Field Evaluation of Animal-Waste Lagoons: Seepage Rates and Subsurface Nitrogen Transport

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Earthen lagoons are an integral part of the waste-management plan at many animal feeding operations (AFOs). Lagoon waste contains high concentrations of N, P, salts, and other nutrients that, in many cases, are applied to farmland as liquid fertilizer. However, while the waste is being stored and treated in the lagoon, subsurface-seepage losses may affect soil and water quality near the facility. Research was conducted to develop water-balance methods and instrumentation for measuring whole-lagoon seepage from large-scale, commercial AFOs. Seepage(s) losses were calculated as the difference between changes in waste depth (D) and evaporation (E) when all other inflow and outflow were precluded. Waste-level recorders were developed that could measure D to within 0.16 millimeter (mm). Evaporation was quantified using floating evaporation pans and meteorological models. Different strategies for calculating E and S were compared. Results showed that S from lagoons could be determined to within ± 0.5 millimeter per day (mm d^{-1}) by making precision water-balance measurements over short periods (5 to 10 days), if E was less than 6 mm d^{-1} (Ham, in press).

Water-balance methods were used to study seepage losses and nitrogen export from soil-lined lagoons at ten different swine and cattle feedlots in southwestern Kansas. Lagoons ranged in size from 0.5 to 2.5 hectare (ha) and had waste depths between 1.5 and 5.6 meters (m). Compacted-soil liners were between 0.30 to 0.46 m thick and built with native soil or, in some cases, a soil-bentonite mixture. Seepage rates from the lagoons ranged from 0.02 to 2.5 mm d^{-1} , with an overall average of rate of 1.2 mm d^{-1}. At some locations, seepage results were combined with data on lagoon geometry and liner construction to estimate the in-situ permeability of the compacted liner. In lagoons built with silt loam liners (no bentonite), permeabilities on a whole-lagoon basis were about five times less than those measured from soil cores collected prior to the addition of waste. Results imply that permeability was reduced by organic sludge on the bottom of the lagoons. The average ammonium-N (NH_4^+-N) concentrations in the swine-waste and cattle-feedlot lagoons were 673 and 98 milligrams per liter, respectively. Calculated NH_4^+-N export rates (seepage losses) from the swine waste lagoons were between 2,000 and 3,000 kilograms per hectare per year (Ham and DeSutter, in press). Analysis of soil cores collected beneath 11- to 20-year-old lagoons showed that a large fraction of the NH_4^+-N in the leachate remained in a shallow (for example, 6 m) adsorption zone directly beneath the lagoon. When lagoons are closed, emptied, and dry; NH_4^+-N could convert to nitrate and more readily move towards the ground water. More information is needed regarding the fate of NH_4^+-N deposited in soil (vadose zone) beneath lagoons.

References

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