Environment and Natural Resources Trust Fund

2026 Request for Proposal

General Information

Proposal ID: 2026-149

Proposal Title: Ambient Alkaline Hydrolysis, an Emergency Livestock Mortality Disposal

Project Manager Information

Name: Veluchamy Chitraichamy

Organization: U of MN - WCROC

Office Telephone: (320) 589-1711

Email: chitr012@umn.edu

Project Basic Information

Project Summary: The Project team will evaluate the feasibility of Ambient alkaline hydrolysis (AAH): as an emergency management mortality disposal method for livestock in Minnesota.

ENRTF Funds Requested: $706,000

Proposed Project Completion: June 30, 2029

LCCMR Funding Category: Energy (E)

Project Location

What is the best scale for describing where your work will take place?

Statewide

What is the best scale to describe the area impacted by your work?

Statewide

When will the work impact occur?

During the Project and In the Future

Narrative

Describe the opportunity or problem your proposal seeks to address. Include any relevant background information.

Minnesota has faced several mass mortality events in recent years, including highly pathogenic avian influenza (HPAI) in 2015 and 2022-2025. Currently, more than 185 infected sites in 51 counties are reported in Minnesota affecting a flock inventory of 9.8 million birds. The threat of other large-scale livestock disease outbreaks remains high, during such events, there are only a few viable options for effective disposal of thousands, or millions of livestock. The options vary depending on jurisdiction and site specifics, but some combinations of landfilling, burial, incineration, or composting are typically employed. Each has advantages and disadvantages, but currently on-site composting is favored in most jurisdictions because it reduces the movement of mortalities off the farm. However, composting still has limitations such as: heterogeneity in the process, need for sufficient co-compost substrate (e.g. straw, wood chips), risk of environmental contamination (leachate, gas emissions, pests), and available land to construct windows. Alkaline hydrolysis has also proposed as disposal option because of its efficacy at pathogen inactivation, but it requires specialized equipment that's costly and works at elevated temperature (>100°C) and pressure (103kPa) to rapidly digest mortalities in 3+ hours. For this reason, it hasn't adopted as preferred disposal method.

What is your proposed solution to the problem or opportunity discussed above? Introduce us to the work you are seeking funding to do. You will be asked to expand on this proposed solution in Activities & Milestones.

The purpose of this research is to simplify the Alkaline hydrolysis process by conducting hydrolysis under ambient conditions at room temperature and pressure and ensuring environmentally friendly disposal methods by coupling the process to fermentation and/or anaerobic digestion for biofuel and bioenergy production. Because of ambient temperature and pressure that slows down the hydrolysis reactions, conducting the process in a biosecure container ensures that the extended duration does not compromise biosecurity on site. The kinetics of whole animal degradation at ambient conditions are currently unknown at different weather conditions, so we propose to determine ambient alkaline hydrolysis (AAH) at multiple temperatures using different molarities of alkaline medium. The hydrolysate remaining after hydrolysis will be pathogen-free and rich in nutrients but highly caustic, which limits its direct-use for land application, composting, fermentation and anaerobic digestion, because these processes are pH sensitivity.
So, we propose to test multiple strategies for partial neutralization of hydrolysate, including incubation with corn silage (could be useful substrate for biogas production) and inorganic acid addition. We also propose to determine the bioproducts of hydrolysates such as production of lactic acid, alcohols, VFAs, biogas and fertilizer value when they are further processed via fermentation and anaerobic digestion.

What are the specific project outcomes as they relate to the public purpose of protection, conservation, preservation, and enhancement of the state's natural resources?

A mass livestock mortality event represents a significant financial loss for a producer, and potentially a major risk to other members of the industry and the public.
Improved Biosecurity: Ambient alkaline hydrolysis eliminates pathogens, reducing the risk of disease spread during emergency mortality events and protecting livestock and public health.
Reduced Environmental Contamination: By neutralizing hydrolysates and integrating them into anaerobic digestion (AD), It will minimize risks of leachate, gas emissions, and groundwater contamination associated with traditional disposal methods.
Renewable Biofuel Production: Hydrolysates processed through fermentation and AD can generate biofuel and biogas, that reduces reliance on fossil fuels.

Activities and Milestones

Activity 1: Methodology development and optimization of ambient alkaline hydrolysis (AAH) degradation kinetics and hydrolysate neutralization

Activity Budget: $319,431

Activity Description:
We will investigate the AAH degradation kinetic in 10 L sealable polyethylene containers using intact (non-eviscerated) livestock mortalities. For this study, livestock will be obtained from the Willmar poultry farm, and the Activity 1, experiment will be carried out at UMN WCROC. A full factorial experiment will compare degradation between three alkaline sources (NaOH, KOH, CaO) with three different molarities (2M, 4M, 8M) at three different incubation temperatures (5, 15, 25°C). Alkaline solution and poultry will be mixed at a 2:1 (volume/volume) ratio, then sealed and incubated until degradation is complete. Degradation will be assessed visually every 5 days and subsamples taken for chemical analysis.

Partial Neutralization of hydrolysate (pH <9) will be achieved using two different methods. The most efficient alkaline source obtained from hydrolysis study will be used to neutralize the hydrolysates. 1) Corn silage will be mixed with hydrolysates in different ratios (weight/weight) to determine what ratio is necessary to achieve the target pH. 2) Hydrolysates will be neutralized by addition of inorganic acid (e.g. HCl) in different ratios (w/v). We will also evaluate detailed characterization of hydrolysate for potential application such as land application, composting, and fermentation.

Activity Milestones:

Description	Approximate Completion Date
Determine the kinetics of mortality degradation using different alkaline sources, and molar concentrations	December 31, 2026
Determine the kinetics of mortality degradation using different temperatures for optimized molar concentration	March 31, 2027
Explore the different strategies for partial neutralization of hydrolysate	June 30, 2027
Determine the detailed characteristics of neutralized hydrolysate for potential application	July 31, 2027

Activity 2: Quantification of biogas production from neutralized hydrolysate via anaerobic digestion

Activity Budget: $238,891

Activity Description:
We will quantify the biogas potential from hydrolysates using an automated methane potential system (AMPTS III, BioProcess Control) operated at either psychrophilic (20°C), mesophilic (38°C) or thermophilic (55°C) temperature. Hydrolysates from Activity 1 (neutralized using two different methods) will be compared to non-neutralized hydrolysate and non-hydrolyzed chicken homogenate (control). Microbial inoculum will be obtained from the Riverview Dairy farm digester, and inocula will be adapted to target operating temperature prior to use. We will also optimize the process parameter such as hydraulic retention time, organic loading rate using a batch and continuous anaerobic digester using the optimized “recipe” from Milestone 1. Total biogas volume will be continuously measured. Biogas composition, total and volatile solids, COD, pH, EC and nutrients contents will be analyzed weekly once for both batch and continuous digester.

We will conduct an economic feasibility study, including a preliminary estimation of logistic costs related to chemical and reagent procurement, container purchases, mortality processing, transportation, and hydrolysate storage, biogas

production and its usage in renewable industry. We will test a variety of scenarios, validate mass & energy balance assumptions and provide a comprehensive database for implementing system models at the farm level or closed loop operation.

Activity Milestones:

Description	Approximate Completion Date
Determine the biochemical methane potential of neutralized hydrolysate: optimize Food/Microorganims ratio and temperature	December 31, 2027
Determine the optimum hydraulic retention time using batch anaerobic digester	June 30, 2028
Optimization of organic loading rate in continuous anaerobic digester	September 30, 2028
Provide a feasibility (logistics and economics) assessment of the technology	May 31, 2029

Activity 3: Estimating the conversion of neutralized hydrolysate to lactic acid via fermentation process

Activity Budget: $147,678

Activity Description:

We will investigate the fermentation process for converting neutralized hydrolysate from activity 1, to a value-added bioproducts. To maximize the value added bioproducts such as lactic acid and alcohol production from neutralized hydrolysate, we will first determine the suitable environmental conditions for fermentation process. This involves screening and identifying various lactic acid bacterial strains to select the most efficient one for hydrolysate conversion from neutralized hydrolysate to lactic acid . We will systematically evaluate key fermentation parameters including temperature, pH, substrate concentration and inoculum etc., in a batch reactor setup to optimize the lactic acid production yield. We will also further test the optimized conditions in a scale up pilot-scale fermenter available at the Prof. Pillai Lab at the Food Science Department, University of Minnesota, St. Paul. as a proof of concept and also to validated its performance in the continuous operating fermentation reactor. This study will assess the scalability, efficiency, and practical feasibility of lactic acid production from neutralized hydrolysate for potential biofuel applications.

Activity Milestones:

Description	Approximate Completion Date
Determine the suitable conditions for the neutralized hydrolysate for fermentation	December 31, 2027
Screening the Lactic acid bacteria strains to maximize lactic acid production	June 30, 2028
Optimization of fermentation parameter at batch reactor	September 30, 2028
Test the optimized parameters in a pilot scale fermenter as a proof-of concept	May 31, 2029

Project Partners and Collaborators

Name	Organization	Role	Receiving Funds
Brandon Gilroyed	University of Guelph Canada	Collaborator- Research Scientist- Mentoring the graduate student to develop and conduct Ambient alkaline hydrolysis	No
Prasanth K S Pillai	University of Minnesota	Collaborator- Research scientist- Mentoring the graduate student to conduct fermentation, support analyses	Yes

Long-Term Implementation and Funding

Describe how the results will be implemented and how any ongoing effort will be funded. If not already addressed as part of the project, how will findings, results, and products developed be implemented after project completion? If additional work is needed, how will this work be funded?

Developed methods will be available for interpretation and implementation by the Minnesota Board of Animal Health, MN State poultry association. The research findings will be shared through peer-reviewed publications, professional society conferences, regional board and association annual stakeholder presentations and discussions (i.e. Minnkota Agri-Builders), the economic analysis will be a critical piece to accompany the technical recipe and aid in adaptation to local systems. The data generated will allow us to acquire a larger NSF or USDA, NIFA grant. Additional long-term funding will be sought to conduct research with other livestock mortality management.

Project Manager and Organization Qualifications

Project Manager Name: Veluchamy Chitraichamy

Job Title: Research Assistant Professor

Provide description of the project manager's qualifications to manage the proposed project.

Dr. Veluchamy Chitraichamy is a Research Assistant Professor in the College of Food, Agricultural and Natural Resources Science at the University of Minnesota. Dr. Chitraichamy finished his post-doctoral training at the University of Guelph Canada on various research project that focus on biomass valorization, waste management, resource recovery, and environmental sustainability. Prior to he completed a PhD in Civil Engineering specialized in Environmental engineering at the Indian Institute of Technology Guwahati, India and earned B.Tech degree in Agricultural Engineering from Tamil Nadu Agricultural University, India. He has 9 years of research experience in sustainable waste management and resource recovery from various bioresource waste materials for biofuels and bioenergy production. His interdisciplinary research program focuses on integration of renewable bioenergy with agriculture and the environment. He has successfully conducted interdisciplinary research projects by collaborating with various academic institutions, industry stakeholders, and government agencies. Dr. Chitraichamy has guided students in laboratory research, experimental design, data analysis, fostering a collaborative and productive research environment that ensures rigorous project oversight and effective knowledge transfer to team members and stakeholders. His current and past research projects include the conversion of organic wastes into biofuel and value-added byproduct development, bioreactor designs, development of kinetic model and evaluating techno-economic analysis (TEA), evaluating novel farm-scale technologies, determining the fate of various contaminant and pathogens, monitoring greenhouse gas emissions and developing decision support guidance. He has a proven track record of publishing peer-reviewed journals, presenting research findings at national and international conferences. He advocates dissemination of science to the public through research outreach and extension activities, public talk and social media.

Organization: U of MN - WCROC

Organization Description:

In the College of Food, Agricultural and Natural Resources Sciences (CFANS) at the University of Minnesota, we look at

the bigger picture. When we envision a better tomorrow, it includes disease- resistant crops, products that protect our health, lakes free from invasive species, and so much more. We use science to find answers to Minnesota and the world's grand challenges and solve tomorrow's problems.

The Department of Bioproducts and Biosystems Engineering (BBE), in CFANS, discovers and teaches solutions for the sustainable use of renewable resources and the enhancement of the environment. We discover innovative solutions to address challenges in the sustainable production and consumption of food, feed, fiber, materials, and chemicals by integrating engineering, science, technology, and management into all degree programs.

The UMN West central Research and Outreach Center (WCROC), located at Morris, will serve as the primary project location. The WCROC is a 1,100-acre, one of the University's living laboratories where agricultural research can be demonstrated at scale, and it serves as a regional center for agricultural stakeholders to discuss current issues in agriculture. The faculty and staff have considerable experience in developing and effectively implementing applied research, outreach, and extension programs at the applied farm-level.

Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	$ Amount
Personnel								
1 Research Assistant Professor		Project manager - Overseeing the project, mentoring the graduate research assistant, design of experiment, data processing, validation			36.6%	0.24		$43,853
1 Assistant professor		Co-PI, Overseeing the fermentation research, metering graduate student			36.6%	0.24		$43,857
1 Research Scientist		Scientific staff, working on experimental design, data collection, write peer review research articles			25.9%	2		$165,417
2 Graduate Research Assistant (stipend and tuition fee)		Conducting the experiments, data collection, validation of results as proposed			83.6%	6		$359,003
							Sub Total	**$612,130**
Contracts and Services								
tbd	Service Contract	Sample analysis (10-20 samples each year) by an external testing laboratory (about $300-400 per sample) to determine the effectiveness of pathogens level after alkaline treatment				-		$15,000
							Sub Total	**$15,000**
Equipment, Tools, and Supplies								
	Tools and Supplies	Funds ($15,000 in Year 1, $15,365 in Year 2, and $15,365 in Year 3) are requested to purchase laboratory chemicals (various alkaline chemicals, reagents, containers, analysis kits and personal protection supplies.	Funds are requested to purchase laboratory chemicals, reagents, containers for alkaline hydrolysis, anaerobic digestion and fernetation experiments.					$45,730
	Equipment	Ancillary equipment such as bioreactor, COD digester, FOS/TAC analyzer, piping/hoses	Enable us to test our proposed process.					$20,870
							Sub Total	**$66,600**
Capital Expenditures								

							Sub Total	**-**
Acquisitions and Stewardship								
							Sub Total	**-**
Travel In Minnesota								
	Conference Registration Miles/ Meals/ Lodging	One conference trip per year for PI and 2 student per year, $250 registration per person ($750 total per year), 500 miles per year ($300), lodging for 3 persons and 2 nights ($900), and meals ($620 for 3 persons, two days per year)	PI and two students each year will present and share research results in in-state conferences, and network with peers.					$6,270
							Sub Total	**$6,270**
Travel Outside Minnesota								
							Sub Total	**-**
Printing and Publication								
	Publication	Open-access journal publication cost	Publish research results in open-access journal, about $2,000 per year for one paper					$6,000
							Sub Total	**$6,000**
Other Expenses								
							Sub Total	**-**
							Grand Total	**$706,000**

Classified Staff or Generally Ineligible Expenses

Category/Name	Subcategory or Type	Description	Justification Ineligible Expense or Classified Staff Request

Non ENRTF Funds

Category	Specific Source	Use	Status	Amount
State				
			State Sub Total	**-**
Non-State				
			Non State Sub Total	**-**
			Funds Total	**-**

Total Project Cost: $706,000

This amount accurately reflects total project cost?

Yes

Attachments

Required Attachments

Visual Component

File: 0d989f0b-d1d.pdf

Alternate Text for Visual Component

An overview of the hypothesis/methodology and the project deliverable...

Supplemental Attachments

Capital Project Questionnaire, Budget Supplements, Support Letter, Photos, Media, Other

Title	File
Letter of Authorization to Submit	33ae6cf5-1f7.pdf
Audit	b6ab60bc-35d.pdf

Administrative Use

Does your project include restoration or acquisition of land rights?

No

Do you understand that travel expenses are only approved if they follow the "Commissioner's Plan" promulgated by the Commissioner of Management of Budget or, for University of Minnesota projects, the University of Minnesota plan?

Yes, I understand the UMN Policy on travel applies.

Does your project have potential for royalties, copyrights, patents, sale of products and assets, or revenue generation?

No

Do you understand and acknowledge IP and revenue-return and sharing requirements in 116P.10?

N/A

Do you wish to request reinvestment of any revenues into your project instead of returning revenue to the ENRTF?

N/A

Does your project include original, hypothesis-driven research?

Yes

Does the organization have a fiscal agent for this project?

No

Does your project include the pre-design, design, construction, or renovation of a building, trail, campground, or other fixed capital asset costing $10,000 or more or large-scale stream or wetland restoration?

No

Do you propose using an appropriation from the Environment and Natural Resources Trust Fund to conduct a project that provides children's services (as defined in Minnesota Statutes section 299C.61 Subd.7 as "the provision of care, treatment, education, training, instruction, or recreation to children")?

No

Provide the name(s) and organization(s) of additional individuals assisting in the completion of this proposal:

Wendy Moylan and University of Minnesota

Do you understand that a named service contract does not constitute a funder-designated subrecipient or approval of a sole-source contract? In other words, a service contract entity is only approved if it has been selected according to the contracting rules identified in state law and policy for organizations that receive ENRTF funds through direct appropriations, or in the DNR's reimbursement manual for non-state organizations. These rules may include competitive bidding and prevailing wage requirements

Yes, I understand