

# PAM protects against pollutants and pathogens

By Marcia Wood, Agricultural Research Service - USDA

An environmentally friendly compound nabs nutrients and troublesome microbes before they can escape from farmers' fields and make their way to ponds, lakes, streams, or rivers. Known as a polyacrylamide, or PAM, this powder can help keep nutrients — such as the phosphorus in fertilisers — from traveling beyond the farm in irrigation runoff. Similarly, PAM helps keep disease-causing microbes, like those in cow, pig, or fish manure, from being swept beyond the confines of farmyards or feedlots.

That's according to investigations by ARS scientists with the Northwest Irrigation and Soils Research Laboratory in Kimberly, Idaho.

Researchers there are already world leaders in discovering safe, practical, and affordable PAM-based tactics that prevent soil particles from ending up in irrigation water. Without PAM's help, particles can become dislodged when farmers irrigate their fields.

Findings from the team's laboratory and outdoor experiments have prompted US growers to put PAM to work on more than 400,000 hectares of irrigated farmland.

"Growers who mix PAM with irrigation water can expect to reduce erosion from their furrow-irrigated fields by 80 to 99 per cent," says Rodrick Lentz, an ARS soil scientist at Kimberly. "About 30 grams of PAM anchors as much as 455 kgs of topsoil that might otherwise be carried away by irrigation water."

Says Kimberly colleague David Bjerneberg, "We achieved slightly less dramatic results with sprinkler irrigation." David is an ARS agricultural engineer.

The idea of using PAM to thwart erosion from furrow-irrigated fields dates back to about 1975. But the Kimberly studies, begun in 1991, were the first to determine precisely how much PAM farmers should use, as well as when, where, and how to apply it. In fact, their work has led to PAMs being hailed as "possibly the most



Jim Entry (left) and Dave Bjerneberg record sediment concentrations from furrow irrigation runoff samples. The darker sample on the left is from an untreated furrow. (Photo by Peggy Greb)

successful soil-conservation practice ever developed for furrow irrigation”.

Now, new information from ARS soil microbiologist James Entry and ARS soil scientist Robert Sojka shows that pairing PAM with other compounds boosts its ability to fasten onto nutrients in runoff.

“It’s a matter of when a nutrient becomes a pollutant,” says James, in explaining their interest in keeping nutrients in fields. “On the farm, nitrogen and phosphorus are regarded as nutrients plants need to thrive. If these same natural chemicals make their way into water as it leaves the farm, however, they may become pollutants.”

### PAM Catches Nutrients

Nitrogen and phosphorus in runoff, for example, can become culprits behind algal blooms in ponds or lakes. Fueled by these pollutants, algae flourish. Later, their decay uses up oxygen needed by fish and other aquatic dwellers. So some US states — in setting pollution limits for runoff — specify not only the allowable amount of sediment, but also the permitted amount of these potentially polluting nutrients.

PAM helps growers avoid exceeding these “Total Maximum Daily Loads” for sediments and nutrients. James and Robert, building on the Kimberly lab’s earlier nutrient-pollution studies, tried some new PAM-chemical combinations to see whether they would bolster PAM’s pollution-fighting prowess. In these nutrient-loss trials, they combined PAM with aluminum sulfate or calcium oxide.

Why match PAM with these other chemicals? Explains James, “We already knew, from work others had done, that chemicals like aluminum sulfate and calcium oxide can slow the loss of phosphorus. We also knew, from textbook chemistry, that they would help PAM bind to phosphorus.”

James and Robert put PAM in furrows containing cow, pig, or fish manure. They irrigated the field and then analysed the runoff. James reports, “PAM alone did a good job of removing nutrients, as we’ve seen before. But the new PAM combinations were even more effective.”

Waterborne nutrients can either flow overland or move down through the soil and potentially pollute underground water. “In a washed-sand



Wey prepares to count colonies of faecal coliform bacteria in a water sample.  
(Photo by Peggy Greb)

study in our laboratory," James notes, "we mimicked the flow of nutrients as they leach through soil."

### Sand Columns Simulate Nature

James and Robert assembled 48 plastic columns, each 18 inches high and four inches in diameter. They added clean, loosely packed sand to each column.

To some columns, they added a small amount of either PAM or PAM mixed with one of the other chemicals. On top of that, they placed some cow or pig manure from local farms, or fish droppings from a nearby hatchery. Then they poured distilled water into the columns and captured this leachate as it flowed out the bottom into flasks.

"This is a tough challenge for PAM," says James, because water drains through clean sand faster than through most soils. The fast rate of flow means PAM has much less time to grab onto nutrients.

"We found that water draining from sand columns that had PAM alone contained significantly fewer nutrients from the cow or pig manure," says James. "But columns with the PAM combinations held back twice as many nutrients from those manures. None of the treatments reduced already low levels of target nutrients in flow-through from fish manure."

Robert comments, "Earlier, our outdoor studies had suggested that if nutrient concentrations in runoff are low to begin with, there's less chance that the nutrients will contact binding sites on PAM molecules. We think that might be the case with the fish manure leachates."

Even though they provide needed nutrients, manures can pose a problem: they usually harbour microbes — some of which can cause disease. That's why James and Robert have newly explored PAM's ability to grasp such pathogenic microbes from runoff. They did this by analysing microbes from the column leachate and furrow runoff.

### PAM Works on Manure Microbes

"PAM alone significantly reduced bacterial microbes in these water samples," James points out. "Specifically, PAM alone reduced populations of total and faecal coliform and faecal streptococci in the cow and pig leachate from the column experiments — as well as from our



Agricultural engineer Dave Bjerneberg demonstrates a PAM application method for furrow irrigation. About two tablespoons of PAM would be used per 305 metres of furrow. (Photo by Peggy Greb)

outdoor runoff — by about 90 per cent.”

The PAM combinations did even better. PAM plus aluminum sulfate and PAM plus calcium oxide reduced total and faecal coliform bacteria and faecal strep by about 99 per cent. “From a practical water-treatment standpoint, that means the PAM combinations were far more effective than PAM used alone. That’s the same thing we observed in our nutrient studies,” says James.

Says Robert, “We think these findings have important implications for keeping microbes from moving away from farms or places where animal manure accumulates. For instance, if producers use manure on their fields, they could apply PAM with their irrigation water.”

James adds, “We want to find out if PAM might be used effectively around the perimeter of farmyards or feedlots. Farmers and feedlot managers already do many things to control losses of nutrients and pollutants from manure. But sometimes their systems fail. Let’s say a manure pond breaks or overflows during a storm or flood. When that happens, you need an emergency measure. We plan to determine whether — under these conditions — putting down a layer of PAM could help limit the spread of microbes that otherwise might flow into streams or groundwater.

“Keeping the microbes in place helps protect the health of water users downstream,” emphasises James. “PAM doesn’t kill microorganisms. With or without PAM, they die off at the same rate. The advantage of PAM is it keeps down the number of these microbes in farm runoff.

“PAM’s performance in clinging to microbes in water in confined spaces, such as sewage-treatment plants, is already well-known,” James says. “But our data are likely the first about PAM’s interaction with microbes in water flowing over land.”

More information about these and other PAM results from the Kimberly scientists is presented on the World Wide Web at <http://kimberly.ars.usda.gov/pampage.shtml>

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