

By Steve Werblow

Separation anxiety

Livestock producers await newest struvite crystallization system

Livestock producers anxious to find efficient ways to deal with phosphorus in manure may soon benefit from a new crystallization process that can remove 50% or more of the phosphorus from dairy manure and 80% from swine effluent.

Balancing nitrogen and phosphorus can be a challenge when applying manure to crops. Phosphorus (P) is also getting the attention of an increasing number of regulators concerned about its effects on water quality. That means managing it may continue to be an issue for livestock producers.

“(Limiting phosphorus is) not mandatory in our nutrient-management plans today, but they’re going to be watching it,” predicts dairyman Andy Werkhoven, who milks 900 cows and farms 700 acres with his brother, Jim, near Monroe, Wash.

P balance. Kraig Westerbeek of Smithfield Foods hog subsidiary Murphy-Brown in Warsaw, N.C., who hosted a crystallizer pilot project, points out that many producers may someday hit an upper limit for phosphorus application. They’d then be forced to spread their applications out over more acres, add commercial nitrogen to get their manure back in the proper agronomic balance, or both.

“Generally the issue of phosphorus management has been attacked on the downstream side—add more land,” Westerbeek says, adding, “What I like

about this tack is it has the possibility of allowing the producer to dial in a nitrogen/phosphorus ratio without having to buy additional nitrogen.”

The crystallizer removes phosphorus from the manure and takes it off the farm, says Keith Bowers of Multifarm Harvest Inc. in Seattle, Wash.

Bowers’ process converts available phosphorus in the manure into mag-

►**Above:** Keith Bowers of Multifarm Harvest in Seattle, Wash., is fine-tuning the process of crystallizing phosphorus in manure as struvite.

nesium ammonium phosphate, or struvite, used in nurseries and turf as a slow-release source of magnesium.

Flushwater from the Werkhovens’ dairy stalls is blended with an acid that loosens the bonds between phos-





To prevent acidosis of the rumen, cows are fed a buffer of bicarbonate of soda, Bowers adds. His chemical treatment of the manure requires significant changes in pH, so managing dairy manure means fighting that buffer with more chemicals.

On the plus side, dairy cattle in the Northwest tend to eat a lot of magnesium, a key ingredient in struvite. That means Bowers hasn't had to add magnesium—a costly input—to the manure blend in his dairy pilot plant.

Digested waste. The Werkhovens recently installed a 200-foot by 80-foot methane digester on their dairy, giving Bowers a chance to test his system on a very different quality of manure—the low-solids digestate.

Digestion converts more phosphorus to the extractable form, he explains, “so we might be able to punch through the 50% ceiling—to have the potential for getting a higher percentage of the total phosphorus removed.”

Digesters also serve as manure accumulators, Bowers adds: “You can get economies of scale because you can have more than one dairy, or one big dairy, feeding into the digester.”

Ultimately, it's all about economics. “We've got to be very diligent in making sure any technology is affordable,” says Westerbeek.

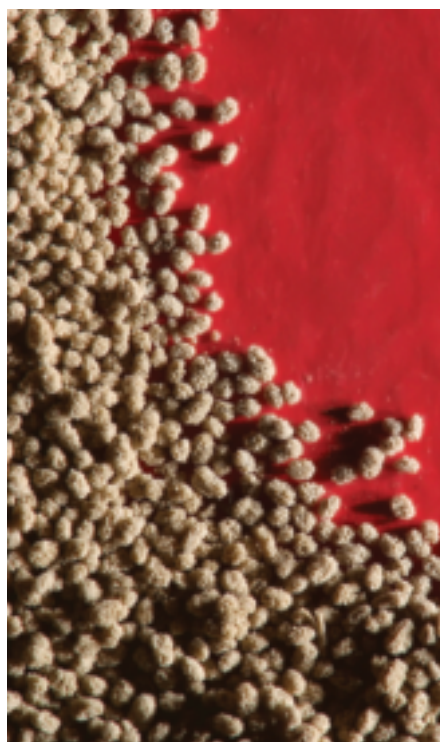
Bowers' prototype was funded by the U.S. Department of Agriculture's Small Business Innovation Research (SBIR) program to fine-tune and demonstrate the economic feasibility of the crystallizer system.

He figures capital costs will run \$150,000—over 10 years, that's 4 cents per cow per day, on a 1,000-head dairy—and he's targeted chemical costs of 15 cents per cow per day, or less than 1.5 cents per hog per day.

As phosphorus becomes increasingly scrutinized, that could be money well-spent, says Andy Werkhoven.

“We don't really have a nutrient management issue yet, but we'd like to grow the dairy,” he says. “In an urban environment like ours, close to Seattle, odor control, nutrient management, and anything we can do to be environmentally friendly is key.” ■

►**Above:** Bowers built this crystallizer pilot plant at Werkhoven Dairy to treat about 50,000 gallons per day. ►**Left:** In its crystallized form, struvite has a similar consistency to that of wet sand. Ornamental and turf growers apply struvite as a slow-release source of magnesium.



with a little left in the cone to serve as seed crystals for the next batch.

The new crystals feel like wet sand, and dry in about 30 minutes on a nice day, Bowers says. Treated manure is pumped off to the irrigation system for land application.

Bowers is designing the system to be quick and simple. A farm's hired hand could handle day-to-day operations—checking chemical levels, pouring the day's struvite into a filter bag—while Bowers' company would regularly drop off the inputs, pick up the struvite to sell as fertilizer, and maintain the machinery.

Dairy challenges. Dairy manure presents key challenges, Bowers says.

Cows' ability to digest cellulose yields manure with a lot of residual cellulose and cellulose derivatives—the same sorts of ingredients that are used to thicken food and paint. Viscous manure can interfere with the fluidized action of the struvite bed.

Cows also eat a lot of calcium, which forms tight bonds with phosphorus. In Bowers' dairy system, those calcium-phosphorus bonds must be broken with acid treatment, a step he can skip when he works with hog manure.

phorus and calcium. The treated manure is pumped into the bottom of a 15-foot-tall cone along with a solution of weak caustic soda or anhydrous ammonia. The mixture pushes up through a bed of struvite crystals, which separate and flow as if they, too, were a fluid—which is why the system is called a fluidized-bed process. Meanwhile, the abrupt rise in pH causes the newly freed phosphorus atoms to bond to the jostling struvite seed crystals, coating them. As the crystal bed grows, most is harvested,