NEWTRIENT EVALUATION SUMMARY

CONSERVATION INNOVATION GRANT (CIG):

FAN Bedding Recovery Unit (BRU) Drum Composting Technology

Dairy Manure Treatment Innovations – Enhancing Water Quality and Sustainability

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INSIDE

BACKGROUND

Fessenden Dairy, a longstanding dairy operation in King Ferry, New York, has earned recognition for its pioneering efforts in dairy sustainability. Owned by Tim and Ronda Fessenden, the farm's commitment to environmental stewardship led to the implementation of an innovative manure management system. This system converts dairy manure solids into heat-treated bedding for cows. In an era of tight profit margins for dairy producers, the rising cost of traditional bedding materials and disposals prompted the adoption of Recycled Manure Solids (RMS) as an alternative. While RMS offers economic advantages, they can harbor pathogens, posing a challenge for cow health. The central objective of this project was to thoroughly assess the performance and effectiveness of the FAN BRU system in generating top-tier bedding material from RMS for the dairy.

TABLE 1: MANURE MANAGEMENT SYSTEM SUMMARY

Number of cows	650 lactating cows, 600 heifers
Uncovered manure storage dimensions	First stage: 82' x 175' x 14' Earthen Berm
Covered manure storage dimensions	Second stage: 365' x 175' x 14' Earthen Berm
Cover material	60 mil HDPE, Environmental fabrics inc.
Estimated total loading rate	16,000 gallons per day
Covered Storage Volume (total)	7,000,000 gallons
Solid-liquid separator	During study - FAN ™ Separators Currently - DODA™ Separators
Biogas utilization	Flare
Carbon credits sold/accumulated	Not currently being collected[1]
Stall bedding material	Separated manure solids
Year installed (cover)	2007

[1] Originally retained by Environmental Credit Corporation.

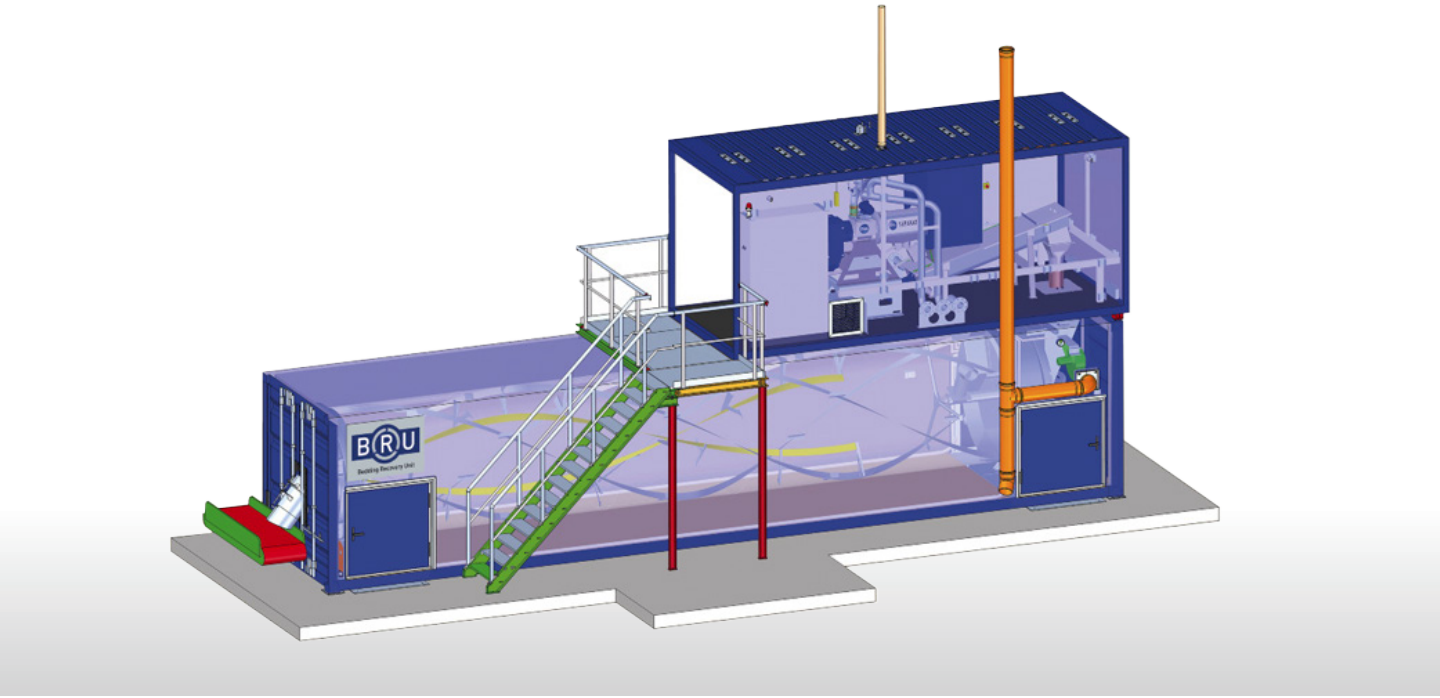
This table has been updated with 2023 data.

INTRODUCTION

Fessenden Dairy partnered with FAN, a European company specializing in separation and slurry technology, to implement the FAN Bedding Recovery Unit (BRU) system. This system combines coarse solid separation and drum composting technologies to produce pathogen-free bedding from RMS, reducing operational costs and minimizing the farm's environmental impact.

The process starts with solid-liquid separation as a pre-treatment for rotary drum composting. The RMS are then fed into a rotary drum composter, where they are dried for 1-3 days at around 70°C, utilizing constant aeration and agitation to reduce moisture, eliminate odors, and neutralize pathogens. The outcome is high-quality, homogenized bedding material, which is then transferred to a compost pile upon completion of processing.

FIGURE 1: FAN BEDDING RECOVERY UNIT (BRU) SYSTEM



The FAN BRU system at Fessenden Dairy consists of a specially designed screw press on top of the 40-foot container containing the drum, isolated for heat protection, where an auger delivers the solids. The screw press can be in a 20-foot container located on top of the 40-foot container, isolated for low-temperature applications. The separator removes solids and minimizes humidity. The drum in this container can be filled with over 70% volume and has a ventilator for regulating the aerobic process, producing pathogen-free bedding. The FAN BRU continuously processes liquid manure from the 40' x 14' holding tank (Inflow), separating solids with a screw press, returning liquid manure to the holding tank (Outflow), inputting solids into the FAN drying drum (Pre-compost), and transferring processed solids to the compost pile (Compost).

METHODOLOGY

Samples of the liquid influent going into the screw press, liquid effluent coming out of the screw press, solids coming from the screw press, and solids from the rotary drum were taken to assess the efficacy and performance of FAN BRU. For the entirety of the 15-week project, samples were taken three times a week, except in the last four weeks in which samples were taken twice a week. All samples were sent to A&L Great Lakes Laboratories for analyses. Three types of analyses were performed depending on the origin of the sample: a manure analysis, compost analysis, and an in-depth compost analysis.

The manure analysis was performed to test the differences in percentage of moisture, solids, ash, organic matter, organic carbon, organic nitrogen, and phosphorus between liquid influent and effluent. The compost analysis was performed to test the differences of the carbon to nitrogen ratio, pH, and the percentage of moisture, solids, total nitrogen, phosphorus, and potash between pre- and post-compost. The in-depth compost analysis was also performed to test the differences of the carbon to nitrogen ratio, pathogen colony-forming units (CFU), and the percentage of moisture, solids, total nitrogen, phosphorus, and metals between pre-and post-compost.

DISCUSSION OF RESULTS

Key Benefits of FAN BRU

Evaluation of the FAN BRU system's outcomes offers valuable insights into its operational efficiency, economic viability, pathogen reduction capabilities, and its role in minimizing the environmental footprint of a dairy.

Performance: Throughout the study, the FAN BRU system effectively processed liquid manure, with an average input rate of about 522 gallons per hour. The liquid outflow, which was returned to another holding tank, had an average rate of about 452 gallons per hour. The inside of the drum where the processing occurred maintained an average temperature of 174°F, while the compost pile's average temperature was 99.7°F, which did not necessarily match the outside temperature.

A comprehensive analysis of the samples was conducted to assess the quality of the compost produced by the FAN BRU unit. The results indicated that the removal of solids by the FAN BRU unit increased the moisture content in the outflow, as expected. Organic matter decreased, but most other measures remained consistent between inflow and outflow. Additionally, further treatment of the raw solids in the composting process led to a decrease in moisture between the pre-compost and compost samples.

These analyses collectively offer a comprehensive understanding of the FAN BRU system's performance and effectiveness in producing high-quality bedding material. Notably, the system consistently met expectations, as revealed by analytical data indicating increased solids as moisture was removed in both manure and compost analyses. Furthermore, the system's ability to achieve acceptable pathogen levels in post-compost samples reaffirms its contribution to safer and healthier bedding for Fessenden Dairy's cows, all while reducing input costs and minimizing the dairy's environmental footprint.

Cost Savings: The FAN BRU system operates in a circular manner, consistently producing top-quality bedding for the farm. This not only enhances cow comfort and boosts milk production but also leads to significant cost reductions related to bedding materials and waste disposal. Additionally, any surplus compost generated by the system can be sold externally to other farms as bedding or as potting soil and fertilizer, creating an additional income source for the farm. This integrated approach not only optimizes farm operations but also diversifies revenue streams, reinforcing the farm's financial sustainability.

The system's ability to achieve acceptable pathogen levels in post-compost samples reaffirms its contribution to safer and healthier bedding for Fessenden Dairy's cows.

Pathogen Reductions: The FAN BRU system demonstrated a remarkable reduction in the presence of harmful pathogens in the compost, transitioning from initially high levels to nearly undetectable amounts. In the March in-depth compost analysis, the presence of fecal coliform was measured at 4,390 CFU per gram (indicating a fail) in the pre-compost, and a significant reduction to 20 CFU per gram (indicating a pass) in the post-compost stage. Similarly, during the June analysis, the pre-compost exhibited a presence of 4,180 CFU per gram (also indicating a fail), while the post-compost showed less than 2 CFU per gram (a pass). Utilizing bedding material with such substantial reductions in pathogens ensures a safer and healthier environment for the cows.

Environmental Footprint: In addition to performance and economic benefits, the FAN BRU system plays a pivotal role in reducing the farm's environmental footprint. Drum composting has been shown to contribute to a significant decrease in greenhouse gas (GHG) emissions (Fillingham et al., 2017). By recycling manure solids instead of storing them in large basins or lagoons and reducing the need for trucking sand to the farm, the system mitigates methane (CH_4) and carbon dioxide (CO_2) emissions. In addition, the generation of a more nutrient dense, lighter compost reduces the risk for leaching nitrates into groundwater during land-application and storage. The resulting compost product eases transportation of the fertilizer and allows for a better distribution of nutrients on the field during application. Liquid effluent collected after separation can also be used as fertilizer on land-applications, fit for the use of efficient low-pressure drop nozzles.

Key Issues and Challenges

During the study, several key operational issues were identified and addressed as outlined below.

Air Emissions: One of the primary challenges associated with these systems is the direct emissions of exhaust, such as ammonia, volatile organic compounds (VOCs), and CO_2 into the atmosphere, typically without the use of emission control devices. This can contribute to air quality concerns and environmental impacts.

TABLE 2: IN-DEPTH COMPOST ANALYSIS – MARCH

SAMPLE	MOISTURE	SOLIDS	TOTAL NITROGEN	PHOSPHORUS	METALS	FECAL COLIFORM	C:N
PRECOMPOST	63.52%	36.48%	0.46%	0.06%	Pass	4390CFU (Fail)	38.9:1
COMPOST	56.29%	43.71%	0.58%	0.07%	Pass	20CFU (Pass)	36.7:1
DIFFERENCE	7.23%	-7.23%	-0.12%	-0.01%			2.2

TABLE 3: IN-DEPTH COMPOST ANALYSIS – JUNE

SAMPLE	MOISTURE	SOLIDS	TOTAL NITROGEN	PHOSPHORUS	METALS	FECAL COLIFORM	C:N
PRECOMPOST	61.7%	38.3%	0.53%	0.09%	Pass	4180CFU (Fail)	35.2:1
COMPOST	58.31%	41.69%	0.56%	0.11%	Pass	<2CFU (Pass)	36.4:1
DIFFERENCE	3.39%	-3.39%	-0.03%	-0.02%			-1.2

Ammonia Nitrogen Volatilization: Long-term research on manure composting has revealed the potential for significant ammonia nitrogen volatilization, ranging from 8% to 43%. While not explicitly studied in the context of drum composting, it is presumed that ammonia volatilization may also occur, posing a potential challenge for nutrient management.

Odor Release: The emission of volatile carbon and sulfur compounds is likely to result in odor release from these systems. Managing and mitigating these odors is crucial to address potential environmental and community concerns.

IMPLICATIONS

Drum composting holds significant implications for enhancing sustainability and efficiency in the dairy industry. Notably, the successful conversion to RMS bedding, as demonstrated by many dairies without encountering notable increases in mastitis or somatic cell counts, highlights the feasibility and advantages of this sustainable bedding approach. The primary driver for adopting such technology lies in the compelling cost savings and simplified manure management it offers, which justify its installation. To enhance the effectiveness of the FAN BRU system and promote optimal drum composting technology while reducing GHGs directly into the atmosphere, further research on integrating an emission control device is essential. Such a device would serve to restrict the release of carbon and sulfur emissions during odor release and minimize the volatilization of ammonia, which is presumed to occur during drum composting. By achieving reductions in nutrient levels, heavy metals, and the elimination of pathogens, FAN BRU is an innovative, sustainable, and feasible approach for utilizing RMS as bedding in dairy operations.

For additional information on the vendor, environmental impacts, financial implications, and FAN BRU technology visit the FAN BRU Vendor Snapshot on the **Newtrient website**.

REFERENCES

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Newtrient's mission is to reduce the environmental footprint of dairy while making it economically viable to do so.

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