Water, Water Everywhere...

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moisture content and air temperature. That translates to about 24 gallons, or 200 pounds a day.

Not only do cows need water in wholesale quantities, but the quality has to be there, as well. And though a dairy cow may turn up her nose at water that has an unusual taste or smell, she has other more serious ways of communicating her dissatisfaction with the watering hole; lower milk production, breeding problems and abortions, to name a few.

According to Penn State extension dairy specialist Richard Adams, researchers began to pay attention to water quality during the early 1970's, when other factors failed to explain health problems in some dairy herds. "We found that the herds that were free of health and reproductive problems all had good water," says Adams.

If a herd isn't performing up to its potential, the specialist urges farmers to look at other variables, such as ration, herd management and disease problems first. Water-related problems simply aren't that common, he says. Of the more than 200 farms that his department investigates annually, says Adams, only about 10 to 15 percent have problems related to water quality.

Strasburg dairyman John Good adjusts the valves on his sulfate tank. Two taller tanks in the foreground remove nitrates.

Water problems are often regionally related, says Adams. Heavily mined areas, for example, may have highly acidic or alkaline water. The water in the extreme southeastern portion of the state is noted for its acidity, and the southeast in general has comparatively high nitrate levels.

Dr. Richard Croyle is more than a little familiar with water quality problems in southeastern Pennsylvania. "We've got a blockbuster situation here," says Croyle, the owner of Biometrics, a commercial water and soil testing laboratory near Quarryville. Certified by both EPA and DER for water analysis, Croyle and his wife Nancy, a microbiologist, test water from some 300 dairy operations annually.

Biometrics tests water primarily from Lancaster, York and Chester Counties, where increasing livestock densities and residential development are creating water quality problems. Although other factors, such as pH and sulfate levels, can impact on dairy herds, Croyle says that bacteria and nitrates are easily the two most common culprits.

Many types of bacteria may be implicated in water-related problems, but the most common ones are the coliforms, of which

Dr. Richard Croyle, of Biometrics, tests a dairy farm water sample. Testing some 300 samples from dairy herds annually has convinced Croyle that bacteria and nitrate contamination is on the increase in southeastern Pennsylvania.

Escherichia coli is the best-known species. Croyle points out that, while coliforms inhabit all warm-blooded animals, certain strains can be pathogenic.

Bacterial pollution can lower milk production by as much as 10 to 15 percent and can impede the overall performance of first-calf heifers, says Croyle. The level of coliform bacteria in water is normally expressed in colony forming units, one colony being a growth of bacteria visible to the unaided eye and composed of millions of individual bacteria. "When we find one CFU we say it (water) is inadvisable for human consumption," says the biochemist. "I would try to get rid of it for the cows, too. Who's to say that the source of pollution can't contribute more than one?"

Like bacteria, excess nitrate levels can be traced to septic systems or animal manure, but industrial wastes are also a possible source, says Croyle. Highly mobile when converted to nitrate form in soil, excess nitrogen moves easily into groundwater supplies.

Excessive nitrate levels may disrupt a cow's breeding cycle, as well as increase a herd's abortion rate. Breeding problems may arise as well, with cows failing to settle after numerous services.

The confusion that seems to surround just what is an acceptable nitrate level for dairy herds is compounded by the fact that nitrate levels can be expressed in two ways. The conventional way of expressing nitrate levels in water is in parts per million of nitrate nitrogen (NO^3—N). On this scale, the maximum nitrate concentration for human consumption is 10 ppm. Using the nitrate ion concentration scale (NO^{3-}), however, drinking water levels should not exceed 45 ppm.

Just what level of nitrates can a dairy herd tolerate? Richard Croyle says that problems may begin cropping up at 25 to 50 ppm on the nitrate nitrogen scale.

To be sure, not all dairymen will experience difficulties at these nitrate levels, but Strasburg's John Good was one who did. Good, who milks 50 to 60 Holsteins, detected a slow deterioration in herd health as well as milk production during the early 1980s.

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Nature Can Cause Water Problems

BY JACK HUBLEY

While bacteria and nitrates occupy center stage in the water quality drama, dairymen can't afford to ignore two potential villains waiting in the wings, says Dennis Martin.

Martin, who owns Martin Water Conditioning Company, operating out of Lebanon and Lancaster, says that sulfates and pH level can definitely stifle herd performance.

Since he began focusing on farm water treatment about 10 years ago, Martin has tested nearly 1,000 farm water supplies throughout Pennsylvania and contiguous states.

"Sulfates are definitely a problem in Lancaster County, as well as in other areas of Pennsylvania," he says. Sulfates are negatively charged ions that tie up selenium, vitamin E and copper, making them unavailable to the cow. Unlike nitrates, though, they occur naturally in the minerals gypsum and pyrite.

What high sulfate concentrations do best, according to Martin, is lower milk production. "We've seen herds drop to one-half of their expected production because of high sulfate," he maintains.

He recalls the case of eight dairymen who moved from Pennsylvania, where sulfate levels were less than 100 parts per million, to an area in Ohio where the level was 1,500 ppm. "Herds that were milking 50 pounds a day fell to 30 pounds," he remembers.

We probably treat one sulfate job for every 10 nitrate jobs that we do," Martin estimates, adding that his firm recommends treatment when levels exceed 100 ppm. Removing sulfates is accomplished through an anion exchange system similar to those used for nitrates, he explains.

One of the most commonly overlooked influences on herd performance is pH, Martin emphasizes. "A low pH water (acidic) is an aggressive water that will dissolve copper and galvanized plumbing," he cautions, adding that metals leaching into drinking water can be toxic. In addition, he says, an acidic water lowers the pH of a cow's rumen, which can lead to inefficient utilization of feeds.

Dennis Martin, owner of Martin Water Conditioning, displays a battery of beakers filled with filtering resins used to combat water quality problem. Behind them is ultraviolet water sterilizer used to kill bacteria.

Although a high pH won't affect plumbing, it can influence milk production, says the expert.

Martin considers a pH of 6.5 to 7.5 to be acceptable for herd health. To raise the pH of acidic water he installs a neutralizing tank. Lowering pH is a more difficult--and expensive--process, involving the injection of acidic material into the water. About three out of every 10 farms that the firm tests do not have what they consider to be an ideal pH for livestock.

Coliform problems turn up in from 20 to 40 percent of the farms that Martin tests. Treatment can involve chlorination, ultraviolet light, or, in the case of farms without electricity, an iodine system.

Bacteria and nitrate problems seem to turn up in about equal measure in Lancaster County, says Martin. He recommends nitrate removal when levels in water to be consumed by breeding stock exceed 10 ppm. Non-breeding livestock can safely tolerate levels of 20 ppm.

Martin's firm removes nitrates with an anion exchange column containing three to four filtering materials that simultaneously adjust pH. This latter step is important, he emphasizes, since the resins used to remove nitrates also lower the pH of the water by removing bicarbonates. "So it's important to consider pH when installing a nitrate or sulfate system," he points out.

The cost of treating water varies greatly according to the nature of the contaminates. Martin estimates the average cost of an ultraviolet system for bacteria treatment at $600 to $700, while pH treatment can run $10 to $30 per milking cow, depending on which direction the pH must be adjusted.

Sulfate systems run from $22 to $40 per milking cow, while nitrate removal will cost from $30 to $50, depending on the severity of the problem. To calculate annual maintenance costs on any of the above treatments, a good rule of thumb is to figure on spending about 10 percent of the initial installation cost yearly, says Martin.

But regardless of what system a farmer may require, Martin's advice is to get a second, and possibly a third, opinion on what equipment is needed. Shopping with dealers certified by a national organization known as the Water Quality Association isn't a bad idea, he concludes.

In addition to making consumption difficult to monitor, giving cows access to to streams can increase exposure to chemicals, nitrates and disease-causing agents.