Livestock and Poultry Environmental Stewardship (LPES) curriculum

CAFO Fact Sheet series

Fact Sheet #24: Technology Options to Comply with Land Application Rules

Disclaimer
This fact sheet reflects the best professional judgment of the contributing authors and is based on information available as of the publication date. Also, your state may have additional, more stringent requirements than EPA's requirements. Contact your permitting authority for complete information on the regulations that apply to you.

By Alan Sutton, Purdue University, and Frank Humenik, North Carolina State University

Introduction

U.S. Environmental Protection Agency (EPA) Concentrated Animal Feeding Operation (CAFO) regulations require all large CAFO operators to ensure proper application of manure, litter, and other process wastewater to land under the control of the CAFO. Land application must be in accordance with a nutrient management plan that establishes application rates for each field based on the technical standards each state has established for nutrient management. Generally, that means the operator may only apply animal manures and wastewaters to land at rates that meet the nutrient needs of current or intended crops grown on the land. A thorough discussion on establishing agronomic rates for a CAFO is presented in *CAFO Fact Sheet #25: Making Decisions Abaout Application Rates.*

Some CAFO operators may not have sufficient land to apply the manure and wastewaters to meet the agronomic rate requirements. However, technology options exist to treat and process the manure and wastewater to reduce the volume, the concentration of nutrients [especially nitrogen (N) and phosphorus (P)], and the organic loading of manure and wastewaters generated at a CAFO. Value-added products can be produced that are easily transported to land sites needing nutrients from these wastes. By implementing these technologies, CAFO operators can reduce their need for the land required to apply the manure and wastewater and comply with the CAFO rule to improve and maintain a sustainable environment. Reduced land requirements for terminal waste management on farms may also reduce potential requirements of nonpoint source control or total watershed management regulations being considered that would limit runoff from lands receiving livestock and poultry waste.

Continued on next page

Animal Ration Modification

The composition and availability of nutrients in animal diets can greatly affect the amount of nutrients excreted in manure. Reducing excess nutrients, increasing the availability of the nutrients, and balancing nutrients in the animal's diet can dramatically increase the percentage of nutrient retention in the animal and animal products and reduce nutrient excretion. Reducing the crude protein and adding synthetic amino acids in swine or poultry diets can reduce N excretion (possibly up to 50%).

Careful selection of protein sources and reducing the protein in dairy and beef cattle rations can reduce N excretion (possibly up to 25%). Using specific processing techniques (grinding, pelleting, steam flaking, etc) will enhance the nutrient availability of feeds for animals. Reducing inorganic P supplements in diets and using an enzyme, phytase, in swine and poultry diets will greatly reduce P excretion (up to 30%). Other enzymes can be used to enhance nutrient availability and retention and to reduce nutrient excretion. Reducing the inorganic P supplements in beef and dairy cattle diets can reduce P excretion (up to 30%). For further information, contact your consulting nutritionist, feed supplier, or state cooperative extension nutrition specialist.

Manure Treatment

Advanced technologies are being developed for the biological, physical, and chemical treatment of manure and wastewaters. Some of these greatly reduce constituents in the treated solids and liquids that must be managed on the farm. Byproduct recovery processes are being developed that transform waste into value-added products that can be marketed off the farm.

Physical Treatment

Systems that separate solids from liquid have been used to concentrate solids and facilitate treatment of the liquid stream. Gravity settling tanks and mechanical separation systems commonly remove from 15% to 25% of the solids, approximately 15% to 25% of the P, and 15% to 25% of the N from liquid manure. Additional removals require biological or chemical treatment.

After the separation process, the solids can be stored for land application or stacked in windrows or piles for composting where they are turned with a windrow turner or a manure loader. During composting, the volume of the solids is reduced by 40% to 50%, N is incorporated into bacterial cells in the organic form, odors are reduced to a humus-like aroma, and the concentrated nutrients become a stable form that can be easily stored and transported to application sites. Often manure compost is sold commercially for nurseries, lawns, golf courses, horticulture use, mushroom production, and other soil amendment uses outside the watershed of origin. Adding inorganic fertilizer to the compost to balance the nutrient levels for specific applications and pelleting the mixture for commercial sales may also be feasible.

Chemical Treatment

Adding flocculants such as aluminum sulfate (alum), magnesium chloride, ferric chloride, and several polyacrylamides can increase the removal of particulate and dissolved constituents by several processes such as solids separation and sedimentation. Phosphorus is commonly removed during wastewater treatment by adding chemicals that result in its removal through flocculation and then sedimentation. The federal CAFO rule stipulates that manure nutrient applications must not exceed the agronomic rate for the intended crop grown on the land. In most cases, P becomes the limiting nutrient, and any means of reducing the P content will significantly reduce the amount of land required for manure application.

Biological Treatment

Aerobically treating the waste stream to convert N in the wastewater to nitrate followed by an anaerobic process to denitrify the nitrate to N_2 gas will significantly reduce the N loading to cropland. Sequencing batch reactors provide

alternative aerobic and anaerobic conditions to convert N to nitrate during the aerobic cycle and nitrate to N gas during the anaerobic cycle. They can remove about 90% of the total N and 98% of the ammonia N. Trickling filters can provide a less energy intensive method to convert waste N to nitrate, which then can be converted to N_2 gas by a following anaerobic unit such as a lagoon or a facultative unit such as constructed wetlands. Solids removal is necessary before introducing the waste stream into constructed wetlands, which will then provide about 90% removal of the total N. If nitrified influent is provided to the constructed wetland, then even higher removal of N is possible.

Removal of P in biological systems is limited. Sequencing batch reactors can be operated to provide up to 70% removal of P from the liquid stream with the removed P being in the bottom sludge. If chemical flocculation and sedimentation are employed before a constructed wetland, then high removals of N and P are possible, which would greatly reduce the amount of land required to apply the liquid manure.

Summary

Land application areas on some animal feeding operations may not be sufficient to meet the CAFO rule requirements to apply nutrients at agronomic rates for the cropping program. Technology options are available to reduce the nutrient loading in the waste stream and to concentrate valuable nutrients in the solids portion for transport and utilization off farm in an environmental friendly and sustainable manner. The initial nutrient content of the waste stream can be dramatically reduced by using proper feed management and diet modification practices to reduce nutrient excretion in manure. These technologies can substantially reduce the land required for terminal management of livestock and poultry waste. This may facilitate easier compliance with CAFO regulations for land application and may reduce requirements for total watershed management regulations being considered that would limit runoff from land application sites. As CAFOs grow in size, these technologies may prove economically attractive in lieu of expanding the land resource base for manure application through ownership or leasing. ●

Definition of Terms

Aerobic–Biological degradation of organic matter by microorganisms that require free oxygen.

Anaerobic–Biological degradation of organic matter by microorganisms that require no free oxygen.

CAFO–Concentrated Animal Feeding Operation. Animal feeding operations classified as large or presenting a high risk to discharge can be classified as CAFOs and are likely required to have an NPDES permit.

Composting–The controlled aerobic biological decomposition of organic matter into a stable humus-like product.

Flocculation–The process of using chemical compounds that will react with nutrients to produce a precipitant or complex that can easily be separated from the waste stream.

Land application area–Owned, rented, or leased land for the agronomic application of manure, litter, or process wastewater from the production area.

Phytase–Enzyme that when added to rations of non-ruminant animals makes the phosphorus in grains and other feed ingredients more available during digestion.

Sequencing batch reactor–An in-vessel, self-contained system with alternate aerobic and anaerobic stages of biological treatment to biodegrade organic matter, convert nitrogen to nitrogen gas, and precipitate phosphorus in the settled sludge.

Authors
Alan Sutton, an animal nutrition and waste management specialist at Purdue University, can be reached at www.ansc.asutton@purdue.edu. Frank Humenik, a waste management specialist at North Carolina State University, can be reached at www.frank_humenik@ncsu.edu.

Reviewers
The authors wish to thank John Classen, North Carolina State University; Mark Risse, University of Georgia; and John Sweeten, Texas A&M University, for their review of this fact sheet.

For More Information

Environmental Regulations Related Resources

EPA CAFO Phone Line–202-564-0766

http://www.epa.gov/npdes/caforule/–To obtain copy of regulations

http://www.epa.gov/npdes/afo/statecontacts/–To obtain state environmental agency contacts

http://www.epa.gov/agriculture/animals.html/–To obtain compliance assistance information from EPA

http://cfpub.epa.gov/npdes/contacts.cfm?program_id=7&type=REGION/–To obtain EPA Region Animal Feeding Operation contacts

Land-Grant University Resources

The local contact for your land-grant university Cooperative Extension program is listed in the phone book under "Cooperative Extension" or "*(county name)* County Cooperative Extension."

http://www.reeusda.gov/1700/statepartners/usa.htm/–To obtain state Cooperative Extension contacts

http://www.lpes.org/–To view the Livestock and Poultry Environmental Stewardship (LPES) curriculum resources

USDA Farm Bill Resources

To obtain more information about the Farm Bill 2002, see the USDA-NRCS website at http://www.nrcs.usda.gov/programs/farmbill/2002/. You can also contact your local USDA Service Center, listed in the phone book under "U.S. Department of Agriculture," or your local conservation district.

The LPES educational materials were developed with support from the USDA-CSREES, the U.S. EPA's National Agriculture Compliance Assistance Center, and the University of Nebraska Cooperative Extension at Lincoln, under Cooperative Agreement Number 97-EXCA-3-0642.

MWPS (MidWest Plan Service), headquartered at Iowa State University, is the primary distributor of LPES curriculum materials. To order the materials online, access their website at <http://www.mwpshq.org> and visit the catalog section.

Discounts are offered on LPES materials purchased as package deals or in bulk.