SUSTAINABLE PRODUCTION OF SWINE: PUTTING LIPSTICK ON A PIG?

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I. INTRODUCTION

The term "sustainability" entered the mainstream of public discourse in 1987 with the publication of the Brundtland Commission report. That report defined sustainability as development that "meets the needs of the present without compromising the ability of future generations to meet their own needs."[1] Implicit in the term is the recognition that human development and patterns of consumption are depleting the world's natural resources and must be changed to ensure that those resources remain available—not just for future generations, but also for our own.

But what exactly do we mean by sustainability, especially in the agricultural context? Our farmers are producing more food than ever before.[2] But are the practices that we use to grow, process, prepare, and transport the foods we eat sustainable? As the Brundtland Commission recognized in its chapter on food security, "increases in food production are undermining the base for future production."[3] We must therefore examine the means of production, assessing the "whole farm" in terms of its environmental and agronomic impacts, balanced with economic factors.[4]

While the concept of agricultural sustainability has thus far eluded distillation to a finite set of practices or technologies, common themes have emerged: "to be sustainable, agriculture must be 1) economically viable, 2) ecologically sound, 3) socially responsible, and 4) humane."[5] It is a "societal goal," characterized by the use of renewable resources, protection of natural resources, and improvement of quality of life that also generates profit, considers the long-term good of all members of the community, and

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† I would like to extend my thanks to Kelly Leong, Reference Librarian at Duke University School of Law, for her research assistance, and to the *Vermont Law Review* for the opportunity to talk and write about this critical intersection of agricultural and environmental policies.

1. U.N. Comm. on Env't and Dev., *Our Common Future, overview*, ¶ 27, U.N. Doc. A/42/427 (March 1987).
2. *Id.* at ¶ ¶ 2, 5.
3. *Id.* at ch. 5, ¶ 1.
4. *See* C.A. Rotz et al., *Environmental and Economic Comparisons of Manure Application Methods in Farming Systems*, 40 J. ENVTL. QUAL. 438, 439 (2011) (proposing whole-farm simulation as a tool for evaluation).
5. FRANCIS THICKE, A NEW VISION FOR IOWA FOOD AND AGRICULTURE 33 (2010).

produces nutritious and wholesome food.[6] It is a systems approach that explores the interconnections between individual farms and the broader ecosystem.[7] Even Congress has weighed in, directing the United States Department of Agriculture (USDA) to create a research program and guidelines for sustainable agriculture and defining the concept as:

> An integrated system of plant and animal production practices having a site-specific application that will, over the long-term—
> (A) satisfy human food and fiber needs;
> (B) enhance environmental quality and the natural resource base upon which the agriculture economy depends;
> (C) make the most efficient use of nonrenewable resources and on-farm resources and integrate, where appropriate, natural biological cycles and controls;
> (D) sustain the economic viability of farm operations; and
> (E) enhance the quality of life for farmers and society as whole.[8]

As noble as the goal of sustainability may be, it has led to surprising debates,[9] perhaps because it signals an intentional and stark rejection of the practices that characterize conventional production of agricultural products. These practices have been roundly criticized in popular media, and the meteoric popularity of local Farmers' Markets—many of which impose strict limits on the geographic radius within which the farm must be located, the size of farms eligible for membership, and the growing practices employed—has empowered the ranks of those who refused to "get big or get out" and challenged the conventional wisdom that farmers are price "takers" rather than price "makers."[10]

This Article examines hog production through this lens. The first two parts of this article provide an overview of the production of hogs for food,

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6. *See, e.g.* John M. Gerber, *Principles of Agricultural Sustainability* (1990), http://www.umass.edu/umext/jgerber/principl.htm (discussing principles of agricultural sustainability).

7. Sustainable Agric. Coal., *What is Sustainable Ag?,* SUSTAINABLEAGRICULTURE.NET, http://sustainableagriculture.net/about-us/what-is-sustainable-ag/ (last visited Apr. 7, 2013).

8. 7 U.S.C. § 3103(18) (2006).

9. *See generally* H.R. 1094, 2011 Gen. Assemb., Reg. Sess. (N.C. 2012), *available at* http://www.ncleg.net/Sessions/2011/Bills/House/PDF/H1094v1.pdf (discussing removal of the word "sustainable" from the title of a bill); Under the Dome, *Don't Call it 'Sustainable'*, NEWSOBSERVER.COM (June 5, 2012), http://projects.newsobserver.com/under_the_dome/dont_call_it_sustainable; AGENDA 21, *available at* http://agenda21conspiracy.com/ (referring to Agenda 21 and its principle of sustainability as a U.N. "blueprint for depopulation and total control").

10. *See, e.g.*, FOOD, INC. (Magnolia Pictures 2008) (portraying conventional agricultural production in a negative light); MICHAEL POLLAN, THE OMNIVORE'S DILEMMA 10–11, 52 (2006) (discussing how the food industry has caused us to lose touch with the food we eat).

from its history to the advent of production through Concentrated Animal Feeding Operations, or CAFOs. The third Part examines the question of the modern industry's sustainability through environmental, public health, and economic lenses, and concludes that the current model of production in CAFOs is unsustainable from any perspective. The fourth Part provides an overview of the legal structures that have failed to mitigate the industry's environmental impact. The fifth Part examines and compares two different paths that have emerged in an effort to put the production of hogs on a sustainable path: the use of advanced treatment technologies, and a counter movement back to small-scale production. The final Part of the Article offers a brief overview of policies and regulatory changes necessary to support a sustainable model of production.

II. A BRIEF HISTORY OF PORK PRODUCTION IN THE UNITED STATES

Hog farming has long been a part of the rural landscape in the United States. Hogs were first domesticated in China around 4900 B.C.; they were introduced to what is now Florida by Hernando de Soto in 1539, and to Jamestown by Sir Walter Raleigh in 1607.[11] It was common for farmers to keep a few hogs—they ate scraps from the table, leftovers from the harvest of crops, and foraged in the woods for acorns and nuts.[12] These free-ranging animals dropped their manure in the woods and on fallow pastures, and the relatively low numbers of animals across the landscape allowed the soil to absorb the nutrients. In the fall, the hogs were brought in for slaughter, earning the farmer some extra cash and some meat for the winter months.[13]

The development of the refrigerated train car encouraged more concentrated and centralized production of swine, with hog production, slaughtering and processing concentrated in the upper mid-west, proximate to where the grain was grown.[14] Then, in 1971, Earl Butz became the Secretary of the USDA and ushered in a new era of agricultural policy that emphasized the production of commodity crops, advising farmers to "get big or get out."[15] This directive and the associated shift in federal funding priorities for agricultural production led to surplus production—and falling

11. Mick Vann, *A History of Pigs in America*, AUSTIN CHRON., (April 10, 2009), http://www.austinchronicle.com/food/2009-04-10/764573/ (discussing the origins and history of pig farming in the United States).

12. *See generally* Daniel W. Gade, *Hogs*, THE CAMBRIDGE WORLD HISTORY OF FOOD II.G.13 (Kenneth F. Kiple & Kreimhild C. Ornelas, eds., 2000), *available at* http://www.cambridge.org/us/books/kiple/ hogs.htm (discussing the history of pigs in America).

13. *Id.*

14. Vann, *supra* note 11.

15. *See* Tom Philpott, *A Reflection on the Lasting Legacy of 1970s USDA Secretary Earl Butz*, GRIST.ORG (Feb. 8, 2008, 1:31 AM), http://grist.org/article/the-butz-stops-here/.

prices—of commodity crops such as corn and soybeans.[16] Butz's policies "encourage[ed] the growth of corporate factory-farms and increase[ed] subsidised production of staples for export."[17]

The abundance of cheap grain fueled changes in food production and animal production methods. The numbers of CAFOs—industrial-scale feedlots in which large numbers of animals are brought into enclosed areas for feeding and watering—exploded, and "[a]n increasingly consolidated meat industry learned to transform cheap grain into cheap—but highly profitable—burgers, chops, and chicken nuggets."[18]

While most of the U.S. population was unaware of and unaffected by these changes, lawmakers in the Midwest were confronting demands to address nuisance conditions that these new production practices created. Concerns about insects, dust blowing off bare land, the dumping of manure into lakes, and the disposal of dead animals raised serious concerns.[19] Testimony about the extent and magnitude of these problems led Congress to include CAFOs in its definition of "point source" under the federal Clean Water Act—the only industry to be singled out in the entire statute.[20]

Since that time, the number of farms raising hogs has been in steady decline, although the number of hogs produced has continued to rise. "Between 1982 and 1997, the number of animal feeding operations in the United States decreased by 51 percent, while livestock production increased 10 percent. In some areas, even greater changes in concentration have occurred."[21]

For example, in North Carolina, the number of hogs produced in the state jumped from 2.4 million in 1986 to more than 10 million in 1998,[22] when a moratorium was imposed on the construction of new hog farms and expansion of existing farms.[23] During that same time, the number of farming operations fell from 15,000 to 5,800,[24] and current reports indicate

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16. *Id.*

17. Michael Carlson, *Earl Butz: US politician brought down by racist remark*, Obituary, THE GUARDIAN (Feb. 3, 2008), http://www.guardian.co.uk/world/2008/feb/04/usa.obituaries.

18. Philpott, *supra* note 15.

19. *See* Bills Amending the Federal Water Pollution Control Act and Other Pending Legislation relating to Water Pollution Control, Kansas City, MO, Serial no. 92-H11 (April 2, 1971).

20. 33 U.S.C. § 1362(14) (2006).

21. AD HOC COMM. ON AIR EMISSIONS FROM ANIMAL FEEDING OPERATIONS *ET AL.*, AIR EMISSIONS FROM ANIMAL FEEDING OPERATIONS: CURRENT KNOWLEDGE, FUTURE NEEDS 17 (2003), *available at* http://www.nap.edu/catalog/10586.html (citation omitted).

22. The number of farms with more than 1,000 hogs controlled nearly 98% of the inventory. *Hog Farming*, *North Carolina in the Global Economy*, DUKE UNIV. DEP'T OF SOCIOLOGY, http://www.soc.duke.edu/NC_GlobalEconomy/hog/overview.shtml (last updated Aug. 23, 2007)

23. H.R. 458, 1997 Gen. Assemb., Reg. Sess., (N.C. 1997), *amended by* H.R. 188, 1998 Gen. Assemb., Reg. Sess. (N.C. Sess. 1998).

24. *North Carolina in the Global Economy*, *supra* note 22.

that the number has declined even further, to fewer than 2,500.[25] Nationwide, the trends in concentration have continued, with increases in the number of operations housing more than 5,000 hogs and declines in the number of operations housing fewer than 5,000.[26]

Concomitant with concentration in animal production is concentration in manure production, an aspect of factory farming that has captured the public's and lawmakers' attention. As farms have become bigger and more specialized, animal production has become separate from crop production, severing the cycling of nutrients that took place on smaller diversified farms.[27] A farm with 10,000 hogs produces prodigious amounts of manure,[28] and conventional waste management practices, in which the waste is mixed with water into a slurry and stored in open cesspools, make it messy and expensive to transport the manure to the farms on which crops are grown.[29] An imbalance results: Nutrients are shipped to the animals in the form of feed, but the nutrients contained in the animals' excreta are maintained at the CAFO. Moreover, the storage and disposal of such large volumes of minimally treated manure creates tremendous problems for neighbors, and the measures required to raise animals in such confined quarters create public health problems of their own. The following section chronicles some of these concerns.

III. WHAT IS A CAFO?

In the United States, most hogs raised for food are raised in CAFOs,[30] a term employed in the federal Clean Water Act (CWA) to identify a specific type of food animal production facility that is subject to regulation as a "point source" under that title.[31] The CWA defines a "large" CAFO as a facility in which more than 1,000 "animal units" (i.e., 2,500 hogs each

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25. *Id.*

26. USDA, NAT'L AGRIC. STATISTICS SERV. (NASS), OVERVIEW OF THE U.S. HOG INVENTORY 1 (2009), a*vailable at* http://usda01.library.cornell.edu/usda/current/hogview/hogview-10-30-2009.pdf.

27. Ellen K. Silbergeld et al., *One Reservoir: Redefining the Community Origins of Antimicrobial-resistant Infections,* 92 MED. CLINICS N. AM 1391, 1392 (2008).

28. *Id.* at 1399.

29. *Id.*

30. AD HOC COMM., *supra* note 21, at 31. Many types of food animals are raised in CAFOs in the United States, including hogs, poultry, sheep, cattle and cows. In other countries, other types of animals—including dogs and horses—are raised in CAFOs. *See* HAL HERZOG, SOME WE LOVE, SOME WE HATE, SOME WE EAT: WHY IT'S SO HARD TO THINK STRAIGHT ABOUT ANIMALS 186 (2011) (discussing dog meat).

31. 33 U.S.C. § 1362(14).

weighing more than fifty-five pounds)[32] are confined, and fed or maintained, for a minimum of forty-five days within a twelve-month period, and at which crops are not sustained in the confinement area.[33] The legal definition refers only to the size of the operation and does not include the practices employed to manage, treat or dispose of the waste produced by the animals.

In lay terms, the term CAFO refers to a livestock operation in which animals are bred and raised in confinement, usually in long metal buildings that hold up to 800–1,200 growing pigs.[34] A typical farm will have two to six (or even more) stocked buildings.[35] The living quarters are tight: the pigs are allotted seven to eight square feet of space each, and no bedding is provided. Typically, the animals spend the duration of their lives in the CAFO, with production practices aimed to facilitate rapid growth and shorten the time from birth to slaughter. Such practices extend from selective genetics[36] to the regular application of antibiotics to suppress disease and accelerate growth.[37]

"In most modern commercial swine operations, pigs are raised in ventilated barns with slatted floors"[38] made of concrete. The floors are slatted to allow manure and urine to fall and collect in large underground storage pits. In some collection systems, the manure is stored up to several months between cleanings; in "flush" systems, pumped water is used to remove collected manure several times per day.[39] The collected waste is transferred, via gravity of flush water, into "lagoons," open-air retention ponds several acres in size that store millions of gallons of waste.[40] Older lagoons are not lined,[41] but current guidelines published by the Natural

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32. 40 C.F.R. § 122.23(b)(4)(iv) (2012). The actual number of animals varies depending on species. For hogs, the number also varies depending on the animals' stage of growth. For example, for farrowing operations (nurseries), the regulatory limit for categorization as a "large" CAFO is 10,000 hogs each weighing less than 55 pounds. *Id.* § 122.23(b)(4)(v). *See* 40 C.F.R. § 122.23(b)(4)(i)–(xiii) (2012) (defining CAFO sizes for different types of animals).

33. 40 C.F.R. § 122.23(b)(1)(i)–(ii).

34. AD HOC COMM., *supra* note 21, at 37.

35. *Id.*

36. *See, e.g.,* SMITHFIELD FOODS, INC., 2012 INTEGRATED REPORT (discussing genetics of hogs).

37. Silbergeld, *supra* note 27, at 1394 (citing Charles P. Gerba & James E. Smith Jr., *Sources of pathogenic microorganisms and their fate during land application of wastes*, 34 J ENVTL QUALITY 42 (2005)).

38. Smithfield Foods, Inc., *Our Commitments: Air Quality* (Dec. 31, 2012), http://smithfieldcommitments.com/core-reporting-areas/environment/compliance/air-quality/#callout-9.

39. *Id.*

40. *Id.*

41. These unlined lagoons are a significant contributor to groundwater contamination. *See* R.L. Huffman & P.W. Westerman, *Estimated Seepage Losses from Established Swine Waste Lagoons in the Lower Coastal Plain of North Carolina*, 38 TRANSACTIONS OF THE ASAE 449 (1995); P.W. Westerman *et al.*, *Swine-lagoon Seepage in Sandy Soil*, 38 TRANSACTIONS OF THE ASAE 1749, 1749 (1995).

Resources Conservation Service (NRCS) recommend lining them with compacted clay or other impervious material to minimize the seepage of waste into soil and groundwater.[42] The waste slurry is stored in the lagoons and contains high levels of nutrients, such as nitrogen, phosphorus, potassium, calcium, magnesium, and boron, along with metals such as copper and zinc.[43] As excreta, it also contains pathogens and bacteria.[44] The nutrient-rich liquid layer is siphoned off and sprayed onto pastures to fertilize crops—mainly hay in the southeast.[45] Solids collect at the bottom of the lagoon and must be removed periodically.[46] Unlike human biosolids, there is no requirement that hog waste be treated before being applied to land.[47]

IV. ARE CAFOS SUSTAINABLE?

In the past two decades, CAFOs have come under increasing scrutiny due to their impacts on communities. In the eastern United States, this scrutiny has occasionally made headlines due to high profile events such as ruptures of waste storage lagoons; hurricanes that left hundreds of thousands of dead pigs in their wake; and eutrophication of coastal watersheds, which negatively affects fishing, recreational uses of the water, and biodiversity.[48] In other areas, CAFOs have been implicated in the contamination of drinking water supplies and fresh produce.[49] The issue that

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42. *See* USDA NAT'L RES. CONSERVATION SERV., WASTE TREATMENT LAGOON, 359, *available at* http://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/national/technical/cp/ncps/?cid=nrcs143_026849 (discussing ways to minimize seepage).

43. *See, e.g.*, Ardeshir Adeli, et al., *Effect of Long Term Swine Effluent Application on Selected Soil Properties*, 173.3 SOIL SCIENCE 223-35 (2008) (discussing the effect of swine effluent on soil quality); J.P. Zublena, et al., *Soil Facts: Swine Manure as a Fertilizer Source*, N.C. EXTENSION SERV., http://www.soil.ncsu.edu/publications/Soilfacts/AG-439-04/ (last updated Dec. 1997) (discussing the nutrient content of manure).

44. *See* Ann Huber, *Survival of Manure Pathogens in Swine Manure*, THE PIG SITE (June 24, 2009), http://www.thepigsite.com/articles/2786/survival-of-manure-pathogens-in-swine-manure (discussing pathogens in manure).

45. *See* USDA, NAT'L RES. CONSERVATION SERV. NUTRIENT MGMT. 590 (2012), *available at* http://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/national/technical/?cid=nrcs143_026849 (discussing standards for nutrient management).

46. U.S. EPA, WASTEWATER TECHNOLOGY FACT SHEET, ANAEROBIC LAGOONS, 2 (2002), *available at* http://www.bvsde.paho.org/bvsacd/leeds/lagoons.pdf.

47. Silbergeld, *supra* note 27, at 1399.

48. *See* AD HOC COMM., *supra* note 21, at 21; Roland W. Melse & Maikel Timmerman, *Sustainable Intensive Livestock Production Demands Manure and Exhaust Air Treatment Technologies,* 100 BIORESOURCES TECH. 5506, 5506 (2009).

49. *See e.g.,* CARRIE HRIBAR, NAT'L ASS'N OF LOCAL BDS. OF HEALTH, UNDERSTANDING CONCENTRATED FEEDING OPERATIONS AND THEIR IMPACT ON COMMUNITIES 3–4 (2010) (explaining the potential dangers of groundwater contamination from CAFOs); Anurag Mishra, Brian L. Benham & Saied Mostaghimi, *Bacterial Transport from Agricultural Lands Fertilized with Animal Manure*, 189

most often brings CAFOs to the attention of public officials is complaints about odors. To many scientists, the greatest concerns are the industry's emissions of methane and nitrous oxides, two potent greenhouse gases associated with climate change,[50] and its reliance on copious quantities of antibiotics essential to the treatment of human disease.[51]

The price consumers pay for pork, beef, and poultry at conventional supermarkets does not reflect the true costs of production. Most of the costs associated with large-scale production of food animals is borne by society at large—and by tax-payers—in the form of subsidies; depressed land prices in surrounding areas; contamination of water, air and soil; and, increasingly, declining public health.[52] These issues have been addressed extensively in numerous studies and publications, and thus will not be presented in detail here. Instead, this section provides an overview of some of those costs.

A. Environmental damage

1. Water Pollution

The Environmental Protection Agency (EPA) and USDA have identified livestock production as the largest cause of water quality impairment in the country's rivers, streams, lakes, ponds, and reservoirs, and the fifth leading contributor to impairment of estuaries.[53] They contribute to the impairment of approximately 37% of the nation's surveyed rivers and streams.[54] These impacts are the combined result of the geographic concentration of the animals and the primitive waste management and disposal practices employed by the industry.

WATER AIR & SOIL POLLUTION 127, 127 (2008) (identifying runoff from agricultural practices, including the application of animal manure, as a leading source of water quality impairment).

50. AD HOC COMM., *supra* note 21, at 15.

51. *See* M.E. Anderson & M.D. Sobsey, *Detection and Occurrence of antimicrobially resistant E. coli in groundwater on or near swine farms in eastern North Carolina*, 54 WATER SCIENCE & TECH. 211, 218 (2006).

52. Erin Tegtmeier and Michael Duffy, *External Costs of Agricultural Production in the United States*, 2 INT'L J. OF AGRICULTURAL SUSTAINABILITY 1, 15 –16 (2004); DOUG GURIAN-SHERMAN, CAFOS UNCOVERED: THE UNTOLD COSTS OF ANIMAL FEEDING OPERATIONS (2008), *available at* http://www.ucsusa.org/food_and_agriculture/our-failing-food-system/industrial-agriculture.

53. CLAUDIA COPELAND, CONG. RESEARCH SERV., RL31851, ANIMAL WASTE AND WATER QUALITY: EPA REGULATION OF CONCENTRATED ANIMAL FEEDING OPERATIONS (CAFOS) 4 (2002) (citing U.S. EPA, EPA-841-R-08-001, NATIONAL WATER QUALITY INVENTORY: REPORT TO CONGRESS FOR THE 2004 REPORTING CYCLE 18–19 (2009)).

54. Stephen Harden, *Characterization of Surface-Water Quality Associated with Swine CAFOs in Eastern North Carolina*, Proposal submitted to the N.C. DEP'T OF ENV'T AND NATURAL RES., DIV. OF WATER QUALITY 1, 3 (May 9, 2011) (citing the EPA's 2002 National Water Quality Inventory).

Hogs produce a prodigious amount of waste, approximately "two to four times as much waste as an adult human."[55] "According to the USDA, confined food animals excrete approximately 335 million tons (dry weight) of waste per year, more than 40 times the total mass of human biosolids produced annually."[56] Managing this amount of waste in a way that avoids environmental harm is a challenge.[57] Despite this quantity of excrement, most CAFOs employ only the most basic measures for waste management and disposal: collection, in-ground storage, and land-application.[58]

In swine CAFOs, the excreta is collected in large, underground pits beneath the slatted floors on which the hogs spend their entire lives. The CAFO operator uses fresh water to periodically flush the accumulated waste from the pits into open-air storage basins called lagoons. The solids settle to the bottom of the lagoon, and the remaining slurry, which is rich in nutrients—nitrogen, phosphorous and potassium—is periodically siphoned off and sprayed onto surrounding land called "sprayfields." Lagoons constructed before 1997, when North Carolina adopted its first permitting requirements for the swine industry, did not require lining, and many of these lagoons remain in use today. Lagoons constructed after 1997 require lining , either with compacted clay or a synthetic material, or with hydraulic conductivity of no more than 1 x 10^{-6} centimeters per second.[59] Land-application standards were similarly lenient, with setbacks of fifty feet from the riparian edge as the primary control.[60]

Seepage from lagoons, both lined and unlined, has contaminated groundwater. In eastern North Carolina, studies have conclusively shown that swine CAFOs are contaminating shallow groundwater.[61] The connection is particularly strong near the lagoons that store the manure slurry prior to land application.[62] A recent study conducted in the region

55. THICKE, *supra* note 5, at 38 (citing, U.S. EPA NAT'L RISK MGMT LAB., EPA/600/R-04/042, RISK MANAGEMENT EVALUATION FOR CONCENTRATED ANIMAL FEEDING OPERATIONS (2004)).

56. Silbergeld, *supra* note 27, at 1400 (citing USDA, AGRIC. RES. SERV., NATIONAL PROGRAM 206: MANURE AND BYPRODUCT UTILIZATION FY 2005 ANNUAL REPORT (2008), *available at* http://www.ars.usda.gov/research/programs/programs.htm?np_code=206&docid=13337).

57. NOEL GOLLEHON ET AL., USDA ECON. RES. SERV., ECON. RES. SERV. AGRIC. INFO BULL. NO. 771, CONFINED ANIMAL PRODUCTION AND MANURE NUTRIENTS (2001).

58. *See id.* at iv.

59. 15A N.C. Admin. Code. 2T.0505 (2013). However, even lined lagoons experience seepage and leaching into the surrounding soil. *See* J.M. Ham, *Seepage Losses from Animal Waste Lagoons: A Summary of a 4-year Investigation in Kansas*, 45.4 TRANSACTIONS OF THE ASAE 983, 983 (2002), *available at* http://www.prairieswine.com/pdf/3034.pdf.

60. Current regulations specify a minimum setback of 100 feet from perennial streams. 15A N.C. Admin. Code 2T.0505 (2013); NATIONAL PROGRAM 206, *supra* note 56.

61. Anderson & Sobsey, *supra* note 51, at 218.

62. *Id.* at 211.

showed that *E. coli*[63] was found more frequently in groundwater on swine farms than on crop farms without swine, regardless of whether the swine farm employed lagoon-sprayfield technology or used alternative technology to separate and land-apply the solids.[64]

Because subsurface flow contributes a significant portion of the total flow of many rivers, contaminated groundwater can be a source of contamination of surface waters.[65] Additionally, runoff from sprayfields contributes nutrients, suspended solids, and other pollutants to surface waters.[66] And many operations in eastern North Carolina, where the soils are porous and the water table high, are underlain with tile drains to lower the water table and increase agricultural production.[67] The subsurface tile drains collect excess liquid and discharge it into drainage ditches and adjoining waters.[68] They constitute a significant source of nitrate (NO_3) transport to surface waters in some agricultural watersheds.[69]

The waste lagoons are also a source of surface water contamination, prone to leaks and spills, and vulnerable to inclement weather. In just a three-year period, "from 1995 to 1998, 1,000 spills or pollution incidents occurred at livestock feedlots in 10 states and 200 manure-related fish kills resulted in the death of 13 million fish."[70] "When Hurricane Floyd hit North Carolina in 1999, at least five manure lagoons burst and approximately 47 lagoons were completely flooded."[71] With pictures of drowning pigs gracing the front pages of newspapers across the country,[72] the state developed a program to move waste storage lagoons out of the

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63. *E. coli* is widely used to demonstrate fecal contamination of water, and its presence is regarded as evidence of a public health risk from intestinal pathogens. *Id.*

64. *Id.* at 217. An especially troubling discovery in this study was that the *E. coli* bacteria were resistant to multiple drugs (4-6) used in both swine feed and in the treatment of human disease. *Id.*

65. *See* Michael Mallin, *Impacts of Industrial Animal Production on Rivers and Estuaries*, 88 AM. SCIENTIST 2, 11 (2000); J.W. GILLIAM, ET AL., WATER RES. RESEARCH INST. OF THE UNIV. OF N.C., CONTAMINATION OF SURFICIAL AQUIFERS WITH NITROGEN APPLIED TO AGRICULTURAL LAND 1 (1996) (finding that movement of shallow groundwater is lateral toward streams).

66. *See* PEW COMM'N ON INDUS. FARM ANIMAL PROD., PUTTING MEAT ON THE TABLE: INDUSTRIAL FARM ANIMAL PRODUCTION IN AMERICA 23 (2008).

67. Harden, *supra* note 54, at 3.

68. U.S. Geological Survey, N.C. Water Sci. Ctr., *Artificial Drainage*, http://nc.water.usgs.gov/projects/tile_drains/overview.html (last visited Feb. 10, 2013).

69. *Id.*

70. *Facts About Pollution from Livestock Farms*, NRDC.ORG (Jan. 13, 2011), http://www.nrdc.org/water/pollution/ffarms.asp.

71. *Smithfield Agreement*, NATUREWORKSORGANICS.COM, http://www.natureworksorganics.com/smithfield.htm (last visited Jan. 26, 2013).

72. Peter Kilborne, *Hurricane Reveals Flaws in Farm Law as Animal Waste Threatens N. Carolina Water*, N.Y. TIMES, Oct. 17, 1999,http://www.nytimes.com/1999/10/17 /us/hurricane-reveals-flaws-in-farm-law-as-animal-waste-threatens-n-carolina-water.html.

floodplains.[73] During the initial phase of the program, the Division of Soil and Water Conservation received eighty-five applications covering eighty-one sites, totaling nearly $52 million.[74] In the most recent phase, round four of the buyout program, the Division received thirty-four applications, totaling more than $20 million in requests.[75]

2. Air Pollution

a. Odor

Hog pens and CAFOs have long been notorious for their disagreeable odor. Before the advent of modern statutes (and industrial production practices), malodorous hog pens were treated as "nuisances" under common law theories, with neighbors asserting that the associated smells, dust and flies fouled their homes and prevented them from enjoying their property.[76]

Unfortunately, bringing hogs indoors in confinement houses did little to ameliorate these problems, and, in fact, has exacerbated them. Indeed, regulatory and elected officials regularly hear complaints from constituents concerned about CAFOs. The conditions that cause these air quality problems are well known and understood. When the manure slurry is stored in the lagoon, it undergoes a "radical transformation" that "alters its chemical nature and creates compounds that are not only foul-smelling but toxic."[77] The manure begins to decompose, "but because the liquid-manure environment lacks sufficient oxygen for complete decomposition, the system becomes anaerobic (without oxygen) and the manure putrefies," producing "more than 300 volatile organic compounds of varying degrees of toxicity."[78] When inhaled, the compounds absorb deep in the lungs and are exhaled in the breath and exuded from the skin.[79] It is no wonder, then, that they also have a documented adverse effect on mood.[80]

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73. Cecil H. Yancy, Jr., *North Carolina Is Expanding Hog Buyout*, SOUTHEAST FARM PRESS, (Aug. 1, 2001), http://southeastfarmpress.com/north-carolina-expanding-hog-buyout.

74. Press Release, N. C. Dep't of Env't and Natural Res., Div. of Soil & Water Conservation Announces Second Phase of Voluntary Swine Buyout Program (Jan. 23, 2002), *available at* http://www.enr.state.nc.us/DSWC/newsreleases/swine%20buyout.html.

75. N.C. Soil & Water Conservation Comm'n, Minutes, at 4 (May 27, 2008), *available at* http://www.ncagr.gov/SWC/commission/documents/Minutes5-27-08.pdf. Information on Round 5 is not yet available.

76. *See e.g.* Royalty v. Strange, 220 S.W. 421, 421 (Tex. 1920) (providing an example of a neighbor claiming nuisance due to pig odors and the presence of flies around the pigs).

77. THICKE, *supra* note 5, at 45.

78. *Id.*

79. Susan S. Schiffman, et al., *The Effect of Environmental Odors Emanating from Commercial Swine Operations on the Mood of Nearby Residents*, 37 Brain Res. Bull. 369 (1995),

Scientists have studied the odors emanating from swine CAFOs and shown that they comprise a spectrum of chemical compounds, including ammonia, hydrogen sulfide (which breaks down to sulfur dioxide) and volatile organic compounds (VOCs). More than merely "unpleasant" or malodorous, these compounds have measurable adverse impacts on human health. Ammonia is an irritant that affects the skin, eyes, nose and throat and causes respiratory distress, including asthma.[81] Over the long-term, exposure to low levels of ammonia can lead to respiratory and pulmonary disease.[82] Hydrogen sulfide, which has the characteristic smell of rotten eggs, is a neurotoxin. "At high concentrations, hydrogen sulfide will cause rapid unconsciousness and death through respiratory paralysis and asphyxiation. That is why when CAFO ventilation systems fail, the confined animals—and even CAFO workers—can quickly be overcome and die from hydrogen sulfide poisoning."[83]

b. Particulate Matter

CAFOs are also a source of particulate matter, coating neighboring houses, cars, and outdoor furniture with dust. Pathogens, including *E. coli* and *Clostridium*, and fecal coliform bacteria have been documented on dust particles that drift across property lines, even entering neighboring homes through open doors and windows.[84] Like odor, these contaminants also pose a health risk to farmers, as well as downwind neighbors and communities.[85]

CAFOs contribute particulate matter through several means, including fans that ventilate the swine houses "and air entrainment of mineral and organic material from soil, manure, and water droplets generated by high-pressure liquid sprays."[86] Their emissions of ammonia, nitrogen oxide and hydrogen sulfide also contribute to the formation of fine particulate matter when those compounds are converted to aerosols through reactions in the atmosphere. "Particles produced by gas-to-particle conversion generally are

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available at http://geography.ssc.uwo.ca/faculty/baxterj/readings/schiffman_et_al_odors_mood_swine_BRB_1995.pdf.

80. *Id.* (finding people living near swine operations suffer health effects associated with mood disorders).

81. THICKE, *supra* note 5, at 46.

82. *Id.*

83. *Id.*

84. Gwangpyoko Ko, et al., *Investigation of Bioaerosols Released from Swine Farms using Conventional and Alternative WasteTreatment and Management Technologies,* 42 ENVTL. SCI. TECH. 8849, 8849, 8852 (2008).

85. *Id.*

86. AD HOC COMM., *supra* note 21, at 55.

small and fall into the PM2.5 size range."[87] Such fine particulate matter "can reach and be deposited in the smallest airways (alveoli) in the lungs, whereas larger particles [PM10] tend to be deposited in the upper airways of the respiratory tract."[88]

c. Climate Change

In addition to local and regional impacts on air quality, CAFOs add significantly to global climate change. CAFOs emit large quantities of nitrous oxide, a potent greenhouse gas with 300 times the global warming potential of carbon dioxide,[89] and methane,[90] another powerful greenhouse gas with approximately twenty times the potency of carbon dioxide.[91]

Methane is a natural gas that is a byproduct of digestion.[92] In the U.S., swine CAFOs produce approximately 40% of the total reported methane emissions generated by the decomposition of animal manure, or approximately 788,000 mt of methane per year.[93] Very little of the methane generated by hog operations is produced by the hogs' digestion of feed; nearly 90% of methane emissions from hog production is caused by the storage of manure slurry in lagoons.[94] The anaerobic—oxygen-limited—condition of liquid manure storage produces "significant quantities of methane."[95] This stands in sharp contrast to more aerobic solid waste management approaches—which produce little, if any, methane.

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87. *Id.*

88. *Id.* "Smaller particles are also most effective in attenuating visible radiation, causing regional haze." *Id.* at 55.

89. U.S. EPA, *Greenhouse Gas Emissions: Nitrous Oxide Emissions*, http://www.epa.gov/climatechange/ghgemissions/gases/n2o.html (last updated June 14, 2012). *See also* Melse & Timmerman, *supra* note 48, at 5508.

90. Melse & Timmerman, *supra* note 48, at 5506; AD HOC COMM., *supra* note 21, at 21.

91. U.S. EPA, *Greenhouse Gas Emissions: Methane Emissions*, http://epa.gov/climatechange/ghgemissions/gases/ch4.html (last updated June 14, 2012).

92. *Id.*

93. R.R. Sharpe & L.A. Harper, *Methane Emissions from an anaerobic swine lagoon*, 33 ATMOSPHERIC ENV'T 3627, 3627 (1999) (citations omitted). The authors attribute this estimate to the EPA, and note that other research, including their own, produces widely varying estimates, ranging from 255,000 mt and 4,400,000 mt per year. *Id.* at 3632.

94. THICKE, *supra* note 5, at 42 (citing U.S. EPA, 1990–2010 430-R-12-001 6-1, INVENTORY OF U.S. GREENHOUSE GAS EMISSIONS AND SINKS (2012), *available at* http://www.epa.gov/climatechange/Downloads/ghgemissions/US-GHG-Inventory-2012-Main-Text.pdf).

95. AD HOC COMM., *supra* note 21, at 45.

B. Damage to Society

1. Public Health Concerns

a. Pathogens

Neighbors of swine CAFOs have long worried about their exposure to disease-causing pathogens from CAFOs, whether from contamination of drinking water wells[96] or outbreaks of swine flu.[97] These concerns are warranted: animal waste contains disease-causing pathogens, such as *Salmonella*, *E. coli*, *Cryptosporidium*, and fecal coliform. More than 40 diseases can be transferred to humans through manure.[98] Farmworkers are especially vulnerable and experience multiple health problems. Those who feed, water, and handle the animals indoors are regularly exposed "to dangerously high levels of dust, ammonia, carbon dioxide, and other gasses."[99] Studies have shown that "nearly 70% of the workers experience one or more symptoms of respiratory illness or irritation," and "workers in hog factories have more job-related health problems than workers in any other confinement operation."[100]

Scientists are now corroborating the community's concerns, acknowledging that because of the "marginally effective" waste management and treatment processes of CAFOs, the emission of airborne contaminants, including microbial pathogens that can be transmitted from one animal species to another (e.g., from swine to humans or *visa versa*), may adversely affect human and animal health.[101] "High-throughput ventilation systems—essential for animal health when thousands of

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96. E.g., in Oklahoma, nitrates from Seaboard Farms' hog operations contaminated drinking water wells, prompting the U.S. EPA to issue an emergency order in June 2001 requiring the company to provide safe drinking water to area residents. *In the Matter of Seaboard Farms, Inc.*, Emergency Administrative Order Pursuant to Section 1431(a) of the Safe Drinking Water Act, 42 U.S.C. § 300i(a), Docket No. SDWA-06-2001-1239, U.S. EPA, Region 6 (2001).

97. *See, e.g.,* CENTERS FOR DISEASE CONTROL, INFORMATION ON SWINE INFLUENZA/VARIANT INFLUENZA VIRUSES (2012) *available at* http://www.cdc.gov/flu/swineflu/ (explaining what swine flu is, and how it can be transmitted to humans).

98. U.S. EPA, DETECTING AND MITIGATING THE ENVIRONMENTAL IMPACT OF FECAL PATHOGENS ORIGINATING FROM CONCENTRATED ANIMAL FEEDING OPERATIONS (2005).

99. Melissa Guay, *Eating Local for Health*, GLEN FALLS POST STAR (June 1, 2011), http://www.poststar.com/lifestyles/health-med-fit/eating-local-for-health/article_7d21b072-8c52-11e0-b3e0-001cc4c002e0.html

100. JO ROBINSON, PASTURE PERFECT: THE FAR-READING BENEFITS OF CHOOSING MEAT, EGGS, AND DAIRY PRODUCTS FROM GRASS-FED ANIMALS 50 (2004). *See* Iowa State Univ. Extension Nat'l Agric. Safety Database, *Livestock Confinement Dust and Gases* (June 1992), *available at* http://nasdonline.org/document/1627/d001501/livestock-confinement-dust-and-gases.html.

101. Dick Heederik et al., *Health Effects of Airborne Exposures from Concentrated Animal Feeding Operations*, 115 ENVTL. HEALTH PERSP. 298, 298 (2007).

chickens or hogs are raised in close confinement—permit the release of bacteria into the surrounding environment."[102] Significant levels of airborne microorganisms can be released during land application of lagoon effluent, with potential impacts to public health on farm properties and farm neighbors.[103] Studies have documented these strains downwind of hog operations, in groundwater and surface waters, as well as in the confinement houses and lagoon water. [104] In fact, CAFO farmers and neighbors have reported "increased levels of respiratory illnesses, including infectious diseases, allergy, and toxicosis," and [e]pidemiological studies have shown increases in the incidence rates of [intestinal] diseases during farm irrigation seasons."[105] These conditions may be attributed to exposure to bioaerosols from the CAFOs.[106]

More recently, epidemiologists have expressed concern that farm workers may transmit those pathogens to nearby communities. Farm workers are exposed to pathogens carried by the animals and contained in their waste and, because they "are provided little to no protective equipment," are at increased risk of carrying those bacteria and infections into their households and the larger community.[107] Studies conducted in North America and European countries have documented this connection with Methicillin-Resistant Staphylococus Aureus (MRSA), and in one study, "32% of patients with these exposures were positive for MRSA. Taken together, these studies provide strong evidence that cattle, horse, and swine farms are significant sources for community-acquired MRSA and for the movement of this pathogen into the hospital setting."[108]

A team of scientists from the United States and the Netherlands released a study in early November, 2012, documenting that those who reside near CAFOs also have increased exposure to MRSA.[109] As noted above, previous studies documented that CAFO workers who came into direct contact with the animals had increased risk of MRSA exposure;[110] the November 2012 study showed that the risk extended to those who live in

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102. Silbergeld, *supra* note 27, at 1395–99.

103. Ko, *supra* note 84, at 8856.

104. Silbergeld, *supra* note 27, at 1399.

105. Ko, *supra* note 84, at 8849.

106. *Id.*

107. Silbergeld, *supra* note 27, at 1395.

108. *Id.*

109. Beth J. Feingold, et al., *Livestock Density as Risk Factor for Livestock-associated Methicillin-Resistant Staphylococcus aureus, the Netherlands*, EMERGING INFECTIOUS DISEASES J., Nov. 2012, available at http://wwwnc.cdc.gov/eid/article/18/11/11-1850_article.htm.

110. Seventeen percent of veterinary field workers carried livestock-associated MRSA "after short-term occupational exposure to pigs." John Barker, *Living Near Livestock Ups MRSA Chances,* DUKE CHRON., (Nov. 8, 2012), http://www.dukechronicle.com/article/living-near-livestock-ups-mrsa-chances.

areas of concentrated livestock production, even if they do not come into contact with the animals or live with someone who does. Although the study confirms a geographical relationship to the risk of carrying and being infected by livestock-associated MRSA, it was not designed to identify the possible routes of exposure.[111] The study's authors have identified that as an urgent area of future study, as it has significant implications for public health.[112]

b. Antibiotic Resistance

A related public health issue is the use of antibiotics in food animal production. "The intensive use of antimicrobials as feed additives in food animal production began in the United States in the 1950s and paralleled other changes in the organization and structure of the industry."[113] The swine industry administers antibiotics to food animals for three main purposes: treating sick animals, preventing the spread of disease, and promoting growth.[114] Animals raised in "grossly unhygienic surroundings" are chronically exposed to pathogens and diseases and must continually be given antibiotics to remain healthy and grow quickly.[115] This practice has economic benefits for the grower, as it decreases the time required for the animal to grow to market weight.

But many of these antibiotics, such as tetracycline and ciproflaxin, are important for treating human illnesses.[116] And the uncontrolled administration of sub-therapeutic doses of antibiotics "presents the worst possible scenario for resistance selection and infection control."[117] The antimicrobials used in CAFOs "are poorly absorbed in the gut of the animal, and as much as 90% of the parent compound can be excreted in urine and up to 75% in feces."[118] As a result, the animals "excrete significant amounts of biologically active forms of the antimicrobials administered in feeds."[119] "Coupled with incomplete biosecurity and biocontainment, and mostly nonexistent waste treatment, these conditions lead to dissemination into human hosts and the environment, with

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111. Feingold, *supra* note 109.

112. *Id.*

113. Silbergeld, *supra* note 27, at 1394.

114. *Id.*

115. *Id.* at 1393.

116. The antimicrobials used in animal production represent "all the major classes of antimicrobials approved for human clinical use." *Id.* at 1394.

117. *Id.* at 1393 (citing J. OTTE ET AL., INDUSTRIAL LIVESTOCK PRODUCTION AND GLOBAL HEALTH RISKS (2007)).

118. *Id.* at 1400.

119. *Id.*; Anderson & Sobsey, *supra* note 51, at 211.

amplification of reservoirs of resistance."[120] As a result, bacteria and pathogens, such as MRSA, that are resistant to multiple antibiotics are increasing.[121]

The emergence of antibiotic-resistant bacteria is a significant public health concern. "Approximately half of the antibiotics produced globally" are used for food animal production.[122] In the United States (and, until recently, the European Union), drug use in animal feeds "accounts for between 60% and 80% of total antimicrobial production."[123] Although direct information about antimicrobial use is unavailable,[124] it is estimated that the amount of antimicrobials used in animal feed "in North Carolina alone exceeds total human clinical use for the entire United States population."[125]

A vast and growing body of scientific studies provides uncontroverted evidence that the routine use of antibiotics in the production of food animals contributes to "the growing public health crisis of human antibiotic resistance" and the spread of infectious disease.[126] The practices CAFOs employ create ideal conditions for sharing pathogens and developing resistance to treatment with antimicrobial drugs.[127] In a CAFO, "thousands to tens of thousands of animals are crowded together close to or on top of their wastes. Crowding, stress, inappropriate feeds, ventilation practices, and waste management techniques inherent to this system enhance release of microbes into the external environment."[128] Studies have documented high percentages of antimicrobial resistant bacteria in livestock waste and human exposure to agricultural animal fecal bacteria via food and

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120. Silbergeld, *supra* note 27, at 1393 (citing J. OTTE, *supra* note 118).

121. Anderson & Sobsey, *supra* note 51, at 212.

122. *Id.*; *see also* CTR. FOR GLOBAL DEV., NON-THERAPEUTIC USE OF ANTIBIOTICS IN ANIMAL AGRICULTURE, CORRESPONDING RESISTANCE RATES, AND WHAT CAN BE DONE ABOUT IT (2009), *available at* http://www.cgdev.org/content/article/detail/1422307/.

123. Ellen K. Silbergeld, et al., *Industrial Food Animal Production, Antimicrobial Resistance, and Human Health*, 29 ANN. REV. PUB. HEALTH 151, 157 (2008) (discussing the prevalence of non-therapeutic drug use in agriculture).

124. "[I]nformation on antimicrobial usage was unavailable and even deemed proprietary when it comes to what antibiotics are included in the swine feed." Anderson & Sobsey, *supra* note 51, at 215.

125. Silbergeld, *supra* note 27, at 1394 (citing KAREN FLORINI ET AL., RESISTANT BUGS AND ANTIBIOTIC DRUGS: STATE AND COUNTY ESTIMATES OF ANTIBIOTICS IN AGRICULTURAL FEED AND ANIMAL WASTE 9 (2005)).

126. *See* PEW HEALTH GRP., PEW CHARITABLE TRUSTS, ANTIBIOTIC RESISTANCE AND FOOD ANIMAL PRODUCTION: A BIBILIOGRAPHY OF SCIENTIFIC STUDIES (1969-2012) (2012), *available at* http://www.pewhealth.org/uploadedFiles/PHG/Content_Level_Pages/Issue_Briefs/HHIFBibliographyFinal%20with%20TOC%20_111312.pdf (describing briefly a vast number of studies done over the last 33 years founded in the concern of antibiotic resistance in humans and animals).

127. *Id.*; Silbergeld, *supra* note 27, at 1393.

128. Silbergeld, *supra* note 27, at 1394.

occupational exposure.[129] Worldwide, there are reports of resistant bacteria and resistance genes in consumer meat products, vegetables, soils and irrigation water.[130]

In response, "the World Health Organization (WHO), the World Organization for Animal Health, and the Food and Agriculture Organization of the United Nations . . . have specifically recommended ending the practice of adding antimicrobials to feed," especially for purposes unrelated to disease treatment.[131] As a leading official with the Centers for Disease Control cautions, "[a]ntibiotics are a finite and precious resource," and we must promote their "prudent and judicious" use.[132]

2. Economics of CAFOs

The true costs of these impacts to natural resources, biodiversity and human health "are external to agricultural systems and markets . . . [and] are borne by society at large."[133] In considering the costs, one must include the costs that regulatory agencies incur by virtue of their statutory responsibilities for permitting, enforcement, and administering the numerous programs that benefit agriculture.[134] While programmatic costs may be easy to calculate on the basis of the agencies' budgets, the negative impacts to the environment and public are more difficult to estimate.[135] Estimates may be derived, for example, by calculating the costs of treating water to meet federal standards for fecal coliform and nitrates or for moving waste storage lagoons out of floodplains. It is unsurprising that economists and scientists have concluded swine CAFOs "contribute to economic marginalization of workers and socioeconomic decline in rural communities."[136]

a. Public Subsidies for Manure Management

As currently operated, CAFOs are unsustainable from environmental and public health perspectives. They are also economically unsustainable.

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129. Dana Cole et al., *Concentrated Swine Feeding Operations and Public Health: A Review of Occupational and Community Health Effects*, 108 ENVTL. HEALTH PERSP., 685, 688, 692 (Aug. 2000).

130. Silbergeld, *supra* note 27, at 1395.

131. *Id.* at 1401.

132. Greg Cima, *Experts Give Views on Antimicrobial Use, Resistance,* 235 J. OF THE AM. VETERINARY ASS'N 256, 257 (August 1, 2009).

133. Erin M. Tegtmeier & Michael D. Duffy, *External Costs of Agricultural Production in the United States,* 2 INT'L J. AGRIC. SUSTAINABILITY 1, 1 (2004).

134. *Id.* at 3.

135. *Id.* at 2.

136. Silbergeld, *supra* note 27, at 1392.

As discussed above, they externalize their costs of production onto the communities in which they are located. These costs damage natural resources and ecosystem services, impair public health, and ruin economic vitality of rural communities. The vertical integration of hog producers and packers, combined with the market dominance of a small handful of multinational corporations, drives down prices for independent producers and eventually drives them out of business. [137]

What's more, CAFOs are supported by a network of federal programs that offer financial incentives, financial and technical assistance, and direct subsidies to producers. While some of these programs are designed to encourage growers to implement voluntary measures to reduce environmental harm, others subsidize compliance costs. This section provides an overview of some of the programs administered by USDA that benefit swine (and other) CAFOs. It is not meant to be an exhaustive, comprehensive examination of the USDA's programs and activities, but rather an illustration of some of the ways in which the public actually finances the damages CAFOs impose on our communities.

The USDA's responsibilities include food assistance programs to aid low income families; managing national forests; regulating the safety of meat and poultry products; overseeing agricultural trade; and conserving natural resources.[138] Several USDA divisions, such as the Natural Resources Conservation Service (NRCS) and the Farm Service Agency (FSA),[139] administer programs that involve livestock and their environmental effects. The Agricultural Research Service (ARS) and the Cooperative State Research, Education, and Extension Service (CSREES) conduct research and outreach activities that aid livestock producers.[140] NRCS began managing voluntary conservation programs authorized by federal farm legislation in 1985. These include the Environmental Quality

137. When Smithfield Foods merged with Premium Standard Farms, "the merged company left 2,500 independent hog producers with just one regional buyer for their market-ready animals." Timothy A. Wise, *Agribusiness and the Food Crisis: A New Thrust at Anti-Trust*, GLOBAL DEV. AND ENV'T INITIATIVE, (Mar. 22, 2010), http://www.ase.tufts.edu/gdae/Pubs/rp/ GC22March10Wise.pdf.

138. AD HOC COMM., *supra* note 21, at 146.

139. The Farm Service Agency was established in 1994 and manages several USDA resource conservation programs. It has primary responsibility, with NRCS assistance, for the Conservation Reserve Program (CRP), a voluntary program under which farm owners and operators are paid to take eligible land (e.g., highly erodible cropland, marginal pasture land) out of production and employ approved conservation practices for a 10–15 year period. Farm legislation enacted in 2002 increased the maximum CRP enrollment from 36.4 million to 39.2 million acres. *See* 16 U.S.C.A. § 3831(d) (2008) (discussing USDA resource conservation programs). "FSA also implements the Conservation Reserve Enhancement Program, a federal-state partnership, and the Emergency Conservation Program, which provides cost-share payments to producers for the rehabilitation of farmland damaged by natural disasters." AD HOC COMM., *supra* note 21, at 147.

140. AD HOC COMM., *supra* note 21, at 146.

Incentives Program (EQIP) (discussed in detail below), Conservation of Private Grazing Land Program, the Conservation Security Program,[141] Farmland Protection Program, Wetlands Reserve Program, Wildlife Habitat Incentives Programs, and others.[142] NRCS personnel work with owners and operators of CAFOs, providing them with technical and financial assistance.

NRCS helps hog growers (and other livestock producers) develop and implement dozens of practices designed to minimize adverse impacts to natural resources.[143] It maintains a comprehensive list of Conservation Practice Standards that are eligible for technical and cost-share financial assistance.[144] In accordance with the program's primary focus on livestock production, many of the standards address the unique waste management challenges presented by the geographically concentrated production of livestock in CAFOs. For example, there are conservation practice standards for facilities to manage both the routine and disaster-related animal mortalities; anaerobic digestors, waste lagoons and composting facilities for manure treatment; and waste facility closure.[145]

NRCS has also developed a Conservation Practice Standard for nutrient management, which guides the design and implementation of the Comprehensive Nutrient Management Plans mandated by federal CAFO regulations.[146] In 2001, for example, NRCS helped producers to apply nutrient management systems on 5.4 million acres and "[p]lanned or applied 10,500 waste management systems, including waste storage structures, treatment lagoons, composting facilities, and roof runoff management."[147]

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141. The Conservation Security Program (CSP) was added "in the 2002 Farm Bill. The CSP pays producers for adopting or maintaining conservation practices that help to protect or improve the quality of soil, water, air, energy, and plant and animal life . . . . Eligible producers enter conservation contracts that set out the required conservation practices . . . . In exchange, producers receive payment" and part of the cost (up to 75% for most producers, or 90% for beginning and low resource farmers) of adopting or maintaining the required conservation practices. Although "[l]ivestock farmers are not excluded from the CSP," payment is limited to practices that exceed regulatory requirements. AD HOC COMM., *supra* note 21, at 149; 16 U.S.C. § 3838c (3)(A).

142. AD HOC COMM., *supra* note 21, at 199.

143. *See* USDA NAT. RES. CONSERVATION SERV., NAT'L CONSERVATION PRACTICE STANDARDS, available at http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/technical/cp/ncps/ (discussing National Conservation Practice Standards).

144. *Id.*

145. *See* USDA NAT. RES. CONSERVATION SERV., ALPHABETICAL INDEX OF CONSERVATION PRACTICE, available at http://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/national/technical/?cid=nrcs143_02684 (listing various standards).

146. *See* USDA NAT. RES. CONSERVATION SERV., CONSERVATION PRACTICE STANDARD NO. 590, NUTRIENT MANAGEMENT, *available at* http://ftp-fc.sc.egov.usda.gov/NHQ/practice-standards/standards/590.pdf; 40 C.F.R. §§ 122.42(e), 412.4(c).

147. AD HOC COMM., *supra* note 21, at 147.

The key program aiding CAFOs is EQIP, which dedicates a minimum of 60 percent of its budget to livestock producers.[148] Congress authorized EQIP in 1996 "in part to help livestock and other producers comply with federal and state environmental regulations" that were designed to protect water and air quality and wildlife habitat, reduce erosion, and conserve surface and groundwater.[149] The program is also intended to provide assistance with installing and maintaining conservation practices, and to help streamline conservation planning and regulatory compliance.[150] Through EQIP, NRCS may enter into contracts, up to a maximum length of ten years, with producers who agree to implement eligible environmental and conservation practices in exchange for cost-share and incentive payments, and provide technical assistance to help the producers design and implement the specified conservation practices.[151]

EQIP has grown in the sixteen years since its creation. Originally, it was aimed at providing assistance to small, independent producers. In 2002, Congress expanded the program to allow large-scale livestock production and processing companies to participate, and removed the yearly cap on costs the government would cover.[152] Correspondingly, Congress significantly increased the program's funding, progressing up to $1.75 billion in fiscal year 2012.[153]

Significantly, EQIP subsidizes the costs incurred for managing the excrement generated by large-scale feedlots.[154] This includes the costs of building lagoons and irrigation lines to service the sprayfields. In North Carolina, it now also includes the costs of replacing lagoons with advanced treatment technologies authorized by state law.[155] NRCS authorizes the manure management systems that are eligible for cost-share assistance—currently limited to waste lagoons and anaerobic digestors—and the incentive payments for producers who develop comprehensive nutrient

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148. *Id.* at 149.

149. *Id.* at 148.

150. *Id.* (citing 16 U.S.C. §§ 3839aa(2)(B)–(C) (2006)).

151. AD HOC COMM., *supra* note 21, at 148.

152. 16 U.S.C. § 3839aa-5(a)(3) (2006).

153. USDA NAT. RES. CONSERVATION SERV., AT A GLANCE: ENVIRONMENTAL QUALITY INCENTIVES PROGRAM (2008), *available at* http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1044030.pdf.

154. Andrew Martin, *In the Farm Bill, a Creature from the Black Lagoon*, N.Y. TIMES, Jan. 13, 2008, http://www.nytimes.com/2008/01/13/business/13feed.html.

155. In 2009, EQIP "began a 5-year initiative with additional funding for North Carolina livestock farmers who participate in the [Lagoon Conversion Program]." Ann Perry, *Producers and Pigs Profit From Manure,* 58 AGRIC. RESEARCH 22, 24 (2010), *available at* http://www.ars.usda.gov/is/AR/archive/aug10/pigs0810.htm.

management plans mandated by EPA's NPDES regulations for CAFOs.[156] Payments are limited to $300,000 per entity for all contracts entered into during fiscal years 2002 through 2007.[157] Congress authorized additional payments up to $450,000 per entity for certain projects of "special environmental significance," as determined by the USDA, including projects involving methane digesters.[158]

b. Public Subsidies for Feed Costs

In addition to subsidies for installing pollution control measures, CAFO operators benefit from subsidies provided to producers of commodity crops, primarily corn and soybeans, used to feed the animals. The Freedom to Farm Act, which Congress enacted in 1996, eliminated many of the supply management measures (such as acreage restrictions and land set-asides) in federal farm policy.[159] With the removal of these constraints, farmers overproduced and prices for corn and soybeans fell dramatically: by 2005 the prices U.S. farmers received for corn and soybeans had fallen 32% and 21%, respectively.[160] The 1996 Farm Bill also introduced costly new subsidies, which have allowed soybean and corn growers to sell their crops at amounts far below the actual costs of production.[161]

The cost of feed is the largest component of food animal production, amounting to an estimated 60% of the total cost of producing pigs.[162] Underpriced feed allows large meat companies to undercut smaller, diversified and more sustainable farmers. One study estimates these feed subsidies gave large companies a $35 billion boost over an eight year period, equivalent to a 5–15% reduction in overall operating costs.[163] For

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156. Some criticize the use of subsidies for anaerobic digesters, noting that they "require animals to be in confinement so that their manure can be collected to be put into the digester," and are needed only to prevent emissions from industrial-style, CAFO production systems. THICKE, *supra* note 5, at 43.

157. USDA NATURAL RES. CONSERVATION SERV., *supra* note 153.

158. *Id.*; USDA NATURAL RES. CONSERVATION SERV., FACT SHEET: ENVIRONMENTAL QUALITY INCENTIVES PROGRAM (2009), *available at* http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs143_007742.pdf.

159. Le Ann Ormsby, *Freedom to Farm Act Changed Crop Acreages*, SOUTHEAST FARM PRESS (Apr. 14, 2010), southeastfarmpress.com/freedom-farm-act-changed-crop-acreages.

160. *Feeding the Factory Farm*, TUFTS UNIV. GLOBAL DEV. AND ENV'T INST., http://www.ase.tufts.edu/gdae/policy_research/BroilerGains.htm (last visited Feb. 22, 2013).

161. Inst. for Agric. & Trade Policy, *Leveling the Playing Field*, THINK FORWARD BLOG (Jan. 29, 2008), http://www.iatp.org/blog/2008/01/leveling-the-playing-field.

162. AD HOC COMM., *supra* note 21, at 28.

163. ELANOR STARMER & TIMOTHY A. WISE, TUFTS UNIV. GLOBAL DEV. AND ENV'T INST., FEEDING AT THE TROUGH: INDUSTRIAL LIVESTOCK FIRMS SAVED $35 BILLION FROM LOW FEED PRICES 1, (2007), *available at* http://www.ase.tufts.edu/gdae/Pubs/rp/PB07-03FeedingAtTroughDec07.pdf.

the hog industry, industrial operations' feed costs were 26% lower than what farm families were paying to produce their own feed, which lowered total production costs for factory farms by 15%. The discount to large and industrial hog operations housing over 2,000 hogs each totaled almost $1 billion per year between 1997 and 2005.[164] For Smithfield Foods, this amounted to a savings of more than $2.5 billion.[165]

The research and numbers suggest that federal farm policy, not efficiency gains from economies of scale, creates the cost advantages for industrial livestock operations "at the expense of smaller scale, diversified, locally-owned crop and livestock farms."[166] Such policies "have serious economic, social, structural, and environmental effects. Smaller scale diversified family farms that grow crops and raise livestock have a difficult time competing with specialized operations that can purchase" below-cost feed and receive public aid to defray their operational and compliance costs.[167] Meanwhile, the country is losing family farms—including swine and other livestock operations—and many other businesses that served that community and depended on rural farms for their livelihood.[168] CAFOs are not sustainable farming systems that are "capable of maintaining their productivity and usefulness to society indefinitely."[169] Despite the costs CAFOs impose on society, the economy, and the environment, [170] numerous regulatory exemptions and legal preferences enable this method of food animal production.

V. ENVIRONMENTAL LAWS APPLICABLE TO CAFOS

"Agriculture has long enjoyed favored status under the law, and agricultural operations have been exempt from numerous federal and state laws that govern other businesses."[171] Although there is mounting evidence of the harms CAFOs have on important natural resources, elected officials are reluctant to repeal explicit exemptions and regulatory agencies have

164. *Feeding the Factory Farm*, *supra* note 160.
165. STARMER & WISE, *supra* note 163, at 2.
166. *Feeding the Factory Farm, supra* note 160.
167. *Id.*
168. *See generally* PIGS, PROFITS AND RURAL COMMUNITIES (Kendall Thu & E. Paul Durrenberger eds., 1998) (covering the effects the industrialization of the swine industry has had on rural communities).
169. Mary V. Gold, *Sustainable Agriculture: Information Access Tools*, USDA ALT. FARMING SYS. INTRO CTR. (2009), *available at* http://www.nal.usda.gov/afsic/pubs/agnic/susag.shtml.
170. This assertion is made with full understanding of the impacts other industries and land-use activities impose. However, few, if any, of these other activities enjoy the preferential legal treatment and taxpayer subsidies provided to the livestock industry. Consequently, these topics, while deserving of fuller treatment and discussion, are nonetheless outside the scope of this article.
171. AD HOC COMM., *supra* note 21, at 130.

been slow to use the legal authorities they possess. This section examines the existing legal authorities and regulatory efforts to limit pollution from CAFOs, and identifies additional measures that could be taken.

A. The Clean Water Act

Only one federal environmental statute, the Clean Water Act, specifically references CAFOs and purports to regulate them.[172] The goal of the Clean Water Act is "to restore and maintain the chemical, physical, and biological integrity of the Nation's waters."[173] As an interim measure, Congress articulated a benchmark of protecting and propagating fish, shellfish, and wildlife, and enabling recreation in and on the water.[174] These objectives embody the essence of sustainability: ensuring that human activity facilitates, rather than impairs, the innate functioning and role of the ecosystem. Although the Act has been successful in reducing pollution from conventional point sources and mitigating impacts to water quality,[175] to date it has failed as a tool for managing the impacts to water quality from CAFOs.

When Congress enacted the Clean Water Act in 1972, it included CAFOs as a specific class of activity in the definition of the term "point source"[176] and included "agricultural waste discharged into water" in the definition of "pollutant."[177] The legislative history reveals that members of Congress were aware of and concerned about the pollution from this type of animal production and wanted the EPA to develop regulations similar to those for other industrial sources of pollution and waste treatment operations.[178] This concern is reflected in other provisions of the statute, such as the explicit directive for EPA to work with the USDA to "determine new and improved methods and the better application of existing methods" for reducing agricultural pollution as it developed the new national program for "preventing, reducing and eliminating pollution" of the nation's

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172. 33 U.S.C. § 1362(14) (2006).

173. 33 U.S.C. § 1251(a).

174. 33 U.S.C. § 1251(a)(2).

175. *See, e.g.,* James Salzman, *Why Rivers No Longer Burn*, SLATE.COM (Dec. 10, 2012, 5:20AM), http://www.slate.com/articles/health_and_science/science/2012/12/clean_water_act_ 40th_anniversary_ the_greatest_success_in_environmental_law.html (discussing CWA's impact on eliminating pollution discharges from point sources); Peter Lehner, *40 Years Ago Clean Water Act Transformed How America Views Water, Time to do it Again*, SWITCHBOARD, (Oct. 18, 2012), http://switchboard.nrdc.org/ blogs/plehner/40_years_ago_clean_water_act_t.html (discussing similar CWA impacts on water quality).

176. 33 U.S.C. §1362(14) (2006).

177. 33 U.S.C. §1362(6) (2006).

178. S. REP. NO. 92-414, at 3 (1971).

waters.[179] The statute further authorized research funding to develop and implement pollution control measures for agricultural operations.[180]

The EPA established size-based regulatory classifications for animal feeding operations (AFOs) and CAFOs in 1976 and nominally prohibited them from discharging waste, except in the event of a 25-year, 24-hour storm.[181] However, it took more than two decades—and a citizen suit—for the agency to develop a comprehensive regulatory program for this class of facilities.[182] In the meantime, Congress amended the definition of "point source" by adding exemptions for agricultural stormwater[183] runoff and irrigation return flows.[184] These terms, which Congress did not define and which were supported by sparse legislative history, have been interpreted to create loopholes that severely restrict the EPA's ability to regulate and reduce pollution from CAFOs that impair water quality.[185]

The Clean Water Act (CWA) aims to achieve its objectives by, *inter alia*: prohibiting the discharge of toxic chemicals; eliminating the discharge of pollutants; developing technologies necessary to eliminate the discharge; and developing programs to control non-point sources.[186]For most point sources, the EPA has developed a rigorous federal-state permitting system pursuant to section 402 of the CWA.[187] The National Pollutant Discharge Elimination System (NPDES) permit program prescribes technology and water-quality based requirements to individual dischargers, including schedules for monitoring and reporting.[188] "Technology-based requirements are designed to reflect the levels of effluent quality achievable through the use of pollution control technolog[ies]."[189]

179. 33 U.S.C. § 1254(p) (2006).

180. 33 U.S.C. §1255(e) (2006).

181. Concentrated Animal Feeding Operations, 41 Fed. Reg. 11,458 (Mar. 18, 1976) (to be codified at 40 C.F.R. pts. 124, 125).

182. *See generally* Natural Res. Def. Council v. Reilly, No. 89–2980, 1991 U.S. Dist. LEXIS 5334 (D.D.C. Apr. 23, 1991), *rev'd sub nom.* Natural Res. Def. Council v. Whitman, No. 89–2980 (D.D.C. Jan. 31, 1992) (resulting in a consent decree that required the EPA to develop new effluent limitation guidelines for some CAFOs).

183. Act of Feb. 4, 1987, Pub. L. No. 100-4, 101 Stat. 503 ("To amend the Federal Water Pollution Control Act to provide for the renewal of the Feb. 4, 1987 quality of the Nation's waters, and for other purposes.").

184. S. REP. NO. 95-217, 95th Cong., 1st Sess. 35 (1977), *reprinted in* 1977 U.S.C.C.A.N. 4326, 4360.

185. *See, e.g.*, Waterkeeper Alliance, Inc. v. U.S. EPA, 399 F.3d 486, 502 (2d Cir. 2005) (discussing the limited restrictions the CAFO rule has on discharges).

186. THE CLEAN WATER ACT HANDBOOK 1–7 (Mark Ryan ed., ABA Publishing 3d ed. 2011).

187. 33 U.S.C. § 1342(a)(5) (2006). This description excludes those facilities that discharge directly to a publicly-owned treatment works, which instead must comply with pre-treatment standards. *See* 33 U.S.C. § 1317 (delineating pre-treatment standards).

188. *See* 33 U.S.C. § 1317 (discussing technology standards and water-quality requirements).

189. THE CLEAN WATER ACT HANDBOOK, *supra* note 186, at 4.

The technology requirements are intended to reduce concentrations of conventional pollutants (such as fecal coliform and pH), toxic pollutants, and non-conventional pollutants in effluent discharged by all point sources.[190] The water-quality based requirements impose restrictions on the amounts of pollutants that may be discharged into a given water body. Also, they are based on scientific determinations of the water quality necessary to support specific uses of the water body (such as public water supply or recreation), as designated by the state in which the discharging facility is located.[191]

In 1999, the EPA and USDA released a draft Unified National Strategy for Animal Feeding Operations.[192] This strategy outlined the steps the EPA and USDA would take, using existing legal and regulatory authorities, to reduce water quality and public health impacts from improperly managed animal wastes. The strategy was based in part on eleven "listening sessions" the agency held around the country in 1998.[193] Three years later, in 2001, the EPA published final regulations for AFOs and CAFOs in the country's first attempt to set national standards for industrial-scale livestock production.[194]

The EPA's CAFO regulations established a two-part approach to regulating the industrial production of food animals: first, the facility must be categorized as an "animal feeding operation" (AFO).[195] An AFO is defined as a facility (1) in which animals are stabled or confined, and fed or maintained, for a cumulative total of 45 days during any 12-month period, and (2) on which vegetation (including post-harvest residues) are not sustained during the normal growing season over any portion of the facility.[196] If the facility qualifies as an AFO, then the second part of the

190. *Id.* at 3.

191. *See Id.* at 39–40 (discussing water-quality based treatment controls and designated uses).

192. Draft Unified National Strategy for Animal Feeding Operations, 63 Fed. Reg. 63,823, 63,823–26 (proposed Nov. 17, 1998).

193. *Unified National Strategy for Animal Feeding Operations: Public Listening Sessions*, EPA, *available at*, http://www.epa.gov/npdes/pubs/afomeet.htm (last visited April 7, 2013). Remarkably, no listening session was conducted in North Carolina — or anywhere on the southeastern seaboard — despite the fact that North Carolina is one of the nation's largest livestock producers, ranking in the top four states in the country for hog, broiler, turkey and egg production. USDA, NORTH CAROLINA'S RANK IN U.S. AGRICULTURE 2011 (2011), *available at* http://www.ncagr.gov/stats/crops/Ranking.pdf. North Carolina was notoriously suffering from the cumulative environmental and public health impacts associated with the poor management of this staggering amount of waste. *E.g.,* Pat Stith, Joby Warrick & Melanie Sill, *Boss Hog: the Power of Pork,* RALEIGH NEWS & OBSERVER, (Feb. 19, 1995), http://www.pulitzer.org/archives/5892 (for summary of this five-part Pulitzer-prize winning report).

194. *See* National Pollutant Discharge Elimination System Permit Regulation and Effluent Guidelines and Standards for Concentrated Animal Feeding Operations, 66 Fed. Reg. 2960 (proposed Jan. 12, 2001) (to be codified at 40 C.F.R. pts. 122, 412) (regulating standards for concentrated animal feeding operations (CAFOs)).

195. 40 C.F.R. § 122.23(b)(1)(2) (2012).

196. 40 C.F.R. § 122.23(b)(1).

analysis kicks in. An AFO is a CAFO if it: (1) contains a certain number of "animal units,"[197] (2) is designated as a CAFO by the permitting authority on a case-by-case basis,[198] or (3) discharges pollutants to waters of the United States.[199]

Once designated as a CAFO, the facility must obtain an NPDES permit from the EPA or applicable state permitting authority.[200] Otherwise, any discharge from the operation constitutes an unpermitted discharge and subjects the operation to enforcement action by the agency or citizens.[201] The NPDES permit incorporates narrative, non-numeric effluent limitation guidelines (ELGs) that require best management practices for the land application of waste and prohibit discharges of "process wastewater" to waters of the United States.[202] The best management practices are set forth in a Comprehensive Nutrient Management Plan (CNMP) developed in accordance with NRCS Conservation Practice Standards.[203] The CNMP establishes specific nutrient limits for the manure slurry applied to the land, based on soil type and the nutrient needs of the crop or vegetation to be grown.[204] Rates for the application of manure must be designed to "minimize phosphorus and nitrogen transport from the field to surface waters."[205] The BMPs for land application also require periodic manure and soil sampling, inspection of land application equipment, and setback requirements from surface waters and drainage contours.[206]

The two exceptions to prohibiting discharges to surface waters are for "agricultural storm water discharge"[207] and discharges that result from chronic or catastrophic precipitation events greater than the 25-year, 24-

197. The EPA's regulations use the term "animal unit" with reference to the specific number of different species of animals. *See* 40 C.F.R. §122.23(b)(4)(i)–(xiii) (for "animal unit" references).

198. 40 C.F.R. § 122.23 (a).

199. 40 C.F.R. § 122.23(b)(6)(ii)(A).

200. *See* 33 U.S.C. § 1311(a) (1995) (discussing discharge); *see also* Waterkeeper Alliance, Inc. v. U.S. EPA, 399 F.3d 486, 504 (2d Cir. 2005) (establishing a permitting scheme under the Clean Water Act to regulate emissions of water pollutants, requiring every CAFO owner or operator either apply for a permit, and comply with the effluent limitations contained in the permit, or affirmatively demonstrate that no permit was needed because there was no potential to discharge).

201. *See Waterkeeper*, 399 F.3d at 492 (authorizing agencies to issue orders requiring compliance or bring a civil action or criminal penalties for negligent violations).

202. *See generally* Best Management Practices (BMPs) for Land Application of Manure, Litter, and Process Wastewater, 40 C.F.R. § 412.4 (2003); *Waterkeeper*, 399 F.3d at 498.

203. 40 C.F.R. § 412.4(c)(1) (2003); USDA & U.S. EPA, UNIFIED NATIONAL STRATEGY FOR ANIMAL FEEDING OPERATIONS § 3.2 COMPREHENSIVE NUTRIENT MANAGEMENT PLANS (1999), *available at* www.epa.gov/npdes/pubs/finafost.pdf

204. 40 C.F.R. § 412.4.

205. *Id.* § 412.4(c)(2).

206. *Id.* § 412.4(c)(3)–(5).

207. 40 C.F.R. § 122.23(e)(2012).

hour storm.[208] The EPA stated that as long as the CAFO was designed, constructed, operated, and maintained to contain all process-generated wastewater, plus the runoff from a 25-year, 24-hour storm, discharges that occur during exceptional rain events would be permitted, consistent with its approach for wet-weather discharges from other regulated point sources.[209] The EPA anticipated that some pollutants—properly applied to land in accordance with approved nutrient management plans—would be carried to surface waters in runoff resulting from normal rainfall, but that this would be exempt as agricultural stormwater discharge.[210] Discharges that occurred during dry weather would not constitute agricultural stormwater runoff, and would be strictly prohibited.[211]

During the rulemaking process, the EPA considered additional measures to safeguard water quality, such as groundwater and surface water monitoring, the use of anaerobic digestors, and gas recovery technology for the treatment of manure.[212] It ultimately rejected those measures for existing swine CAFOs, asserting that its economic models predicted larger numbers of operators would be forced to close and, therefore, it was not economically feasible to mandate their use, regardless of the potential benefits for water quality and human health.[213] The EPA also rejected these technology requirements for new swine CAFOs on similar grounds, despite recognizing that those and other superior technologies—including solids separation and dry manure systems—were being used at CAFOs in Europe and Canada. The EPA also recognized that the industry had asserted that new operations were moving away from open-air lagoons, and the new technologies could "include . . . cost savings (or even revenue, in some cases) from electricity generation, a better-stabilized waste, significant odor reduction, and improved marketability of the digester solids."[214] The EPA

208. 40 C.F.R. § 412.13(b) (2003). The amount of precipitation that qualifies as a 25-year, 24-hour storm event varies among different parts of the country, and may be determined by consulting the National Weather Service's "Technical Paper NO. 40, Rainfall Frequency Atlas of the United States," May 1961, as amended. *See* 40 C.F.R. § 122.23(e) (2012) This definition changes over time, especially as the climate changes and storms become more frequent and more severe in certain areas.

209. 40 C.F.R. § 412.13(b) (2012).

210. National Pollutant Discharge Elimination System Permit Regulation and Effluent Limitations Guidelines and Standards for Concentrated Animal Feeding Operations (CAFOs), 66 Fed. Reg. 2960, 3029 (proposed Jan. 12, 2001) (to be codified at 40 C.F.R. pts 122, 412).

211. *Id.*

212. *Id.* at 3059, 3061.

213. National Pollutant Discharge Elimination System Permit Regulation and Effluent Limitations Guidelines and Standards for Concentrated Animal Feeding Operations (CAFOs), 68 Fed. Reg. 7176, 7218 (Feb. 12, 2003) (amending 40 CFR § 9, 122, 123, 412) (finding that such a requirement would result in the closure of 11% of the existing swine CAFOs). It rejected these requirements for new swine CAFOs on similar grounds, even though the agency acknowledged their environmental benefits and potential for generating revenue for the grower. *See id.* at 7220–21.

214. *See id*.

determined that requiring new swine CAFOs to improve their systems to include the direct precipitation and runoff from a 100-year, 24-hour rainfall event was sufficient.[215] The agency also rejected requiring surface and ground water monitoring at new swine CAFOs on the basis of similar economic concerns.[216]

Even with its limited requirements, the EPA's regulatory program has been mired in litigation since its adoption. The CWA is clear that any entity that discharges pollutants into surface waters may do so only in accordance with an NPDES permit.[217] Because the EPA has determined that "all or virtually all" CAFOs have either discharged—or have the potential to do so—it required every CAFO to apply for an NPDES permit.[218] The livestock industry challenged this part of the regulation, disputing the EPA's authority to require permits based on the potential to discharge.[219] Courts have ruled that the EPA has no authority to require a CAFO operator to apply for a permit, unless it had evidence of an actual discharge of pollutants: "The Clean Water Act gives the EPA jurisdiction to regulate and control only *actual* discharges—not potential discharges, and certainly not point sources themselves."[220]

A fundamental shortcoming of the EPA's regulatory proposal was its failure to show, or even assert, that all swine CAFOs that are located within a certain distance of surface waters and employ certain management practices, such as open-air lagoons or fans to ventilate gasses from the confinement houses, discharge pollutants to surface waters via the deposition of ammonia, VOCs, and other chemical compounds, including particulate matter. The Second Circuit Court of Appeals implied that had the EPA argued for a regulatory presumption of actual discharge, a different conclusion might have been reached.[221]

In fact, the EPA did make this tacit assertion in issuing three guidance letters that advised poultry growers of their obligation to obtain an NPDES permit for the release of dust through the confinement house ventilation fans.[222] Implicit in this guidance was the agency's understanding that

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215. *Id.*

216. *Id.*

217. 33 U.S.C. § 1342(a)(1) (2006).

218. Standards for CAFOs, 68 Fed. Reg. at 7176, 7202.

219. *See* Nat'l Pork Producers Council v. U.S. EPA, 635 F.3d 738, 741 (5th Cir. 2011) ("challenging the EPA's procedures for issuing rules that the Poultry Petitioners allege were final.").

220. Waterkeeper Alliance, Inc. v. U.S. EPA, 399 F.3d 486, 505 (2d Cir. 2005) (citing Natural Res. Def. Council v. EPA, 859 F.2d 156, 170 (D.C. Cir. 1998)).

221. *Id.* at 506 n.22.

222. *See Nat'l Pork Producers Council*, 635 F.3d at 747 ("Shortly after the EPA issued the 2008 Rule, it issued three guidance letters, a common practice following the issuance of complex regulations.").

emissions of particulate matter from the confinement houses that are then deposited into surface waters constitutes a discharge of pollutants from a point source, and therefore require an NPDES permit.[223] The poultry industry challenged this requirement, arguing that it imposed new legal requirements and should have been subject to notice and comment rulemaking in accordance with the Administrative Procedures Act.[224] The court rejected this argument, ruling that the CWA has always prohibited the discharge of pollutants without a permit, and the EPA's letters merely restated that requirement and created no new legal obligations.[225] If the discharge of manure through poultry house ventilation fans constitutes an impermissible discharge of pollutants from a point source, then the discharge of manure—and ammonia and other gasses that impair water quality—from swine house ventilation fans should also constitute an impermissible discharge and be subject to NPDES permit controls as well.

The industry's challenge to the EPA's regulations also included the agency's treatment of the exemption for "agricultural stormwater" that was added to the definition of point source in 1987.[226] In defining the term point source, the Clean Water Act specifically includes CAFOs, along with other discrete conveyances such as pipes and ditches, but also exempts agricultural stormwater discharges.[227] The Second Circuit found that the Act was "self-evidently ambiguous as to whether CAFO discharges can ever constitute agricultural stormwater," and noted that the Act "makes absolutely no attempt to reconcile the two" concepts.[228]

The EPA regulations defined the agricultural stormwater exemption to apply to precipitation-induced runoff of effluent that had been applied to land according to the operation's site-specific nutrient management plan.[229] Consistent with the court's holding in *Southview Farms*, the agency tied the application of the exemption to weather, advising that it would not apply to discharges caused by the over-application of waste, or discharges that occurred during dry weather.[230] The court determined that this was a reasonable interpretation of the statute.[231]

The effluent limitation guidelines established in the CAFO regulations are based on the swine industry's current practice of storing waste in open-

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223. *Id.* at 755.
224. *Id*.
225. *Id*. at 756.
226. *Id.* at 743.
227. 33 U.S.C. § 1362(14) (2006).
228. Waterkeeper Alliance, Inc. v. U.S. EPA, 399 F.3d 486, 507 (2d Cir. 2005).
229. Standards for CAFOs, 68 Fed. Reg. at 7176, 7198; 40 C.F.R. §122.42(e) (1)(vi)–(ix).
230. *See* Concerned Area Residents for the Env't v. Southview Farm*,* 34 F.3d 114, 120–21 (2d Cir. 1994).
231. *Id.* at 121.

air lagoons and applying the effluent to sprayfields. But the EPA missed the opportunity to use its statutory authority to require industry to use superior methods of managing waste and protecting water quality, even though it has acknowledged that it has "considerable discretion under CWA section 304(b)(2) to determine whether and when a particular technology or process is BPT, BCT, or BAT."[232] However, the regulations do authorize the use of alternative technologies that perform equal or superior to conventional waste treatment systems.[233] As more and more research is conducted into alternative methods of waste treatment, and certain segments of the industry employ those methods, the EPA may revise its regulations to mandate the use of technologies that offer superior protections for water quality, air quality, and neighboring communities. The EPA recently revised the CAFO regulations to comply with the Fifth Circuit's decision.[234]

B. Clean Air Act

1. Amnesty Agreement

The federal Clean Air Act (CAA)[235] regulates air pollution from stationary and mobile sources, and delegates to the EPA the authority to develop and enforce a program of rules and permits designed to protect public health and welfare.[236] The CAA directs EPA to develop standards for ambient air quality for a variety of pollutants known to adversely affect human health and welfare,[237] and stringent measures for regions that violate those standards.[238] These National Ambient Air Quality Standards (NAAQS) are the centerpiece of the statute and the primary focus of regulation.[239] To attain those NAAQS, the CAA directs the EPA to develop operating permits for stationary sources of air pollution,[240] and measures to control hazardous air pollutants.[241] The CAA also gives the agency the authority to initiate enforcement action and assess civil penalties against

232. Standards for CAFOs, 68 Fed. Reg. at 7214.
233. *See Id.* at 7202; 40 C.F.R. § 412.31(a)(2) (2012).
234. National Pollutant Discharge Elimination System Permit Regulation for Concentrated Animal Feeding Operations: Removal of Vacated Elements in Response to 2011 Court Decision, 77 Fed. Reg. 44,494, 44,494–97 (July 30, 2012) (to be codified at 40 C.F.R. pt. 122).
235. 42 U.S.C. §§ 7401–7671q (2006).
236. 42 U.S.C. § 7401 (a) (2006).
237. 42 U.S.C. § 7409 (a)(1) (2006).
238. 42 U.S.C. § 7502 (2006).
239. *See* 42 U.S.C. § 7408(a)–(e) (mandating administrator to promptly devise and implement air pollutant regulations).
240. 42 U.S.C. § 7411(a)(1) (2006).
241. 42 U.S.C. § 7412(d)(1)(2) (2006).

any facility that violates the terms of its permit.[242] As with the CWA, states play an important role in implementing the CAA by developing State Implementation Plans (SIPs) to ensure that state air quality meets federal air quality standards.[243]

The CAA defines "air pollutant" as "any air pollution agent or combination of such agents, including any physical, chemical, biological, radioactive . . . substance or matter which is emitted into or otherwise enters the ambient air. Such term includes any precursors to the formation of any air pollutant . . . ."[244] The EPA has established primary NAAQS for the six "criteria pollutants" identified by EPA and regulated under the CAA: sulfur dioxide (SO_2), nitrogen dioxide (NO_2), particulate matter (PM), carbon monoxide (CO), ozone (O_3), and lead.[245] Volatile Organic Compounds (VOCs) and ammonia are also regulated, as they are considered to be precursors of ozone and PM 2.5, respectively.[246] The CAA also identifies more than 180 air pollutants as "hazardous air pollutants" (HAPs),[247] and directs the EPA to periodically review and revise the list by rule:

> [A]dding pollutants [that] threaten adverse human health effects (including, but not limited to, substances which are known to be, or may reasonably be anticipated to be, carcinogenic, mutagenic, teratogenic, neurotoxic, which cause reproductive dysfunction, or which are acutely or chronically toxic) or adverse environmental effects whether through ambient concentrations, bioaccumulation, deposition, or otherwise . . . ."[248]

A number of the air emissions produced by livestock facilities are pollutants regulated under the CAA, such as particulate matter, oxides of nitrogen, VOCs and ammonia. There is no question that these pollutants can

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242. 42 U.S.C. § 7414(a)(1) (2006).

243. *See* 42 U.S.C. § 7407(a) (requiring states submit an implementation plan specifying the manner in which national primary and secondary ambient air quality standards will be achieved and maintained within the state).

244. *See* 42 U.S.C. § 7602(g) ("any air pollution agent or combination of such agents, including any physical, chemical, biological, radioactive (including source material, special nuclear material, and byproduct material) substance or matter which is emitted into or otherwise enters the ambient air. Such term includes any precursors to the formation of any air pollutant, to the extent the Administrator has identified such precursor or precursors for the particular purpose for which the term "air pollutant" is used").

245. 42 U.S.C. § 7409(c); 40 C.F.R. §§ 50.4–12 (2006). They are called criteria pollutants because EPA regulates them by developing health-based criteria for setting the maximum permissible concentrations in the ambient air for each pollutant. *See* EPA, THE PLAIN ENGLISH GUIDE TO THE CLEAN AIR ACT, *available at* http://www.epa.gov/airquality/peg_caa/cleanup.html.

246. 42 U.S.C. § 7412(k)(2) (2006). EPA, THE PLAIN ENGLISH GUIDE TO THE CLEAN AIR ACT, *supra* note 246.

247. 42 U.S.C. § 7412(b)(1) (2006).

248. 42 U.S.C. § 7412(b)(2).

have serious adverse impacts on human health and welfare.[249] However, CAFOs emit pollutants from many different structures and practices, and most of them lack a discrete point from which measurements can be taken.[250] Moreover, a number of different factors—meteorological conditions, topography, size of operation, type of animals raised, and on-farm management practices—affect the amount and rate of emissions.[251] As a consequence, emissions from lagoons and land application cannot be measured with precision and instead must be estimated.[252] Consequently, although the CAA does not exempt CAFOs from compliance with its permitting and technology requirements, the EPA and state regulatory agencies have rarely taken action against CAFOs or forced them to comply.[253]

In the absence of sound protocols to reliably measure and estimate emissions from CAFOs, the EPA entered into an agreement with the livestock industry to conduct a National Air Emissions Monitoring Study (NAEMS)[254] that would:

> 1) . . . quantify aerial pollutant emissions from dairy, pork, egg, and broiler production facilities, 2) . . . provide reliable data for developing and validating emissions models for livestock and poultry production and for comparison with government regulatory thresholds, and 3) . . . promote a national consensus on methods and procedures for measuring emissions from livestock operations.[255]

Participating AFOs paid a civil penalty, ranging from $200 to $100,000, based on the size and number of facilities they operated.[256] As part of the Agreement, the EPA agreed not to sue participating operations for past

249. *See e.g.,* 6 COMM. ON ACUTE EXPOSURE GUIDELINE LEVELS, NAT'L RESEARCH COUNCIL, ACUTE EXPOSURE GUIDELINE LEVELS FOR SELECTED AIRBORNE CHEMICALS 59–60 (2008) (explaining that ammonia can cause severe irritation and burning of the eyes, skin, and respiratory tract, and in higher concentrations, even death); 9 COMM. ON ACUTE EXPOSURE GUIDELINE LEVELS, NAT'L RESEARCH COUNCIL, ACUTE EXPOSURE GUIDELINE LEVELS FOR SELECTED AIRBORNE CHEMICALS 177 (2010) (describing how hydrogen sulfide can cause death in humans through respiratory failure, most times occurring in confined spaces, such as manure pits, animal processing facilities, and sewers).

250. AD HOC COMM., *supra* note 21, at 44, 75.

251. *Id.* at 57, 169.

252. *Id*. at 98.

253. Animal Feeding Operations Consent Agreement and Final Order, 70 Fed. Reg. 4958, 4959 (proposed Jan. 31, 2005).

254. *Id.* at 4958.

255. CLAUDIA COPELAND, CONG. RESEARCH SERV., RL 32947, AIR QUALITY ISSUES AND ANIMAL AGRICULTURE: EPA'S AIR COMPLIANCE AGREEMENT 11 (2012).

256. Animal Feeding Operations Consent Agreement, 70 Fed. Reg. at 4958. Overall, the facilities and industry trade associations contributed approximately $14.6 million to fund the NAEMS.

violations of the CAA, CERCLA, and EPCRA.[257] The Consent Agreement specified that the EPA would use the emissions data to develop emissions-estimating methodologies (EEMs) to estimate emissions from CAFO operations to clarify their regulatory obligations pursuant to the CAA, CERCLA, and EPCRA.[258]

Although the NAEMS was expected to be completed within two years,[259] THE EPA did not publish its initial findings until 2011, five years after the Consent Agreement took effect, and it has yet to finalize any EEMs.[260] The EPA did develop three alternative EEMs for ammonia emitted from swine and dairy housing structures and manure storage units, but has not finalized any EEMs for lagoons.[261] Moreover, due to limited data collection and availability, the agency has not developed EEMs for VOCs or particulate matter, and is still in the process of developing EEMs for hydrogen sulfide.[262] The agency's own Science Advisory Board has roundly criticized its efforts.[263] At this time, it is uncertain what the agency's next steps will be.

2. Greenhouse Gasses

In addition to emitting criteria and hazardous air pollutants, CAFOs also emit greenhouse gases, such as methane and nitrous oxide, that contribute to global climate change, accounting for "7.5 percent of total anthropogenic [methane] emissions and 4.7 percent of [nitrous oxide] emissions in the U.S."[264] Consequently, in its recent rulemaking to quantify national greenhouse gas emissions, the EPA included animal agriculture operations that emit more than 25,000 metric tons of carbon dioxide

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257. *Id.*

258. *Id*. at 4961. The Consent Agreement focused on emissions of ammonia, hydrogen sulfide, particulate matter, and VOCs.

259. EPA, OFFICE OF AIR QUALITY PLANNING AND STANDARDS, DRAFT DEVELOPMENT OF EMISSIONS ESTIMATING METHODOLOGIES FOR LAGOONS AND BASINS AT SWINE AND DAIRY ANIMAL FEEDING OPERATIONS vii (2012) [hereinafter DRAFT DEVELOPMENT OF EMISSIONS], *available at* http://www.epa.gov/airquality/agmonitoring/pdfs/ afolagooneemreport2012draftnoapp.pdf. Community-based and environmental organizations challenged the Consent Agreement as exceeding the EPA's enforcement authority and violating the APA's notice and comment rulemaking requirements, but the court rejected the challenge. *See* Ass'n of Irritated Residents v. U.S. EPA, 494 F.3d 1027, 1028 (D.C. Cir. 2007).

260. DRAFT DEVELOPMENT OF EMISSIONS, *supra* note 259, at vii.

261. *Id.* at 57.

262. DRAFT DEVELOPMENT OF EMISSIONS, *supra* 259, at viii.

263. *SAB Panel Rejects CAFO Emissions Methods, Despite Justification from EPA,* INSIDE EPA, DAILY NEWS (Aug. 14, 2012).

264. Mandatory Reporting of Greenhouse Gases, 74 Fed. Reg. 56260, 56339 (Oct. 30, 2009) (to be codified as 40 C.F.R. pts. 86-7, 89-90, 94, 98, 1033, 1039, 1042, 1045, 1048, 1051, 1054, 1065). Methane emissions from manure management systems totaled 44 million metric tons CO2e, and N2O emissions were 14.7 million metric tons CO2e in 2007. *Id.*

equivalent (CO2e) per year.[265] Owners or operators of covered facilities are required to collect emission data, calculate GHG emissions, and follow specified procedures for quality assurance, recordkeeping, and reporting.[266] To reduce the burden of determining whether an individual CAFO needed to report under the rule, the EPA included a population threshold table for beef, dairy, swine, and poultry operations.[267] For swine CAFOs, the EPA determined that the rule applies only to those CAFOs that raise more than 34,100 animals annually.[268]

The Mandatory Greenhouse Gas Reporting Rule does not purport to regulate the emissions of GHGs, but rather is a reporting mechanism by which the EPA can gather data on large emissions sources and determine whether future regulation is necessary. Facilities covered by the rule were required to begin reporting their emissions starting in 2010, with the first reports due in 2011.[269] However, in 2011, Congress prohibited the EPA from expending any funds to implement the GHG Reporting Rule with regard to CAFOs.[270] Although the EPA advised the livestock industry that the restriction applies only to the EPA's expenditure of funds and does not alter any requirements in the regulations themselves,[271] any CAFOs are unlikely to comply.

C. CERCLA and EPCRA

Many of the pollutants emitted by CAFOs (such as hydrogen sulfide, ammonia, VOCs, nitrogen oxide and particulate matter)[272] are also subject to regulation pursuant to the Comprehensive Environmental Response,

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265. U.S. EPA, FINAL RULE: MANDATORY REPORTING OF GREENHOUSE GASES (2009), *available at* http://www.epa.gov/ghgreporting/documents/pdf/infosheets/manuremanagement.pdf. Significantly, this calculation applies only to the confinement houses and manure management systems, and excludes enteric fermentation (a significant source of methane on beef and dairy feedlots) or the land application of manure.

266. *Id.*

267. *Id.*

268. Mandatory Reporting of Greenhouse Gases, 74 Fed. Reg. at 56,485.

269. EPA, *Greenhouse Gas Reporting Program Basic Information* (Feb. 5, 2013), http://www.epa.gov/ghgreporting/basic-info/index.html.

270. Mandatory Reporting of Greenhouse Gases, *supra* note 266.

271. *See* frequently asked question 282: "*Can someone tell me if livestock operations need to report this year or not? I have heard from EPA personnel, Cattlemen industry people and state officials, but continue to get conflicting information*." *Greenhouse Gas Reporting Program's Frequently Asked Questions*, EPA, http://www.ccdsupport.com/confluence/pages/viewpage.action?pageId=91980293 (last visited Feb. 8, 2013) (indicating that the restriction in subpart JJ of Part 98 applies to EPA's expenditure of funds and does not alter the requirements under part 98).

272. EPA, CERCLA/EPCRA Administrative Reporting Exemption for Air Releases of Hazardous Substances from Animal Waste at Farms, 73 Fed. Reg. 76,948, 76,950 (Dec. 18, 2008) (to be codified at 40 C.F.R. pt. 302, 355).

Compensation and Liability Act (CERCLA)[273] and the Emergency Planning and Community Right to Know Act (EPCRA).[274] Among other requirements, both statutes establish reporting requirements about the storage and release—which includes emissions[275]—of hazardous and toxic chemicals in excess of specific amounts for purposes of emergency planning, notification and response.[276] For example, the "reportable quantity" for both ammonia and hydrogen sulfide is 100 pounds per day, or 18.3 tons per year.[277] CAFOs are significant sources of both ammonia and hydrogen sulfide.[278]

The EPA has generally not enforced the reporting requirement against livestock operations that release hazardous or toxic pollutants, initiating only two enforcement actions—both against large pork producers—for failure to comply with the statutes' reporting requirements. The EPA attributed this lack of enforcement in part to limitations in estimating emissions and releases. In addition, CERCLA excludes the "normal application of fertilizer" from the definition of "release," and EPCRA excludes any substance "used in routine agricultural operations" from its definition of hazardous chemicals. And, when the EPA entered into the Consent Agreement with certain AFOs to conduct the National Air Emissions Monitoring Study, it agreed not to sue participating operations for past violations of CERCLA and EPCRA as well.[279] The data and EEMs that the EPA hoped to develop would also be used to clarify the livestock industry's regulatory obligations pursuant to CERCLA and EPCRA.[280]

Before the EPA published its draft of the EEMs, however, several poultry producers petitioned the EPA to exempt them from reporting their ammonia emissions pursuant to EPCRA and CERCLA.[281] After a period of study and solicitation of public comments, the agency published a notice stating that it would exempt "certain releases of hazardous substances to the air from the notification requirements of CERCLA . . . as implemented in

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273. 42 U.S.C. § 9601(22)(D) (2006).

274. U.S. EPA, LIST OF LISTS: CONSOLIDATED LIST OF CHEMICALS SUBJECT TO EPCRA, CERCLA AND SECTION 112(R) OF THE CLEAN AIR ACT iv-v, 25-26 (2011).

275. 42 U.S.C. § 9601(22); 42 U.S.C. § 11049(8).

276. 42 U.S.C. § 9603(a) (2006); 42 U.S.C. § 11004(a) (2006).

277. 40 C.F.R. § 355, App. A (2012) (listing extremely hazardous substances); AD HOC COMM., *supra* note 21, at 138.

278. *See, generally,* Animal Feeding Operations Consent Agreement and Final Order, 70 Fed. Reg. 4,958 (Jan. 31, 2005).

279. Animal Feeding Operations Consent Agreement, 70 Fed. Reg. at 4961.

280. *Id.* The Consent Agreement focused on emissions of ammonia, hydrogen sulfide, particulate matter, and VOCs.

281. COPELAND, CLAUDIA, CONG. RESEARCH SERV., RL 33691, ANIMAL WASTE AND HAZARDOUS SUBSTANCES: CURRENT LAWS AND LEGISLATIVE ISSUES (2011).

40 CFR 302.6."[282] Specifically, the EPA exempted from CERCLA's notification requirements "all releases of hazardous substances to the air from animal waste at farms."[283] In addition, the EPA announced that it would offer a more limited exemption to farms from EPCRA's section 304 emergency notifications, requiring only those CAFOs that exceed the CWA's regulatory threshold to comply; smaller operations, and those that do not stable or confine their animals, would be exempt.[284] The EPA justified its action on the basis of its belief "that Federal, State or local response officials are unlikely to respond to notifications of air releases of hazardous substances from animal waste at farms."[285]

Several environmental organizations and livestock industry trade groups challenged the final rule.[286] After mediation failed, the EPA sought and received a voluntary remand, without vacatur, of the final rule for reevaluation based on issues raised during the mediation process and newly available data.[287] The EPA now anticipates publishing a new proposal for public review and comment in late 2013, after it finalizes the relevant EEMs.[288] Some members of Congress have taken interest in the EPA's actions and sought to shield the livestock industry from the statutes' basic reporting requirements, introducing legislation that would exclude "manure" and emissions associated with its decomposition from CERCLA's definition of hazardous waste, and eliminate reporting requirements under both CERCLA and EPCRA.[289] It is unclear whether these bills will be reintroduced during the current session of Congress.

From air pollution, to water contamination, to soil damage, to human health impacts, the current industrial model has proven itself unsustainable. It extracts value from nature and neighbors, and from the farms themselves, and transfers that wealth to the executives and shareholders of the dominant industry players.[290] Conventional regulatory programs have failed to

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282. Administrative Reporting Exemption for Air Releases of Hazardous Substances, 73 Fed. Reg. at 76,948, 76,950.

283. *Id.* Notably, the final rule applies to all animal feeding operations, not just poultry operations.

284. *Id.*

285. *Id*. at 76,949.

286. COPELAND, *supra* note 281, at 6.

287. Waterkeeper Alliance v. EPA, Nos. 09-1017, 09-1104 (consolidated), 2010 U.S. App. LEXIS 21658, at *1(D.C. Cir., Oct. 19, 2010); *see also* EPA, REGULATORY DEVELOPMENT AND RETROSPECTIVE REVIEW TRACKER, CERCLA/EPCRA REPORTING REQUIREMENTS FOR AIR RELEASES OF HAZARDOUS SUBSTANCES FROM ANIMAL WASTE AT FARMS, *available at* http://yosemite.epa.gov/opei/rulegate.nsf/byRIN/2050-AG66#3.

288. *Id.*

289. H.R. 2997, 112th Cong. (2011); S. 1729, 112th Cong. (2011).

290. *See, e.g.,* SMITHFIELD FOODS, PROXY STATEMENT SCHEDULE 14A 2 (2012) *available at* http://www.sec.gov/Archives/edgar/data/91388/000130817912000171/lsmithfield_def14a08092012.htm

meaningfully reduce harm to the environment or improve conditions for those who live near CAFOs.[291] Industry practices must change in order to reduce these impacts and move to a more sustainable model of production.

VI. CAN HOGS BE RAISED SUSTAINABLY? (OR ARE WE MERELY PUTTING LIPSTICK ON A PIG?)

It remains to be seen whether current levels of production can be maintained to achieve any measure of sustainability, but in recent years two alternative models of production have emerged in response to the impacts associated with the concentrated production of livestock. One involves the development of sophisticated technologies for the treatment, utilization, and disposal of animal wastes that are scaled to the CAFO model of animal production. The other involves a return to more traditional means of raising food animals, one backed by a growing body of science and principles for animal husbandry. These alternative models are reviewed in more detail below.

A. Waste Management and Disposal for Industrial Hog Production

The concept of making beneficial use of animal manures is not new. Manure has been used in crop production and burned to provide heat for millennia.[292] But modern farms have grown in size and become increasingly specialized.[293] In the United States, crop and livestock production are now largely removed from one another, and manure has been replaced by synthetic fertilizers to meet the crops' nutrient demands. This high degree of specialization results in geographic concentrations of manure that far exceed local demands and lead to the litany of problems reviewed above.[294]

(stating that in fiscal 2012, the company posted "record sales and the second highest net income in its history").

291. Nor have the existing regulatory programs improved the abhorrent, cruel conditions in which the animals are raised. *See generally,* CAFO: THE TRAGEDY OF INDUSTRIAL ANIMAL FACTORIES 11–13 (Daniel Imhoff ed. 2010). In fact, aside for the Humane Slaughter Act, 7 U.S.C. §§ 1901–1907, no federal program exists to address animal welfare for food animals, and the industry has been slow to adopt voluntary measures to address such concerns.

292. AD HOC COMM., *supra* note 21, at 164.

293. Matias Vanotti, *Development of Clean Technologies for Management of Wastes from Pig Production and their Environmental Benefits*, ENGORMIX.COM (Oct. 22, 2012), http://en.engormix.com/MA-pig-industry/management/articles/development-clean-technologiesmanagement-t2390/124-p0.htm (indicating that U.S. agriculture was previously dominated by numerous small operations but has become highly concentrated in large operations, separating animal production from crop production).

294. *Id.* (explaining that the amount of manure produced exceeds local demand for use as fertilizer).

A number of publicly and privately funded research projects have been conducted to better manage, treat, and utilize the large quantities of manure produced in CAFOs.[295] Technologies and practices studied include the use of storage covers (ranging from chopped straw to high-density polyethylene) for slurry storage tanks, anaerobic lagoons, filtration for treatment of exhaust air from the houses, aeration of the waste stream, separation of solid and liquid waste, composting waste, redesigning the confinement houses, and different land application methods.[296] These studies have shown that swine waste may be used:

> to produce energy in the form of methane, biogas, diesel fuel, or electricity for direct on-farm purposes; [as] synthetic growth media for high-value ornamental plants, or soil amendments for residential or commercial landscaping purposes; [as] nitrogen- and phosphorus-rich fertilizer materials for direct application to crops such as corn, cotton, sweet potatoes, and so forth, or for fast-growing pine and/or hardwood plantations; … and [as a source of] protein products for industrial applications including industrial antibodies and enzymes used in detergents, recycling, and processing of pulp, paper, textile, and chemical products.[297]

These studies also show the new technologies to be effective at reducing emissions, odor, runoff, and pathogens.[298]

The costs associated with advanced manure treatment can be high, and currently limit their widespread adoption. The three main alternative approaches are to: (1) retrofit existing lagoon systems to recover and treat nutrients and volatile solids to generate value-added products; (2) use anaerobic digesters to recover methane and generate biogas that can be used to generate electricity and heat; and (3) use dry systems, such as deep bedding (in which manure is mixed with dry matter, such as wheat straw or wood shavings) or separation of urine and solids in the house.[299]

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295. AD HOC COMM., *supra* note 21.

296. *See, e.g.,* AD HOC COMM., *supra* note 21, at 47–48 (parenthetical in memo); Melse & Timmerman, *supra* note 48, at 5509 (2009); Vanotti, *supra* note 293, at 3.

297. AD HOC COMM., *supra* note 21, at 164 (noting, although the concept of fattening animals with their own bodily waste is anathema, there is potential to use swine manure in "*feeding materials and nutritional supplements* to enhance feed conversion efficiency in fish, poultry, and livestock production").

298. *Id.*

299. Vanotti, *supra* note 293.

1. Smithfield-North Carolina Study Overview

In 2000, the state of North Carolina entered into an agreement with Smithfield Foods. The Agreement authorized the "designee"[300] to certify technologies as "environmentally superior," consistent with articulated standards, and called for the creation of an advisory panel to aid him in this endeavor.[301] The advisory panel was composed of representatives from the industry, state and local governments, environmental advocacy organizations, and concerned citizens.[302] Smithfield Foods agreed to contribute $15 million to fund the study and cover the out-of-pocket costs incurred by the advisory panel, and agreed to install technologies selected by the advisory panel on its company-owned farms for testing and evaluation by a team of scientists.[303] The company pledged another $50 million to fund local efforts to restore water quality in the region most severely affected by the industry's expansion.[304] The most powerful commitment, however, was the company's pledge to replace existing lagoons with certified ESTs on all its company-owned farms, and to assist its contract growers with their own conversion to ESTs.[305]

The technology selection process was competitive: the advisory panel published a nationwide Request for Proposals and received more than 100 proposals, from which it selected eighteen technologies to evaluate over a three-year period.[306] The advisory panel hired an engineering firm, Cavanaugh and Associates, to administer the project and a team of scientists to take the measurements at each participating facility.[307] The North Carolina Attorney General dedicated two staff members to monitor and enforce the agreement. For the next five years, the advisory panel met

300. C.M. (Mike) Williams, director of the Animal and Poultry Waste Management Center at North Carolina State University, was appointed designee by NC State University Chancellor Marye Anne Fox. Memorandum from Richard Whisnet to Charles Michael Williams 1 (Dec. 1, 2005) (available at App. D, Economics Subcommittee Reports).

301. Agreement Between the Att'y Gen. of N.C. and Smithfield Foods, Inc. 8 (July 25, 2000) [hereinafter *Smithfield Agreement*], *available at* www.cals.ncsu.edu/waste_mgt/smithfield_projects/agreement.pdf.

302. *Id.*

303. *Id.* at 3.

304. *Id. See also* C.M. Williams, *Development of Environmentally Superior Technologies in the U.S. and Policy*, 100 BIORESOURCES TECH. 5,512, 5,513 (2009) (acknowledging the EST program as a partnership between Smithfield and North Carolina).

305. *Smithfield Agreement*, *supra* note 301, at 3.

306. C.M. WILLIAMS, DEVELOPMENT OF ENVIRONMENTALLY SUPERIOR TECHNOLOGIES: PHASE 1 REPORT FOR TECHNOLOGY DETERMINATIONS PER AGREEMENTS BETWEEN THE ATTORNEY GENERAL OF NORTH CAROLINA AND SMITHFIELD FOODS, PREMIUM STANDARD FARMS, AND FRONTLINE FARMERS, 8 (2004) [hereinafter *Phase 1 Report*], *available at* http://www.cals.ncsu.edu/waste_mgt/smithfield_projects/phase1report04/front.pdf.

307. *Id.* at 4.

several times each year to review and select candidate technologies, visit test sites, discuss the project's overall progress, review and approve the budget, refine the environmental and economic criteria, review scientific and economic reports, and meet with experts.[308]

The Agreement articulated environmental performance standards and economic benchmarks against which each technology would be evaluated, and specified that only those technologies that achieved *both* the environmental and economic performance standards would be certified as "Environmentally Superior Technologies" (ESTs).[309] The Agreement defined an EST as:

> [A]ny technology, or combination of technologies that (1) is permittable by the appropriate governmental authority; (2) is determined to be technically, operationally, and economically feasible and (3) meets the following environmental performance standards:
> 1. Eliminate the discharge of animal waste to surface waters and groundwater through direct discharge, seepage, or runoff;
> 2. Substantially eliminate atmospheric emissions of ammonia;
> 3. Substantially eliminate the emission of odor that is detectable beyond the boundaries of farm;
> 4. Substantially eliminate the release of disease-transmitting vectors and airborne pathogens; and
> 5. Substantially eliminate nutrient and heavy metal contamination of soil and groundwater.[310]

The advisory panel refined these goals, distilling them to definable and measureable criteria. For example, the advisory panel developed an eight-point scale for measuring odor, and determined that odor intensity levels above two would fail the odor reduction mandate. 4-log reductions in

308. C.M. WILLIAMS, DEVELOPMENT OF ENVIRONMENTALLY SUPERIOR TECHNOLOGIES: PHASE 2 REPORT FOR TECHNOLOGY DETERMINATIONS PER AGREEMENTS BETWEEN THE ATTORNEY GENERAL OF NORTH CAROLINA AND SMITHFIELD FOODS, PREMIUM STANDARD FARMS, AND FRONTLINE FARMERS, 5 (2005), *available at* http://www.cals.ncsu.edu/waste_mgt/smithfield_projects/phase2report05/cd,web%20files/summary.pdf.

309. Williams, *supra* note 304, at 5512.

310. *Smithfield Agreement*, *supra* note 301, at 3–4. These performance standards were derived from a statute the N.C. General Assembly enacted in 1997 that created a limited, performance-based exception to the moratorium on the construction of new hog farms or the expansion of existing farms. H.R. 458, 1997 Gen. Assemb., Reg. Sess. (N.C.1997) (amended by H.R. 188, 1998 Gen. Assemb., Reg. Sess (N.C. 1998). In 2007, the General Assembly made these performance standards permanent by enacting a ban on the construction of new lagoons or the expansion of existing waste lagoons for manure storage and treatment. Only those hog farms that employ waste treatment technologies that have been certified to meet the performance standards may be built. H.R. 1678, 2007 Gen. Assemb., Reg. Sess. (N.C. 2007) (to be codified as N.C. GEN. STAT. §143-215.101).

pathogens would be required as compared with raw manure, and waste storage facilities and land application sites had to achieve an 80% reduction in ammonia emissions.[311]

Scientists documented statistically significant reductions in airborne contaminants from three of the treatment technologies.[312] Technologies that included a process for separating the solid and liquid components of the manure easily met the performance standards for odor reduction. They also eliminated nearly all odor detected at the fenceline of the properties on which they were located,[313] and showed marked ammonia reductions.[314] Several technologies met the 4-log reduction in pathogens, and one, a mesophilic digestor with water reuse system, recorded a 6-log reduction in certain pathogens.[315] Only three: Super Soils; ORBIT (a high solids anaerobic digestor limited to the treatment of solid waste); and the mesophilic digestor made significant reductions in total nitrogen, and only one, Super Soils, met the 80% ammonia reduction benchmark.[316]

The economic criteria proved more controversial. As explained above, to be designated as an "Environmentally Superior Technology," the alternative technology had to not only meet the environmental benchmarks, but also had to be determined "economically feasible." Although the Agreement did not articulate criteria for this determination, it did specify that technologies that cost more than the conventional lagoon and sprayfield system could be determined to be *economically feasible*.[317] The Economics Subcomittee recommended that a 12% reduction in the State's hog population resulting from EST implementation be considered "economically feasible,"[318] a recommendation the Designee accepted in his final report.[319] The Subcommittee estimated the costs to construct an

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311. C.M. WILLIAMS, DEVELOPMENT OF ENVIRONMENTALLY SUPERIOR TECHNOLOGIES: PHASE 3 REPORT FOR TECHNOLOGY DETERMINATIONS PER AGREEMENTS BETWEEN THE ATTORNEY GENERAL OF NORTH CAROLINA AND SMITHFIELD FOODS, PREMIUM STANDARD FARMS, AND FRONTLINE FARMERS, 36 (2006) [hereinafter *Phase 3 Report*], *available at* http://www.cals.ncsu.edu/waste_mgt/smithfield_projects/phase3report06/pdfs/report%20summary.pdf.

312. Gwangpyoko Ko, *supra* note 84, at 8855-56.

313. *Phase 1 Report*, *supra* note 306, at 34 (showing a table with approximations for average odor intensity).

314. *See id.* at 36 (showing a table with values on reductions as compared to ammonia emissions from comparable conventional technology sites).

315. *See Phase 3 Report*, *supra* note 311, at 54 (showing a table with a mesophilic digester with water reuse system that recorded a 6-log reduction in certain pathogens).

316. *Id.* at 50–56.

317. *Smithfield Agreement*, *supra* note 302, at 10.

318. *Phase 3 Report*, *supra* note 311, at 6.

319. *Id.* A minority of the Economics Advisory Panel Members, composed entirely of hog growers and industry representatives, disagreed with this determination. APP. D: ECONOMICS SUBCOMMITTEE REPORTS, Memorandum from Richard Whisnant, Econ. Subcomm. Chair, to Dr. Charles Michael Williams, Designee, re: Econ. Feasibility Determinations, 6, footnote 8 (Dec. 1, 2005)

operation using a lagoon and sprayfield system for waste management in compliance with then-current (2004) regulatory requirements to be $85 per unit (1,000 pounds steady-state live weight per year).[320] This compared with an estimated additional cost of between $90 and $400 per unit to retrofit an existing CAFO with an EST for the complete system of manure and liquid treatment, a cost that failed the Subcommittee's criteria cost metric for economic feasibility.[321] It is important to note, however, that the model used to estimate impacts on the industry did not include estimates of the social costs imposed by CAFOs, nor did it include estimates of the potential social benefits that could be achieved by the reduction in pollution associated with improved waste management.[322] It also did not consider the availability of cost-share programs and other subsidies that could help finance the additional costs of ESTs, even though the Agreement explicitly authorized the consideration of such assistance.[323]

In the end, a combination of Super Soils, nitrification-denitrification or soluble phosphorus removal, along with one of four other specified treatment technologies, was determined to be an acceptable EST for new and existing CAFOs.[324] Several other technologies were determined to meet the environmental performance standards,[325] but none met the economic standards for existing farms.[326]

2. Super Soils

The Super Soils technology was tested on a 4,400-head finishing operation in Duplin County, NC.[327] It is designed to treat "the entire waste stream from a swine farm using a wastewater treatment system consisting of solids separation, nitrification/denitrification, and soluble phosphorus removal. . . ."[328] The scientific team certified that the process far exceeded the Agreement's environmental benchmarks, removing "97.6% of the suspended solids, 99.7% of BOD [biological oxygen demand], 98.5% of TKN [total Kjehldahl nitrogen], 98.7% of ammonia, 95% of total P

[hereinafter *Whisnant memo*], *available at* http://www.cals.ncsu.edu/waste_mgt/smithfield_projects/phase3report06/pdfs/Appendix%20D.

320. *Id.* at 41.

321. *See* Williams, *supra* note 304, at 5517.

322. *See Phase 3 Report*, *supra* note 311, at 41 (omitting these factors from the impact analysis).

323. *Id.* at 6.

324. *Phase 3 Report*, *supra* note 311, at 45.

325. Williams, *supra* note 304, at 5516.

326. *Id.* A minority of the advisory panel members disputed this determination.

327. Matias B. Vanotti et al., Technology in North Carolina: The Super Soil Project 3 (on file with the Vermont Law Review).

328. *Id.* at 3.

[phosphorous], 98.7% of copper and 99.0% of zinc. . . . [It] also removed 97.9% of odor compounds in the liquid and reduced pathogen indicators to non-detectable levels."[329] In addition to the substantial reductions in pollutants, the process also:

> produced 657 tons of separated solid waste that were converted to organic plant fertilizer, soil amendments, or energy. . . . A total of 285 bags of calcium phosphate product containing 1,160 lbs of P were produced and left the farm in a 9-month period. The phosphorus was 90% plant available based on standard citrate P [phosphorus] analysis used by the fertilizer industry.[330]

The developers of Super Soils wanted to create a technology that would meet the economic feasibility criteria for existing farms as well as new and expanding operations. They embarked on a second generation pilot study, tested over three production cycles (15 months) on a 5,200-head finishing operation.[331] The separated solid manure was trucked to a centralized facility where it was combined with cotton gin waste and composted.[332] Scientists employed to measure the operation's performance reported that these composts "conserved 95-100% of the nitrogen and other nutrients and met EPA Class A biosolids quality standards due to low pathogen levels."[333] "The system produced a deodorized and disinfected liquid effluent…. [and] recycled clean water to flush the barns. The treated water was stored in the former lagoon and used for crop irrigation. The solids were removed from the barn, composted and used for the

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329. *Id.* at 4.

330. *Id.* at 4. The phosphorous removed could be quite valuable on the market, sold as commercial fertilizer or for other industrial applications. Some websites state that phosphorous sells for approximately $30 per 100 grams. *Phosphorous Element Facts*, CHEMICOOL.COM, http://www.chemicool.com/elements/phosphorus.html (last visited Feb. 13, 2013). At this rate, the phosphorous removed and recovered by Super Soils would have a market value of approximately $157,850. Another means of estimating the value is to consider the cost of removing phosphorous from polluted waterways. In 2005, a team of scientists working with the Florida Ranchlands Environmental Services Project, a public-private partnership to improve water quality and restore the natural ecology of the Florida Everglades, documented costs ranging from $106-$173 for every pound of phosphorous removed from cattle pastures. Sarah Lynch et al., *Final Report: Assessing On-Ranch Provision of Water Management Environmental Services*, FLORIDA RANCHLANDS ENVTL SERVICE PROJECT 2, 6 (June 2005), *available at* http://www.fresp.org/pdfs/FRESP%20on-ranch%20assessment%20final.pdf (estimating the range of the average cost of removing a pound of phosphorous between $106 and $157 when the total amount removed is 278,000 pounds per year, and $117 to $173 when the amount is 311,000 pounds per year). *See also* Patrick J. Bohlen et al., *Paying for Environmental Services from Agricultural Lands: An Example from the Northern Everglades,* 7 ECOLOGICAL SOC'Y AM. 46, 47 (2009) (discussing the Florida Ranchlands Environmental Services Project, and the difficulties in implementing such plans).

331. Vanotti, *supra* note 293.

332. *Id.*

333. *Id.*

manufacture of value added products."[334] It also achieved even better environmental performance than its first generation version, removing "99.99 percent of pathogens, 99 percent of odor-causing components, 95% of total phosphorous, 97 percent of ammonia, and more than 99 percent of heavy metals copper and zinc."[335]

In addition to meeting the Agreement's environmental benchmarks, Super Soils substantially reduced greenhouse gas emissions. The scientists "estimated a 96.9% reduction in GHG [methane and nitrous oxide] emissions by replacement of traditional lagoon-spray field technology with this cleaner EST technology. . . ."[336] The process also led to significant improvements in animal health, by reducing ammonia in the air in the confinement houses and improving the growing environment.[337] Scientists documented a 47% reduction in mortality, with increased daily weight gain and improved feed conversion that resulted in "substantial economic benefits to the producer" in each production cycle.[338] However, in the absence of a legal mandate, cost-share assistance, or some other change in the industrial livestock market, it is unlikely that large numbers of operations will convert their lagoons and adopt this advanced technology anytime soon.

B. Duke University and Loyd Ray Farms

Other initiatives are also underway, with private actors seeking to implement technologies that reduce the negative externalities from the concentration of manure while making profitable use of the waste stream. One such effort involves a waste-to-energy partnership among Duke University's Carbon Offsets Initiative, Duke Energy, and Loyd Ray Farms, a forward-thinking hog farmer.[339] The Loyd Ray Farms Project uses anaerobic digestion, a technology that met the Agreement's environmental benchmarks and was authorized pursuant to North Carolina law, to generate

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334. *Id.*
335. *Id.*; Perry, *supra* note 155, at 23.
336. Vanotti, *supra* note 293; Perry, *supra* note 155, at 23.
337. Perry, *supra* note 155, at 23.
338. Vanotti, *supra* note 293.
339. *See Sustainability: The Loyd Ray Farms Swine Waste-to-Energy Offsets Project,* DUKE UNIV., *available at* http://sustainability.duke.edu/carbon_offsets/Projects/loydray.html (last visited Jan. 27, 2013) [hereinafter *The Loyd Ray Farms*] (intending to serve as a model for waste management and development of on-farm renewable power); *see generally* Karl Leif Bates, *Dukes Enter into Hog Waste Partnership*, DUKE TODAY (September 27, 2010), *available at* http://today.duke.edu/2010/09/hogwaste.html (discussing the collaboration between Duke and the power company, with funding from the state and federal agencies for a pilot system for managing hog waste to control greenhouse gas emissions, reduce pollutants and generate renewable energy).

renewable energy and carbon offsets.[340] The project is designed to provide Duke Energy with renewable energy credits mandated by the state of North Carolina.[341] It will also help Duke University meet its objective of becoming carbon neutral by 2024.[342] Finally, it will test the viability of this innovative waste management system in an effort to make it more accessible and widely used by the state's hog industry. Its primary components are an anaerobic digester, a gas conditioning skid, and a 65-kW microturbine with a flare used to destroy excess biogas.[343] Anaerobic digestion "is the [same] process that occurs in anaerobic lagoons. When conducted in closed vessels, gaseous emissions including methane, carbon dioxide, and small amounts of other gases (possibly ammonia, hydrogen sulfide, and volatile organic compounds) are captured and can be burned for electricity generation or water heating, or simply flared."[344]

Loyd Ray Farms is a farrow-to-finish hog CAFO, with nine barns housing approximately 5,000 hogs and one large anaerobic lagoon for the management of approximately 365,000 gallons of waste produced each week.[345] The barns are tunnel-ventilated, with two large fans at the end of each building that circulate air inside the building and emit particulate matter and gases that accumulate inside the barns. As is customary for hog operations in North Carolina, the lagoon effluent is piped to sprayfields on which Bermuda hay is grown.[346] The Farm produces an estimated 5,183 metric tons of carbon dioxide equivalents ($MTCO_2e$) per year.[347]

The Loyd Ray Farms Project involved retrofitting the facility with two additional waste basins, one an anaerobic digester and the other an aeration basin.[348] The anaerobic digester is covered with a synthetic material. The

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340. *See The Loyd Ray Farms*, *supra* note 339; *See* N.C. GEN. STAT. § 62-133.8(e) (2011) (describing renewable energy requirements).

341. N.C. GEN. STAT. § 62–133.8 (e) (2011).

342. *Growing Green: Becoming a Carbon Neutral Campus: Duke University Climate Action Plan*, DUKE UNIV. (Oct. 15, 2009), http://sustainability.duke.edu/climate_action/Duke%20Climate%20Action%20Plan.pdf.

343. *See Loyd Ray Farms, U.S. EPA AgStar Partnership Program*, U.S. EPA, (Sept. 26, 2012), http://www.epa.gov/outreach/agstar/projects/profiles/loydrayfarms.html (discussing the project).

344. AD HOC COMM., *supra* note 21, at 47.

345. *AgStar Partnership Program*, *supra* note 343.

346. *See id*.

347. *Id.* It is noteworthy that hogs, unlike cattle, produce very little methane from digestion: 90 percent of the methane emitted from hog CAFOs comes from the manure *after* it has left the animal, and is generated when the manure is stored in anaerobic conditions. Scientists have advised that more aerobic solid waste management, or raising hogs on pasture or in deep-bedded housing, will result in the generation of very little methane. AD HOC COMM., *supra* note 21, at 53; THICKE, *supra* note 5, at 42 (citing EPA, INVENTORY OF U.S. GREENHOUSE GAS EMISSIONS AND SINKS: 1990–2010, 430-R-12-001, at 6-1 (2012), *available at* http://www.epa.gov/climatechange/Downloads/ghgemissions/US-GHG-Inventory-2012-Main-Text.pdf.)

348. *See AgStar Partnership Program, supra* note 343 (describing the system).

methane gas is collected, conditioned, and sent to a microturbine where it provides the power for five of the CAFO's nine barns and the waste management system itself. The excess methane is flared.[349] The liquid effluent is then sent to an open-air waste storage basin, in which pumps agitate and stir the waste for several hours each day.[350] The incorporation of oxygen into the liquid manure slurry results in denitrification.[351] The nutrient-reduced effluent is then piped to the original open-air anaerobic waste lagoon, where it is stored until applied to the sprayfields.[352]

As anticipated with a commercial scale test project, the system has experienced some setbacks along the way.[353] Even so, during the first full year of operation, the system produced electricity more than 60% of the time and generated 367.5 MWh of electricity.[354] The gas is composed of roughly 60% methane and 40% carbon dioxide, and contains between 1,000 and 1,500 ppm hydrogen sulfide.[355] Based on the composition of the biogas and documentation of the electricity generated by the waste management system, the project staff estimate that during the first year of operation, the system destroyed more than 2,000 metric tons $MTCO_2e$, or roughly 40% of the project's potential reductions of greenhouse gasses.[356] In addition, substantial reductions in ammonia emissions and odor were documented.[357]

C. *Premium Standard Farms, Next Generation Technologies*

As Smithfield Foods and the state of North Carolina were negotiating their agreement for the study of advanced waste treatment technologies, the state of Missouri initiated its own legal action against Premium Standard

349. *See AgStar Partnership Program, supra* note 343 (discussing the project). Plans are underway to purchase an additional microturbine, which would generate enough electricity to satisfy the demands of the entire facility, with electricity sold back to the power grid. Interview with David Cooley, Associate for Project Development, Duke Carbon offsets Initiative (Dec. 17, 2012).

350. *Id.*

351. *Id.*

352. *Id.*

353. Most significantly, the gas-conditioning skid, which dehumidifies, cools and compresses the gas for delivery to the microturbine, clogged and disrupted electricity production. After several attempts to repair the system, the project's engineers are replacing the skid with a more reliable model. *Id.*

354. DUKE CARBON OFFSETS INITIATIVE, ONE-YEAR PROGRESS REPORT, LOYD RAY FARMS INNOVATIVE ANIMAL WASTE MANAGEMENT PERMIT (2012) [hereinafter ONE-YEAR PROGRESS REPORT].

355. *Id*. at 3. According to the project's staff, the microturbine selected for the project can withstand high concentrations of hydrogen sulfide without corroding. *Id.; see also AgStar Partnership Program, supra* note 343 (describing the system).

356. ONE-YEAR PROGRESS REPORT, *supra* note 354, at 5.

357. *See* E-mail from Tatjana Vujic, Dir., Duke Carbon Offsets Initiative, to Melissa Rosebrock, N.C. Dep't Env't and Natural Res., Div. of Water Quality (Feb. 15, 2012) (on file with author).

Farms (PSF), the largest hog grower in that state.[358] The Missouri Attorney General filed a lawsuit against the company alleging multiple violations of the federal Clean Water Act and Clean Air Act, the Missouri Clean Water Law, and the Missouri Clean Air Conservation Law.[359] In settlement of those claims, the court approved a landmark consent judgment in which the company agreed "to undertake a two-tier Capital Improvement Program to research, develop and implement next generation waste handling/environmental control technologies (Next Generation Technology)[360] at its Missouri swine operations"[361] and pay penalties of $1 million to the State of Missouri.[362] The consent judgment also created a three-person advisory team to review, evaluate, and oversee PSF's activities and technology development.[363]

The advisory team developed criteria for review and evaluation of technologies, including nitrogen and phosphorous management, pathogen risk reduction, and odor reduction from barns, land application fields, and lagoons.[364] The company committed to cut by half the nutrients produced from its waste handling systems, allowing the company to reduce the land used for waste application.[365] For odor reduction, the criterion was a "reduction of at least 70% relative to an untreated barn using a flushing system."[366] Air monitoring was also included: the company committed to measuring baseline emissions from an untreated lagoon and an untreated barn, in addition to measuring emissions from a covered lagoon, wastewater treatment cells and barns involved in a dust control test.[367] "An on-site lab will be measuring emissions of hydrogen sulfide, ammonia, particulate

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358. Smithfield Foods, Inc. acquired Premium Standard Farms in 2006.

359. State *ex rel.* Nixon v. Premium Standard Farms, Inc., Case No. CV99-0745, Consent Judgment 1 (Cir. Ct. MO, 2001). In December 2012, Premium Standard Farms, LLC, changed its name to Murphy-Brown of Missouri, LLC.

360. The Consent Judgment defined Next Generation technology as "an improved waste-handling and storage system designed to reduce or eliminate the release or threatened release, discharge or emission of contaminants, odor and/or pollutants from all barns, lagoons and wastewater application acreage and associated appurtances for the handling, storage, treatment, transportation and application of wastewater, to the fullest possible extent." *Id.* at 2.

361. *Id.*

362. *Id.* at 15.

363. *Id.* at 3.

364. *Id.*

365. Press Release, Gordon Becton, Premium Standard Farms News, http://www.continentalgrain.com/conticonnect/article.aspx?id=80 (last visited Jan. 26, 2013). It was also expected to benefit area farmers, by providing more dilute water that could be applied to their crops, potentially replacing irrigation. *Id.*

366. State *ex rel* Koster v. Premium Standard Farms, Inc., 02CV217957, Judgment Extending Consent Judgment (Sept. 1, 2010), Exhibit 1, at 2, ¶ 3 [hereinafter *Koster Judgment Exhibit*], *available at* http://ago.mo.gov/environment/pdf/SvPSF2010.pdf).

367. *Id.* at 2.

matter and non-methane volatile organic compounds at both the treatment and control sites."[368]

In 2004, the process was already bearing results, "including reducing by more than 90 percent the use of traveling irrigation sprayers, the successful testing and implantation of numerous scientifically advanced technologies … extensive useful air quality data collection and analysis, and detailed water quality sampling and analysis…"[369] By 2010, the advisory panel had certified several Next Generation Technologies: the Crystal Peak Fertilizer (CPF) process, permeable lagoon covers with Advanced Nitrification/De-nitrification (AND), and a "sustainable technology system" (STS) consisting of a digester and barn scrapers.[370] The Crystal Peak Fertilizer project processes manure into a high-quality, 3-11-1 fertilizer that is certified organic by the Washington State Department of Agriculture. Internal Recirculation Process (IRP) units concentrate and condition manure solids, which are then pumped to digesters where they remain for approximately one month.[371] The digested solids are then pumped to a centrifuge, spun at high speeds to remove excess water. The resulting "cake" goes to a mixer to be blended with other inputs before it moves to the dryer.[372] According to the company's website, "bio-gases generated during the digestion process will be collected and used to fuel the dryer."[373] Liquids from the process are pumped to storage cells and applied to crops for irrigation.[374] "The plant has been designed for minimal emissions by use of thermal oxidation and wet scrubbing of exhaust gases. Dust emissions from the dryer are controlled by a traditional bag house and cyclone and recycled back into the product."[375]

368. Becton, *supra* note 365.

369. *Koster Judgment Exhibit*, *supra* note 366, at 2. However, the company continued to experience problems on its existing operations, and the Second Consent Judgment settled additional claims the state of Missouri brought against the company for spills and discharges of waste. *Id.* The company also agreed "to reduce the hog population at three farms, install mechanical devices designed to scrape manure from the subfloors of barns at certain Missouri farms (the scrapers), and make a voluntary payment of $1.0 million to the road funds and school funds in specified Missouri counties where PSF operates." SMITHFIELD FOODS 2011 ANNUAL REPORT 1, 12, *available at* http://files.shareholder.com/downloads/SFD/906647085x0x487821/0381B046-9EC2-4254-A885-17847C0D1576/Smithfield_AR_11.pdf (last visited Jan. 26, 2013).

370. *Koster Judgment Exhibit, supra* note 366, at 4.

371. *Crystal Peak*, PREMIUM STANDARD FARMS, http://www.psfarms.com/crystal_peak.html (last visited Jan. 27, 2013).

372. *Id.*

373. *Id.*

374. *Id.*

375. *Id.*

The company also evaluated approximately thirteen technologies to control barn odor.[376] The researchers found that replacing the lagoon flush system with automated scrapers in tunnel-ventilated swine barns effectively controlled odor and reduced emissions.[377] The automated scraper uses a metal or flexible blade below the slatted floor to move manure to the end of the barn, where it falls directly into a storage unit or is conveyed by a sump to anaerobic treatment lagoon.[378] Researchers determined that by running the scrapers every two hours, gas production within the building was reduced, as were emissions from the recycled flush water.[379] The company found it was also easier and less costly to implement because it eliminated traditional barn flushing.[380] In combination with an anaerobic digester, "[t]he production of renewable energy . . . as well as resulting reduction of greenhouse gas emissions are valuable additional assets."[381]

By 2012, the company had fully complied with the consent judgment and installed Next Generation Technologies on all the farms in its Missouri operations, including installing barn scrapers in 366 barns.[382] The company "estimated that it has spent a total of more than $49 million to install improved environmental technologies, including the previous installation of lagoon covers, treatment facilities, and land application technologies, equipment and practices that are among the most advanced in the U.S."[383] "Included in these expenditures is a fertilizer plant in northern Missouri that converts waste into commercial grade fertilizer."[384]

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376. The company reported that controlling barn odor was the most challenging part of the process. *Premium Standard Farms begins implementing final phase of next generation technology*, AGPROFESSIONAL (Aug. 24, 2012), http://www.agprofessional.com/news/premium_standard_farms_begins_implementing_final_phase_of_next_generation_technology_120028649.html.

377. SMITHFIELD FOODS, 2012 YEAR IN REVIEW, REDUCING ODOR THROUGH 'BARN SCRAPER' TECHNOLOGY48, *available at* http://smithfieldcommitments.com/core-reporting-areas/environment/compliance/air-quality/.

378. *Id*.

379. *Id.*.

380. *Koster Judgment Exhibit*, *supra* note 366, at 1 (discussing Sustainable Technology Systems (STS)).

381. *Id*.

382. *See* Press Release, *PR Newswire, Premium Standard Farms Completes Installation of Next Generation Technology Seven Months Ahead of Schedule*, THE BUSINESS JOURNALS (Jan. 11, 2012), *available at* http://www.bizjournals.com/prnewswire/press_releases/2012/01/11/cg34588) (announcing the successful installation of Next Generation Barn Scraper Technology seven months ahead of schedule.

383. *Id.*

384. SMITHFIELD FOODS 2011 ANNUAL REPORT, *supra* note 369, at 12.

D. Back to the Land

Each of the approaches discussed above involve an "end-of-pipe" solution, i.e., the use of advanced technologies to manage, treat and dispose of the large volumes of waste generated at a typical swine CAFO. The technologies are designed to mitigate the negative impacts that flow from the concentration of large volumes of waste and require significant expenditures of capital and labor to implement. These technologies should be adopted on a large scale to make the current system sustainable in environmental and public health terms. These technologies will also force changes to the legal and economic structure of the industrial system of producing animals for food.[385] These changes will certainly include an increase in the cost that consumers pay for pork products, but may also include changes to the contract terms between processing companies and their growers. For example, a company that owns a patent for a particular technology may want to mandate that its growers use that technology and modify the contract to include a licensing agreement. If the technology results in the creation of a commercially valuable product or generates marketable carbon credits, the contract may be modified to specify which entity owns the product or credits. This added complexity in contractual relationships could result in more company-owned farms and fewer production contracts for family-owned farms. Regardless of the ways in which the system evolves, however, it is likely that the expanded use of advanced treatment technologies will result in more industry consolidation and larger CAFOs to achieve improved economies of scale. And while the environmental and public health impacts may be reduced, the economic and social impacts in rural communities may be increased, resulting in an industry that is even less sustainable over time.

It is therefore encouraging that another model is emerging, one that is grounded in the modern food "movement" and represents a return to more traditional methods of hog production that dominated the country well into the 20th century. More and more farmers are now raising hogs outdoors, on pasture, or in deep-bedded hoop-houses.[386] These methods are particularly attractive to small-scale independent hog producers and limited resource

385. "[T]he costs of hog production include the external (pollution) costs, and as long as those costs are being imposed involuntarily on people, communities and businesses outside the farm operation, there will be contingent liabilities (risks) facing the industry. It is only when those costs are substantially eliminated or are internalized that the industry will escape the risk of regulatory change designed to capture the costs." *Whisnant Memo*, *supra* note 319, at 11.

386. Christopher W. Bordeaux, Optimizing Nutrient Management and Vegetative Ground Cover on Pastured-Pig Operations 1, 1 (October 28, 2010) (unpublished M.S. thesis, North Carolina State University), *available at* http://repository.lib.ncsu.edu/ir/bitstream/1840.16/6532/1/etd.pdf.

farmers because of the lower start-up costs—including lower capital needs for buildings and equipment—lower energy costs, water requirements, and greater independence.[387] In addition, "the market sale price per pound is typically 40 to 60% higher than conventionally raised hogs."[388] A number of research efforts are underway to measure the results of pasture-based production in terms of meat yield, animal health, cost of production, and environmental impact.

"Pasture-raised pigs (PRP) is . . . defined as raising pigs outdoors on pasture" with the use of portable housing and electric fencing to rotate among pasture sites.[389] PRP systems combine practices to increase animal welfare (such as sufficient space for the pigs to express their natural behaviors, deep bedding for farrowing, and restrictions on the use of antibiotics) and minimize environmental impact (such as maintaining groundcover or removal of nutrients through crop rotation and harvest).[390] Some assert that hogs are among the easiest animals to raise on pasture, as they are natural foragers and browsers and will readily eat grass, legumes, standing crops, or other types of ground cover.[391] Raising pigs on pasture is considered a "go-slow operation," as animals are allowed to mature at their natural pace, unaccelerated by hormones and antibiotics.[392] This method of production is popular in Germay, due to the benefits to animal welfare, low investment costs, and consumer preference.[393] In addition, legislation has imposed nutrient limits on land application of manure in order to minimize harm to the environment, and significant investment and advances have been made in developing and implementing manure treatment technologies.[394]

"Pigs kept outdoors spend more than half their active time foraging" for different foods and nest materials, and to create wallows.[395] The pigs

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387. *Id.*

388. *Id.* The author also notes that an "economic analysis performed in 1996 suggested that the return on investment in this business, excluding the cost of land, is about 15.5% per litter (Larson et al., 1996)." *Id.* at 5.

389. *Id.* at 1.

390. Ronaldo Vibart, Short Review: Conservation Practices In Pasture-Raised Pork Systems 1, 1 (unpublished, undated manuscript) (on file with author).

391. ANIMAL FEED, GRACELINKS.ORG, http://www.gracelinks.org/260/animal-feed (last visited Apr. 7, 2013). Although pigs will eat a number of plant species, they do require more nutrients than pasture alone can provide, and their diet may be supplemented by a variety of crops such as turnips, kale, sweet potatoes and beets. *Id.*

392. ROBINSON, *supra* note 100, at 5.

393. Michael Quintern & Albert Sundrum, *Ecological Risks of Outdoor Pig Fattening in Organic Farming and Strategies for their Reduction—Results of a Field Experiment in the Centre of Germany*, 117 AGRIC., ECOSYSTEMS & ENV'T 238 (2006).

394. Melse, *supra* note 48, at 5507.

395. Vibart, *supra* note 390, at 1. Wallows are depressions in the soil, which the pigs create for lounging and cooling, especially in the warmer months. Wallows are often filled with water, and the

enjoy grazing, digging, and rooting, which can "loosen up the soil and improve soil pore volumes similar to tillage."[396] The pigs are free to explore their environment and express their natural behaviors, "resulting in less stressed animals than those confined in commercial operations."[397] One health benefit associated with PRP operations is "improved immunity against bacteria as compared to pigs reared in confinement."[398]

The benefits of outdoor production are largely determined by farm management, and PRP operations can present environmental risks if not adequately managed. Unlike confinement operations, however, most of the environmental impacts of PRP production result from "the natural behavior of hogs"—the rooting and foraging can result in erosion of vegetative ground cover, soil compaction, irregular nutrient distribution, and nutrient losses to ground water and to the atmosphere.[399] When maintained at suitable stocking densities, animals that live and graze on pasture spread their manure across the landscape, where the manure decomposes and returns the nutrients to the soil naturally. The manure emits few greenhouse gases or odors during this natural process of decomposition.[400]

While there are limited "documented guidelines on how to minimize natural resource degradation in alternative, smaller-scale swine production,"[401] an increasing body of research is being developed that offers suggestions for minimizing environmental impacts and making efficient, beneficial use of the nutrients in the manure. In general, the environmental impacts associated with PRP production "varies with animal class, physiological stage and concentration, genetics and diet, vegetative ground cover, climate, soil texture, drainage and topography, and nutrient removal

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pigs will lie in them and coat themselves with mud to protect their skin from sunburn. Deborah Barconnier, *Wallowing in Mud is More Than Just Temperature Control*, PHYSORG.COM (May 2, 2011), http://www.phys.org/news/2011-05-wallowing-mud-temperature.html.

396. Bordeaux, *supra* note 386, at 6.

397. *Id.*

398. *Id.*

399. SILVANA PIETROSEMOLI ET AL., CONSERVATION PRACTICES IN OUTDOOR HOG PRODUCTION SYSTEMS: FINDINGS AND RECOMMENDATIONS FROM THE CENTER FOR ENVIRONMENTAL FARMING SYSTEMS 2 (2012); Quintern & Sundrum, *supra* note 393, at 238–39 (internal citations omitted); *see also* Vibart, *supra* note 390, at 4 (explaining that pigs have distinct exploratory patterns); ROBINSON, *supra* note 100, at 51 (referencing a study conducted at the University of Texas that showed that properly run, pasture-based hog farms produce very little odor, in sharp contrast with confinement operations).

400. Similarly, animals housed in deep-bedding operations, in which manure packs are composted, emit much fewer greenhouse gases than manure kept in pits for anaerobic digestion. THICKE, *supra* note 5, at 43.

401. Vibart, *supra* note 390, at 2.

and crop rotation."[402] Among these factors, scientists have determined that the maintenance of groundcover is the most critical challenge.[403]

> Vegetative ground cover reduces erosion by increasing infiltration, trapping sediments, stabilizing the soil, and reducing the effects of intense rainfall. Ground cover ensures that nutrients from swine waste are held within the plants and soil, and are kept from leaching or flowing to surface waters. Vegetative ground cover also influences animal welfare by altering the temperature near the soil surface and improving animal comfort; this means animals have fewer joint problems, sows demonstrate better reproductive performance and, indirectly, soil fauna habitat is preserved.[404]

Research suggests that pigs have a strong preference for legumes such as white clover and alfalfa, as compared with tall fescue and buffalo grass.[405] Thus, there may be a trade-off between forages with greater ground cover potential and those with a higher nutrient content.[406] At one demonstration farm, a rich combination of fescue, crabgrass, ryegrass, dallisgrass, orchardgrass, and clover, with other perennials and annuals mixed in, ensured that forage grew year round and resulted in improved groundcover.[407] Another consideration is that the length of time the animals spend on the pasture affects the establishment and maintenance of groundcover.[408] Weekly rotation of paddocks used for grazing, and frequent relocation of shade, feeding and watering installations also benefit the maintenance of groundcover.[409] "[A] more intense infrastructure rotation schedule may be effective in nutrient distribution" and maintenance of groundcover.[410]

Perhaps the most important aspect, however, is the maintenance of stocking rates appropriate to the soil type and the ability of crops to remove nutrients.[411] As with conventional production systems, otherwise valuable

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402. *Id.* at 1.
403. *Id.* at 3; ROBINSON, *supra* note 100, at 11.
404. PIETROSEMOLI, *supra* note 399.
405. Vibart, *supra* note 390, at 6.
406. *Id*. at 8.
407. PIETROSEMOLI, *supra* note 399, at 36.
408. Vibart, *supra* note 390, at 4.
409. Quintern & Sundrum, *supra* note 393, at 249.
410. Bordeaux, *supra* note 386, at 50. *See also id.* at 17–18 (stating that "[i]mplementation of a rotational shade, water, and feed infrastructure scheme . . . may . . . lead[] to better distribution of nutrients . . . .").
411. Quintern & Sundrum, *supra* note 393, at 239.

manure may become a pollutant in livestock-dense situations.[412] Studies have shown that stocking densities of 10-15 sows and piglets per acre are suitable "for maintaining adequate ground cover in rotationally-managed, irrigated, well-established pastures."[413] For wean-to-finish operations, stocking densities should be kept to 15-30 hogs per acre per cycle, depending on the groundcover established.[414]

In addition to maintaining groundcover and stocking densities, other sound management practices for outdoor hog production include allowing periods of time for the land to rest between herds—including growing and removing an annual crop between production cycles, integrating hog production with crop production and using rotational grazing to facilitate nutrient uptake, providing hay or other silage to hogs when they enter new pastures, rotating an annual crop into the pasture after two production cycles of animal feeding composting hog manure, and using deep-bedded, portable houses.[415] Additional research is needed to refine management practices for improved groundcover and improved nutrient removal. "Future research should focus on evaluating an integrated approach to minimizing the environmental impacts of outdoor hog production systems, with a particular emphasis on best nutrient management practices to be implemented in grass and legume mixtures."[416]

E. Hoop-houses and Deep Bedding

Hoop houses are another low-cost alternative to conventional slatted-floor barns, one that combines indoor production with improved environmental performance and animal welfare. Sweden transitioned to this method of production after the government enacted strict animal welfare protections[417] and banned the sub-therapeutic use of antibiotics in livestock production methods.[418] These new methods seem to work well on diversified, mid-sized farms.[419]

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412. Vibart, *supra* note 390, at 9.

413. *Id.* at 8.

414. PIETROSEMOLI, *supra* note 399, at 5–6; *see also* Howell N. Wheaton & John C. Rea, *Forages for Swine,* UNIV. OF MO. EXTENSION (Oct. 1993), *available at* http://extension.missouri.edu/publications/DisplayPub.aspx?P=G2360 (describing ideal foraging conditions and acreage for sows in pastures).

415. *See, e.g.,* PIETROSEMOLI, *supra* note 399, at 7, 9, 11, 14–15 (describing a number of best practices for hog production).

416. *Id.* at 54.

417. These included a prohibition on farrowing crates. Mark S. Honeyman, *Västgötmodellen: Sweden's Sustainable Alternative for Swine Production*, 10 AM. J. ALT. AGRIC. 129, 129–130 (1995).

418. *Id*. at 129.

419. *Id.*

Hoop houses are partially enclosed structures within the production area that are filled with deep bedding.[420] High quality straw is an important part of the hoop house system, and new straw is added frequently.[421] Manure is removed regularly and composted[422] or spread on land.[423] In these structures, pigs are allowed to express natural behaviors such as rooting and lounging, and during farrowing, animals are only confined for short periods of time.[424] Scientists report low piglet mortality and rapid growth with this production system, and overall productivity is reported to be comparable to that of conventional industrialized systems.[425] As with other types of animal production systems, management is an important factor in successful production with hoop houses.[426]

In sum, animal agriculture is a fundamental aspect of sustainable agriculture, contributing to the creation of jobs and economic activity in rural areas.[427] But to be truly sustainable—enhancing profit and improving the area's environmental and socioeconomic conditions[428]—improved methods of livestock production are essential.

F. Economics of PRP Production

As discussed above, economic considerations are paramount when evaluating the sustainability of livestock production. Although hogs raised in a natural environment will forage widely, enjoying a variety of grains, legumes and grasses, when raised in confinement, their diet consists mainly

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420. *Id.* at 130.

421. *Id.* at 130–31. Other materials, such as baled cornstalks, grass hay, ground corn cobs, even baled newsprint, also may be used. Katherine E. Buckley, *Composting Hog Manure—Is it Right for Your Farm?,* AGRIC. AND AGRI-FOOD CANADA SWINE SEMINAR 3 (January 29–30, 2003), *available at* www.gov.mb.ca/agriculture/livestock/pork/pdf/bab17s04.pdf (discussing the use of bedding in hoop houses).

422. Buckley, *supra* note 421, at 3, 4–5 ("Composting is the aerobic (oxygen requiring) decomposition of manure or other organic materials in the thermophilic temperature range of 104–149 degrees F…. The composted material is odourless, fine-textured, and low-moisture and can be used for non-agricultural and agricultural purposes with little odour or fly breeding potential. … The process increases the value of raw manures by destroying pathogens and weed seeds…."). Scientists in Illinois have documented no difference in yields in corn and soybeans grown on soils amended with compost when compared with crops grown with inorganic commercial fertilizers. Paul Walker, *Waste (Manure) Processing and Handling: Composting*, ENGORMIX (May 28, 2009), *available at* http://en.engormix.com/MA-pig-industry/news/p0.htm.

423. PEW COMM'N INDUS. FARM ANIMAL PROD., PEW CHARITABLE TRUSTS, PUTTING MEAT ON THE TABLE: INDUSTRIAL FARM ANIMAL PRODUCTION IN AMERICA 23 (2008); *see also* AD HOC COMM., *supra* note 21, at 40 (2003) (discussing the uses of pig manure to spread on land).

424. Bordeaux, *supra* note 386, at 4.

425. Honeyman, *supra* note 417, at 131.

426. *Id.* at 132.

427. *Id.* at 129.

428. *Id.*

of soy and corn.[429] CAFO owners and operators feed soy and corn to their animals because it is cheap—thanks to government subsidies—and because it fattens the animals.[430] But the feed, which also includes unwholesome products such as meat from other animals, manure, plastics, garbage and antibiotics, as well as pesticide residues and genetically-engineered grains, is not healthy for the animals; in fact, it impairs their health.[431] Corporations pass on the low prices to consumers, but they "are also passing on a host of medical, economic and environmental threats, which we pay for with our health, our taxes and our quality of life."[432] Indeed, a new method of accounting is needed to adequately measure the true costs of industrial methods of hog production.

CAFO proponents often dismiss such concerns, brashly asserting that it "smells like money"[433] and touting the supposed economic benefits to the communities in which CAFOs proliferate. In truth, however, consolidating hog production has serious economic repercussions. "For every $5 million in investment, between 40 and 45 new jobs are created; but each new hog CAFO puts an estimated 126 independent hog farmers out of business, resulting in a net loss of jobs."[434] "One full-time person can provide the routine daily labor required by 4000 to 5000 nursery pigs or growing hogs."[435] Moreover, "hog factories buy most of their supplies from within the company, bypassing local suppliers and further undermining the local economy."[436]

Hog CAFOs also enjoy contractual arrangements with slaughtering and processing facilities that ensure access and sale to processing facilities at a secure price.[437] As the National Academy of Sciences' Research Council noted, the market for pigs in the United States comprises "a mix of spot markets, contracts, and processor ownership."[438] But according to the USDA, only 14.1% of hog sales to slaughterhouses and processors were conducted through spot market transactions; the remaining 85.9% were conducted either through marketing contracts or were packer-owned.[439] As many have explained, the slaughterhouses find it easier to work under

429. ANIMAL FEED, *supra* note 391, at 1.
430. *Id.*
431. *Id.*
432. *Id.* at 3.
433. Stith, Warrick & Sill, *supra* note 193.
434. ROBINSON, *supra* note 100, at 49.
435. AD HOC COMM., *supra* note 21, at 37.
436. ROBINSON, *supra* note 100, at 49 (citing GEORGE BOODY & MARA KRINKE, THE MULTIPLE BENEFITS OF AGRICULTURE: AN ECONOMIC, ENVIRONMENTAL & SOCIAL ANALYSIS (2001)).
437. AD HOC COMM., *supra* note 21, at 29.
438. A spot market refers to a sale in which prices are negotiated within 24 hours of the delivery of pigs to market. *Id.*
439. *Id.*

contract with large growers, because they can more easily control for uniform growing conditions[440] (size of market animal and timing of production) and only have to pick up one large lot of finished hogs rather than meeting their production needs with multiple stops at smaller farms.[441] By these metrics, it is easy to understand how an industry that produces record profits for its leading companies impoverishes the communities it calls home.

In contrast, using more traditional methods to raise hogs benefits both the farmer and the community. "Research in Iowa and North Dakota has found that on a per-hog basis the profitability of raising hogs in pasture-based systems or in deep-bedded hoop houses—two alternatives to CAFOs—is about the same as raising hogs in CAFOs."[442] Indeed, as Starmer and Wise demonstrated,[443] operating costs for CAFOs would increase by 2.4–10.7% if they were forced to account for the environmental damage caused by their operations and implement improved waste management techniques.[444] If feed subsidies were eliminated, operating costs would increase by 17.4–25.7%, completely eliminating the unfair, and unsustainable, competitive advantage swine CAFOs currently enjoy over more diversified, humane and sustainable methods of production.[445] Raising pigs on pasture is beneficial to the animals and the consumer. A 1965 study documented that pigs raised indoors on concrete floors showed signs of lameness, and the meat was of lower quality and flavor. [446] Other studies have shown that pasture-raised pork has a higher nutritional value, including more vitamin E and more omega-3 fatty acids.[447] It is no wonder pasture-raised pork commands a higher price in the marketplace. The

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440. Indeed, large production companies like Smithfield Foods tightly control the genetics of their animals to promote uniformity of the finished product. *See* Press Release, Smithfield Foods, Inc, Smithfield Foods, Inc. Announces the Expansion of its Genetics Development Program, (Feb. 28, 2000), *available at* http://files.shareholder.com/downloads/SFD/0x0x176049/a481852b-a7df-49e6-820f-7d430b1b513b/SFD_News_2000_2_28_General.pdf (stating that Smithfield tightly controls the genetics of their animals to promote uniformity of the finished product).

441. *See* THICKE, supra note 5, at 25–26.

442. *Id.* at 25–26 (citing Ben Larson et al., *Economics of Finishing Pigs in Hoop Structures and Confinement: A Summer Group*, IOWA STATE UNIV., http://www.ipic.iastate.edu/reports/02swinereports/asl-1818.pdf (last visited Jan. 25, 2012); D.G. Landblom et al., *An Economic Analysis of Swine Rearing Systems for North Dakota*, DICK. RESEARCH CTR., http://www.ag.ndsu.edu/archive/dickinso/research/2000/swine00c.htm (2001)).

443. ELANOR STARMER & TIMOTHY A. WISE, LIVING HIGH ON THE HOG: FACTORY FARMS, FEDERAL POLICY, AND THE STRUCTURAL TRANSFORMATION OF SWINE PRODUCTION 3 (2007).

444. *Id.*

445. *Id.*

446. ROBINSON, *supra* note 100, at 50 (discussing results of a study comparing pasture raised pigs with those raise on concrete floors).

447. *Id.* at 51; Iwao Koizumi et al., *Studies on the Fatty Acid Composition of Intramuscular Lipids of Cattle, Pigs and Birds*, 37 J. NUTR. SCI. VITAMINOLOGY 545 (1991).

savings in feed costs, plus improved animal health and firmer, more nutritious meat, "favors the use of pasture where possible."[448]

VII. WHAT IS NEEDED TO FACILITATE MORE SUSTAINABLE PRODUCTION?

When managed properly, the current system of production and waste management is reliable in terms of avoiding direct discharges to surface waters and reducing runoff from land application of waste. However, the design is dependent on the overuse of antibiotics, intensifies odor, encourages emissions of ammonia and methane, and concentrates waste in a way that overwhelms the environment's capacity to assimilate it. In addition, these costs are transferred to the communities in which the CAFOs are located and, increasingly, to the rest of society. Some are more emphatic, asserting that "[t]hrough its emphasis on high production, the industrial model has degraded soil and water, reduced the biodiversity that is a key element to food security, increased our dependence on imported oil, and driven more and more acres into the hands of fewer and fewer 'farmers,' crippling rural communities."[449] To facilitate more sustainable production of hogs—whether in CAFOs or on small pastured lots—many aspects of the industry, regulatory policy, and governance must be reformed. Some of these reforms are briefly addressed below.

A. USDA Reforms

At the CAFO level, the primary need is to replace the thousands of open-air waste lagoons with advanced technologies. At least one state, North Carolina, has banned new and expanding hog operations from using the lagoon and sprayfield system for waste management,[450] a move that could lead to increased competition for contract growers.[451] Fortunately, there are many viable waste management technologies from which to choose. It isn't necessary to settle on one technology for all categories of operations; rather, individual growers and companies can select the

448. ROBINSON, *supra* note 100, at 50; *see also Agricultural and Resource Economics,* N.C. STATE UNIV. AGRIC. AND RES. ECON., *available at* http://www.ag-econ.ncsu.edu/extension/outdoor_hogs.html (last visited Jan. 29, 2013) (providing access to an on-line tool for those deciding whether to raise hogs on pasture, including evaluations of economic performance and management decisions); SYLVANA PIETROSEMOLI, ET AL., CONSERVATION PRACTICES IN OUTDOOR HOG PRODUCTION SYSTEMS: FINDINGS AND RECOMMENDATIONS FROM THE CENTER FOR ENVIRONMENTAL FARMING SYSTEMS (2012), 3, available at http://www.cefs.ncsu.edu/publications/conservation_practices_2012.pdf.

449. RICHARD EARLES, SUSTAINABLE AGRICULTURE: AN INTRODUCTION 1–2 (2005), *available at* https://attra.ncat.org/attra-pub/summaries/summary.php?pub=294.

450. H.R. 1678-79, 2007 Gen. Assemb., Reg. Sess. (N.C. 2007).

451. SMITHFIELD FOODS 2011 ANNUAL REPORT, *supra* note 369, at 17.

technology best suited to the climate and land-use needs in which their operation is located. To aid companies and independent producers with this transition, existing USDA programs could be modified to provide cost-share and technical assistance.[452] Another option is to provide payments for the provision of ecosystem services, as NRCS did through two Conservation Innovation Grants in conjunction with the Florida Ranchlands Environmental Services Project.[453] In the interim, there is no reason to delay the implementation of management practices, such as the immediate incorporation of manure into soil, to reduce concerns about odor, runoff, and emission of greenhouse gases.[454]

B. Rebuilding Infrastructure for Small-Scale Production

A critical piece of the puzzle is restoring the infrastructure for small-scale production, including systems for aggregating, processing, and distributing the animals and products from small-scale producers. As farms consolidated production, so too did the systems that move animals and products to market. Much of that infrastructure is now geared to the national and international levels, making it inefficient—and unavailable—for use at the local or even regional scale.[455] For example, twelve plants account for the slaughter of the majority of hogs in the United States, and most of these are owned by a small number of companies that are vertically integrated, i.e., they also serve as the retailer and own the brand labels under which the finished products are marketed.[456] As a result of market consolidation, retail, food-service, and institutional buyers source very little food from smaller-scale producers.[457]

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452. This could also be done for conversion to pasture-raised systems, although most BMPs for pasture-based livestock production currently are directed toward grazing ruminants and not grazing pigs. Vibart, *supra* note 390, at 3.

453. *See* THE FLA. RANCHLANDS ENVT'L SERVS. PROJECT, http://www.fresp.org/ (last visited March 4, 2013) (discussing payment plan for pollution reduction by ranchers).

454. AD HOC COMM., *supra* note 21, at 171.

455. Food today travels an average of 1,500 miles from farm to table and changes hands more than a dozen times, "moving along a food supply chain that links producers, packers, shippers, food manufacturers, wholesale distributors, food retailers, and consumers." ALLISON S. PERRETT, THE INFRASTRUCTURE OF FOOD PROCUREMENT AND DISTRIBUTION: IMPLICATIONS FOR FARMERS IN WESTERN NORTH CAROLINA 2 (2007), *available at* http://www.asapconnections.org/special/research/Reports/Infrastructure%20of%20Distribution%20Final.pdf.

456. *See* RACHEL J. JOHNSON, ET AL., ECONOMIC RESEARCH SERVICES/U.S. DEPARTMENT OF AGRICULTURE SLAUGHTER AND PROCESSING OPTIONS AND ISSUES FOR LOCALLY SOURCED MEAT 10–11 (2012), *available at* http://www.ers.usda.gov/media/820188/ldpm216-01.pdf (discussing small scale slaughtering and processing).

457. *See,* JENNIFER CURTIS, FROM FARM TO FORK: A GUIDE TO BUILDING NORTH CAROLINA'S SUSTAINABLE LOCAL FOOD ECONOMY 42–43 (2010), *available at* http://www.cefs.ncsu.edu/resources/stateactionguide2010.pdf.

The current supply chain for pork effectively shuts out smaller farmers as well as the smaller scale businesses that once slaughtered and processed their animals and purchased their products. Small-scale processing facilities have declined rapidly in number, and many small growers now lack access to slaughter facilities. In other areas, producers have access to slaughter facilities "but have difficulty finding inspected cutting and packaging services of the desired quality."[458] Conversely, some small-scale slaughter and processing facilities struggle because there are too few local growers.[459] Meanwhile, consumer demand for locally-sourced pork (and other meats) is increasing at a strong rate.[460]

The supply chain is rusty for smaller-scale production. It will take time, capital, and scientific knowledge to rebuild the infrastructure and return to healthier, more sustainable methods of food animal production.[461] Some potential strategies for increasing volumes of local meats in local markets include the use of mobile slaughter units, pooling production, and developing local and regional market aggregators—producers who can collectively provide a small- or mid-scale processor with more steady, year-round business.[462] Fortunately, there are entrepreneurs taking on these roles, government and philanthropic institutions willing to provide financial assistance, non-profit organizations analyzing the community's needs and identifying opportunities to invest in and retool aging infrastructure, and consumers willing to pay more for meat that is produced in accordance with their values.

C. Legal and Regulatory Tools

As discussed above, to properly treat manure produced on a large scale in a way that safeguards human health and the environment—and makes use of the valuable nutrients and gasses within the waste stream—requires a complex combination of technologies. Unless the industry moves to even greater concentration—such as seen at facilities in Utah and South Dakota—it will also require long-term contracts with farmers that set forth

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458. *See* Johnson, *supra* note 456, at 17, 19 (explaining that there are fewer small slaughter and processing plants operating now than in the past).

459. *Id.* at 1 (discussing a study that showed a relatively small percentage of the existing capacity to slaughter on a small-scale was being utilized, primarily due to a shortage of skilled labor and the seasonality of the livestock industry).

460. *See Id.* at 3 (explaining that demand for locally sourced meat has increased in recent years).

461. ROBINSON, *supra* note 100, at 36 (indicating the potential to rebuild sustainable farming practices).

462. *See* Johnson, *supra* note 456, at 17, 19, 21, (introducing ideas like using smaller slaughter and processing facilities, like mobile slaughter units and the development of local and regional market aggregators); PERRETT, *supra* note 455, at 9.

a predictable delivery schedule and guaranteed quantities, and provides clarity about the ownership and distribution of any profits or credits derived from the sale of the end products (such as sale of electricity or compost, carbon credits, etc.). To accomplish this will require the development of a legal and regulatory environment that encourages and supports the adoption of the technologies. For example, a combination of strict limits on the use of antibiotics, restrictions on manure use that are based on the assimilative capacity of the region in which the manure is generated, appropriate subsidies for adoption of new technologies, and provisions for the use of manure as a source of renewable energy are all viable options. Similar practices have been developed in Europe, including the development of subsidies for generating energy from manure.[463] Such measures can be implemented in the United States as well.

Legal and regulatory tools also must be adapted to restore a competitive marketplace for sustainable production of food animals that are based on more traditional, less industrial, methods of production. The lack of attention to the trade practices employed by the industry's dominant players has contributed to the disintegration of the rural infrastructure that is essential for small-scale producers to access the marketplace. Development of technical resources to support small-scale, sustainable production is important, but so is the development of small-lot slaughtering and processing facilities that have the flexibility to handle different species of food animals, licensing of mobile abattoirs, and aggregators that can help farmers market their products in more densely-populated areas. Additionally, food safety laws must be tailored to meet the needs of smaller-scale producers without compromising public health.[464]

VIII. CONCLUSION

The actions highlighted above—while sorely needed—are unlikely to be developed on a national scale in the current political climate. Even in the absence of government imperatives, however, many private companies, universities, and communities are moving forward to develop and implement improved waste management measures and restore essential supply-chain connections for small-scale producers. In the short-term, perhaps the best we can hope for is the elimination of subsidies that confer

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463. Melse & Timmerman, *supra* note 48, at 5507 (2009).

464. *See* ROLAND MCREYNOLDS, CAROLINA FARM STEWARDSHIP ASS'N HURTING NC'S LOCAL FOODS HARVEST: THE UNINTENDED CONSEQUENCES OF FEDERAL FOOD SAFETY LEGISLATION ON NORTH CAROLINA'S SMALL AGRICULTURAL ENTERPRISES 6 (2010), *available at* http://www.carolinafarmstewards.org/wpcontent/uploads/2012/04/Hurting_NCs_Local_Food_Harvest042010.pdf (discussing small farmer's concerns about redundant regulations).

significant competitive advantages to CAFO-style production—a fair outcome when one considers that no other industry in the country is paid by the taxpayers to control its pollution or comply with the law, even when subject to increasingly stringent pollution control requirements. Longer-term, it will be up to the states to regulate the more localized impacts, and to the consumers to continue "voting with their forks" by supporting production methods and infrastructure development for a more sustainable future for hog production.