

## **Environment and Natural Resources Trust Fund**

## 2026 Request for Proposal

## **General Information**

Proposal ID: 2026-274

Proposal Title: Tool for Food Waste Upcycling in Ethanol Biorefineries

## **Project Manager Information**

Name: Bo Hu Organization: U of MN - College of Food, Agricultural and Natural Resource Sciences Office Telephone: (612) 625-4215 Email: bhu@umn.edu

## **Project Basic Information**

**Project Summary:** This project develops a decision support tool to integrate food waste discard into corn ethanol biorefineries, enhancing ethanol production, improving feed quality, and promoting sustainable waste management in rural Minnesota.

**ENRTF Funds Requested:** \$494,000

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? Region(s): Metro

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 19 corn ethanol biorefineries producing ethanol biofuel and distiller grains as animal feeds. However, the current ethanol production system relies heavily on corn as a feedstock, leaving limited opportunities for incorporating alternative, renewable resources. Meanwhile, food waste is a growing problem across the state, with significant amounts of edible food being discarded. They are of large quantity, seasonal, variable, and highly local; and Greater Minnesota areas often have limited infrastructure for waste management compared to urban areas. This includes fewer composting facilities, anaerobic digestion plants, and other waste processing facilities that are needed to handle food waste in an environmentally sustainable manner.

There is a significant opportunity to address both of these challenges by diverting food waste to ethanol production. Food waste, particularly from local businesses and food processors, is an untapped resource that can be integrated into the ethanol production process, providing a sustainable and circular solution. This could reduce the environmental impact of food waste, enhance ethanol production efficiency, and help the state meet its sustainability and renewable energy goals. However, the lack of infrastructure and data tools to optimize this process has hindered progress in leveraging food waste as a feedstock for ethanol production.

# 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.

To address the issue, we propose developing a spatial decision support system (SDSS). This tool will enable stakeholders, such as food waste processors and ethanol biorefineries, to make data-driven decisions regarding the incorporation of food waste into the ethanol production process. The SDSS will map and analyze the availability of food waste across the state, identify local corn-ethanol facilities, and assess the economic and environmental benefits of using food waste as a feedstock. The system will integrate data on the types of food waste available (starch-rich, protein-rich, and fiber-rich materials), local infrastructure, and ethanol facility capabilities.

Through this tool, we aim to optimize food waste management, boost ethanol production, and create higher-quality animal feed. The SDSS will visualize different scenarios for food waste integration, such as enhancing fermentation through starch-rich materials, improving co-product protein profiles, and reducing fiber content for monogastric animals. The system will provide stakeholders with the necessary information to implement cost-effective and sustainable solutions at scale. This project will focus on developing the SDSS, validating it with lab-based research, and refining it for practical implementation. Ultimately, we seek to enhance the efficiency of Minnesota's corn-ethanol industry while tackling food waste and reducing environmental impacts.

# 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 enhance the sustainable management of food waste and discard by diverting it from landfills, reducing greenhouse gas emissions, and promoting its upcycling into valuable ethanol biofuels and animal feed. By integrating food waste into ethanol production, the project supports resource conservation, reducing reliance on traditional feed ingredients and improving the efficiency of biofuel production. It will also preserve natural resources by minimizing waste disposal needs and conserving land used for crop production. Ultimately, this project will contribute to the state's efforts in promoting a circular economy, supporting both environmental sustainability and economic growth.

## Activities and Milestones

## Activity 1: Data Inventory and Stakeholder Engagement

Activity Budget: \$160,000

#### **Activity Description:**

We will build a comprehensive data inventory and engage relevant stakeholders. The data inventory will include collecting detailed information on food waste generation, disposal practices, and available quantities within different regions of Minnesota. We will also gather data on existing corn-ethanol biorefineries, including production capacities, current feedstock usage, and any sustainability goals. This data will be critical for the development and effectiveness of the SDSS tool. Simultaneously, we will engage a variety of stakeholders to ensure broad support for the project and gather valuable input. Stakeholders will include local food waste producers, corn-ethanol biorefinery operators, and animal nutritionists, local farming community. By fostering collaboration, we aim to align the project's objectives with the interests of all parties involved and gather insights into current barriers to food waste upcycling in ethanol production. Stakeholder engagement will be continuous throughout this activity, with a focus on establishing strong partnerships and encouraging the exchange of information. Regular feedback will ensure that the data inventory is comprehensive and reflects the needs of all relevant sectors. This process will also help in identifying potential challenges in integrating food waste into the ethanol production system and enable solutions to be built into the SDSS tool design.

#### **Activity Milestones:**

Description	Approximate	
	Completion Date	
Completion of data inventory from food processors and ethanol facilities	August 31, 2027	
Stakeholder consultation meetings and incorporation of feedback into SDSS design	June 30, 2029	
Aggregation of data into the SDSS platform for further analysis	June 30, 2029	

## Activity 2: Lab Research and Feasibility Validation

#### Activity Budget: \$165,000

#### **Activity Description:**

We will conduct lab research to validate the feasibility of using food waste as a feedstock for corn ethanol biorefineries. The objective is to assess the technical and economic viability of incorporating food waste into the existing ethanol production process. We will work controlled laboratory experiments that simulate the conversion of food waste into bioethanol. The research will explore the most effective methods for preprocessing, fermentation, and distillation when integrating food waste with traditional corn-based processes. Additionally, we will investigate the environmental impact of using food waste in ethanol production, including a detailed life-cycle analysis to determine the reduction in greenhouse gas emissions, energy consumption, and resource utilization compared to conventional corn ethanol production. The lab research will help refine the SDSS tool, providing accurate data and predictions for decision-making in real-world applications. To ensure that our findings are applicable at scale, we will validate the feasibility by testing different types of food waste and evaluating their compatibility with current biorefinery infrastructures. The results will be shared with stakeholders to demonstrate the potential for scaling up food waste upcycling in ethanol production. This research will lay the foundation for future pilot projects and large-scale implementation, advancing the sustainable biofuel industry.

#### **Activity Milestones:**

Description	Approximate
	Completion Date

Completion of solid-state fermentation trials	June 30, 2027
Laboratory validation of improved feed quality	June 30, 2028
Integration of lab results into the SDSS tool for economic and technical assessment	June 30, 2029

## Activity 3: SDSS Development and Tool Creation

#### Activity Budget: \$169,000

#### **Activity Description:**

We will develop the spatial decision support system (SDSS) tool, which will integrate key data on food waste availability, corn-ethanol facility capacities, and economic benefits. This tool will be designed using ArcGIS software, and a comprehensive database will be built to track food waste and biorefinery operations in Minnesota. The tool will allow stakeholders to visualize regional food waste flows and analyze how different waste streams can be incorporated into ethanol production. It will also enable economic assessments to demonstrate potential revenue streams from food waste upcycling and ethanol yield optimization. Key tasks in this activity include setting up the SDSS platform, designing the database structure to accommodate various data types, and ensuring the tool is user-friendly for stakeholders with diverse expertise. The tool will also be designed with scalability in mind, allowing for future updates and data integration. Additionally, we will ensure that the SDSS tool is easily accessible for updates and new data sources, allowing it to remain relevant as new food waste and discard streams and biorefinery capacities emerge. Regular testing and feedback loops with stakeholders will refine the system, ensuring it meets user needs for optimizing food waste management and ethanol production.

#### **Activity Milestones:**

Description	Approximate Completion Date
Completion of database structure design and integration with SDSS	June 30, 2027
Successful implementation of ArcGIS software for data visualization	June 30, 2027
Final testing and launch of the SDSS tool	June 30, 2029

**Project Partners and Collaborators** 

Name	Organization	Role	Receiving Funds
Pedro Urriola	University of Minnesota	Co-PI, Animal Science and Veterinary Population Medicine	Yes
Gerald Shurson	University of Minnesota	Co-PI, animal science and nutrition	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?

The results of this project will be implemented through the SDSS tool, which will be integrated into existing corn-ethanol facilities for ongoing use. Stakeholders, including ethanol producers, food waste managers and crop and livestock farmers, will use the tool for decision-making and resource optimization. After project completion, we will seek partnerships with local governments, businesses, and industry stakeholders to maintain and expand the tool. Future funding may come from state sustainability programs, renewable energy grants, or collaborations with agricultural and energy sectors. Continued research will explore scalability and additional applications, funded through grants and industry partnerships.

## Other ENRTF Appropriations Awarded in the Last Six Years

Name	Appropriation	Amount Awarded
Novel Nutrient Recovery Process from Wastewater	M.L. 2021, First Special Session, Chp. 6, Art. 6, Sec. 2,	\$200,000
Treatment Plants	Subd. 04b	
Phytoremediation for Extracting Deicing Salt	M.L. 2022, , Chp. 94, Art. , Sec. 2, Subd. 08g	\$451,000
Novel Nutrient Recovery Process from Wastewater	M.L. 2024, , Chp. 83, Art. , Sec. 2, Subd. 04g	\$486,000
Treatment Plants		

## Project Manager and Organization Qualifications

#### Project Manager Name: Bo Hu

#### Job Title: Professor

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

Dr. Bo Hu is a Professor and Director of Undergraduate Studies in the Department of Bioproducts and Biosystems Engineering at the University of Minnesota, where he has played a pivotal role in enhancing undergraduate education, particularly in the area of sustainability. With his innovative teaching methods, Dr. Hu integrates sustainability concepts across various courses, providing students with both theoretical knowledge and practical, real-world applications. His focus on critical thinking and hands-on learning ensures that students are well-prepared to address global environmental challenges in their future careers.

In addition to his commitment to education, Dr. Hu has over 20 years of active research experience, specializing in biomass utilization, fermentative conversion, and waste management. His research projects include innovative solutions for removing phosphorus from manure and wastewater, using plants to clean polluted soil and water, and exploring synthetic ecology through the co-cultivation of microalgae and fungi in lichen biofilms. His team is also working on upcycling low-quality agricultural byproducts into nutritious animal feeds.

Dr. Hu's research team at the University of Minnesota has developed cutting-edge techniques, such as 16s rDNA-based microbial analysis using high-throughput pyrosequencing to study microbial species in waste treatment, and ITS sequencing to identify fungal species. Additionally, his team is advancing several conversion platforms, including fungal and microalgae co-cultivation, pelletized fungal fermentation, and solid-state fermentation of filamentous fungi, to produce biofuels and bioproducts from agricultural waste while addressing nutrient removal and pollution in contaminated water.

Organization: U of MN - College of Food, Agricultural and Natural Resource Sciences

#### **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. Almost 93 percent of students who earn CFANS undergraduate degrees find jobs in their

career field or enter graduate school within six months of graduation.

The Department of Bioproducts and Biosystems Engineering, 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.

We have a public impact through community engagement and extension efforts. We develop and deliver high quality, regionally and nationally-recognized research-based programs to meet current and emerging needs of industry and communities. We also have a long-standing tradition of close partnerships with alumni, industry professionals, organizations, government agencies, donors and community members.

# Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineli gible	% Bene fits	# FTE	Class ified Staff?	\$ Amount
Personnel								
PI summer salary only		Lead project, research, supervise, analyze			26.8%	0.24		\$61,908
Co-PI - summer		Animal nutrition research			26.8%	0.12		\$21,110
One research		Research work on life cycle assessment on animal			26.8%	0.21		\$21,114
One research professional		SDSS setup, data inventory, and lab experiments			26.8%	3		\$358,883
							Sub Total	\$463,015
Contracts and Services								
Lab Services	Internal services or fees (uncommon)	Lab analytical service for the animal feeds				0		\$6,183
							Sub Total	\$6,183
Equipment, Tools, and Supplies								
	Tools and Supplies	Lab supplies	Chemicals and supplies to work on lab experiments, protective eyewear, gloves, masks for personnel safety					\$24,802
							Sub Total	\$24,802
Capital Expenditures								
							Sub Total	-
Acquisitions and Stewardship								
							Sub Total	-

Travel In Minnesota					
				Sub Total	-
Travel Outside Minnesota					
				Sub Total	-
Printing and Publication					
				Sub Total	-
Other Expenses					
				Sub Total	-
				Grand Total	\$494,000

# 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: \$494,000

This amount accurately reflects total project cost?

Yes

## Attachments

### **Required Attachments**

*Visual Component* File: <u>19b97cb5-c83.pdf</u>

#### Alternate Text for Visual Component

This visual shows how we will integrate food waste into Minnesota's ethanol production using a Spatial Decision Support System (SDSS). By mapping food waste availability and ethanol facility capacities, the tool optimizes waste management, enhances biofuel production, and supports sustainability and circularity....

#### Supplemental Attachments

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

Title	File
Letter of Approval to submit	<u>c4a33a34-b1c.pdf</u>
Audit	<u>89163d8c-5c4.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?

N/A

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?

No

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?

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

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