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MODELING NITROGEN BUDGETS IN SWINE CAFOS: A BAYESIAN NETWORK APPROACH

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ABSTRACT: North Carolina has witnessed a large growth in commercial swine operations since the 1990s. Treatment technologies within these confined animal feeding operations (CAFOs) have been designed to reduce the environmental impact from nutrient loading which accompanies large-scale animal farming. Many facilities treat animal waste in anaerobic lagoons where bacterial processes ultimately consolidate nutrients into lagoon sediments. Further treatment is afforded by spraying the lagoon slurry over agricultural fields as a crop fertilizer. Despite the requirement that every CAFO follow a state approved nutrient management plan (NMP) to be compliant under National Pollutant Discharge Elimination System (NPDES) regulations, evidence indicates that both air quality and water quality remain threatened. Specifically, atmospheric ammonia deposition, seepage from aging lagoon liners, and overapplication of lagoon slurry threaten regional waterbodies with accelerated eutrophication caused by enhanced nutrient loading. Calculations made in NMPs disregard both the variability in measured values and the uncertainty in published reference values resulting in unwarranted confidence that air and water resources are being adequately protected. This study presents a preliminary Bayesian network to model the potential impact of nitrogen on surface water, groundwater, and atmospheric resources from a hypothetical farrow-to-finish operation in Eastern North Carolina. The Bayesian network captures uncertainty in model predictions by decomposing multivariate probability distributions into simpler conditional and marginal probability distributions. This model characterizes within-farm variability of common parameters used to assess compliance in NMPs, thereby providing a more realistic assessment of nitrogen impacts. Furthermore, this modeling framework provides a means for quantifying the effect of management actions on environmental nitrogen fluxes. Consequently, our model informs both regulators and CAFO operators whether current NMPs are likely to be successful in protecting environmental resources. Future efforts will focus on reducing the uncertainty in the model estimates by incorporating expert knowledge and data from a particular farm.

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