



Environment and Natural Resources Trust Fund

2027 Request for Proposal

General Information

Proposal ID: 2027-326

Proposal Title: Keeping Minnesota Nitrogen Fertilizers in Their Place

Project Manager Information

Name: Brett Barney

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

Office Telephone: (612) 562-3061

Email: bbarney@umn.edu

Project Basic Information

Project Summary: We will develop natural slow-release nitrogen fertilizers using current waste and byproduct feedstocks to provide a form of nitrogen for agricultural applications that dramatically lowers contaminated water and atmospheric losses.

ENRTF Funds Requested: \$289,000

Proposed Project Completion: June 30, 2030

LCCMR Funding Category: Small Projects (G)

Secondary 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.

Many current slow-release fertilizers utilize polyacrylate, polystyrene or polyurethane, oil-derived polymers in their formulations that leave these plastics behind in soils once the fertilizer components have migrated to the soil and plants to which they are applied. While the intent behind these fertilizer/polymer formulations is to slow the transport of nitrogen and phosphorus into runoff and groundwater during high rain events or extensive watering, the concerns about these current plastics has resulted in bans of their use in places like the European Union, and many fertilizer companies and organic farmers are looking for suitable alternatives that are sustainable and do not further contribute to plastic contamination from modern agricultural practices.

Our laboratory studies natural, biodegradable biopolymers that are rich in nitrogen, and that bind to soils to remain in place during rain or watering events. These polymers are safe for application to the land, or if ingested by animals or humans. Importantly, the polymers, while biodegradable, release small quantities of plant-available nitrogen over time, similar to current commercial products that utilize plastics. Our laboratory has studied various natural nitrogen-containing polymers with the goal of developing a suitable alternative to petroleum derived polymers.

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 use modern biosynthetic techniques to convert carbon and nitrogen waste streams into natural biodegradable polymers that are safe for application on agricultural crops across the state of Minnesota. Our laboratory is exploring a range of natural polymers that contain nitrogen as a component of the biopolymer. As these polymers decompose by natural processes in the soil, natural nitrogen compounds that include amino acids or other benign monomers are made available to the plant. These polymers can be formulated into small pellets that will bind tightly to soil, assuring that the nitrogen does not rapidly migrate into the groundwater. Nitrogen is released over longer periods of time in close proximity to the plant, assuring that multiple applications are not required. Natural polymers can be generated through natural fermentations, resulting in technologies that assure high-tech jobs that will establish Minnesota as a hub for the production of safe and sustainable slow-release nitrogen fertilizers. Feedstocks for the production of these biopolymers are obtained from low-value byproducts or waste streams from local agricultural and dairy industries, helping to find economically viable solutions and secondary uses for their waste streams, while providing a solution to a continuing issue facing Minnesota.

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 develop a process to produce slow-release and fully biodegradable nitrogen fertilizers to test for potential field application. These alternative nitrogen-rich biopolymers will not leave a legacy of slow-degrading plastics in the soil, and will lower the impacts on our soils and water from migrating nitrogen compounds such as nitrates. Additionally, this will lower losses of nitrogen that result in recurring costs to farmers, and result in further nitrogen impacts to our lakes, streams, rivers and groundwater.

Activities and Milestones

Activity 1: Develop Strategies for Commercial Biosynthetic Production of Four Classes of Natural Slow-Release Nitrogen Fertilizers

Activity Budget: \$168,000

Activity Description:

Over the past few years, our laboratory has investigated a variety of natural polymers that are rich in nitrogen. These polymers are found naturally throughout the environment, and have no adverse affects on the health of plants or animals. These biopolymers are fully biodegradable. Most important to this project, because the nitrogen is locked inside the polymer backbone, the biodegradation is a slow process, resulting in a delayed and measured release of the available nitrogen over time. We have preliminary results demonstrating successful production of two classes of polymers from simple biological fermentations that can utilize waste byproducts from the agricultural and dairy industries. We will also explore two additional classes of biopolymers to determine the potential of each class either alone or in combination with one another.

Activity Milestones:

Description	Approximate Completion Date
Optimize production of two current nitrogen-containing biopolymers for optimal production from industrial microbes.	August 31, 2028
Investigate the potential for production of two additional nitrogen-containing biopolymers from industrial microbes.	December 31, 2028
Test production potential of suitable natural slow-release nitrogen fertilizers using agricultural and dairy waste streams.	December 31, 2029

Activity 2: Test the Ability to Produce Commercial Quantities of Slow-Release Nitrogen Fertilizers using Waste Byproducts from the Agricultural and Dairy Industries

Activity Budget: \$121,000

Activity Description:

We have identified a number of potential partners in various agricultural and dairy industries from across Minnesota and the Midwest who are providing us with samples of low-value byproducts or waste streams for preliminary testing as a feedstock to produce our slow-release nitrogen fertilizers. The primary goal of this activity is to demonstrate that we can produce sufficient quantities for testing in greenhouse and field studies. Preliminary yields show some promise, but commercial partners will want to see sufficient quantities to run testing with a variety of plants in different conditions, and will require agronomic growth studies. Successful production of these materials will not only protect our water, but would lower our dependence on industrial fertilizers from other parts of the world, creating a local economy for the production of these materials. Additionally, by using potential waste streams that end up in wastewater or landfills, we will divert current waste streams into a sustainable product that can be applied to agricultural fields with no adverse effects.

Activity Milestones:

Description	Approximate Completion Date
Scale up production of sustainable nitrogen biopolymers using low-cost fermentations for selected waste stream.	March 31, 2030
Identify suitable commercial partners to expand the adoption of sustainable slow-release nitrogen biopolymers.	June 30, 2030

Dissemination

Describe your plans for dissemination, presentation, documentation, or sharing of data, results, samples, physical collections, and other products and how they will follow ENRTF Acknowledgement Requirements and Guidelines.

We will share results from this research with the broader scientific community through publications in open access journals. We are working with specific industries from around Minnesota who provide samples from waste streams to determine the potential to produce this sustainable slow-release fertilizer while lowering the waste generated by other industries. We will also work with the Technology Commercialization office at the University of Minnesota to identify future corporate sponsors to assure that this alternative can reach the market. Work from this research project will be shared with students and stakeholders across the state through various outreach aspects that will be overseen by the Principal Investigators, Postdoc and Graduate Student. This outreach will include the development and maintenance of an expanded website related to this project, where we will share information related to the status of the project. We will also develop various short descriptive videos to showcase some of the work and accomplishments of the project, which will be shared through outlets such as YouTube and other social media outlets. The Environmental and Natural Resources Trust Fund will be acknowledged through attribution in the acknowledgements section of any peer reviewed research. The use of the trust fund logo will be used in any presentation or electronic media, publications and signage as detailed in the ENRTF Acknowledgement Guidelines.

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 anticipate that this project will not require long-term funding. We have some promising preliminary results demonstrating that we can produce these polymers from natural strains, and once we are able to demonstrate proof of concept, we intend to develop these technologies into products that can be studied in the field with various agronomists and local industries. We are only seeking funds to allow us to demonstrate successful proof of concept.

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
Healthy Native Prairie Microbiomes for Cleaner Water	M.L. 2025, First Special Session, Chp. 1, Art. 2, Sec. 2, Subd. 04q	\$468,000

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) spent six years in the medical device manufacturing sector, before returning to complete a PhD in 2003. 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

Environmental and Ecological Engineering, Agricultural Engineering, and Biological 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). He spent several years researching Superfund bioremediation of soil and waters contaminated with polyaromatic hydrocarbons (PAHs) and pentachlorophenol (PCP).

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, 9 month appointment		Project design and management, two weeks of summer salary support per year.			36.6%	0.12		\$30,000
Graduate Research Assistant		Research Assistant, Performing Laboratory Experiments and Data Analysis, supervised by the Principal Investigator, Educational Support			24.2%	1.5		\$188,000
Undergraduate Research Assistant		Research Assistant for Laboratory Experiments and Production Scale-Up, supervised by the Principal Investigator and Graduate Student. Primarily summer research work for one student each year to learn about the research field.			0%	0.75		\$40,000
							Sub Total	\$258,000
Contracts and Services								
Various 3rd Party DNA Sequencing Services	Service Contract	As part of this project, we require some DNA sequencing services performed by a 3rd party external laboratory. This amounts to about \$1330 per year and is performed by reputable external laboratories.				-		\$4,000
							Sub Total	\$4,000
Equipment, Tools, and Supplies								
	Tools and Supplies	Non-Capitalized Lab Scientific or Field Supplies	Laboratory Supplies: General Laboratory Chemicals, Media, Reagents and Safety Materials for students, including gloves (\$120 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). Projected at					\$24,000

			\$8000 per year based on historical cost predictions for similar projects.					
							Sub Total	\$24,000
Capital Equipment								
							Sub Total	-
Acquisitions and Stewardship								
							Sub Total	-
Travel In Minnesota								
							Sub Total	-
Travel Outside Minnesota								
							Sub Total	-
Printing and Publication								
	Publication	Publications of one paper in Scientific and Engineering Journals	Many engineering journals have charges associated with publications, generally around \$3000 per journal. We plan to publish one manuscript before the end of 2029, and will investigate other low-cost publication charges for a second at the end of the grant period.					\$3,000
							Sub Total	\$3,000
Other Expenses								
							Sub Total	-
							Grand Total	\$289,000

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: \$289,000

This amount accurately reflects total project cost?

Yes

Attachments

Required Attachments

Visual Component

File: [259d0bef-343.pdf](#)

Alternate Text for Visual Component

Image of slow release fertilizers describing the current problem associated with plastic resins and the potential solution of replacing these with sustainable biomaterials that naturally biodegrade and provide additional nutrient to plants....

Supplemental Attachments

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

Title	File
Letter of Approval to Submit	216041fe-6c6.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