New tool helps dairy farms evaluate economic and environmental benefits of multistage manure treatment.

Waste to Bioproducts via DAIRIEES

Digester-Algae IntegRation for Improved Environmental and Economic Sustainability

The traditional method of dealing with cattle waste on a dairy farm is dirt simple and environmentally challenging. Manure — solid and liquid wastes combined — is collected and dumped into lagoons or open ponds. While this mixture can be used as a low-cost agricultural fertilizer, it can wash into nearby waterways, overloading rivers and lakes with nitrogen and phosphorous. It also releases heat-trapping gases into the atmosphere.

The environmental consequences are substantial. The dairy industry is one of the country's largest industrial sources of greenhouse gas emissions, creating an estimated 6.4 million tons of carbon dioxide and CO_2 equivalents each year.

Making the Most of Manure

Anaerobic digesters can convert manure into methane, a flammable gas that can be burned onsite to generate electricity for use by the dairy or for selling to a power company. The technology is promoted by both the Environmental Protection Agency and the Innovation Center for U.S. Dairy. Yet, wide-scale adoption has been limited due to high initial costs compounded by additional operation and maintenance. In places where electricity is inexpensive, the equipment may never pay for itself.

Idaho National Laboratory has partnered with University of Idaho and Boise State University to assess the effectiveness of deploying a two-stage anaerobic digester system coupled to an algal cultivation pond. The system would produce multiple valued-added commodities that enhance overall economics while sequestering carbon and reducing nutrient runoff.

Digester-Algae IntegRation for Improved Environmental and Economic Sustainability, or DAIRIEES, is an evaluation

Changing the World's Energy Future

Idaho National Laboratory

platform that facilitates more informed decisions concerning the environmental benefits and economic costs of an integrated manure-algae system.

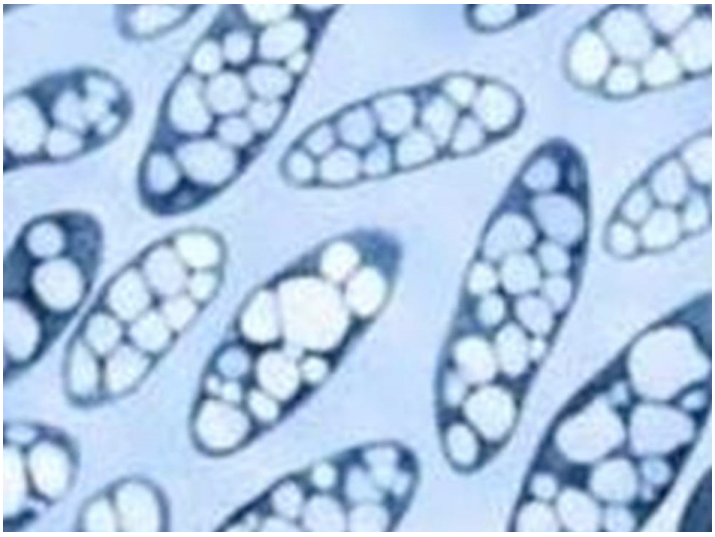
The DAIRIEES platform allows the user to change parameters of the system based on the type of manure treatment proposed or in use. It also scales results based on the size of the dairy herd. The goal is to help users better understand benefits and costs related to implementing this type of manure treatment system.

A Multistep Solution

The multistage manure treatment and energy-capturing process builds upon the anaerobic digester's capabilities. It links five interdependent steps that each contribute either commercially viable products or material for other stages of the process.

First, manure is moved into a fermenter, where it is broken down into volatile fatty acids and remaining solids. Most of the remaining solids are routed to an anaerobic digester to create methane. The solid byproducts of this process can be used as fertilizer or for animal bedding, while a portion of the CO_2 may be diverted to serve as the carbon source for algae cultivation.

Next, the volatile fatty acids, which are precursors to bioplastics, are fed into a "PHA reactor," where bacteria feast upon them. These microbes then produce PHA (polyhydroxyalkanoates), which can be used to create biodegradable plastics ranging from thin, flexible films to sturdy milk jugs.



In a PHA reactor, microbes produce polyhydroxyalkanoates (PHA), which can be used to create biodegradable plastics ranging from thin, flexible films to sturdy milk jugs.

Liquid and solid byproducts from each step are rich in nutrients and may be used as an energy source to cultivate algae. The algae can then be used as a fertilizer, soil conditioner, biofuel precursor and livestock feed supplement, and in consumer products.

Finally, heat and chemical treatment of the algae and residual bacterial biomass from the PHA production can yield precursors for organic oils and/or fertilizer.

Evaluating Options

The environmental benefits of an integrated manure-algae system are numerous compared to today's lagoon approach. However, the economic considerations associated with a manure-algae system are even more complex than those associated with a simple anaerobic digester. How is a dairy farmer to know whether installing one will pay off? That's where the DAIRIEES platform comes in.

DAIRIEES allows users to specify parameters to determine the economic feasibility of an integrated manure-algae system. Taking into account factors unique to an individual dairy farm, the model helps users make an educated decision about deploying an integrated system.

In addition to calculating the economic benefits, the DAIRIEES platform determines the system's environmental advantages, both in terms of reducing greenhouse gas emissions and preventing excess nutrient release into waterways.

The platform is available as open-source software at https://github.com/idaholab.

For more information

Technical Contact
Donna Post Guillen
208-526-1744
donna.guillen@inl.gov

General Contact
Nicole Stricker
208-526-5955
nicole.stricker@inl.gov

www.inl.gov

A U.S. Department of Energy
National Laboratory