EXECUTIVE SUMMARY

for

Economic Feasibility of a Biological Wastewater Treatment System for California Dairies

Cal Poly Project #: 49664

May 26, 2017

Cal Poly Principle Investigator: Sean Hurley

Sustainable Conservation Project Manager: Joseph Choperena

Introduction

In the Central Valley of California, there is a 750 cow dairy operation. On any given day it is milking approximately 610 Jersey cows, which have an average milk production of 50 pounds per cow per day. These cows are estimated to produce nearly 20,000 tons of manure per year. This manure contains approximately 250,000 lbs. of nitrogen (N), 41,000 lbs. of phosphorous (P), and 109,000 lbs. of potassium (K). The dairy has 85 acres of land to spread this nutrient rich manure and has a limited ability to export some of the excess nutrients. In the last five years it has used crop rotations that consist of corn silage, soft dough oat silage, sudangrass silage, soft dough triticale, and soft dough wheat silage to absorb the nutrients produced by the cows while generating a source of feed for their stock.

Given the land base that the dairy has available, it is in search of a technology that will reduce the amount of nutrients that it needs to spread on its own land or export off-farm while maintaining the current herd size. The technology that was identified as a potential solution was developed by Biofiltro. This solution is a patented worm-base technology that filters the dairy manure through a biological system that can reduce the amount of N-P-K in the dairy effluent. The purpose of this study was to provide an economic analysis of a system for managing excess nitrogen on a Central Valley dairy with a special emphasis on estimating the cost of reducing a pound of nitrogen in the dairy effluent before it is spread on the feed crops.

Methods and Major Assumptions

To develop an estimated cost for the per pound nitrogen reduction using the Biofiltro system, a model was developed with the usage of several sources of information. The basis for the estimate was the annual reports submitted to the California Regional Water Quality Control Board by the dairy studied. Crop rotation, manure spreading practices, number and type of cows, and nutrient exports were gleaned from these reports, which spanned from 2012 through the 2015 crop years. The model incorporated manure nutrient estimation by utilizing the California Central Valley Dairy Waste and Dairy Nutrient Management system hosted by Merced County. Capital and operating costs were provided by representatives of Biofiltro. Dairy and crop budgets were developed from data provided by representatives from the dairy studied. Operating costs for the Biofiltro system were also collected from representatives of the dairy operation that was studied.

There are a few key assumptions that drive the cost estimations that were made. It was assumed that the dairy would have a 20 year investment horizon with a 4.25% discount rate/cost of capital. It was assumed that the castings from the system could be sold for $80 per cubic yard every eighteen months and that the system would also have a replenishment of wood shavings upon casting removal. The model was generalized so that a cost estimate could be made for excess nitrogen that ranged from 25,000 to 150,000 lbs. per year using a power sizing model. While the model was developed for the specific dairy studied, it has been generalized to work for any dairy interested in utilizing the Biofiltro system.

Key Findings and Recommendations

The Biofiltro system is very efficient in cleaning up nitrogen that enters the system. Removal rates averaged around 88% when the system was operational with an upper end of nearly 98% to a lower end of 73%. While these results are very promising, an issue that Biofiltro's system encounters is that there is not a large amount of nitrogen in the lagoon water on a per 1,000 gallon basis. Dairy effluent from the cow is estimated to have approximately 37 to 52 pounds of nitrogen per 1,000 gallons of effluent. Due to dilution from water used for the dairy operation, the average amount of nitrogen being cleaned by the system is approximately 8 lbs. per 1,000 gallons. This dilution effect implies that a dairy operation such as the one studied will need to have a relatively large system to handle the manure and nitrogen that is being produced by the cows to handle all of its excess nitrogen.

Table 1 below provides the cost of removing a pound of nitrogen employing the Biofiltro system. This table is based on an average removal rate of 8 lbs. per 1,000 gallon and shows what size system would need to be built to handle a certain level of excess nitrogen. The table demonstrates that cost removal on a per pound basis ranges from $1.97 to $0.62 per pound for systems that can handle between 25,000 to 150,000 lbs. of excess nitrogen with cost reductions occurring as the system expands in size.

Table 1: Cost per Pound for Removing Nitrogen Utilizing the Biofiltro System

Surplus Nitrogen (lbs)	Size of Biofiltro System (Gallons/day)	Yearly Cost (O&M + Capital Payback)	Cost Per Pound of Nitrogen Removal
25,000	8,617	$49,308	$1.97
50,000	17,235	$62,500	$1.25
75,000	25,852	$72,156	$0.96
100,000	34,470	$80,074	$0.80
125,000	43,087	$86,916	$0.70
150,000	51,705	$93,012	$0.62

The Biofiltro system is not cost competitive against land application that is relatively close to the operation. In the case of the dairy studied, the system is worthwhile if it cannot ship the manure off farm for less than $0.70 to $0.80 per pound of nitrogen removal. Given the historic prices of milk, it can make economic sense for a dairy that cannot find the land base to spread all its nutrients to use the Biofiltro system rather than reduce its herd numbers.

There are several recommendations that come from this study. First, more data needs to be collected on the operational cost until they are at a long-run steady-state. As with any new technology, as time passes operating costs tend to increase due to wear and tear on the technology. Due to the short time horizon for studying the technology, the focus of this study was on developing the cost side of developing and operating the system. More research needs to be conducted on understanding the benefits of operating the technology. These benefits could come from better crop production, better air quality, less nitrogen loading on the land base, etc.