Environment and Natural Resources Trust Fund

2026 Request for Proposal

General Information

Proposal ID: 2026-330

Proposal Title: Biocrude from Microbes to Extend Agricultural Sustainability

Project Manager Information

Name: Brett Barney

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

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Project Basic Information

Project Summary: We will investigate methods to maximize the production of a sustainable crude oil alternative generated from agricultural residues and other waste streams using a novel soil microbial consortia.

ENRTF Funds Requested: $509,000

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.

The production of biofuels and sustainable aviation fuels is limited by the yields of suitable compounds that can substitute for current petroleum derived feedstocks. Microbial production of biofuels often requires additional energy intensive chemicals to grow microbial biomass and convert plant biomass into usable fuel products. Our laboratory has worked for twenty years in the biofuel space, and has recently developed an approach that accumulates large quantities of a natural compound that is easy to extract and convert into various petrochemical alternatives suitable for biofuels and aviation fuels.

We utilize a novel microbial chassis that grows on a range of feedstocks including sugars derived from agricultural residues (corn stover and post-harvest plant biomass) and requires no additional nitrogen requirements. Biofuel yields currently account for more than 30% of the biomass from this process, with projections of achieving 60% conversion. The remaining biomass following biocrude extraction is rich in nitrogen, and can be applied as a soil fertilizer substitute. The next step to exploit the potential of this approach is to scale up the process and improve process efficiency while testing various methods for the potential to convert the biocrude into a range of commodity fuel components.

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 have a specific microbe and extended microbial consortia that accumulates a variety of rich hydrocarbons that are suitable as a crude oil substitute. We will test the feasibility of scaling up biocrude production using a variety of feedstocks that include agricultural residues, algal biomass or alternative waste streams. We will study approaches to extract the biocrude components of the biomass and convert the biocrude into simple chemical feedstocks or biofuels, including aviation fuels. We will also test the suitability of the remaining nitrogen rich biomass to be applied as a soil amendment to lower nitrogen and phosphorus fertilizer costs, and add organic carbon back to the soil. The entire process will contribute to a circular bioeconomy that converts atmospheric carbon into suitable petroleum replacements and strengthens state agriculture and developing markets.

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?

We will produce a microbial consortia that is able to transform current agricultural residues or simple organic waste streams into high yields of oils and sustainable aviation fuel using biosynthetic strategies and chemical engineering approaches. When completed, this process will generate a suitable petroleum substitute along with a nitrogen-rich soil supplement that can be applied to soil to improve soil health and lower nitrogen fertilizer requirements.

Activities and Milestones

Activity 1: Scale up and test biocrude production using a variety of agricultural residues or low-value waste streams as feedstocks.

Activity Budget: $240,000

Activity Description:
Our laboratory has already developed one microbial chassis that produces high yields of a natural oil hydrocarbon that is a suitable substitute for crude oil. We anticipate that we can further increase our current yields from 30 percent of cellular biomass up to greater than 50 percent of the biomass. To date, we have tested our strains using simple sugar feedstocks, which could utilize sugars and by-products from Minnesota sugarbeets. Our laboratory also has strains of algae that produce simple sugars which could be coupled with this project. As part of this project, we will test a variety of alternative feedstocks using this microbial chassis and a consortium of other microbes that are capable of using various feedstocks while producing a range of potential biofuel precursors and a remaining biomass by-product that can be added back to soil.

Activity Milestones:

Description	Approximate Completion Date
Optimize yields of biocrude from microbial consortia in laboratory experiments.	December 31, 2026
Test various agricultural residues and waste streams as a suitable feedstock to produce biocrude.	August 31, 2027
Publish results of improved biocrude yields in suitable scientific journals.	September 30, 2028

Activity 2: Test the potential of remaining microbial biomass to serve as a suitable soil amendment providing nitrogen and phosphorus to crops.

Activity Budget: $150,000

Activity Description:
As our second activity, we will characterize the remaining biomass obtained following biocrude extraction. Biocrude can be extracted from cultured microbes using a solvent recycle system that is commonly used to extract food grade oils from oilseed crops. The remaining biomass following biocrude extraction is rich in nitrogen and phosphorus, and should act as a slow release fertilizer when applied to agricultural fields, improving nutrient availability to crops. This process should result in a circular economy to ensure that soils are not depleted of important nutrients over time. We will characterize the remaining biomass following biocrude extraction and apply this to soil to determine if this can be used as a suitable soil amendment.

Activity Milestones:

Description	Approximate Completion Date
Characterize the remaining biomass obtained following biocrude extraction to determine nitrogen, phosphorus and other nutrients.	December 31, 2027
Test remaining non-biocrude biomass as a soil amendment to grow plants in greenhouse studies.	December 31, 2028

Activity 3: Test strategies to convert biocrude into suitable transportation fuels or other high-value chemicals.

Activity Budget: $119,000

Activity Description:

We will employ various common chemical conversion techniques to transform the chemicals obtained from biocrude into suitable drop-in replacements for various transportation fuels as either bio-gasoline, biodiesel or sustainable aviation fuels. Common conversion techniques will include chemical cracking, used by the petroleum industry, and catalytic transformations to make high-value products and petroleum substitutes. If yields are sufficient following scale-up from Activity 1, then we will seek additional partners through our various collaborators or within the petroleum industry to produce sufficient amounts of materials for engine testing.

Activity Milestones:

Description	Approximate Completion Date
Demonstrate successful conversion of biocrude into suitable transportation fuels.	May 31, 2029
Publish finding of biocrude conversion into suitable transportation fuels.	May 31, 2029

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?

We have previously received funds from the National Science Foundation and Department of Energy in relation to earlier aspects of this project. We will use these funds to further this line of research while seeking additional funds through federal agencies or through the support of private industry investments and external stakeholders once proof of concept goals have been met for the demonstration aspects of this project.

Other ENRTF Appropriations Awarded in the Last Six Years

Name	Appropriation	Amount Awarded
Minnesota Microbes for Enhanced Biodegradation of Microplastics	M.L. 2024, , Chp. 83, Art. , Sec. 2, Subd. 08g	$524,000

Project Manager and Organization Qualifications

Project Manager Name: Brett Barney

Job Title: Professor

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

Dr. Brett Barney (Project Manager) received his PhD in 2003. Prior to his PhD work, he spent six years in the medical device manufacturing sector. Following his PhD, he spent six years as a postdoctoral fellow and project manager. He has been a professor with the Department of Bioproducts and Biosystems Engineering and a member of the Biotechnology Institute at the University of Minnesota since 2009. He was the Director of the Microbial and Plant Genomics Institute from 2020 to 2022. The Bioproducts and Biosystems Engineering Department serves as a core department combining Agricultural Engineering, Biological Engineering and Environmental and Ecological Engineering. The University of Minnesota provides a range of facilities and sufficient laboratory space to perform each of the activities described in this proposal.

Dr. Barney's laboratory is focused on minimizing the environmental impacts associated with biofuels and agriculture, and finding innovative methods to remove contaminants from water and wastewater. Dr. Barney has 30 years of experience in both basic and applied research in both academia and industry, including experience managing projects and laboratories in a range of settings. Previous research funding has come from the National Science Foundation (NSF), the United States Department of Agriculture (USDA), the United States Department of Energy (DOE), the Defense Advanced Research Projects Agency (DARPA), the Legislative-Citizen Commission on Minnesota Resources (LCCMR), Minnesota's Discover, Research and InnoVation Economy (MnDRIVE), the Forever Green Initiative and the Initiative for Renewable Energy and the Environment (IREE).

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. Ineligible	% Benefits	# FTE	Classified Staff?	$ Amount
Personnel								
Lead Principal Investigator		Oversee all aspects of project, supervise students and researchers, plan monthly meeting with entire research group and quarterly meetings with broader group of stakeholders. These funds represent partial summer support for the lead Principal Investigator.			36.6%	0.12		$29,000
Graduate Student Research Assistants		Conduct laboratory and scale-up experiments. Train and educate undergraduate students in laboratory research. Write research papers related to project finding and share results with the broader research community through presentations. These funds represent support throughout the duration of the grant period of two graduate students.			83.6%	3		$360,000
Undergraduate Research Assistants (2-3)		Collect data, assist graduate students and learn about laboratory research. These funds represent summer support and part-time support during the academic year for two or three undergrads throughout the duration of the grant period.			0%	2.01		$72,000
							Sub Total	**$461,000**
Contracts and Services								
DNA Sequencing Laboratory Services (Internal and External)	Service Contract	External costs to contract laboratories to perform sequencing runs to identify microbiomes and specific microbes. Anticipating two runs per year, $3000 per run, for all three years. Projections are based on historical costs for similar projects.				0		$9,000
							Sub Total	**$9,000**
Equipment, Tools, and Supplies								
	Tools and Supplies	Lab Supplies	Laboratory Supplies: General Laboratory Chemicals, Media, Reagents and Safety Materials for					$36,000

			students, including gloves ($200 per month) and Kits for Performing Routine Molecular Biology ($200 per kit), Analytical Reagents ($300 per month), Liquid Nitrogen for Strain Storage ($400 per year). Costs are based on a historical budget of approximately $1000 per month for similar research projects.					
							Sub Total	**$36,000**
Capital Expenditures								
							Sub Total	**-**
Acquisitions and Stewardship								
							Sub Total	**-**
Travel In Minnesota								
							Sub Total	**-**
Travel Outside Minnesota								
							Sub Total	**-**
Printing and Publication								
	Publication	Publication of two papers in Scientific and Engineering Journals	Many engineering and scientific journals have charges associated with publications, generally around $1500 per journal. We plan to publish one manuscript before the end of 2027, and another two before the end of 2029.					$3,000
							Sub Total	**$3,000**
Other Expenses								

							Sub Total	**-**
							Grand Total	**$509,000**

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: $509,000

This amount accurately reflects total project cost?

Yes

Attachments

Required Attachments

Visual Component

File: 50a504a3-1a4.pdf

Alternate Text for Visual Component

Image of our current microbial cells accumulating large quantities of biocrude, a suitable crude oil replacement with the potential to produce various transportation fuels. The production of biocrude and the scale-up of this process will be the primary focus of this project....

Supplemental Attachments

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

Title	File
Letter of Authorization to Submit	de3c3f7f-00d.pdf
Audit	566f18d6-c07.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?

N/A

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

Yes

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

Yes

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

No

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, Finance Professional, 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