CHESAPEAKE BAY FOUNDATION
Saving a National Treasure

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Manure Technology: No Panacea for Pennsylvania Waters and the Chesapeake Bay

Manure treatment technologies may be one tool, among many, for improving certain pollution sources for Pennsylvania's waterways and the Chesapeake Bay. These technologies are not necessarily the best, nor the most cost-effective, solutions for addressing pollution from agriculture. Moreover, they have limited application due to the scale and structure of Pennsylvania's agricultural sector.

Manure treatment technologies do not offer a comprehensive solution for pollution reduction, primarily because manure constitutes only a fraction of the total nutrient load to local streams, rivers, and the Chesapeake Bay. Manure contributed approximately 16 percent of the nitrogen and 35 percent of the phosphorus to the Chesapeake Bay from Pennsylvania in 2012, while chemical fertilizer contributed 22 percent of the nitrogen and 20 percent of the phosphorus in the same time period.[1] By reducing the availability of manure as a crop fertilizer, farmers will then rely more on commercial fertilizers, which may also contribute to surface water runoff and leaching to groundwater.[2]

While it may appear to be desirable to build manure technology facilities to treat manure, it is not feasible to utilize advanced manure treatment technologies on the thousands of small and medium-sized farms in Pennsylvania. Moreover, these systems do not reduce sediment pollution, the leading cause of impairment affecting Pennsylvania's streams.[3] **Conservation practices that help keep sediment, along with nitrogen and phosphorus, on crop fields will both sustain long-term agricultural productivity and provide significant water quality improvements to both Pennsylvania's waters and the Chesapeake Bay.** According to Pennsylvania's Chesapeake Bay Watershed Implementation Plan, this reliance on agricultural Best Management Practices (BMPs), or pollution reduction practices, will continue well into the future.

Overview of Manure Treatment Methods

There are many different treatment technologies available that use physical, chemical, and/or biological processes to concentrate or stabilize manure nutrients, reduce odors, control pathogens, and/or produce valuable energy or organic materials.[4] Some of the more prominent technologies include:


Photo by CBF

Composting accelerates the biological decomposition of organic materials, so the nutrients are stable and will not undergo further rapid decomposition in the soil. Compost adds significant amounts of organic matter to improve soil health, so it has a high commercial value, especially in the landscaping and horticultural markets.[5] If applied in crop fields, nutrient losses from the more stable compost are reduced, although some ammonia may be volatilized in the composting process, depending on temperature, moisture and other factors.[6] Advanced techniques can dramatically reduce nitrogen losses through volatilization.[7]

The composting process can be done at a very small scale, with little more than protection from precipitation and runoff, and a form of mechanical aeration.[8] Large-scale production also provides high quality materials for athletic fields, mine land reclamation, vegetable production, landscaping and other uses.[9, 10]

Energy Production from manure is feasible because it is one of the most dependable, consistent forms of energy in the United States, in addition to being an asset for fertilizing crops. Manure generally has about 5,500 to 8,500 British Thermal Units (BTUs) per pound, once water is removed.[11] This is comparable, pound for pound, to other energy sources:

6,800 BTUs in premium wood pellets, 7,200 BTUs in oven-dried switchgrass, or 7,650 BTUs in seasoned firewood.[12] There are two general methods for producing energy from manure: the use of heat in thermochemical processes and the use of bacteria in biological processes.[13] Some examples include:

> ***Thermochemical processes***, including combustion, gasification, pyrolysis, and torrefaction are better suited for manure that is relatively dry, such as poultry litter. They produce a range of potentially valuable products including liquid bio-oils, diesel fuel, combustible gas, and ash. By-products of some processes will have concentrated nutrients with various uses. Some heat-based processes also generate air emissions of polluting nitrous oxides that must be captured, adding to the cost to run the system. Other systems that operate with little or no oxygen release inert nitrogen gas that naturally is part of the atmosphere. Heat-based systems are adaptable to different scales, but vary widely in their effectiveness and cost, and often require high capital investments.[14]
>
> ***Anaerobic digestion*** is more effective for manure with high moisture content, such as dairy or swine manure. It uses bacteria to break down manure and create methane to generate heat and/or electricity. The sludge by-product retains most of the nitrogen and phosphorous, and may be used as a crop fertilizer, with minimal odor. Because this by-product is more concentrated than raw manure, it is easier to apply where and when it is most needed by crops. If solids are separated, they may be used as bedding for dairy cattle or as a soil amendment. Anaerobic digesters typically require a high capital investment, so are only feasible for large farms,[15] but innovations for smaller farms are being developed.[16, 17]

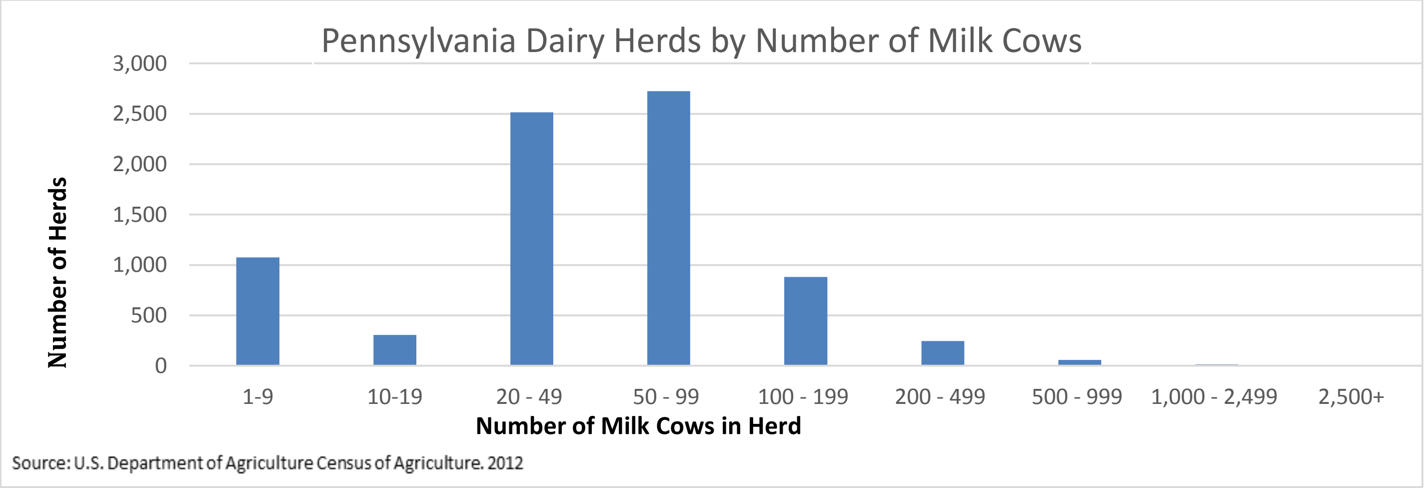
Other Technologies

Separating the manure solids and liquids may increase the management options for some types of manure such as dairy and swine. This process usually leaves a large proportion of the available nitrogen in the liquid fraction and the phosphorus in the solid fraction. Although this does not change the total quantity of nutrients to be managed, it allows targeting of the individual nutrients to locations where they will do the most good. Also, because the solid fraction is more concentrated, it may be feasible to transport it to more remote fields.[18]

Drying and Pelletizing poultry manure produces a fertilizer product that is more balanced and consistent in its nutrient content, as well as pathogen and odor-free.

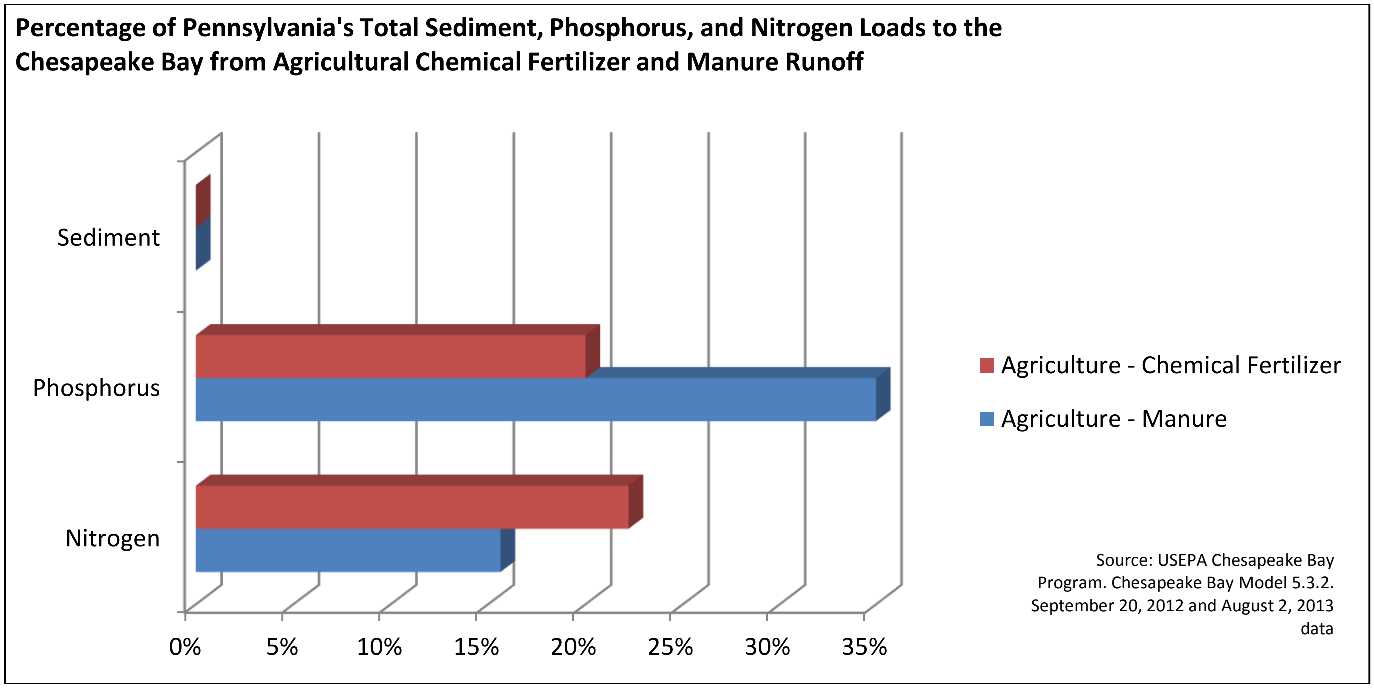
Manure Technology - Applicable to only a Fraction of Nutrient Pollution

Pennsylvania's livestock production is diverse, with poultry, hogs, beef and dairy cattle, and other livestock on farms of all sizes, management systems and geographies. The average dairy herd size in Pennsylvania is only 68 cows. In 2012 6,625 dairy farms had less than 100 cows, while only 16 farms (0.2 percent) had more than 1,000.[19]



The fact that Pennsylvania's dairy industry is widely dispersed and weighted toward many relatively small farms greatly limits the usefulness of advanced manure treatment technologies to significantly resolve nutrient pollution challenges. Small farms may not have enough manure to warrant the investment in manure treatment technologies. Regional manure treatment facilities consolidating the output from many farms have been touted as a potential solution to resolve manure nutrient pollution.[20] However, there are significant challenges to this consolidation. Transporting manure from many farms to one location can be a costly endeavor, as well a potential safety hazard to local citizens on rural roads that may not be able to handle large trucks. Biosecurity concerns with trucks traveling along public roadways, between farms, with potential pathogens can pose additional risks.

Although manure treatment technologies can play a role, the reality is that such practices can only reduce that portion of nutrient pollution that is from manure. Depending on the type of treatment system used to process manure and how the end-products are managed, there may only be a reduction of a small fraction of the manure nutrients. Such technologies cannot address pollution from commercial agricultural fertilizers, lawn fertilizers, sewage treatment plant discharges, septic systems, and other pollution sources. And, unlike many agricultural pollution reduction practices that reduce nutrient pollution, manure technologies do not typically address sediments, the leading cause of river and stream pollution in Pennsylvania.[21]



As the graph above illustrates, of the total pollution loads from all sources, USEPA calculates that roughly 16 percent of the nitrogen pollution and 35 percent of the phosphorus pollution, but none of the sediment pollution, from Pennsylvania are from manure runoff.[1]

This indicates that in the case of nitrogen pollution from runoff, manure is not the primary source; rather, chemical fertilizers running off agricultural lands are the leading source of nitrogen pollution entering into the Bay from Pennsylvania. Manure runoff is the leading source of phosphorus pollution from agricultural operations. **Manure technologies can only treat a portion of the manure, so would only make a small contribution toward achieving Pennsylvania's Chesapeake Bay Blueprint.**

Most manure is used to fertilize crop production. Diverting this resource to support large-scale manure technology would require a shift to costly commercial fertilizers by farmers. Many small livestock farms lack adequate manure storage, and must land-apply the manure frequently or store it in temporary stacking areas, making it difficult to aggregate their manure with that from other farms. Even where consolidation and treatment of manure could be achieved, actual nutrient reductions may be partially offset by additional commercial fertilizer inputs to crop fields that had received manure in the past.

The Chesapeake Bay Blueprint – A Comprehensive Strategy for Pennsylvania

Manure treatment technologies, taken together, represent an important, albeit comparatively expensive, set of tools for use in the Commonwealth to reduce nutrient loads to local waterways and the Chesapeake Bay. The financial risks of multi-million dollar public investments in technological solutions for manure pose a potential liability to the Commonwealth. If a system fails to produce anticipated benefits, a natural disaster occurs at the site, or if the business is simply no longer viable, a single and substantial investment could be lost. Manure treatment technologies may help to reduce nutrient pollution in areas with higher nutrient concentrations than crop needs, such as Lancaster County,[23] but are not a panacea to resolve widespread water quality problems throughout Pennsylvania.

More benefits will accrue to Pennsylvania's environment and economy from continued adoption of the agricultural pollution reduction practices identified in the Commonwealth's Chesapeake Bay Blueprint. BMPs such as cover crops, conservation tillage, forested riparian buffers, manure storage, barnyard improvements, and feed management will provide multiple benefits, such as mitigation of flood risks, prevention of sediment loss, improved soil health, carbon sequestration, increased farm profitability, and energy production.[24, 25, 26, 27, 28, 29, 30] These BMPs typically provide very cost effective pollution reductions relative to other options.

While Pennsylvania policy makers explore opportunities for investment in manure technologies, it is critical that the bulk of the Commonwealth's investments remain – indeed grow – in the area of tried and true BMPs applied on farms of all scales. Nothing can be simpler then focusing on conservation that counts to help us meet our milestone goals in the Chesapeake Bay Blueprint and our local goals to help clean up Pennsylvania's rivers and streams.

Citations

[1] U.S. EPA Chesapeake Bay Program. Chesapeake Bay Model 5.3.2. September 20, 2012 model run.

[2] Penn State College of Agricultural Sciences. 2013-2014. The Agronomy Guide. Part 1, Section 2: Soil Fertility Management. http://pubs.cas.psu.edu/FreePubs/PDFs/agrs026.pdf

[3] Pennsylvania Department of Environmental Protection: Clean Water Act Section 305(b) Report and 303(d) List. 2014 Pennsylvania Integrated Water Quality Monitoring and Assessment Report. http://files.dep.state.pa.us/Water/Drinking%20Water%20and%20Facility%20Regulation/WaterQualityPortalFiles/2014%20Integrated%20List/2014_Pennsylvania_Integrated_Water_Quality_Monitoring_and_Assessment_Report.pdf

[4] Ogejo, J.A. May 11, 2009. Selecting a Treatment Technology for Manure Management. Virginia Cooperative Extension. http://pubs.ext.vt.edu/442/442-306/442-306.html

[5] Penn State College of Agricultural Sciences. 2013-2014. The Agronomy Guide. Part 1, Section 9: Nontraditional Soil Amendments. http://pubs.cas.psu.edu/FreePubs/PDFs/agrs026.pdf

[6] Alberta Agriculture and Rural Development. Manure Composting Manual. http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/agdex8875

[7] Ulsh, Christine Ziegler with Paul Hepperly, PhD. April 13, 2006. Good compost made better— The Rodale Institute takes "black gold" one step further. http://www.newfarm.org/depts/NFfield_trials/2006/0413/compost.shtml

[8] Burdett, H.K. University of Rhode Island Cooperative Extension Water Quality Program. July 2010. Composting Manure On-Farm. Basics for Small Acreage Livestock Farms. http://www.uri.edu/ce/healthylandscapes/livestock/pdf/URI_manure_composting.pdf

[9] Crable, A. June 4, 2009. Composting goes mainstream: In a major effort to keep farm manure out of our waterways, compost headed for everything from sports fields to lawns and gardens here. Lancaster Online. http://lancasteronline.com/article/local/238396_Composting-goes-mainstream.html#ixzz2gaYp9SJx

[10] Torres, C. October 10, 2010. Oregon Dairy Organics Opens Its Doors to the Public. Lancaster Farming. http://www.lancasterfarming.com/Oregon-Dairy-Organics-Opens-Its-Doors-to-the-Public#.UkxTXhY_uGk

[11] Chesapeake Bay Commission. Chesapeake Bay Commission. Manure-to-Energy Summit. 2011. Promising Manure-to-Energy Technologies For the Chesapeake Bay Watershed. http://www.chesbay.us/Manure%20Summit/Technical%20Summary%204%20pager.pdf

[12] USDA Forest Products Laboratory. 2004. TechLine Fuel Value Calculator. WOE-3. http://www.fpl.fs.fed.us/documnts/techline/fuel-value-calculator.pdf

[13] Chesapeake Bay Commission. January 2012. Manure to Energy: Sustainable Solutions for the Chesapeake Region. http://www.chesbay.us/Publications/manure-to-energy%20report.pdf

[14] Chesapeake Bay Commission. January 2012. Manure to Energy: Sustainable Solutions for the Chesapeake Region. http://www.chesbay.us/Publications/manure-to-energy%20report.pdf

[15] Chesapeake Bay Commission. January 2012. Manure to Energy: Sustainable Solutions for the Chesapeake Region. http://www.chesbay.us/Publications/manure-to-energy%20report.pdf

[16] Wang, Z., S. Chen, C. Frear, C. Kruger, D. Granatstein. April 7, 2009. Advanced small-scale anaerobic digester design tailored for household user living in cold climate. Washington State University. http://csanr.wsu.edu/publications/patents/Smallscale%20biogas%20invention%20disclosure%204%2009.pdf

[17] Roberts, G. Small-Scale Manure Digesters: Potential for On-Farm Heat and Energy Intervale Innovation Center, University of Vermont. http://www.uvm.edu/~cmorriso/AltEnergy/smallmanure.pdf

[18] Penn State College of Agricultural Sciences. 2001. Managing Phosphorus for Agriculture and the Environment. http://pubs.cas.psu.edu/FreePubs/pdfs/uc162.pdf

[19] U.S. Department of Agriculture Census of Agriculture. 2012. Table 17. Milk Cow Herd Size by Inventory and Sales. http://www.agcensus.usda.gov/Publications/2012/Full_Report/Volume_1,_Chapter_1_State_Level/Pennsylvania/pav1.pdf
[20] Pennsylvania Department of Environmental Protection. December 15, 2010. Pennsylvania Chesapeake Watershed Implementation Plan, Phase I.
[21] Pennsylvania Department of Environmental Protection: Clean Water Act Section 305(b) Report and 303(d) List. 2014 Pennsylvania Integrated Water Quality Monitoring and Assessment Report.
http://files.dep.state.pa.us/Water/Drinking%20Water%20and%20Facility%20Regulation/WaterQualityPortalFiles/
[23] Mid-Atlantic Water Program. Pennsylvania Budgets. http://www.mawaterquality.agecon.vt.edu/PA/scale_menu.php
[24] Astute Farm Management Practices Can Significantly Enhance Soil Carbon Sequestration. CO2 Science. http://www.co2science.org/articles/V5/N1/COM.php
[25] Penn State College of Agricultural Sciences Cooperative Extension. Riparian Buffers for Wildlife. http://pubs.cas.psu.edu/FreePubs/pdfs/uh165.pdf
[26] S.T. Lovell, W.C. Sullivan. Environmental benefits of conservation buffers in the United States: Evidence, promise, and open questions Agriculture, Ecosystems and Environment 112 (2006) 249–260
http://www.willsull.net/Publications_files/Lovell%20%26%20Sullivan%20buffers.pdf
[27] Delaware Riverkeeper Network. Riparian Buffers (Fact Sheet) http://www.delawareriverkeeper.org/resources/Factsheets/Riparian_Buffers.pdf
[28] Lowrance, Richard, et. al. 1997. Water Quality Functions of Riparian Forest Buffers in Chesapeake Bay Watersheds. Environmental Management 21(5):687-712.
[29] Zeckoski, R. B. Benham and C. Lunsford. Streamside Livestock Exclusion: A tool for increasing farm income and improving water quality. 2007. Virginia Cooperative Extension, VA.
[30] Sweeney, B.W., T.L. Bott, J.K. Jackson, L.A. Kaplan, J.D. Newbold, L.J. Standley, W.C. Hession, and R.J. Horwitz. 2004. Riparian Deforestation, Stream Narrowing, and Loss of Stream Ecosystem Services. Proceedings of the National Academy of Sciences 101(39):14132-14137.

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Founded in 1967, the Chesapeake Bay Foundation is a nonprofit 501(c)(3) conservation organization dedicated to saving a national treasure—the Chesapeake Bay and its rivers and streams. Its motto, Save the Bay, defines the organization's mission and commitment. With headquarters in Annapolis, MD, offices in Maryland, Virginia, Pennsylvania, and the District of Columbia, and 17 field centers, CBF works throughout the Chesapeake Bay's 64,000-square-mile watershed to build an informed citizenry, advocate pollution-reduction strategy, and enforce the law. CBF is supported by more than 200,000 active members and has a staff of 170 full-time employees. Approximately 80 percent of CBF's $23.6 million annual budget is privately raised.