ADVANCES IN SWINE MANURE MANAGEMENT

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Abstract (Summary)
In Jul 2000, the North Carolina attorney general's office announced an agreement with Smithfield Foods Inc to phase out open air hog lagoons and spray fields in North Carolina. Premium Standard Farms signed a similar agreement two months later, pledging $2.1 million. The Animal and Poultry Waste Management Center (APWMC) at North Carolina State University (NCSU) was assigned the central role of coordinating the development and implementation of the hog waste management alternatives. Environmentally Superior Technologies (ESTs) is defined in the agreement as technologies that can be permitted by state government and are determined to be technically, operationally and economically feasible. A Phase 1 Technology Determination Report, issued in Jul 2004, identified two of the original candidates that were capable of meeting the Agreements' environmental performance standards and were declared to be contingent EST. Those technologies were solids separation/nitrification-denitrification/soluble phosphorus removal system and high solids anaerobic digester system. In Phase II, an additional eight candidate ESTs were evaluated.

Full Text (2092 words)

[Headnote]
TECHNOLOGY EVALUATIONS

[Headnote]
North Carolina State University's Animal and Poultry Waste Management Center, with funding from agreements between two major swine producers and the state Attorney General, has tentatively identified five "Environmentally Superior Technologies" to treat swine manure.

IN JULY 2000, the North Carolina attorney general's office announced an agreement with Smithfield Foods, Inc. to phase out open air hog lagoons and spray fields in North Carolina. At the time, the Smithfield Poods represented 70 percent of the state's hog industry, which currently is estimated to include over 10 million animal units. The agreement called for Smithfield Foods to provide $15 million to North Carolina State University (NCSU) to evaluate new technologies to replace open lagoons. An additional $50 million ($2 million annually) was built in to provide environmental improvements and compliance monitoring. Premium Standard Farms signed a similar agreement two months later, pledging $2.1 million. A third agreement was established between the Attorney General and Frontline Farmers in 2002 that facilitates cooperation in the accomplishment of the process.

The Animal and Poultry Waste Management Center (APWMC) at NCSU was assigned the central role of coordinating the development and implementation of the hog waste management alternatives. APWMC began the process of identifying and evaluating technologies that could replace current lagoon and spray field systems. Once technologies were selected, Smithfield and Premium were committed to implementation of technologies that meet all of the criteria on their company-owned farms and to assisting their contract farmers to convert to the new technologies. An article in BioCycle by Rhonda Sherman, "Exploring Superior Systems To Manage Manure" (February 2003), provides excellent background information on the agreement and describes the initial 18 candidate technologies to be evaluated by APWMC. Criteria for evaluating the technologies were spelled out in the legal agreement. Notes Sherman's article, "Environmentally Superior Technologies (EST) is defined in the agreement as technologies that can be permitted by state government and are determined to be technically, operationally and economically feasible."

EST technologies also have to meet five 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 the parcel or tract of land on which the swine farm is located; 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. The accompanying sidebar summarizes how standards 2-5 were defined and quantified.

In addition to the technical performance standards, the Agreements state that unconditional EST must also be operationally and economically feasible as well as permittable by the appropriate regulatory agency. Data regarding operational requirements, costs, and the impact that the adoption of EST may have on the competitiveness of the

North Carolina pork industry are completed; however, determinations regarding operational and economic feasibility as well as the permittability of the EST are not finalized at this time but are anticipated to be made in a Phase 3 report to be released at a later date in 2005 or early 2006 at the latest.

Candidate EST technologies were competitively selected. They included solids separation systems, a covered in-ground anaerobic digester with biological trickling filters and greenhouse vegetable production, mesophilic and thermophilic anaerobic digesters, a sequencing batch reactor, an upflow biological aerated filter system, a gasification system, belt manure removal systems, and wetland systems. In addition to these systems, technologies not funded directly by this initiative but under development by Smithfield Foods in Utah (biodiesel fuel from manure project), Premium Standard Farms in Missouri (manure to fertilizer project and several other technologies per a consent decree between Premium Standard Farms and the state of Missouri and USEPA), Sustainable North Carolina and Frontline Farmers (closed loop swine waste management system located in eastern North Carolina) are being followed as potential EST. There also are other systems interested in being considered according to the same set of criteria, to be funded by monies outside of the Agreements.

A Phase 1 Technology Determination Report, issued in July 2004, identified two of the original candidates that were capable of meeting the Agreements' environmental performance standards and were declared to be contingent EST. Those technologies were: 1) Solids separation/nitrification-denitrification/soluble phosphorus removal system ("Super Soils" technology) and 2) High solids anaerobic digester system ("ORBIT" technology). In Phase II, an additional eight candidate ESTs were evaluated. A Phase II report, released in July 2005, identified three more technologies as contingent ESTs: 1) "Super Soil Systems" centralized composting system (an addition to its first EST designation that focused heavily on the liquid fraction within the system); 2) Gasification for elimination of swine waste solids with recovery of value-added products system; and 3) "BEST" - fluidized bed combustion of solids system.

TECHNOLOGY SUMMARIES

Dr. Leonard Bull, Associate Director of APWMC, will be speaking at BioCycle's Southeast Conference in Charlotte, North Carolina, November 13-16, 2005 (see pages 15-17 of this issue for complete program). Bull serves as an evaluator for several EST projects, and will discuss "Energy Recovery Options for Animal Waste," reviewing the range of technologies evaluated for swine waste management. The following are highlights of some of the projects using technologies that have been selected as ESTs, or are candidates in the pool:

ORBIT: The centerpiece of a project at Timber Ridge Farms near Clinton, North Carolina is a high solids thermophilic anaerobic digester that converts swine waste into biogas, and can also codigest MSW and food residuals, e.g. from cafeterias or other large-scale food service operations. Residence time of material in the digester is expected to be 15 to 21 days. A company called Organic Biotechnologies (ORBIT) forecasts a conversion rate of at least 75 percent of the organic carbon into biogas. Balance of the organic carbon and most other nutrients generate an effluent sludge that can be processed with a screw press to separate the liquid and solid fractions. The liquid fraction will be used to make a value-added fertilizer, while the solids go into a soil amendment. The Orbit management and technical team have been awarded a contract by the State of North Carolina Green Energy Program that provides a 2.5-cent premium on power sales to the grid. The company also has worked with Progress Energy towards achieving grid connection and installation of a generator that can convert the plant's full output when operating at capacity (approximately 10 tons/day). The company is working collaboratively with the APWMC and the NCSU Department of Crop Science to evaluate the digestate for use on state roadside right-of-way for turfgrass establishment. That work is funded by the state Department of Transportation.

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[Photograph]
Timber Ridge Farms installed a high solids thermophilic anaerobic digester (components shown on right) that can codigest swine manure, MSW and food residuals.

Super Soils Systems: The two elements of this project (developed by Super Soil Systems USA) are a liquid treatment system and a solids processing facility. The liquid treatment system is located at Goshen Ridge Farms, a 4,360-head

finishing farm near Warsaw, North Carolina. Goshen Ridge Farms is under contract for production with Premium Standard Farms. The solids portion of this project is located at Timber Ridge Farms near Clinton. Solids separation is accomplished using polyacryalmide, a flocculating agent. The solids are transported to the Clinton site, where they are composted (using the Compost-A-Matic system) and blended with bulking materials such as cotton gin trash and wood chips. This value-added product is then bagged for sale and used off the farm. A portion of the solids was used in evaluating the Orbit technology just described prior to being composted.

The sequencing batch reactor at the Andrews Hunt Farm is designed to treat waste generated by 2,700 animals.

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The sequencing batch reactor at the Andrews Hunt Farm is designed to treat waste generated by 2,700 animals.

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[Photograph]
Julian Barham Farm - a 4,000 farrow-to-wean operation uses an ambient in-ground digester (left). Effluent from the digester flows into a second stage lagoon and is used to fertilize plants and vegetables in a greenhouse (right).

Batch Reactor. A sequencing batch reactor at the Andrews Hunt Farm near Bailey is designed to treat waste generated by 2,700 animals. Alternative Natural Technologies is the provider. The reactor is a large, open-top concrete tank equipped with aerators and mixers where waste is pumped into the reactor once each day. Residuals cycle between aerated and anoxic conditions. Conversion by microbes of ammonia to nitrate occurs during aeration; dentrification takes place in the anoxic cycle when nitrogen is converted into nitrogen gas. Waste flows from the pig houses to a homogenization tank, where it is held before being pumped to the reactor and then to a lagoon. The high phosphorus content solids have value as a fertilizer.

Ambient Digester: At the Julian Barham Farm near Zebulon - a 4,000 head farrow-to-wean operation - the ambient digester consists of an impermeable cover over an inground digester. Methane gas is delivered to a generator, where electricity is produced and heat from the generator yields hot water. Effluent from the digester flows into a second stage lagoon and will fertilize plants and vegetables in a greenhouse. Major components added were a nitrification/denitrification system (as part of an EPA AgStar program).

The North Carolina State University/APWMC website includes the Phase II project report as well as related studies that have been conducted to help complete the evaluations (e.g., an odor dispersion analysis). There also are more detailed descriptions of the selected and candidate EST systems. see www.cals.ncsu.edu/waste jngt/smithfield_projects I smithfieldsite.htm.

[Sidebar]
DEFINING, QUANTIFYING TECHNICAL PERFORMANCE STANDARDS
AT THE heart of the Environmentally Superior Technologies (EST) evaluation process are five technical performance standards (see main article) that must be met. The North Carolina General Assembly established the standards and a committee was appointed to compile guidance on how to define and quantify the performance criteria. The quantification of atmospheric emissions, odors, pathogens arid nutrients has application to anyone composting or land applying organic residuals. The performance standards and guidance for standards 2-5 are quantified as follows:
Atmospheric Emissions Of Ammonia: Approximately 80 percent reduction, as compared to a typical swine farm, of ammonia emissions from waste storage/treatment components and land application areas. Systern must also target reduction of ammonia from the barns.

[Sidebar]

Odor Emissions: Technologies employed must substantially eliminate the emission of odor that is detectable beyond the

boundaries of the parcel or tract of land on which the swine farm is located. Odor intensity levels, measured using an index scale from 0-8, should not exceed the established metric of 2 (or equivalent) at a property line on which the swine farm is located. The Phase II report includes the actual emissions limits.
Pathogen And Vector Attraction Reduction: Approximately 4 log reductions of pathogens (microorganisms documented to be of human health concern) in the treated liquid and solid waste stream, as compared to concentrations of the pathogens in raw manure. All components of the waste management system (treatment technology, fate of farm generated solids, method and location of land application of liquid and/or solids, etc.) are considered factors for pathogen reduction.
Nutrients and Heavy Metals: The standards require that technologies substantially eliminate nutrient and heavy metal contamination of soil and groundwater. Systems should reduce total nitrogen mass by 75 percent and total phosphorus, copper, and zinc mass by 50 percent from influent levels for the whole farm. Current state standards for nutrients and sou metal must be met as well. Reductions may be met by transporting nutrients off the farm, and/or animal diet modification.
Factors to be used to determine economic feasibility include: 1) Projected 10-year annualized cost (including capital, operational and maintenance costs) of each alternative technology expressed as a cost per 1000 pounds of steady state live weight for each category of farm system; 2) Projected 10-year annualized cost (including capital, operational and maintenance costs) per 1000 pounds of steady state live weight for each category of farm system of a lagoon and spray field system that is designed, constructed and operated in accordance with current laws, regulations, and standards, including NRCS design, construction and waste utilization standards; 3) Projected revenues, including income from waste treatment by-product utilization, together with any cost savings from the new technology; 4) Available cost-share monies or other financial or technical assistance from federal, state or other public sources, including tax incentives or credits; and 5) Impact that the adoption of alternative technologies may have on the competitiveness of the North Carolina pork industry as compared to the pork industry in other states.
The ORBIT anaerobic digester project has been awarded a Green Energy contract that provides a 2.5-cent premium on power sales to the grid.

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