

Environment and Natural Resources Trust Fund

2026 Request for Proposal

General Information

Proposal ID: 2026-303

Proposal Title: Greenhouse Gas Mitigation in Minnesota Livestock Farming

Project Manager Information

Name: Veluchamy Chitraichamy Organization: U of MN - WCROC

Office Telephone: (320) 589-1711

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Project Basic Information

Project Summary: This project focuses on monitoring and mitigating greenhouse gas (GHG) emissions from poultry farm and processors across Minnesota by integrating satellite imagery with ML models to track methane and carbon-dioxide

ENRTF Funds Requested: \$406,000

Proposed Project Completion: June 30, 2029

LCCMR Funding Category: Resiliency (A)

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.

Poultry industry in Minnesota (ranks #1-Tturkey and #12-Poultry in nation) generates \$3.2 billion annually. Over 6,198 poultry farms and processing generates a significant amount of greenhouse gas (GHG) emissions, primarily methane (CH₄) and carbon dioxide (CO₂). While poultry farming produces lower methane emissions when compared to ruminant livestock, the sector's large scale—combined with emissions from feed production, manure management, and transportation—results in a significant carbon footprint. Effective tracking and mitigation of these emissions are essential for climate change mitigation and regulatory compliance.

Current emission monitoring methods often lack precision and efficiency, making it difficult to identify emission hotspots and implement effective reduction strategies. This proposal will seeks to address these challenges by leveraging satellite data from Sentinel-5P and NASA'S OCO-2 satellites, combined with machine learning models. By systematically mapping emissions from poultry farms and processors across Minnesota, We will captures both temporal and spatial variations in emissions and identifies key drivers for GHG emissions. We will establish benchmarks and support by target, data-driven mitigation strategies. This will enable industry stakeholders and policymakers to align with state and national climate goals and promote sustainable agricultural practices, making Minnesota poultry sector a leader in environmental stewardship and innovation.

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.

We will develop a cutting-edge, data-driven system that enhances the accuracy and efficiency of greenhouse gas (GHG) emissions monitoring and reduction in the Minnesota poultry sector. We will integrate high-resolution satellite data by using Sentinel-5P and NASA's OCO-2 satellites with advanced machine learning models like Long Short-Term Memory (LSTM) and Extreme Gradient Boosting (XGBoost). This system will systematically track methane (CH₄) and carbon dioxide (CO₂) emissions across poultry farms and processors. This Integration will help us to identify regional and seasonal emission patterns across the state and other key drivers.

We will establish industry-wide performance benchmarks and provide real-time insights to support target mitigation strategies. We will develop predictive models by having close collaboration with poultry industry and processors to ensure the digital monitoring platform needs, providing natural navigation and clear data presentation to forecast emissions trends and create an accessible digital platform for policymakers and industry stakeholders. This developed platform will facilitate data-driven decision-making and progress monitoring toward state and nation climate targets. By leveraging advanced technology and data analytics, this project will empower the poultry industry to adopt more sustainable practices, reduce emissions efficiently, and align with states' environmental goals.

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?

This project will directly contribute to the protection and preservation of Minnesota natural resources by reducing greenhouse gas (GHG) emissions from the poultry sector. By providing accurate, data-driven insights, it will enable targeted strategies to lower methane and carbon dioxide emissions, mitigating climate change impacts. The project supports sustainable agricultural practices, promoting efficient manure management, optimized feed production, and the adoption of renewable energy. These efforts will enhance air quality, conserve soil health, and reduce the sector's overall environmental footprint, aligning with state, national and global climate goals for long-term environmental stewardship and resource conservation.

Activities and Milestones

Activity 1: Collect and integrate high-resolution satellite data and convert it into geospatial formats for analysis

Activity Budget: \$189,157

Activity Description:

We will focus on gathering, standardizing, and integrating high-quality data essential for accurate greenhouse gas (GHG) emissions, monitoring and analysis. We will collect high-resolution satellite data from Sentinel-5P and NASA's OCO-2, along with operational data from over 6138 poultry farms and processors across the state. Additional data sources will include climatic information dataset and emissions reports from Minnesota Department of Agriculture and Minnesota Ag Weather Network.

After collecting the required datasets, the data will undergo rigorous cleansing to remove duplicates, outdated records, and inconsistencies with datasets. The standardized data will then be converted into geospatial formats like Keyhole Markup Language (KML) and shapefiles to support geospatial and statistical analysis. By integrating emissions, climate, and operational data, we will establish a comprehensive dataset that forms the foundation for predictive modeling and emissions tracking. This will develop a target, data-driven strategies to reduce emissions and enhance environmental stewardship.

Activity Milestones:

Description	Approximate Completion Date
Establish data partnerships with satellite agencies and agricultural organizations	September 30, 2026
Collect and compile emissions data from poultry farms and processors across the State	December 31, 2026
Standardize and convert data into geospatial formats for analysis	April 30, 2027
Integrating emissions, climate, and operational data into a unified dataset for model development	July 31, 2027

Activity 2: Development of machine leaning models to predict statewide emissions in poultry and processing centers

Activity Budget: \$149,490

Activity Description:

We focus on building advanced machine learning models to perfectly forecast greenhouse gas (GHG) emissions specifically methane (CH₄) and carbon dioxide (CO₂) from MN poultry farms and processors. Using the high-quality, integrated dataset from Activity 1, we will develop and train models like Long Short-Term Memory (LSTM), Autoregressive Integrated Moving Average (ARIMA), and Extreme Gradient Boosting (XGBoost). These models will be selected because they can handle complex, time-series data and capture both linear and non-linear emission patterns over time. The modeling process will start with data preprocessing, ensuring variables are properly formatted and scaled. We will split the data into training and testing sets to validate model performance. Each model's accuracy will be evaluated by using key metrics like Root Mean Square Error (RMSE), and the best-performing model will be selected for implementation.

In addition to predicting emission trends, these models will identify key drivers behind emission variations, such as seasonal changes, climate factors, and operational practices. This insight will help industry stakeholders target specific sources of emissions more effectively.

Activity Milestones:

Description	Approximate Completion Date
Design and test machine learning models for emissions forecasting	October 31, 2027
Validate models using historical emissions and climate data	December 31, 2027
Identify key drivers and seasonal patterns of methane and CO ₂ emissions	March 31, 2028
Deployment of best-performing models for real-time emissions predictions	June 30, 2028

Activity 3: Creation of a Digital Monitoring Platform

Activity Budget: \$67,353

Activity Description:

Finally, we will focus on developing an accessible, user-friendly digital platform that enables real-time greenhouse gas (GHG) emissions monitoring, analysis, and decision-making strategies. Using the predictive models and integrated dataset from earlier activity 2, the platform will provide poultry industry stakeholders and policymakers with actionable insights to reduce methane (CH₄) and carbon dioxide (CO₂) emissions efficiently. The platform will feature interactive dashboards for visualizing emissions data, model-driven forecasts, and benchmarking tools that compare emissions performance across regions and farms within the state. It will also offer spatial mapping capabilities to identify emission hotspots and seasonal trends. Users will be able to track progress toward emission reduction targets and evaluate the impact of mitigation strategies.

We will develop close collaboration with poultry industry and processors to ensure the digital monitoring platform needs, providing natural navigation and clear data presentation. Training resources and workshops will be carried at West central Research and Outreach Center at Morris to promote widespread adoption and efficient use.

Activity Milestones:

Description	Approximate	
	Completion Date	
Platform requirements and user interface design	September 30, 2028	
Develop attributes for real-time emissions tracking, benchmarking, and model visualizations	December 31, 2028	
Test the platform with industry stakeholders and policymakers	March 31, 2029	
Launch the platform and provide training resources	June 30, 2029	

Project Partners and Collaborators

Name	Organization	Role	Receiving Funds
Luca Zullo	Agricultural Utilization Research Institute	Assist with the collecting data across Minnesota and interpretation of data	No

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?

A web-based dashboard will be developed at the end of the project. Dashboard databases will be made accessible to industry stakeholders and policymakers, providing real-time emissions data, predictive models, and benchmarking tools. We will work closely with the Minnesota Department of Agriculture, Agricultural Utilization Research Institute team to identify opportunities to improve the dashboard and add useful features for public and governmental agencies. Since the database can facilitate fundamental research projects, we are going to apply for NASA, NSF, and USDA NIFA grants to financially support future dashboard development and updates.

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. Ineli	% Bene	# FTE	Class ified	\$ Amount
				gible	fits		Staff?	
Personnel								
1 Research		Principal Investigator, coordinate the research			36.6%	0.24		\$43,855
Assistant		efforts, design experiments, mentor the graduate						
Professor		research assistant, write project reports						
Post		Scientific staff, working on experiment design and			25.9%	2		\$165,417
Doctoral		data collection, manuscript preparation						
Researcher								
1 Graduate		Conducting the experiments, data collection,			83.6%	3		\$179,501
Research		validation of results as proposed						
Assistant								
(stipend and								
tuition fee)								
							Sub	\$388,773
							Total	
Contracts								
and Services								
							Sub	-
							Total	
Equipment,								
Tools, and								
Supplies								
	Tools and	Geospatial software use fee (\$1,800/year)	To analyzing and visualizing geospatial					\$5,400
	Supplies		data of poultry farms and processor					
			across Minnesota					
							Sub	\$5,400
							Total	
Capital								
Expenditures								
							Sub	-
							Total	
Acquisitions								
and								
Stewardship								
							Sub	-
							Total	
Travel In								
Minnesota								

	Conference	One conference trip per year for PI and 1 student per	PI and two students each year will			\$5,827
	Registration	year, \$300 registration per person (\$600 total per	present and share research results in			
	Miles/ Meals/	year), 380 miles per year (\$222), lodging for 2	in-state conferences, and network with			
	Lodging	persons and 2 nights (\$600), and meals (\$520 for 2	peers.			
	0.0	persons, two days per year)	·			
					Sub	\$5.827
					Total	<i>+-)</i>
Travel						
Outside						
Minnesota						
					Sub	-
					Total	
Printing and						
Publication						
	Publication	Open-access journal publication cost	Publish research results in open-access			\$6.000
			journal, about \$2,000 per year for one			. ,
			paper			
			haha.		Sub	\$6.000
					Total	+ =) = = =
Other						
Expenses						
					Sub	-
					Total	
					Grand	\$406.000
					Total	÷ .00,000

Classified Staff or Generally Ineligible Expenses

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

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

Total Project Cost: \$406,000

This amount accurately reflects total project cost?

Yes

Attachments

Required Attachments

Visual Component File: <u>57a83617-1d7.pdf</u>

Alternate Text for Visual Component

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

Supplemental Attachments

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

Title	File
Letter of Authorization to Submit	<u>553c7e52-f2e.pdf</u>
Audit	<u>32883e40-2d4.pdf</u>

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

N/A