RESEARCH ABSTRACT
ENVIRONMENT

Title: Sustainability Evaluation of a Solid-Liquid Manure Separation Operation - **NPB#16-094**

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Scientific Abstract

Field monitoring and laboratory tests were conducted to evaluate efficacy and practicality of a solid-liquid separation barn. The alternative swine finishing barn design made use of V-shape gutter and mechanical scraper system to separate manure into solid and liquid portions. The objectives were to evaluate performance of a solid-liquid separation barn and impact on manure management while considering factors including characteristics of the separated manure, potential nutrient and water recycling, and changes of barn construction and operating costs. This research also incorporated testing the pretreatment and various membrane filtrations for the liquid manure to be repurposed, as well as studying potential economic and environmental impacts. Waterproof pressure loggers were used to monitor the level of separated liquid manure in a collection pit. Volume of the separated solid manure was also monitored, along with barn inventory and feed consumption. The daily liquid manure production ranged from 298 to 1840 gallons, and averaged 885 gallons. The daily estimated solid manure production averaged 299 gallons. Nineteen monthly manure samples were collected for both the liquid and solid manure portions. Eight of the liquid manure samples were excluded from the database because they were outliers due to rainfall dilution, barn washing, or maintenance failure. Based on the averaged nutrient contents and overall production rates, the separated solid manure removed 61.7%, 41.7%, 74.8%, and 46.2% of nitrogen, ammonium, phosphorous, and potassium, respectively, from the total manure production. The removal efficiencies can be verified by the solid removal rate, that the separated solid manure contained 80.2% of the total solids when compared with the liquid manure portion.

The solid-liquid separation barn was shown to have better air quality when compared with deep-pit barns. Only discrete, monthly sampling of ammonia and hydrogen sulfide were conducted for this research. Ammonia concentrations measured at the wall and pit fans ranged from 0.26 to 6 ppm, with an average concentration below 2 ppm. Hydrogen sulfide concentration was below the detection limit of the Dräger tube method, and averaged 0.10 ppm when using the Jerome meter during the last few months of the research. Monthly samples of the separated liquid manure were collected and tested with various pretreatment and filtration, including microfiltration and reverse osmosis. A total of 26 samples were tested for the comparison of the unfiltered, microfiltration and reverse osmosis tests. Filtration of the liquid manure was conducted using a bench-scale crossflow membrane system. The filtration results indicate that the pH values change significantly during the filtration stages, the

microfiltration was capable of removing most if not all of the solids but not the dissolved nutrients. The reverse osmosis process was time and energy intensive, with only minimal nutrient removal. Additional tests were conducted to confirm the filtration efficiency using salt solutions and different types of nanofiltration and reverse osmosis membranes, but no significant improvement could be made even after consulting with the crossflow filter system manufacturer. The construction cost of the solid-liquid separation barn was comparable to (17% higher than) the deep-pit barn. The additional operating costs included daily operation of the scraper and conveyor systems and pumping the liquid manure away from the collection pit. The overall additional electricity cost was $331 per year. The additional maintenance of the scraper system included replacement of motors and scraper components, and averaged $1,342 per year.