NEWTRIENT EVALUATION SUMMARY

CONSERVATION INNOVATION GRANT (CIG):

Forced Air Large Animal Mortality Composting System

Dairy Manure Treatment Innovations – Enhancing Water Quality and Sustainability

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BACKGROUND

Effective mortality management is critical for protecting water quality, reducing disease transmission, recovering nutrients, and maintaining operational efficiency on livestock operations. Traditional disposal methods, including burial, rendering, and static pile composting, can introduce environmental risks, involve lengthy treatment times, or pose biosecurity challenges. As farms grow and consolidate, many producers face tighter operational constraints and increasing demand for more controlled and predictable mortality management solutions.

Forced aeration composting systems have emerged as a practical alternative for improving decomposition efficiency, accelerating pathogen reduction, and enhancing nutrient recovery. These systems integrate mechanical mixing, controlled aeration, and structured loading protocols to maintain consistent composting conditions. The Advanced Composting Technology (ACT) system builds on these principles by combining a grinder/mixer, forced air primary composting bins, and a static secondary composting stage to convert animal mortalities into stable, land-applicable compost.

INTRODUCTION

The ACT system was evaluated on a commercial dairy in Virginia to assess its performance under typical farm conditions. Two complete composting cycles were conducted during summer months, allowing for observation of temperature behavior, physical breakdown, and compost characteristics across both primary and secondary stages.

The evaluation focused on key benchmarks commonly used to understand mortality composting performance, including sustained thermophilic temperatures (heat from active microbes), uniform carcass decomposition, and reduction of biological indicators. Findings from temperature monitoring, pathogen testing, nutrient analysis, and on-farm observations demonstrate that ACT's enhanced composting process provides a controlled, efficient, and sustainable approach for handling routine dairy mortalities. These results indicate that the system can offer producers a predictable and biosecure solution for on-farm mortality management and nutrient recovery.

The Process

The ACT system integrates mechanical preprocessing, forced air bin composting, and static secondary composting into a single workflow for managing dairy mortalities. The process is designed to maintain optimal oxygen, moisture, particle size, and carbon (C)-to-nitrogen (N) ratio balance to support rapid decomposition and reduce pathogen risk.

Preprocessing begins with a grinder/mixer, where mortalities are combined with carbon material and finished compost in a typical 3:2:1 ratio (e.g., 1,500 lbs. mortality, 1,000 lbs. bulking agent, 500 lbs. compost). Mixing for 20-30 minutes produces a uniform blend with smaller particle size, balanced moisture, and improved airflow.

The blended material is then loaded into forced air composting bins, capped with a clean carbon bulking material, and composted for approximately 16 days, as recommended by ACT. This phase generates rapid and sustained thermophilic conditions, while moisture is contained. After primary composting, material is transferred to a static pile for an additional 16 days, where natural airflow continues to maintain elevated temperatures and support decomposition.

Finally, the compost is moved to a covered storage area for approximately 60 days, where moisture and odor are managed until the material is ready for land application. The resulting compost is stable and suitable for use on cropland or pasture under standard nutrient management practices.

FIGURE 1: TRIAL #1 COMPOST MIXTURE PLACED IN BIN PRIOR TO CAPPING.

FIGURE 2: TRIAL #1 COMPOST MIXTURE PLACED IN BIN AFTER CAPPING AND WITH TEMPERATURE. LOCATIONS FLAGGED.

METHODOLOGY

Trials were conducted at a dairy farm in Rockingham County, Virginia, at 1,050 ft. elevation. Environmental conditions included daytime temperatures near 90°F and nighttime temperatures around 68°F. The site featured six ACT forced air composting bins (12,000 lb. capacity each), an ACT grinder/mixer system, a dedicated secondary composting area, a covered concrete floor for all operations, and a 60-day compost storage capacity. Temperature monitoring occurred from August 11 to September 24, 2025.

Each trial used approximately 12,000 lbs. of mixed material, consisting of 3,000 lbs. dairy mortality (two adult cows, two calves), 3,150 lbs. carbon source (double-ground mulch), 4,050 lbs. bedded pack dairy manure, and 1,800 lbs. fines from manufactured wood waste. Mixtures were blended for approximately 20 minutes per batch and moisture adjusted to 35-50%. Prepared mixtures were loaded into aerated bins and capped with fresh carbon material.

Temperature verification followed Natural Resources Conservation Service (NRCS) Conservation Practice Standard (CPS) Code 316 Animal Mortality Facility. During the primary phase (forced aeration, 16 days), temperatures were monitored at depths of 12, 24, and 36 inches using two probe sites per bin and calibrated ReoTemp 36-inch compost thermometers. During the secondary phase (static pile, 16 days), temperatures were monitored at 18 and 36 inches, including the carbon cap. These procedures ensured regulatory-compliant and consistent temperature measurements throughout the composting cycle.

Composite samples from both primary and secondary phases were collected for laboratory nutrient profiling, including organic nitrogen (N), ammonium nitrogen (NH_4^+-N), nitrate nitrogen (NO_3-N), total nitrogen (N), C:N ratio, phosphate (PO_4^{3-}), potash (K_2O) moisture, and pH. Samples were also collected for pathogen testing (fecal coliform, *Salmonella* spp.) to verify compliance with regulatory requirements.

Visual inspections were conducted during each composting phase to document procedures for evaluating soft tissue, bone integrity, and remaining structural fragments.

Leachate monitoring procedures were implemented throughout the trials to determine if additional leachate management measures were necessary.

DISCUSSION OF RESULTS

The evaluation of ACT's mortality composting system across two full cycles provides a comprehensive understanding of system performance under commercial dairy conditions. Temperature data, nutrient dynamics, pathogen testing, and carcass breakdown collectively demonstrate the effectiveness of ACT's integrated approach and its potential operational and environmental benefits.

Key Benefits of Mortality Composting

Reliable Thermophilic Temperatures: The ACT system demonstrated a consistent ability to achieve and maintain thermophilic temperatures well above the NRCS CPS 316 requirement of sustaining at least 130°F for five consecutive days. Across both trials, temperature curves in Figures 3-6 show rapid heating within the first 24-48 hours and stable thermophilic activity throughout the full 16-day primary and secondary cycles. Trial 1 achieved average temperatures of 153.9°F during the primary phase and 143.1°F during the secondary phase, while Trial 2 maintained averages of 151.5°F and 146.0°F, respectively. These consistently high temperatures confirm effective aeration, robust microbial activity, and reliable regulatory performance under real farm conditions.

Strong Pathogen Reduction Meeting Class A Standards: Pathogen testing demonstrated that the ACT system effectively reduces fecal coliform and *Salmonella* to levels compliant with 40 CFR 503 Class A standards. Laboratory analyses show that fecal coliform levels were either non-detectable or well below the 1,000 Most Probable Number per gram of total dry solids threshold, with only one detectable result across all primary samples, but still within acceptable limits. *Salmonella* spp. was not detected in any samples during either trial. Combined with the documented temperature performance, these results confirm that ACT's composting process consistently achieves Class A pathogen reduction suitable for land application.

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TRIAL #1

FIGURE 3: TRIAL #1 TEMPERATURES PRIMARY COMPOSTING.

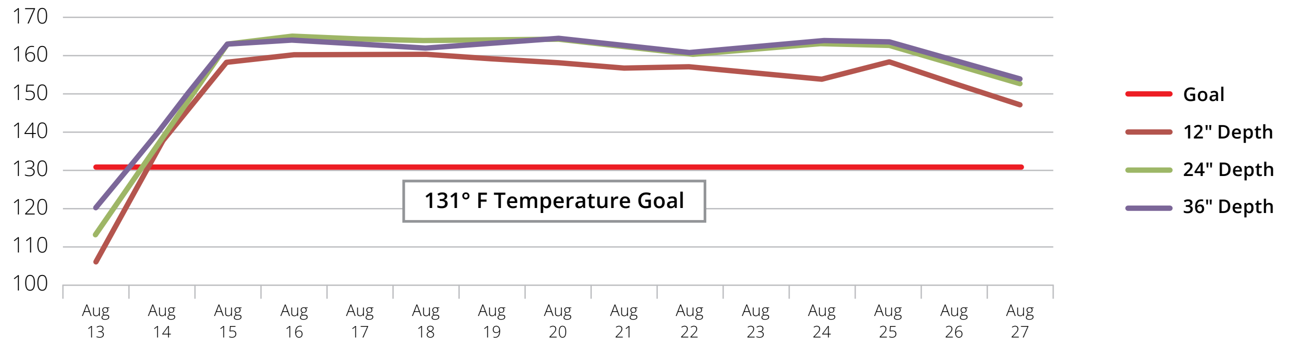
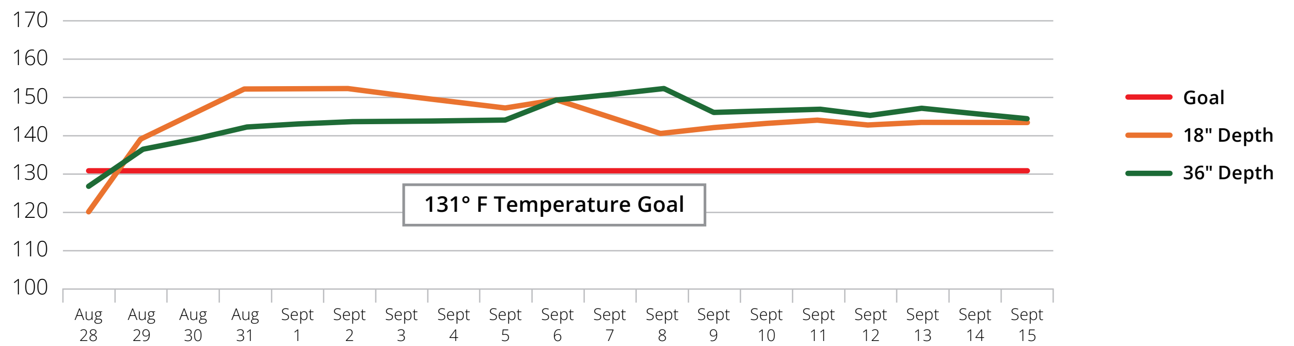


FIGURE 4: TRIAL #1 TEMPERATURES SECONDARY COMPOSTING.



TRIAL #2

FIGURE 5: TRIAL #2 TEMPERATURE PRIMARY COMPOSTING.

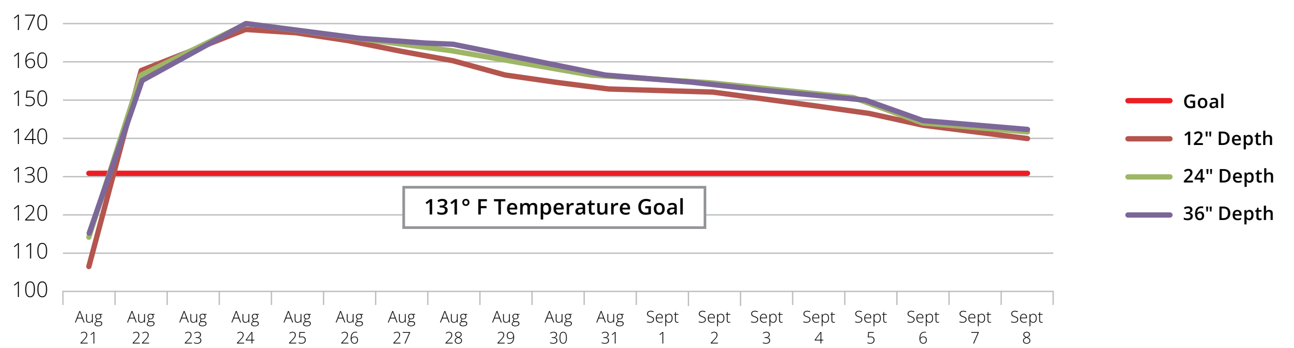
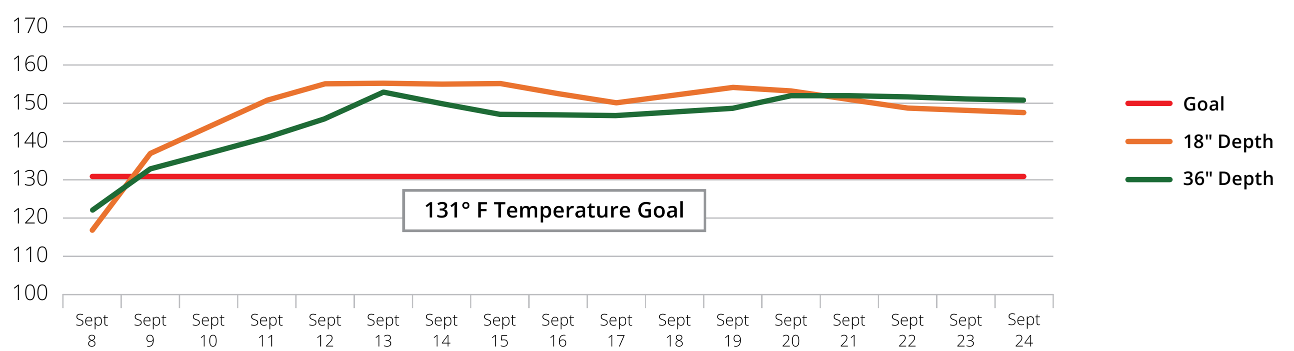


FIGURE 6: TRIAL #2 TEMPERATURES SECONDARY COMPOSTING.



Agronomically Useful Compost: Although N concentrations and C:N ratios varied across sampling dates and between composting phases, the resulting nutrient values fell within ranges commonly found in mortality-based compost (Tables 1-4). These characteristics indicate that the finished material can be incorporated into nutrient management plans as an organic soil amendment.

Thorough Decomposition and Controlled Environmental Conditions: The combined preprocessing and forced aeration system produced a uniform composting mixture that decomposed quickly and thoroughly. All soft tissue was fully broken down by the end of the primary composting phase, and bone material was significantly softened and reduced in size by the end of secondary composting. Throughout both trials, no leachate or liquid runoff was observed, even under warm summer conditions, reflecting the effectiveness of the roofed pad, carbon cap, and moisture-balanced composting mix. Together, these outcomes demonstrate a controlled, contained process that supports efficient decomposition while minimizing water quality risks.

TRIAL #1

TABLE 1: TRIAL #1 PRIMARY COMPOSTING NITROGEN (N) ANALYSIS.

Date	Organic N (% DB)	Ammonium N (% DB)	Nitrate N (% DB)	Total N (% DB)	C:N
8/14/2025	3.75	0.177	0.004	3.93	11.0
8/20/2025	1.67	0.049	0.001	1.72	13.7
8/22/2025	1.88	0.035	0.001	1.92	20.8
8/25/2025	2.05	0.080	0.001	2.13	19.8
8/28/2025	1.81	0.026	0.001	1.84	20.0

TABLE 2: TRIAL #1 SECONDARY COMPOSTING NITROGEN (N) ANALYSIS.

Date	Organic N (% DB)	Ammonium N (% DB)	Nitrate N (% DB)	Total N (% DB)	C:N
9/1/2025	1.48	0.106	0.001	1.59	28.0
9/9/2025	1.79	0.077	0.001	1.87	21.1
9/15/2025	1.87	0.050	0.001	1.92	20.8

TRIAL #2

TABLE 3: TRIAL #2 PRIMARY COMPOSTING NITROGEN (N) ANALYSIS.

Date	Organic N (% DB)	Ammonium N (% DB)	Nitrate N (% DB)	Total N (% DB)	C:N
8/21/2025	1.91	0.035	0.001	1.95	21.0
8/25/2025	1.41	0.049	0.001	1.46	28.6
9/1/2025	1.41	0.064	0.001	1.47	25.5
9/5/2025	1.67	0.105	0.001	1.77	24.4
9/8/2025	1.49	0.043	0.001	1.53	26.3

TABLE 4: TRIAL #2 SECONDARY COMPOSTING NITROGEN (N) ANALYSIS.

Date	Organic N (% DB)	Ammonium N (% DB)	Nitrate N (% DB)	Total N (% DB)	C:N
9/19/2025	1.84	0.036	0.001	1.88	21.20
9/24/2025	1.03	0.047	0.001	1.08	37.68

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Evaluation Key Challenges and Issues

Variability in Nutrient Dynamics Across Composting Stages: While overall nutrient levels were consistent with expectations for mortality compost, the evaluation documented notable variability in N values and C:N ratios across sampling dates. As shown in Tables 1-4, total N during the primary phase fluctuated from 1.72% to 3.93% (dry basis) in Trial 1 and 1.46% to 1.95% in Trial 2. Similarly, C:N ratios ranged widely—from 11.0 to 20.8 in Trial 1 primary samples and from 21.0 to 28.6 in the Trial 2 primary phase. This variability appears to be linked to the incorporation of the carbon cap and base material during pile turning between primary and secondary phases, which introduces fresh carbon and resets part of the composting profile. While not detrimental to compost quality, these shifts complicate predictions of nutrient concentrations for land application planning.

Presence of Residual Bone Fragments After Secondary Composting: Although all soft tissue was fully decomposed by the end of the primary stage and bone material was significantly softened by the end of the secondary stage, both trials showed that small bone fragments (6-8 inches) remained. While these fragments were pliable and structurally degraded, their presence may require consideration when applying compost to fields where equipment damage may be of concern. Additional curing or mechanical screening could further reduce bone size but would add operational steps. The system's performance still represents substantial improvement over traditional static pile composting, which often leaves larger, sharper bone fragments after much longer cycles.

IMPLICATIONS

The evaluation demonstrates that the ACT composting system can process dairy mortalities efficiently while maintaining environmental containment. Across two full cycles, the system achieved rapid thermophilic temperatures, Class A pathogen reduction, and produced stable compost suitable for integration into nutrient management plans. The shortened composting cycle, combined with the containment of leachate, supports improved operational efficiency and minimizes potential excess nutrient runoff or leaching.

While this evaluation was limited to a single commercial dairy site, the results indicate that mechanically preprocessed, forced aeration composting can provide a consistent and predictable method for on-farm mortality management. Expanding evaluations across multiple sites, herd sizes, and climatic conditions would provide additional insight into system performance under variable dairy production scenarios. Overall, the findings suggest that enhanced composting approaches like this can be a practical, environmentally responsible option for dairy farms seeking to manage mortalities safely and effectively.

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

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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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