Beyond the pond: A low-cost, low-tech way to manage manure

By Laura McGinnis, Agricultural Research Service, USDA

A 450 kg steer can produce as much as 36 kg of manure in one day. At that rate, a typical 1000-animal beef feedlot will produce up to 250 tonnes of manure in just one week.

That's a lot of manure – and for the roughly 1800 US feedlots that have 1000 animals or more, it's an important management issue. Most of the manure is collected and used as an organic fertiliser, but some is lost due to runoff.

In the US, the main method for controlling runoff involves storing it in a large temporary pond or basin. Later, it is either distributed as nutrient-rich irrigation water or processed for safe disposal.

Though approved by the US Environmental Protection Agency (EPA), this method is far from perfect. Over time, the nutrients in the stored water can percolate through the soil, becoming a potential groundwater contaminant. Maintenance is expensive and difficult. The smell leaves much to be desired. And of course, as ARS research leader John Nienaber points out, "nobody really wants to look at a manure storage pond."

In the Environmental Management Research Unit at the US Meat Animal Research Center (USMARC) at Clay Center, Nebraska, agricultural engineers Roger Eigenberg and Bryan Woodbury have joined John Nienaber in developing and testing an alternative method of runoff control that avoids many of the disadvantages of traditional runoff control systems.

The water on the left collected in a solids-separation basin at the low end of the feedlot pen (on the right) after a rain. After the solids settle, the water in the basin will be distributed throughout the vegetative treatment area. (Photo by Stephen Ausmus)

WASTE NOT…

Under the alternative system, runoff containing manure solids enters a small temporary storage basin at the base of the feedlot. The basin is large enough to hold runoff for several minutes to allow the solid waste to collect on the bottom. The remaining liquid is then drained through distribution tubes, providing even dispersal over a vegetative treatment area, or VTA, which is essentially a grassy field.

Distribution of the liquid is controlled so that a full basin would empty in six to eight hours, though the process begins as soon as the liquid separates from the solids in the basin. In the fall, solids are removed from the basin and used as fertiliser on adjacent cropland.

The Clay Center VTAs are about twice as large as the surface area of the feedlot pens, a size that efficiently uses runoff water and manure nutrients. The technology could also be applied to other livestock – in fact, the team will soon begin collecting data from a sheep feedlot VTA – but managers would have to adjust basin and field sizes accordingly.

The VTA system, which has been conditionally approved by EPA, has many benefits. It requires minimal management, significantly reduces waste storage time, and eliminates the need for costly pumping of runoff through distribution equipment. In addition, it removes standing water, which can promote the growth of bad-smelling compounds.

This system should be less expensive to construct and maintain than the traditional system, the scientists say, though the cost and suitability would vary with geography, climate, and animal type.

"Our objective was to design runoff control systems that require minimal operator input and use standard equipment to manage," Bryan says. "These systems can incorporate more sophistication, but each level adds costs and management time to ensure proper operation."

For the VTA system to catch on, the scientists need to prove that their method is better than traditional containment. After eight years of operating tests, they are confident that the technology is environmentally sustainable.

Environmental credentials

The scientists use the liquid discharge – which contains nitrogen – to grow hay in the VTA. They found that after harvest, the amount of nitrogen contained in the hay equalled or exceeded the amount they estimated would have entered the area through liquid runoff. Over a four-year period, the scientists found no evidence of water leaching from the VTA, suggesting that the alternative system's potential for contamination is lower than that of traditional management.

SALINITY TOOL ADAPTED TO SHOW NUTRIENTS

Roger and Bryan are making full use of technology to evaluate and compare the environmental impacts of the new and old runoff-control systems. They have been using electrical conductivity maps and soil samples to estimate the levels of nutrients

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and salts in the field. To improve this analysis, they are incorporating a salinity-assessment package called 'ESAP' into their mapping program.

Short for "Electrical conductivity or salinity, Sampling, Assessment, and Prediction," ESAP was developed by ARS scientists at Riverside, California. The program helps determine the best places to take soil samples, and it estimates the amount of nutrients, such as nitrogen and phosphorus, in the soil.

Roger and Bryan collect GPS coordinates and soil electrical conductivity measurements and use that information to develop two-dimensional maps.

"When comparing the maps over time, we can observe changes in soil salt concentrations by measuring the changes in soil electrical conductivity. Increases in salt concentrations tell us where the runoff is going," Roger says. "All this information provides us with a tool to better manage the runoff-control system."

Managed run-off

For example, with their maps, the scientists have found areas in the VTA that were receiving too much runoff and have been able to direct the runoff to areas that were not receiving enough.

In January 2006, USMARC became the first site in Nebraska to receive EPA approval to construct a full-scale system using the new technology. The scientists have since built three new systems and redesigned the original test model.

All four systems are similarly constructed, though two have larger solids-separation basins – designed to hold more runoff – and a different pipe arrangement for liquid distribution. In future studies, the researchers will compare the influence of basin size on a system's ability to separate solids when runoff pressure is higher, for example, during a heavy storm.

"Everyone stands to benefit from this VTA technology," John Nienaber says. "There are lower maintenance costs for the producer and improved environmental protection for consumers and local residents. Plus, nobody has to look at the unsightly mess of a storage pond."

John A. Nienaber, Roger A. Eigenberg, and Bryan L. Woodbury are in the Environmental Management Research Unit, USDA-ARS Roman L. Hruska US Meat Animal Research Center, Ph: +1 (402) 762-4274, Fax: +1 (402) 762-4273. ■

CROP DOCTOR SOUTH

With Peter Reading

NO QUICK FIX FOR GROWERS ON ACID

Soil acidity and subsurface acidity in particular is a widespread and significant constraint threatening production and flexibility in the farming system.

Maintaining optimal pH is necessary if farm productivity is to be maintained.

It therefore falls on growers to assess their circumstances and determine long-term goals for soil management.

If there's no quick fix solution, a longer term view is required. But, if action is repeatedly delayed, soils will continue to acidify and the amelioration cost will increase, while the capacity to pay for those increased costs will decrease.

According to Chris Gazey, senior researcher at the Department of Agriculture and Food WA (DAFWA), the pH of the soil profile, soil type and farming system determine how much lime is required to raise pH to the desired level.

Soil acidity projects, supported by the GRDC for the past 15 years, demonstrate that responses to treating acidity can take several years to appear.

Chris said that applying surface lime can take four to seven years to treat acidity in subsurface layers once topsoil pH, measured in calcium chloride, was maintained at or above pH 5.5.

The amount of acid at pH 4.4 is 2.5 times as much as at pH 4.8, increasing the effects of aluminium toxicity. This is the basis of the recommendations of 5.5 in the surface and 4.8 in the subsurface, Chris indicated.

Increases in grain yield or pasture production from liming indicate that lost productivity has been restored.

Growers need to determine if recovery liming to return soil pH to appropriate levels, or maintenance liming to avoid production losses, is required.

Studies by Chris and other DAFWA researchers show that early liming can avoid production losses, but many factors are involved in assessing the economic viability of managing soil acidity with lime.

The three main factors to consider are the value of the produce, cost effectiveness of lime and response time.

To determine 'value' the grower must consider: future grain prices; land value, in particular land price; gross margin of the paddock and potential yields of crops grown in well managed rotations, where pH is non-limiting, versus where low pH constrains yield and choice of rotation.

Factors affecting cost effectiveness include freight cost and the neutralising value and particle size of lime.

Lime particles less than 0.5 millimetres in diameter neutralise soil acid quicker than larger particles.

Total cost per tonne of neutralising value can be determined using the calculator at *www.soilquality.org.au/calculator*.

The Crop Doctor is GRDC Managing Director, Peter Reading, Ph: 02 6166 4500.
Further information: Chris Gazey, Ph: 08 9690 2000

DAFWA senior researcher Chris Gazey enjoying the 2008 WA Agribusiness Crop Updates dinner at Burswood with GRDC Manager, Agronomy, Soils and Environment, Dr Martin Blumenthal.

Chris Gazey, DAFWA senior researcher and Dave Gartner, DAFWA senior technical officer, examining root growth on a lime treatment.