

Enhanced Biological Phosphorus Removal from Dairy Manure to Meet Nitrogen:Phosphorus Crop Nutrient Requirements

by

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(Abstract)

Over the last two decades, livestock operations have become highly concentrated due to growing trends towards larger, more confined facilities and a decrease in cropland on smaller farms. This has led to greater amounts of excess manure nutrients on farms, increasing the potential for nutrient pollution of water bodies from runoff. The purpose of this study was to determine if enhanced biological phosphorus removal (EBPR) is a viable alternative for managing excess manure nutrients on dairy farms. Assessment of EBPR involved the investigation of various aspects of wastewater treatment modeling and design and farm nutrient management. The fermentation potential (volatile fatty acid (VFA) production) of dairy manure was determined through laboratory analysis to be 15.3% of the total COD. Total VFA production was composed of 57, 23, and 20% acetic, propionic, and butyric acids, respectively. The EBPR component of the BioWin wastewater treatment model was evaluated through a sensitivity analysis. The parameters to which effluent phosphate (PO_4) concentration was most sensitive were maximum specific growth rate, growth yield, aerobic PO_4 uptake rate per unit poly- β -hydroxybutyrate (PHB) utilized, PHB yield from VFA, PO_4 release per unit VFA uptake, and fraction of releasable PO_4 . An EBPR sequencing batch reactor (SBR) was designed for a dairy farm with 700 lactating cows and 325 ha of corn silage. An economic analysis of EBPR for dairy farms employing P-based manure applications was completed. The cost of hauling excess manure to nutrient deficient farms was the most significant expense in comparing costs of manure management with and without EBPR. For a herd of 700 lactating cows, utilizing EBPR was more economical for farms with 270 ha or less cropland, while EBPR did not offer an economic advantage for farms over 270 ha.