Technology

Sewage's Cash Crop

How flushing the toilet can lead to phosphorus for fertilizers BY KATHERINE TWEED

WASTEWATER WONDER: Ostara's Crystal Green, a slow-release fertilizer, incorporates phosphorus retrieved from sewage streams.

Tucked away in Oregon's Willamette Valley, three massive metal cones could help address the world's dwindling supply of phosphorus, the crucial ingredient of fertilizers that has made modern agriculture possible. The cones make consistently high-quality, slow-release fertilizer pellets from phosphorus recovered at the Durham Advance Wastewater Treatment Facility, less than 10 miles from downtown Portland. By generating about one ton of pellets every day, they are changing the view that such recycling could not be done efficiently. Ostara, the firm that makes the reactors and sells the pellets as Crystal Green, thinks that Durham is one of hundreds of facilities that could use the technology.

Humans excrete some 3.3 million tons of phosphorus annually. In fact, phosphorus from domestic sewage, in addition to fertilizer runoff, has traditionally been a nuisance, because it triggers blooms of algae that deplete local waters of oxygen. In some wastewater plants the element can also bind with ammonia and magnesium to form a mineral called struvite, which keeps phosphorus out of waterways but clogs pipes at the facilities. The growing recognition that cheap supplies of phosphorus will grow scarce in the coming decades has led some nations to consider conservation. Sweden has mandated that 60 percent of phosphate be recycled from wastewater by 2015. In 2008 China slapped a 135 percent export tariff on phosphate.

These pressures have made struvite a hot topic in sewage circles. Japan has been recycling struvite for a decade, but the cost-effectiveness and quality of the pellets varied, according to Don Mavinic, professor of civil engineering at the University of British Columbia (U.B.C.) and co-inventor of Ostara's technology. "There's always been a problem of struvite removal," Mavinic says. "I wanted to build a better mousetrap."

To take up phosphates and nitrogen, many sewage facilities use bacteria, which settle down after ingesting the nutrients and are ultimately removed with the sludge. But dying bacteria rupture and release a little of the phosphate back into the wastewater, potentially leading to struvites.

Mavinic got interested in the struvite problem because of the maintenance issue at the plants, but ultimately a grant to find local nutrient sources jump-started the work. U.B.C.'s "mousetrap" pumps treated effluent and magnesium chloride into a 24-foot-tall reactor, where the cone shape acts to create essentially a turbulent thundercloud, tossing around the particles until they form pellets. Mavinic is now fine-tuning the system so that reactors can be sized to make a specific pellet grade for local industries.

In Oregon interest comes primarily from nurseries, where farmers have traditionally bought polymer-coated slow-release fertilizer. Wilco, a farmer-owned co-op about 30 miles from the Durham plant, has been selling Crystal Green since the reactors went online in May. "Having a local source of high-quality slow-release sustainable fertilizer is a great thing," says Jeff Freeman, a regional sales manager at Wilco. "It's something our customers are looking for, and the product has performed outstandingly."

Because of the demand for such fertilizer, the estimated payback of the investment is about five years. Mark Poling, wastewater treatment director at Durham, says it could be faster, because the reactors are functioning better than expected.

The company has sent prototype reactors to wastewater plants in Israel, the U.K. and various cities in the U.S. Shanghai was expected to get a delivery this fall. But Ostara says it is looking to corner the U.S. market first, where the Environmental Protection Agency has been pushing states to more heavily regulate nutrient pollution, including phosphate in sewage effluent.

Wastewater represents a ripe, but small, low-hanging fruit for phosphate recycling, according to experts. It holds only a small fraction of recoverable phosphate, and not all facilities create struvite. "Unfortunately, the phosphorus in human waste is only about 10 percent" of mined phosphate rock, explains David A. Vaccari, director of civil, environmental and ocean engineering at the Stevens Institute of Technology. "Even if you got 8 percent, it would be one piece of the puzzle. And it's one part we should do, but it's only a slim fraction of what we need."

Approximately 80 percent of mined phosphate rock used in food production does not even lead to consumed food. The element is leached from farm fields and lost in food manufacturing. So although U.B.C. has already commercialized one small corner of the market, it has its eyes on a larger prize: agricultural waste.

The scientists have a pilot effort using the same basic reactor to process nutrients from dairy and pig waste while removing methane. They're not alone. Researchers are scaling up a variety of projects to minimize livestock's carbon and water footprint: the nutrient load of one cow is equal to about 25 people. "The domestic wastewater industry has enormous potential," Mavinic says, "but boy, oh, boy, it's nothing compared with the agricultural industry."

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