



An HSUS Report: The Impact of Industrialized Animal Agriculture on the Environment

Abstract

The continuous confinement of chickens, pigs, turkeys, cattle, and other animals raised in industrialized agricultural systems jeopardizes the animals' welfare and degrades the environment. Factory farms produce immense quantities of animal waste and byproducts, which threaten water and air quality and contribute to climate change.

Factory Farming in the United States*

In 2007, nearly 10 billion land animals were raised and killed for meat, egg, and milk production in the United States.^{1,2} Industrialization and raising unprecedented numbers of farm animals have resulted in the intensive confinement of these chickens, pigs, turkeys, cattle, and other animals. More than half, 54%, of all confined farm animals by weight are concentrated in just 5% of the country's industrial animal production facilities.³

Although the terms "factory farm," "animal feeding operation (AFO)," and "concentrated animal feeding operation (CAFO)" are often used interchangeably, "factory farm" is a general term that refers to industrial animal production facilities, while "AFO" and "CAFO" have precise legal definitions. An AFO is a facility in which crops and vegetation are not sustained during the normal growing season, and land animals are confined for 45 days or more within a 12-month period.^{4,5} As described by the U.S. Environmental Protection Agency (EPA), "AFOs congregate animals, feed, manure and urine, dead animals, and production operations on a small land area."⁶ The EPA estimates there are approximately 450,000 AFOs in the United States.⁷

An AFO may be designated as a CAFO in one of three ways: 1) by meeting the definitional requirements for a "large" CAFO;⁸ 2) by meeting the definitional requirements for a "medium" CAFO;⁸ and 3) through special designation by the relevant EPA Regional Administrator or State Director upon determining "that it is a significant contributor of pollutants to waters of the United States."⁹ The EPA estimates there are approximately 18,800 CAFOs in the United States.¹⁰

The definitional requirements of both large and medium CAFOs include minimum numbers of confined animals. A partial list of these numbers appears in Table 1 below.

To qualify as a medium CAFO, a facility must also discharge pollutants into U.S. waters "through a man-made ditch, flushing system, or other similar man-made device" or directly into U.S. waters "which originate outside of and pass over, across, or through the facility or otherwise come into direct contact with the animals confined in the operation."¹¹

* For more information, see "An HSUS Report: The Impact of Industrialized Animal Agriculture on Rural Communities" at www.hsus.org/farm/resources/research/enviro/animal_agriculture_rural.html.

Table 1: Definitions by the Numbers		
	Large CAFOs¹²	Medium CAFOs¹³
Chickens raised for meat	<ul style="list-style-type: none"> • 30,000 chickens for facilities using a liquid manure handling system • 125,000 for other facilities 	<ul style="list-style-type: none"> • 9,000-29,999 chickens for facilities using a liquid manure handling system • 37,500-124,999 for other facilities
Egg-laying chickens	<ul style="list-style-type: none"> • 30,000 for facilities using a liquid manure handling system • 82,000 for other facilities 	<ul style="list-style-type: none"> • 9,000-29,999 for facilities using a liquid manure handling system • 25,000-81,999 for other facilities
Pigs	<ul style="list-style-type: none"> • 2,500 if each animal weighs 55lbs or more • 10,000 if each animal weighs less than 55lbs 	<ul style="list-style-type: none"> • 750-2,499 if each animal weighs 55lbs or more • 3,000-9,999 if each animal weighs less than 55lbs
Cattle	<ul style="list-style-type: none"> • 700 mature dairy cows • 1,000 calves raised for veal • 1,000 other cattle 	<ul style="list-style-type: none"> • 200-699 mature dairy cows • 300-999 calves raised for veal • 300-999 other cattle

Farm Animal Waste

Much of the environmental harm caused by factory farms results from the volume of waste that must be stored and disposed of when continuously confining so many animals exclusively or primarily indoors, with some operations producing as much waste as an entire city.¹⁴ According to data from the U.S. Department of Agriculture (USDA) and the EPA, animal feeding operations produce approximately 500 million tons of manure every year,¹⁵ with CAFOs generating 47¹⁶-60%¹⁰ of this excrement. The EPA has estimated that “all confined animals generate 3 times more raw waste than is generated by humans in the U.S.”¹⁵

Over the past two decades, shifts in animal agribusiness have exacerbated existing waste management problems, with more animals being intensively confined in fewer, but larger, operations.^{17,18} The USDA’s Natural Resources Conservation Service (NRCS) and the EPA outline the changes as including:

- the move toward intensive confinement;
- the steady replacement of small- and medium-sized operations with large confinement operations;
- the continued consolidation of all aspects of production;
- the increase in numbers of confined animals per operation; and
- the spatial concentration of operations in high production areas.^{17,18}

These developments have resulted in industrial animal agriculture facilities producing more manure than can be assimilated by available land, particularly in high production areas.^{17,18} When applied to crops at a rate that the soil is able to absorb, animal waste serves as a useful fertilizer; however, a salient feature of factory farms is their lack of any direct tie to the land and local natural resources,¹⁹ making them “landless” as opposed to land-based like traditional farms.²⁰

On traditional mixed (or diversified) farms, farmers balance the number of animals with the land’s ability to absorb the nutrients in their manure. On factory farms, this recycling of nutrients to replenish the soil and fertilize crops is absent²⁰ because, rather than raise animals and crops together, animals are housed in close confinement indoors and there is typically not enough land available to spread all of the manure.²¹ The increased volume of waste in CAFOs threatens water quality,²² and, “as operations become more numerous and concentrated on limited land bases, there is an increased risk for deterioration of water quality.”²³ Transporting the waste to fields in need of fertilizer is expensive,¹⁹ so it is customarily applied to fields near the operation.²⁴

When animal waste is overapplied to land, thus exceeding the capacity of soil and crops to assimilate its nutrients, it can contaminate water supplies²⁵ and emit harmful gases into the atmosphere.²¹ Because there is no requirement that factory farm manure be treated before it is applied, its disposal poses additional risks to public health.²⁶ Of particular concern are pathogens that may end up in surface water, heavy metals, and nutrients such

as nitrogen and phosphorous that can leach into groundwater, run off fields where manure has been applied, and, in the case of nitrogen, volatilize into ammonia emissions.^{16,27}

The cost of moving farm animal waste gives factory farms an incentive to overapply manure to nearby land,¹⁶ resulting in approximately 90% of manure not leaving the area in which it was produced.²⁸ This exacerbates the problem of concentrating such an abundance of nutrients in a particular locale.²⁹ For example, in 1997, the Southern Seaboard region, home to many pig and poultry operations, produced the largest quantity of recoverable nitrogen from manure and had among the fewest acres of land per animal unit (figure based on animal weight)²¹ on which to apply manure. As such, the USDA's Economic Research Service reported that this region accounted for 27% of all excess nitrogen produced nationally by confinement operations.³⁰

Water Pollution

Water quality issues arising from factory farm-generated waste include contamination of surface water and ground water. This can be caused by overapplication of manure to available land, manure storage tanks and lagoons overflowing or leaking, and pollutants that had been released into the air redepositing into waterways.³¹

According to the EPA, the agricultural sector is “the leading contributor to identified water quality impairments in the nation’s rivers and streams, lakes, ponds, and reservoirs.”³² In particular, the agency has noted that water quality concerns are most pronounced in areas “where crops are intensively cultivated and where livestock operations are concentrated.”³²

For example, in 2003, California’s Chino basin estimated that it would spend more than \$1 million per year to remove nitrates from its drinking water due to the abundance of local dairies and the relatively rapid transformation of nitrogen in manure into nitrates, which were ultimately transported into the community’s drinking water supply.³³ In February 2008, a group of Tulare County, California, residents filed a lawsuit over pollution permits the state water quality control board had issued to 1,600 dairies in the area after learning that wells and public water systems in the county contained unsafe amounts of nitrates, reported *The Sacramento Bee*.³⁴ Tulare County has the country’s highest concentration of cows used for the dairy industry.³⁵

When manure is overapplied to land, it deposits excess nutrients that can end up in waterways.²¹ As noted in a 2007 Congressional Research Service report, “USDA believes that where manure nutrients exceed the assimilative capacity of a region, the potential is high for runoff and leaching of nutrients and subsequent water quality problems.”³⁶ According to the USDA, the problem of excess nutrients is most pronounced in poultry operations, which produce 52% of the excess phosphorous and 64% of the excess nitrogen created by farm animal waste.³⁷ Phosphorous and nitrogen in waterways can cause eutrophication, in which an increase in nutrients depletes the water of oxygen, threatening aquatic life.³⁸

A customary manure storage system used in pig and dairy factory farms is the manure lagoon.^{39,40} In a lagoon system, liquefied manure is stored in an outdoor, open-air pit that can emit pollutants into the air, including methane, a gas implicated in climate change.⁴¹ The stored liquid manure is ultimately sprayed onto fields.¹⁶ Lagoons decrease the amount of nutrients that must be applied to land, in part because much of the nitrogen content is volatilized into ammonia emissions from the lagoon itself.⁴² These ammonia emissions can contribute to increased concentrations of nitrogen (nitrate) in precipitation.⁴³

Manure lagoons pose the additional risk of spillage or leakage, poisoning surface or groundwater. In one incident, more than 20 million gallons of waste spilled from a manure lagoon on a pig factory farm into a nearby river in North Carolina, causing a massive fish kill.⁴⁴ In 2005, a manure lagoon at an upstate New York dairy farm burst, polluting the nearby Black River with millions of gallons of manure and killing more than 375,000 fish.⁴⁵

Although it takes no more than a single factory farm to cause a spill or leak, the trend toward concentrating factory farms within discrete geographical areas raises concerns over the ability to maintain water quality for

residents within a particular watershed.⁴⁶ As the Congressional Research Service has noted, “[g]eographically, areas with excess farm-level nutrients correspond to areas with increasing numbers of confined animals,” adding that “[c]ounties with potential animal waste problems tend to be grouped together.”³⁶

In Oklahoma, between 2006 and 2007, the EPA reportedly levied more than \$7 million in fines against companies operating in the state, primarily factory farms. *The Houston Chronicle* reported that John Blevins, director of the EPA’s Compliance Assurance and Enforcement Division for the region that includes Oklahoma noted, “If the waste from those facilities...[is not] managed properly, you get significant nutrient problems in ground and surface water.”⁴⁷ Epidemiological studies have linked farm animal waste to several outbreaks involving pathogens such as *Campylobacter*, *Salmonella*, *Listeria monocytogenes*, *Helicobacter pylori*, and *E. coli* O157:H7, as well as the protozoa *Cryptosporidium parvum* found in drinking water sources, which can result from runoff into surface waters.²⁶

When natural disasters strike, the latent environmental hazards posed by factory farming can be exacerbated. In 1999, North Carolina was struck by Hurricane Floyd and widespread flooding led to the dispersal of waste from manure lagoons. The ensuing pollution, including the spread of pathogens, increased the risk of disease.⁴⁸ Donald Reuter, Director of Public Affairs for the North Carolina Department of Environment and Natural Resources, attributed the majority of the environmental damage caused by the industry to pig farms and the massive amounts of liquid waste stored on site.⁴⁸

Air Pollution

The microbial breakdown of organic carbon and nitrogen compounds in manure can contribute to air pollution and odor problems.¹⁸ During decomposition, noxious levels of gases are emitted, putting workers and nearby residents at risk of developing a number of acute and chronic illnesses. Waste storage and land application lead to emissions of fine particulates, carbon dioxide, hydrogen sulfide, ammonia, and methane.⁴⁹

The most odiferous of the chemicals emitted by factory farms are ammonia, hydrogen sulfide, and volatile organic compounds.⁵⁰ Viney Aneja, a professor in the Department of Marine, Earth, and Atmospheric Sciences at North Carolina State University and a member of EPA’s Science Advisory Board Staff,⁵¹ has reportedly noted that while some ammonia can end up in waterways as far as 50 miles away, the rest is transported in an airborne form and can reach areas that are hundreds of miles away. In one North Carolina county, during an 11-year period of significant expansion in the pig farming industry, the amount of ammonia in the rain reportedly doubled.⁵²

Of all the gaseous byproducts of farm animal manure decomposition, hydrogen sulfide is regarded as the most dangerous, creating a risk of both unconsciousness and death for those who work in manure pits.⁵³ The National Institute for Occupational Safety and Health (NIOSH) has deemed hydrogen sulfide to be “a leading cause of sudden death in the workplace.”⁵⁴ A number of reports on the NIOSH website document worker fatalities caused by exposure to the chemicals in manure pits.⁵⁵⁻⁵⁸ Indeed, the agency issued an alert in 1990 entitled *Preventing Deaths of Farm Workers in Manure Pits*,⁵⁹ which covers the harmful effects of the chemicals commonly found in these holding tanks.

Climate Change†

Global warming and climate change are not distant threats to the planet but, rather, phenomena that are already occurring. For example, polar bears in the Arctic have been losing sea ice from premature melting, threatening their ability to hunt and survive.⁶⁰ Global warming has also disrupted the biological clocks of some migratory birds who need discrete habitats for breeding, wintering, and resting, preventing them from migrating at the correct times.⁶¹

† For more information, see “An HSUS Report: The Impact of Animal Agriculture on Global Warming and Climate Change” at www.hsus.org/farm/resources/research/enviro/global_warming_animal_ag.html.

Experts also regard global warming as a driving force in current and future conflicts over resources. United Nations Secretary-General Ban Ki-moon has stated that “the danger posed by war to all of humanity—and to our planet—is at least matched by the climate crisis and global warming,” noting that global warming can lead to natural disasters, trigger droughts, and cause other changes that “are likely to become a major driver of war and conflict.”⁶²

In 2006, the Food and Agriculture Organization (FAO) of the United Nations published “Livestock’s Long Shadow: Environmental Issues and Options,” its landmark report assessing the impacts of animal agriculture. The FAO concluded that “the livestock sector emerges as one of the top two or three most significant contributors to the most serious environmental problems, at every scale from local to global.”⁶³ With global meat and milk production expected to double within the next 50 years, the FAO cautions that the “environmental impact per unit of livestock production must be cut by half, just to avoid increasing the level of damage beyond its present level.”⁶³

The most publicized finding in the FAO’s report has been the role animal agriculture plays in climate change. Animal agriculture accounts for 18% of global, human-induced greenhouse gas emissions.⁶⁴

In the United States, rising emissions of methane and nitrous oxide, two potent greenhouse gases, have been linked, in part, to industrial animal agriculture. The EPA has noted that methane emissions from pig and dairy cow manure increased by approximately 37% and 50%, respectively, between 1990 and 2005. This elevation was caused by the shift towards rearing pigs and cows in larger facilities where liquid manure management systems that promote anaerobic conditions, or those in which oxygen is not present, are increasingly used. The U.S. poultry industry’s shift toward litter-based manure management systems, confinement in high-rise houses, and an overall increase in the U.S. poultry population contributed to a 10% rise in nitrous oxide emissions.⁴¹

Conclusion

In April 2008, the Pew Commission on Industrial Farm Animal Production released the results of a 2.5-year investigation⁶⁵ into the problems associated with AFOs and CAFOs. The Commission focused on the impacts of industrial farm animal production on animal welfare, the environment, public health, and the vitality of rural communities,⁶⁶ and determined that industrial farm animal production “often poses unacceptable risks to public health, the environment and the welfare of the animals themselves.”⁶⁵

The Commission’s extensive and detailed recommendations include the following:⁶⁶

- Developing and implementing “a new system to deal with farm waste (that will replace the inflexible and broken system that exists today) to protect Americans from the adverse environmental and human health hazards of improperly handled IFAP [industrial farm animal production] waste.”
- Improved enforcement of existing federal, state, and local regulations to improve siting and protect the health of those who live near these operations.
- Local control and public input for the siting of new facilities, as well as access to redress for neighbors when these operations fail to comply with standards.

The continuous confinement of billions of animals raised for meat, milk, and eggs greatly impairs the welfare of these sentient chickens, pigs, turkeys, cattle, and others, yet the toll taken by factory farms extends beyond the confines of their facilities. Storing and disposing of immense quantities of animal waste from these industrial operations contributes to climate change and threatens water and air quality in surrounding areas. The environmental tolls exacted by factory farming necessitate dramatic and immediate changes in animal agriculture.

References

1. U.S. Department of Agriculture National Agricultural Statistics Service. 2008. Poultry slaughter: 2007 annual summary. www.nass.usda.gov/Publications/Todays_Reports/reports/pslaan08.pdf. Accessed June 17, 2008.
2. U.S. Department of Agriculture National Agricultural Statistics Service. 2008. Livestock slaughter: 2007 summary. www.usda.gov/nass/PUBS/TODAYRPT/lsan0308.pdf. Accessed June 17, 2008.
3. Gollehon N, Caswell M, Ribaldo M, Kellogg R, Lander C, and Letson D. 2001. Confined animal production and manure nutrients. U.S. Department of Agriculture Economic Research Service. Agriculture Information Bulletin No. 771. www.ers.usda.gov/publications/aib771/aib771.pdf. Accessed June 17, 2008.
4. U.S. Environmental Protection Agency. 2003. National Pollutant Discharge Elimination System permit regulation and effluent limitation guidelines and standards for concentrated animal feeding operations (CAFOs); final rule. February 12. Federal Register 68(29):7176-7274.
5. Code of Federal Regulations, Title 40, Section 122.23(b)(1).
6. U.S. Environmental Protection Agency. 2003. Animal feeding operations: frequently asked questions. http://cfpub.epa.gov/npdes/faqs.cfm?program_id=7. Accessed June 17, 2008.
7. U.S. Environmental Protection Agency. 2008. Animal feeding operations. www.epa.gov/agriculture/anafoidx.html. Accessed June 17, 2008.
8. Code of Federal Regulations, Title 40, Section 122.23(b)(2).
9. Code of Federal Regulations, Title 40, Section 122.23(c).
10. U.S. Environmental Protection Agency. 2006. Fact sheet: concentrated animal feeding operations proposed rulemaking. www.epa.gov/npdes/regulations/cafo_revisedrule_factsheet.pdf. Accessed June 17, 2008.
11. Code of Federal Regulations, Title 40, Section 122.23(b)(6)(ii).
12. Code of Federal Regulations, Title 40, Section 122.23(b)(4).
13. Code of Federal Regulations, Title 40, Section 122.23(b)(6).
14. Minority Staff of the U.S. Senate Committee on Agriculture, Nutrition, and Forestry. 1997. Animal waste pollution in America: an emerging national problem. Report compiled for Senator Tom Harkin, p. 11.
15. U.S. Environmental Protection Agency. 2003. National Pollutant Discharge Elimination System permit regulation and effluent limitation guidelines and standards for concentrated animal feeding operations (CAFOs); final rule. February 12. Federal Register 68(29):7176, 7180.
16. Aillery M, Gollehon N, Johansson R, Kaplan J, Key N, and Ribaldo M. 2005. Managing manure to improve air and water quality. U.S. Department of Agriculture Economic Research Service, Report No. ERR-9. www.ers.usda.gov/publications/ERR9/. Accessed June 17, 2008.
17. Kellogg RL, Lander CH, Moffitt DC, and Gollehon N. 2000. Manure nutrients relative to the capacity of cropland and pastureland to assimilate nutrients: spatial and temporal trends for the United States. U.S. Department of Agriculture Natural Resources Conservation Service. www.nrcs.usda.gov/technical/NRI/pubs/mannt.pdf. Accessed June 17, 2008.
18. U.S. Environmental Protection Agency Emission Standards Division. 2001. Emissions from animal feeding operations, draft. August 15. p. xi. www.epa.gov/ttn/chief/ap42/ch09/draft/draftanimalfeed.pdf. Accessed June 17, 2008.
19. Naylor R, Steinfeld H, Falcon W, et al. 2005. Losing the links between livestock and land. Science 310(5754):1621-2.
20. Food and Agriculture Organization of the United Nations, Animal Production and Health Division, Livestock Information, Sector Analysis and Policy Branch. 2005. Responding to the "livestock revolution": the case for livestock public policies. www.fao.org/ag/againfo/resources/documents/pol-briefs/01/EN/AGA01_10.pdf. Accessed June 17, 2008.
21. U.S. Department of Agriculture Economic Research Service. 2007. Environmental interactions with agricultural production: animal agriculture and the environment. www.ers.usda.gov/Briefing/AgAndEnvironment/animalagriculture.htm. Accessed June 17, 2008.
22. Burkholder J, Libra B, Weyer P, et al. 2007. Impacts of waste from concentrated animal feeding operations on water quality. Environmental Health Perspectives 115(2):308-12. www.ehponline.org/members/2006/8839/8839.pdf. Accessed June 17, 2008.

23. Iowa State University and the University of Iowa Study Group. 2002. Iowa concentrated animal feeding operations air quality study, final report.
24. Osterberg D and Wallinga D. 2004. Addressing externalities from swine production to reduce public health and environmental impacts. *American Journal of Public Health* 94(10):1703-8.
25. Sullivan J, Vasavada U, and Smith M. 2000. Environmental regulation and location of hog production. U.S. Department of Agriculture Economic Research Service. *Agricultural Outlook*, September, pp. 19-23. <http://usda.mannlib.cornell.edu/reports/erssor/economics/ao-bb/2000/ao274.pdf>. Accessed June 17, 2008.
26. American Public Health Association. 2003. Precautionary moratorium on new concentrated animal feed operations. Policy number 20037. www.apha.org/advocacy/policy/policysearch/default.htm?id=1243. Accessed June 17, 2008.
27. U.S. Environmental Protection Agency Emission Standards Division. 2001. Emissions from animal feeding operations, draft. August 15. pp. 2-6. www.epa.gov/ttn/chief/ap42/ch09/draft/draftanimalfeed.pdf. Accessed June 17, 2008.
28. Taylor H. 1997. Nutrients. In: Anderson M and Magleby R (eds.), *Agricultural Resources and Environmental Indicators, 1996-97* (Washington, DC: U.S. Department of Agriculture Economic Research Service, pp. 97-115), citing: Bosch DJ and Napit KB. 1992. Economics of transporting poultry litter to achieve more effective use as fertilizer. *Journal of Soil and Water Conservation* 47:342-6.
29. Mullen JD and Centner TJ. 2004. Impacts of adjusting environmental regulations when enforcement authority is diffuse: confined animal feeding operations and environmental quality. *Review of Agricultural Economics* 26(2):209-19.
30. Gollehon N and Caswell M. 2000. Confined animal production poses manure management problems. U.S. Department of Agriculture Economic Research Service. *Agricultural Outlook*, September, pp. 12-18. www.ers.usda.gov/publications/agoutlook/sep2000/ao274f.pdf. Accessed June 17, 2008.
31. U.S. Environmental Protection Agency. 2003. National Pollutant Discharge Elimination System permit regulation and effluent limitation guidelines and standards for concentrated animal feeding operations (CAFOs); final rule. February 12. *Federal Register* 68(29):7176, 7181.
32. U.S. Environmental Protection Agency. 2003. National Pollutant Discharge Elimination System permit regulation and effluent limitation guidelines and standards for concentrated animal feeding operations (CAFOs); final rule. February 12. *Federal Register* 68(29):7176, 7237.
33. U.S. Environmental Protection Agency. 2003. National Pollutant Discharge Elimination System permit regulation and effluent limitation guidelines and standards for concentrated animal feeding operations (CAFOs); final rule. February 12. *Federal Register* 68(29):7176, 7238.
34. Bowman C. 2008. Suit pins bad water in Tulare on dairies. *The Sacramento Bee*, February 16, p. A1. www.sacbee.com/101/story/717031.html. Accessed June 17, 2008.
35. Shultz T. 2000. The dairy industry in Tulare County. University of California Cooperative Extension. <http://cetulare.ucdavis.edu/pubdairy/industry.pdf>. Accessed June 17, 2008.
36. Copeland C. 2007. Animal waste and water quality: EPA regulation of concentrated animal feeding operations (CAFOs). Congressional Research Service report for Congress, August 31, p. CRS-4.
37. Gollehon N, Caswell M, Ribaud M, Kellogg R, Lander C, and Letson D. 2001. Confined animal production and manure nutrients. U.S. Department of Agriculture Economic Research Service. *Agriculture Information Bulletin No. 771*, p. 20. www.ers.usda.gov/publications/aib771/aib771.pdf. Accessed June 17, 2008.
38. U.S. Environmental Protection Agency, Office of Water. 2001. Environmental assessment of proposed revisions to the National Pollutant Discharge Elimination System regulation and the effluent guidelines for concentrated animal feeding operations, p. 3-2. www.epa.gov/waterscience/guide/cafo/pdf/EnvAssessPt1of2.pdf. Accessed June 17, 2008.
39. U.S. Environmental Protection Agency. 2007. Pork production: common manure handling systems. www.epa.gov/agriculture/ag101/porkmanure.html. Accessed June 17, 2008.
40. U.S. Environmental Protection Agency. 2007. Dairy production: common manure handling systems. www.epa.gov/agriculture/ag101/dairymanure.html. Accessed June 17, 2008.
41. U.S. Environmental Protection Agency. 2007. Inventory of U.S. greenhouse gas emissions and sinks: 1990-2005, p. 6-6. www.epa.gov/climatechange/emissions/downloads06/07CR.pdf. Accessed June 17, 2008.

42. Key N. 2006. Regulating ammonia emissions from hog farms would raise costs. U.S. Department of Agriculture Economic Research Service. Amber Waves, February. www.ers.usda.gov/AmberWaves/February06/Findings/findings_re1.htm. Accessed June 17, 2008.
43. U.S. Environmental Protection Agency. 1998. Strategy for addressing environmental and public health impacts from animal feeding operations, draft. www.epa.gov/npdes/pubs/astrat.pdf. Accessed June 17, 2008.
44. Ribaldo M. 2003. Managing manure: new Clean Water Act regulations create imperative for livestock producers. U.S. Department of Agriculture Economic Research Service. Amber Waves, February. www.ers.usda.gov/AmberWaves/feb03/features/managingmanure.htm. Accessed June 17, 2008.
45. New York State Department of Environmental Conservation. 2007. DEC reports: progress since Marks Dairy spill. Press release issued August 9. www.dec.ny.gov/press/36942.html. Accessed June 17, 2008.
46. Gollehon N, Caswell M, Ribaldo M, Kellogg R, Lander C, and Letson D. 2001. Confined animal production and manure nutrients. U.S. Department of Agriculture Economic Research Service. Agriculture Information Bulletin No. 771, p. 5. www.ers.usda.gov/publications/aib771/aib771.pdf. Accessed June 17, 2008.
47. Murphy S. 2007. Oklahoma: EPA reports \$7M in fines. The Associated Press, November 16.
48. Schmidt CW. 2000. Lessons from the flood: will Floyd change livestock farming? Environmental Health Perspectives 108(2):A74-7. www.ehponline.org/docs/2000/108-2/108pa74.pdf. Accessed June 17, 2008.
49. U.S. Environmental Protection Agency, Office of Water. 2001. Environmental assessment of proposed revisions to the National Pollutant Discharge Elimination System regulation and the effluent guidelines for concentrated animal feeding operations. www.epa.gov/waterscience/guide/cafo/pdf/EnvAssessPt1of2.pdf. Accessed June 17, 2008.
50. U.S. Environmental Protection Agency Emission Standards Division. 2001. Emissions from animal feeding operations, draft. August 15. pp. 2-13. www.epa.gov/ttn/chief/ap42/ch09/draft/draftanimalfeed.pdf. Accessed June 17, 2008.
51. U.S. Environmental Protection Agency. EPA Science Advisory Board staff: Viney Aneja. <http://yosemite.epa.gov/sab/SABPEOPLE.NSF/WebPeople/AnejaViney?OpenDocument>. Accessed June 17, 2008.
52. Leavenworth S and Shiffer JE. 1998. Airborne menace. News and Observer, July 5, p. A1.
53. Field B. Beware of on-farm manure storage hazards. Purdue University Cooperative Extension Service. www.ces.purdue.edu/extmedia/S/S-82.html. Accessed June 17, 2008.
54. National Institute for Occupational Safety and Health. 1977. Criteria for a recommended standard: occupational exposure to hydrogen sulfide. I. Recommendations for a hydrogen sulfide standard. www.cdc.gov/niosh/pdfs/77-158b.pdf. Accessed June 17, 2008.
55. National Institute for Occupational Safety and Health, Fatality Assessment and Control Evaluation. 1989. Five family members die after entering manure waste pit on dairy farm. In-house report 89-46. www.cdc.gov/niosh/face/In-house/full18946.html. Accessed June 17, 2008.
56. National Institute for Occupational Safety and Health. 1994. Waste hauling service worker dies after he collapsed in an underground manure waste pit. Minnesota Fatality Assessment and Control Evaluation Investigation 94MN057. www.cdc.gov/niosh/face/stateface/mn/94mn057.html. Accessed June 17, 2008.
57. National Institute for Occupational Safety and Health. 1994. Farmer asphyxiated in manure waste pit. Minnesota Fatality Assessment and Control Evaluation Investigation 94MN045. www.cdc.gov/niosh/face/stateface/mn/94mn045.html. Accessed June 17, 2008.
58. National Institute for Occupational Safety and Health, Fatality Assessment and Control Evaluation. 1992. Hog farm co-owner and employee die of hydrogen sulfide poisoning in manure pit—Minnesota. In-house report 9228. www.cdc.gov/niosh/face/in-house/full9228.html. Accessed June 17, 2008.
59. National Institute for Occupational Safety and Health. 1990. Preventing deaths of farm workers in manure pits. NIOSH Publication No. 90-103. www.cdc.gov/niosh/90-103.html. Accessed June 17, 2008.
60. Young E. 2002. Climate change threatens polar bears. NewScientist.com, May 15. www.newscientist.com/article/dn2285.html. Accessed June 17, 2008.
61. Doyle A. 2007. Migratory birds, whales confused by warming: UN. Reuters, May 7. www.reuters.com/articlePrint?articleId=USL0729128920070507. Accessed June 17, 2008.
62. United Nations News Centre. 2007. Ban Ki-moon calls on new generation to take better care of Planet

Earth than his own. March 1.

www.un.org/apps/news/story.asp?NewsID=21720&Cr=global&Cr1=warming. Accessed June 17, 2008.

63. Steinfeld H, Gerber P, Wassenaar T, Castel V, Rosales M, and de Haan C. 2006. Livestock's long shadow: environmental issues and options. Food and Agriculture Organization of the United Nations, p. xx. www.virtualcentre.org/en/library/key_pub/longshad/A0701E00.pdf. Accessed June 17, 2008.
64. Steinfeld H, Gerber P, Wassenaar T, Castel V, Rosales M, and de Haan C. 2006. Livestock's long shadow: environmental issues and options. Food and Agriculture Organization of the United Nations, p. xxi. www.virtualcentre.org/en/library/key_pub/longshad/A0701E00.pdf. Accessed June 17, 2008.
65. Pew Commission on Industrial Farm Animal Production. 2008. Pew Commission says industrial scale farm animal production poses "unacceptable" risks to public health, environment. Press release issued April 29. www.ncifap.org/images/PCIFAP_Final_Release_PCIFAP.pdf. Accessed June 17, 2008.
66. Pew Commission on Industrial Farm Animal Production. 2008. Putting meat on the table: industrial farm animal production in America. www.ncifap.org/images/PCIFAP_FINAL_REPORT.pdf. Accessed June 17, 2008.

The Humane Society of the United States is the nation's largest animal protection organization—backed by 10 million Americans, or one of every 30. For more than a half-century, The HSUS has been fighting for the protection of all animals through advocacy, education, and hands-on programs. Celebrating animals and confronting cruelty. On the Web at humanesociety.org.