Blue Lagoons on Pig Farms?

A new waste-handling system can make it a reality.

In Duplin County, North Carolina, a full-scale wastewater treatment system (foreground) that replaced the swine lagoon.

The environment and hog producers alike should benefit from a new way developed by ARS scientists and collaborators to treat swine-production wastewater.

In fact, researchers at ARS's Coastal Plains Soil, Water, and Plant Research Center in Florence, South Carolina, are delighted with the new system's stellar performance throughout a recent, extensive evaluation.

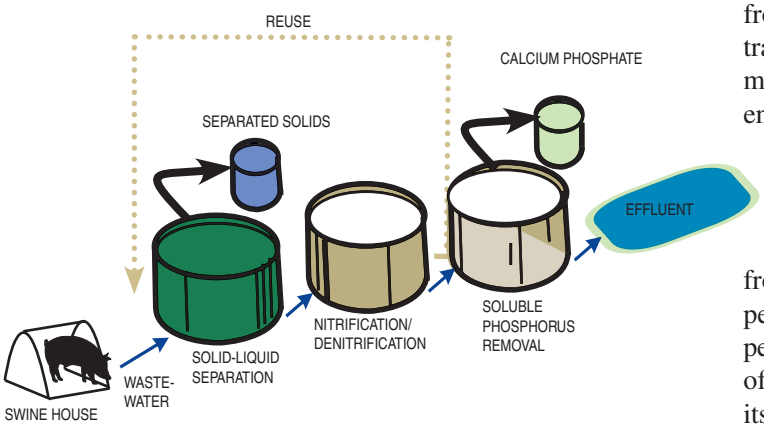
The system—invented by Florence soil scientists Matias Vanotti, Ariel Szogi, and Patrick Hunt—"met all expectations that it would be both efficient and environmentally beneficial," says Vanotti. "This is an important milestone and encourages moving ahead with innovation and evaluation of lower-cost, next-generation systems."

Szogi was with North Carolina State University when the trio first planned the system in 1997.

A combination of technologies developed by companies in the United States, Spain, and Japan, as well as by ARS researchers, the system comprises tanks and staging areas laid out over 200 feet. In three stages, it separates solids and liquids, removes ammonia, recovers soluble phosphorus, and processes the solids into plant fertilizer.

A patent on the system has been allowed (under U.S. Patent Application Serial No. 09/903,620, filed July 13, 2001).

The year-long evaluation was conducted using a full-scale version of the system built at Goshen Ridge Farm, a 4,360-head swine-finishing facility in Mount Olive, North Carolina. It was implemented by the inventors and the Clinton, North Carolina-based private firm Super Soil Systems USA. Construction was part of an agreement between Smithfield Foods of Smithfield, Virginia; Premium Standard Farms of Kansas City, Missouri; and the North Carolina Attorney General's office to use environmentally superior technology to replace current waste lagoons.



The researchers tested the system's ability to eliminate animal-waste discharge to surface and ground waters—along with related release of ammonia, odor, and pathogens. They also evaluated its ability to stem soil and groundwater contamination by nutrients and heavy metals.

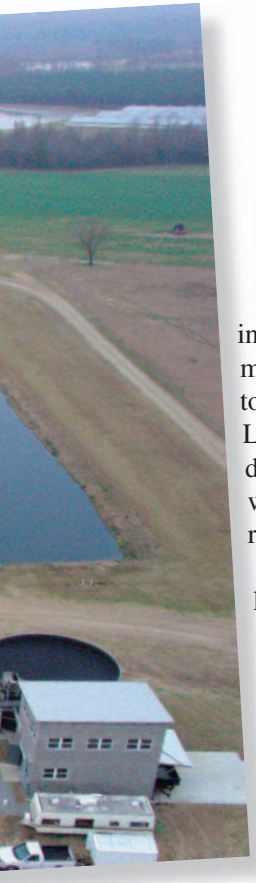
Three Revolutionary Processes

The system performs three critical processes in animal-waste management: It separates solids and liquids from swine wastewater while recovering organic matter; it removes ammonia from wastewater, using acclimated nitrifying bacteria; and it transforms phosphorus removed from wastewater into a solid, marketable fertilizer while converting leftover effluent into an environmentally friendly liquid crop fertilizer.

"Results showed that this system can have a great impact in animal-waste treatment," says Szogi.

How great an impact?

It removed more than 97 percent of total suspended solids from wastewater during the tests. It stripped the water of 95 percent of its total phosphorus, 99 percent of its ammonia, 98 percent of its copper, 99 percent of its zinc, more than 99 percent of its biochemical oxygen demand, and more than 97 percent of its odor-causing components.



The reduction in fecal microorganisms achieved in this system resulted in disinfected effluent. Says microbiologist Patricia Millner, a project cooperator from ARS's Environmental Microbial Safety Laboratory in Beltsville, Maryland, "This prevents dispersion of pathogens into soil, water, or air when the treated effluent is sprayed onto fields or recycled into storage ponds."

Indeed, the evaluation site's old wastewater lagoon was converted into clean, aerated water. "It changed color, from brown to blue," says Hunt.

Minimizing the impact of livestock waste on the environment is one of U.S. agriculture's major challenges. With swine facilities, the problem is compounded when nutrient-rich waste is flushed into lagoons and then applied to cropland. Problems arise when more nutrients are applied than crops or forage can use, causing excess nutrient runoff that can lead to poor drinking water and oxygen depletion in bodies of water.

The magnitude of this challenge was clear during the evaluation. At its operating peak during the trial, the system processed waste generated by more than 4,000 pigs. On average, 12,700 gallons of manure—containing 176 pounds of nitrogen—were flushed from the complex each day!

A Fully Automated System

The system is fully automated, using sensors integrated to a programmable logic controller for round-the-clock operation.

In assembly-line fashion, it uses three modules. The first—the Ecopurin Solid-Liquid Separation Module, developed by the Spain-based firm Selco MC—quickly separates solids and liquids. "This conserves much of the organic fraction of the waste," says Hunt, adding that polyacrylamides—high-viscosity, water-soluble polymers—are used here for coalescing the solids.

In tests, this module, housed in a building of its own, removed 93 percent of all suspended solids, including heavy metals. It removed 94 percent of zinc and copper and 70 percent of phosphorus from the wastewater. It also produced 657 tons of separated solid waste that can be converted to organic plant fertilizer, soil amendments, or energy.

The second step, the biological removal of ammonia, involved the Biogreen Nitrogen Removal Module developed by Hitachi Plant Engineering and Construction Company, in Tokyo. "Once solids are removed, a relatively smaller amount of suspended organic waste remains in wastewater, but it still contains significant amounts of soluble ammonia and phosphorus," says Vanotti. "This biological process consistently removed more than 95 percent of the ammonia and total organic nitrogen present in the manure after separation—even during winter, with below-freezing air temperatures."

From there, the wastewater flowed by gravity to the final step, the Soluble Phosphorus Removal Module, which produces one of the technology's most beneficial results.

Developed by Vanotti, Szogi, and Hunt, it recovers phosphorus as calcium phosphate and destroys pathogens through alkaline pH. It also turns the removed phosphorus into a solid, marketable fertilizer, and it converts leftover effluent into a liquid crop fertilizer that's more environmentally friendly than manure.

Over 9 months, this process produced 285 bags of calcium phosphate, containing 1,160 pounds of phosphorus.

"Overall, it was verified—at full scale—that the system is technically and operationally feasible," says Hunt. Adds Szogi, "It performed well under both cold- and warm-weather conditions."

Says Vanotti, "The innovation can soften the effect of the new demands regarding modern swine production and environmental sustainability."—By **Luis Pons,** ARS.

MARIA CRUZ GARCIA (D033-2)

Soil scientists Patrick Hunt (left), Matias Vanotti (center), and Ariel Szogi examine a sample of calcium phosphate produced by the wastewater treatment system.

This research is part of Manure and Byproduct Utilization, an ARS National Program (#206) described on the World Wide Web at www.nps.ars.usda.gov.

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