock of swine in the state grew by more than 1 million head, a 76 percent increase in the period.⁶⁰ As North Carolina farmers began raising more pigs, the state looked for ways to continue to grow the industry, particularly following the early 1980s recession, which had deep impacts on farms across the nation.⁶¹ Following “aggressive” recruitment of food processing facilities by then Gov. James Martin, officials approved a new pork processing plant at Tar Heel, N.C., in the late 1980s.⁶² The industry thus experienced a new wave of rapid expansion in the late 1980s and into the 1990s, fueled in part by the opening of the plant in Tar Heel in 1992.⁶³ The number of pigs raised in North Carolina tripled from the mid 1980s to the mid 1990s.⁶⁴ And with that growth, came questions—and a catastrophe.⁶⁵ In June 1995, a month with significant and persistent rainfall, the lagoon structure on a farm in Onslow County failed, spilling its contents to the New River.⁶⁶ Approximately 2,000 fish were killed.⁶⁷ Other lagoon failures were reported in 1995, and heavy rains filled many more lagoon basins to the brim.⁶⁸

58. *Principles of Design and Operations of Wastewater Treatment Pond Systems for Plant Operators, Engineers, and Managers* 6–2 U.S. ENVTL. PROT. AGENCY, EPA/600/R-11/088 (Aug. 2011), <https://www.epa.gov/sites/production/files/2014-09/documents/lagoon-pond-treatment-2011.pdf>.

59. See N.C. Env'tl. Mgmt. Comm'n Dept. of Env't and Nat. Res. Swine Waste Management, General Permit, <https://files.nc.gov/ncdeq/Water%20Quality/Aquifer%20Protection/AFO/Permits/AWG100000%20Signed%203-7-2014.pdf> (last visited Apr. 29, 2019).

60. Michael D. Thompson, *This Little Piggy Went to Market: The Commercialization of Hog Production in Eastern North Carolina from William Shay to Wendell Murphy*, 74 *AGRIC. HIST.* 569, 576 (2000).

61. See Brad Haire, *What history can teach us about today's farm recession*, *SOUTHEAST FARM PRESS* (Mar. 15, 2017), <https://www.farmprogress.com/business/what-history-can-teach-us-about-today-s-farm-recession>.

62. Andy Curliss, *The Truth About... Why Hog Farms are in Eastern North Carolina*, *BEYOND BACON BLOG* (Apr. 2, 2018), <https://www.ncpork.org/truth-hog-farms-eastern-north-carolina/>.

63. See USDA APHIS, *PIGS* (last visited Feb. 3, 2019), https://www.aphis.usda.gov/animal_health/emergingissues/downloads/1pigs.pdf (last visited Feb. 3, 2019).

64. See Owen J. Furuseth, *Hog Farming in Eastern North Carolina*, 41 *SOUTHEASTERN GEOGRAPHER* 53, 56 (2001).

65. See *id.* at 54.

66. Thompson, *supra* note 57 at 569.

67. Calvin Harmin, *Flood Vulnerability of Hog Farms in Eastern North Carolina* (Nov. 11, 2015) (unpublished M. thesis, East Carolina University) (on file with East Carolina University).

68. Estes Thompson, *Hog Waste Spills Top N.C. Story*, *THE ASSOCIATED PRESS* (Dec. 30, 1995) https://www.greensboro.com/hog-waste-spills-top-n-c-story/article_863fb95c-86df-52f3-bdff-0725df30542b.html.

The Onslow County spill generated national media attention and galvanized critics of the industry, who cast the lagoon failure as a systemic failure involving an industry with no oversight.⁶⁹ In fact, it was not a systemic failure.⁷⁰ State investigation concluded that the farming operation had not followed its certified animal waste management plan.⁷¹ The operation had not set aside a proper amount of land to receive the treated nutrients from the lagoon. And the structure's walls were weakened by construction of pipes built into them.⁷² It was a site-specific failure.⁷³

But a new era was underway.⁷⁴ A state commission was created to study possible regulations.⁷⁵ In 1996, lawmakers enacted a series of reforms that included (1) the establishment of general permit requirements for farms with more than 250 animals, (2) requirements for a certified animal waste management plan, (3) requirements for annual inspections on the farms by regulators, (4) requirements that farm operators meet continuing education requirements, (5) increases to civil penalty amounts, and (6) the establishment of larger setback requirements from neighboring properties.⁷⁶

The changes were profound, constituting full regulation of the industry. The general permit requirement, in place to this day, includes a range of embedded regulations. These include a plan for properly utilizing manure as a natural fertilizer. In 1997, lawmakers placed a moratorium on new swine operations that was later made permanent.⁷⁷

By 2000, consolidation provided Smithfield Foods of Virginia with a substantial ownership position of swine in the state.⁷⁸ The company entered into a voluntary agreement with the state's Attorney General to conduct research into "environmentally

69. See *Huge Spill of Hog Waste Fuels an old Debate in North Carolina*, N.Y. TIMES (June 25, 1995), <https://www.nytimes.com/1995/06/25/us/huge-spill-of-hog-waste-fuels-an-old-debate-in-north-carolina.html>.

70. See John Warrick & Stuart Leavenworth, *Waste Spill Revives Hog Legislation*, NEWS & OBSERVER OF RALEIGH, N. C., June 25, 1995.

71. *Id.*

72. *Id.*

73. See *id.*

74. See *id.*

75. John Warrick, *Hog Waste Spill Fouls Land, River in Onslow*, THE NEWS & OBSERVER OF RALEIGH, N. C., June 23, 1995.

76. David A. Krouse, *The Evolution of Animal Waste Management Regulations in North Carolina*, NORTH CAROLINA STATE UNIVERSITY, <https://p2infohouse.org/ref/21/20544.htm> (last visited Feb. 3, 2019).

77. ANCHOR, *Key Industries: Hog Farming*, <https://www.ncpedia.org/anchor/key-industries-hog-farming> (last visited Jan. 30, 2019).

78. Jakon Hays & Maureen Watts, eds., *Timeline: The History of Smithfield Foods*, VIRGINIAN-PILOT (May 29, 2019), https://pilotonline.com/business/article_a2a34b25-aeb2-5d29-ab26-54094bb62bfd.html.

superior” technologies, with a pledge to implement such technologies if they are found to be operationally, technically and economically feasible.⁷⁹ None to date have met those criteria, even as more than \$20 million has been spent in a broad range of trials.⁸⁰

This approach underscores an important point: policymakers and the public recognize the importance of the industry to the economy of the state.⁸¹ It is understood that any changes must be in accord with the accepted definition of “sustainable,” which recognizes a triple-bottom line approach that includes profitability and economic success together as an important pillar of sustainability.⁸² At that same time, through a variety of state and federal programs and with support of the North Carolina Pork Council—a trade association that represents the industry—a program was begun to close lagoons in the 100-year flood plain.⁸³ To date, roughly 330 lagoons have been closed.⁸⁴ The number of lagoons that remain at an elevation in the flood plain is now very small, as the results in Hurricane Florence in 2018 and in Hurricane Matthew in 2016 have shown.⁸⁵ Photographs distributed in mass media that focus on hog farms or lagoons tend to bear this point out, showing flooded farms but with the lagoon intact and performing as engineers designed.⁸⁶

79. *Id.*

80. Smithfield provided \$15 million to NCSU projects, and has spent far more in other projects. See *The Agreement*, ANIMAL AND POULTRY WASTE MANAGEMENT CENTER, NC STATE UNIVERSITY, https://projects.ncsu.edu/cals/waste_mgt/smithfield_projects/smithfieldsite.htm. Additionally, Smithfield has recently announced a joint venture that includes a \$125 million investment. See *A Powerful Partnership*, ALIGN, <https://www.alignrng.com/?carousel=4>.

81. Timothy F. Slaper & Tanya J. Hall, *The Triple Bottom Line: What Is It and How Does It Work?*, IND. BUS. REV., <http://www.ibrc.indiana.edu/ibr/2011/spring/article2.html> (last visited Jan. 30, 2019).

82. *Id.*

83. N.C. DEP'T AGRIC. & CONSUMER SERV., *Swine Floodplain Buyout*, <http://www.ncagr.gov/SWC/easementprograms/SwineFloodplainBuyout.html> (last visited Jan. 30, 2019).

84. WRAL NEWS, *More than 2 dozen hog lagoons damaged or overflowed, dozens more on edge* (Sept. 18, 2018) <https://www.wral.com/more-than-2-dozen-hog-lagoons-damaged-or-overflowed-dozens-more-close/17853335/>.

85. Compare NC PORK COUNCIL, *Hurricane Florence's Impact on NC Hog Farms* (Oct. 10, 2018) <https://www.ncpork.org/florenceimpact/>, and NC PORK COUNCIL, *Hurricane Matthew impact was minimal for our industry, and buyout program continues* (Sept. 11, 2018), <https://www.ncpork.org/buyout/>, with Peter T. Kilborn, *Hurricane Reveals Flaws in Farm Law as Animal Waste Threatens N. Carolina Water*, N.Y. TIMES (Oct. 17, 1999), <https://www.nytimes.com/1999/10/17/us/hurricane-reveals-flaws-in-farm-law-as-animal-waste-threatens-n-carolina-water.html>.

86. *E.g.*, Kris Maher & Ben Kesling, *Florence Flooding Hits North Carolina Hog Farms Hard*, WALL ST. J. (Sept. 19, 2018), <https://www.wsj.com/articles/florence-flooding-hits-north-carolina-hog-farms-hard-1537398585>.

Today, North Carolina hog farms comply with the most stringent regulations in the nation.⁸⁷ While issues still occasionally arise, they are the result of a circumstance at the individual farms—not a systems problem as some may suggest.⁸⁸ The moratorium on new construction has helped to illustrate this.⁸⁹ With no new farms in two decades, and continuous use of best management practices, NC DEQ reports extremely high compliance with the implemented rules and regulations.⁹⁰

II. STRIVING INTO THE FUTURE

Agriculture faces tremendous challenges moving forward: to produce more food to feed a growing world population with more income and to do so while utilizing fewer resources.⁹¹

The National Academy of Sciences, in its landmark consensus report, “Toward Sustainable Agriculture in the Twenty-First Century,” defined a framework of sustainability that rests on four key components: “(1) producing enough to satisfy human needs, (2) enhancing environmental quality and protecting the natural resource base, (3) being profitable, and (4) increasing the quality of life for farmers, farm workers, and society as a whole.”⁹² The report outlines approaches both incremental and transformative.⁹³

The pork industry in the United States is at the forefront, among agricultural commodities, of both embracing and studying these approaches. Much has happened already, including ongoing efforts to ensure nutrients produced by livestock are recycled to maximum

87. See generally *c.f.* U. MICH., *Environmental Case Study: Hog Farming in North Carolina*, <http://umich.edu/~snre492/statter.html> (last visited Jan. 30, 2019).

88. See ENVTL. & ENERGY STUDY INST., *Stink, Swine, and Nuisance: The North Carolina Hog Industry and its Waste Management Services* (Aug. 10, 2018), <https://www.eesi.org/articles/view/stink-swine-and-nuisance-the-north-carolina-hog-industry-and-its-waste-management-services> (suggesting regulation is the problem).

89. Joe Vansickle, *North Carolina Extends Moratorium Again*, NAT'L HOG FARMER (Jul. 15, 2001), https://www.nationalhogfarmer.com/mag/farming_north_carolina_extends.

90. See NPC PORK COUNCIL, *Regulations*, <https://www.ncpork.org/responsibility/regulations/> (last visited Jan. 30, 2019); see also *AFO Program Summary*, NORTH CAROLINA DEPARTMENT OF ENVIRONMENTAL QUALITY, <https://deq.nc.gov/about/divisions/water-resources/permits/wastewater-branch/animal-feeding-operation-permits/afo-program-summary>; see also Christine Lawson, *DEQ monitors hog farm operations*, THE NEWS & OBSERVER, <https://www.newsobserver.com/opinion/letters-to-the-editor/article91985822.html>.

91. See generally FOOD & AGRIC. ORG. UNITED NATIONS, *How to Feed the World in 2050* (Oct. 12-13, 2009), http://www.fao.org/fileadmin/templates/wsfs/docs/expert_paper/How_to_Feed_the_World_in_2050.pdf (describing the problem of population growth and food supply).

92. NAT'L ACAD. SCI., et al., *Toward Sustainable Agricultural Systems in the 21st Century* (2010), <https://www.nap.edu/resource/12832/Systems-Ag-Report-Brief.pdf> (last visited Jan. 30, 2019).

93. *Id.*

benefit. Compared with the 1960s, hog farmers today are using 75 percent less land, 25 percent less water, and 7 percent less energy on average to produce pork, according to a 2018 report by researchers at the University of Arkansas.⁹⁴ There has been a decrease as well in global warming potential from pork production, of about 7 percent.⁹⁵ The report cites a wide range of factors that contributed to these positive changes, including improved feed conversion, higher crop yields, and the indoor production environment.⁹⁶

Advances in feed conversion and rationing are generally unnoticed and attract little attention in mass media. But the advances are remarkable. In past decades, more than 4 pounds of feed would be required to generate 1 pound of pork.⁹⁷ That ratio today has been reduced substantially. Now, generally speaking, it takes about 2.5 pounds of feed to generate 1 pound of pork.⁹⁸ This has been accomplished with better understanding of rationing and nutrition as well as selective breeding advances.⁹⁹ Dr. Terry Coffey, Smithfield's chief science and technology officer, has been involved in the company's ongoing efforts to improve feed conversion and nutrition for more than 30 years.¹⁰⁰ He recognizes there has been a resulting positive outcome on the lagoon treatment system from feed conversion advances. "If it takes less pounds of feed to produce a pound of pork, then there's less waste that goes into the barns, that goes into the lagoon," Dr. Coffey has said. "We also know that if we can formulate the feed differently to reduce the excess protein in the diet, it will reduce nitrogen in the waste."

In North Carolina, the inventory of pigs and hogs peaked in 2003 at about 10 million head. Since then, the size of the herd has been

94. See Ben Putnam et al., *A Retrospective Assessment of US Pork Production: 1960 to 2015: Final Report*, UNIVERSITY OF ARKANSAS (July 7, 2018), https://cpb-us-e1.wpmucdn.com/wordpressua.ark.edu/dist/1/446/files/2019/01/Final_Report-1mgj3oo.pdf.

95. Ben Putnam, Jacob Hickman, Prathamesh Bandekar, Marty Matlock and Greg Thoma, *A Retrospective Assessment of the U.S. Pork Industry, 1960 to 2015*, UNIVERSITY OF ARKANSAS (July 7, 2018), <https://bit.ly/2H1jja>. The report cites a wide range of factors that contributed to these positive changes, including improved feed conversion, higher crop yields, and the indoor production environment. In North Carolina, since 1980, our farmers are feeding a growing population while using 60.1 percent less land and 44.8 percent less water.

96. *Id.*

97. See David R. Stender, *Swine Feed Efficiency: Influence of Market Weight*, Iowa St. Univ., <https://web.archive.org/web/20150909053400/http://www.swinefeedefficiency.com/factsheets/IPIC25h%20SFE%20Influence%20of%20Market%20Weight.pdf> (last visited Jan. 30, 2019).

98. See Peter J. Lammers et al., *Niche Pork Production*, IOWA ST. UNIV. (2007) <https://www.ipic.iastate.edu/publications/ipicnpp.pdf>.

99. See generally Putnam, *supra* note 94.

100. See Richard J.M. Poulson et al., *Meeting Consumers' Expectation for Quality and Safety of Pork Products*, U.S. DEPARTMENT OF AGRICULTURE (Feb. 21-22, 2002), <http://ageconsearch.umn.edu/bitstream/33494/1/fo02co01.pdf>.

reduced significantly to a current standing size of about 9 million head. Additionally, it should be noted that at any point in time, more than 3 million pigs, or nearly one-third of the standing stock in the state, weigh under 50 pounds and, thus, produce substantially less manure than is often characterized in the public discourse. Roughly 60 percent of the standing stock is under 120 pounds in weight at any point in time. Likewise, market hogs of 180 pounds in size or greater generally account for fewer than 20 percent of the standing stock in the state at any point in time.¹⁰¹

The focus on sustainable agriculture is occurring on a range of other fronts, involving a broad set of integrated pork production companies and pork producers, from croplands to the feed mills all the way back to the farm. If there is to be continued success and improvement, this is where it will occur. Additionally, a range of production methods are widely in use in the state, and systems in North Carolina meet the highest standards for welfare and other production and farming practices.

Smithfield, as one example, has partnered with the Environmental Defense Fund to develop a plan to reduce its greenhouse gas emissions by 25 percent by 2025, a project that extends throughout the value chain.¹⁰² More recently, Smithfield announced plans to implement “manure-to-energy” projects across 90 percent of its finishing farms in North Carolina and Utah over the next decade, and interest is high across the industry.¹⁰³ The approach by Smithfield, with an announced financial commitment of \$250 million in a joint venture with Dominion Energy, involves covering anaerobic treatment lagoons or digesters to capture biogas.¹⁰⁴ This renewable natural gas will then be transported to processing facilities and distributed throughout the pipeline, powering homes and businesses with a new source of energy.¹⁰⁵

101. See USDA, QUARTERLY HOGS AND PIGS (2018), https://www.nass.usda.gov/Publications/Todays_Reports/reports/hgpg1218.pdf.

102. See *Smithfield Addresses the Hog Industry's Vulnerability to Climate Change*, ENVTL. DEF. FUND (Oct. 25, 2018), <https://www.edf.org/media/smithfield-addresses-hog-industrys-vulnerability-climate-change>; see also Press Release, Globe Newswire, Smithfield Food Announces Landmark Investment to Reduce Greenhouse Gas Emissions (Oct. 25 2018), <https://www.smithfieldfoods.com/newsroom/press-releases-and-news/smithfield-foods-announces-landmark-investment-to-reduce-greenhouse-gas-emissions>.

103. *Smithfield Expands 'Manure-to-Energy' Projects to Three States*, NAT'L HOG FARMER (Oct. 26, 2018), <https://www.nationalhogfarmer.com/business/smithfield-expands-manure-energy-projects-three-states>.

104. *Dominion Energy and Smithfield Foods Partner to Transform the Future of Sustainable Energy*, SMITHFIELD FOODS: SMITHFIELD NEWSROOM (Nov. 27, 2018), <https://www.smithfieldfoods.com/newsroom/press-releases-and-news/dominion-energy-and-smithfield-foods-partner-to-transform-the-future-of-sustainable-energy>.

105. *Id.*

North Carolina has already experienced demonstrated success from these types of renewable energy projects, and the pork industry has been a leader in this regard.¹⁰⁶ The largest project, called Optima KV, captures methane at five farms in Duplin County and generates enough renewable natural gas to power 1,000 homes.¹⁰⁷ The project will soon be expanded to include an additional cluster of nearby farms.

These efforts represent approaches both incremental and transformative, and they demonstrate that a progressive pork industry in North Carolina is proactively moving toward a future that recognizes an ongoing commitment to continuously improve in areas of food safety, animal welfare, environmental stewardship, public health, employee relations and support for our communities.

Indeed, much has been done. There's more to come.

106. See NC PORK REPORT (*Summer 2014 and Winter 2017 issues*), <https://www.ncpork.org/news/pork-report/>

107. *The Next Evolution in Agricultural Biogas – The OPTIMA-KV Pipeline Renewable Natural Gas Project*, CAVANAUGH, <http://www.cavanaugholutions.com/bioenergy/projects/optima-kv/> (last visited Feb. 9, 2019).

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