Environment and Natural Resources Trust Fund

2026 Request for Proposal

General Information

Proposal ID: 2026-448

Proposal Title: Reduce Agricultural Soil Erosion with Precision Cover Crops

Project Manager Information

Name: Judy Yang

Organization: U of MN - St. Anthony Falls Laboratory

Office Telephone: (617) 415-3478

Email: judyyang@umn.edu

Project Basic Information

Project Summary: We aim to integrate cover crops and precision agriculture technology to mitigate soil erosion in Minnesota's corn-soybean farms.

ENRTF Funds Requested: $440,000

Proposed Project Completion: June 30, 2029

LCCMR Funding Category: Land (F)

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.

Soil erosion in Minnesota's corn-soybean farms threatens agricultural productivity and water quality, costing farmers and communities millions of dollars each year. As part of the Corn Belt, Minnesota's fertile soils and high yields are increasingly vulnerable to erosion. Across the Corn Belt, studies show that topsoil erosion reduces crop yields by 6% annually, contributing to an estimated $2.8 billion in economic losses. Eroded soils also carry nutrients and pollutants into Minnesota's lakes and rivers, degrading water quality, harming fisheries, and increasing water treatment costs. Erosion is most severe after harvest when fields are left bare and exposed to rain, snowmelt, and runoff. Although cover crops are widely promoted for erosion control, their success depends on site-specific conditions such as soil type, slope, climate variability, and tillage practices. Minnesota's harsh winters and variable spring conditions further limit cover crop establishment. To ensure cover crops are effective, a precision agriculture approach is needed, one that uses technology and data to tailor cover crop use and management to local conditions. By integrating precision agriculture with cover crop strategies, Minnesota can lead in science-based solutions that reduce soil erosion, protect water, and strengthen rural communities.

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 aim to develop a precision erosion control strategy for Minnesota's corn-soybean farms by using cover crops in erosion-prone areas, tailored to local topography, soil type, and management plans. We will develop this precision control strategy through a combination of lab experiments, remote sensing, modeling, and field investigations. First, we will conduct controlled flume experiments at the Saint Anthony Falls Laboratory to assess the impact of native cover crops on soil erosion under various topographies, soil types, and tillage conditions. We will simulate different rainfall and runoff scenarios to identify the most effective cover crop species and planting strategies for erosion reduction. Second, we will integrate the lab results with remote sensing and the Water Erosion Prediction Project (WEPP) model to identify erosion-prone areas in the paired watersheds. Finally, we will implement the selected cover crops in the erosion-prone areas of one watershed and compare the resulting erosion across both watersheds. This research will provide evidence of the effectiveness of precision erosion control using cover crops to reduce soil erosion and offer guidance on implementing these strategies across Minnesota's diverse farm landscapes.

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 study will achieve three key outcomes that align with protecting and enhancing Minnesota's natural resources: (1) provide science-based recommendations for effective cover crop use to reduce soil loss under varying hillslope and soil conditions; (2) offer actionable guidance to Minnesota farmers on mitigating soil erosion while sustaining crop productivity; and (3) establish landscape-scale practical guidelines for the adoption of cover crops in corn-soybean systems, contributing to improved water quality and long-term soil health across the state.

Activities and Milestones

Activity 1: Flume Experiments to Identify Optimal Cover Crop and Planting Strategy for Erosion Control in Corn-Soybean Soils

Activity Budget: $146,298

Activity Description:
We will conduct controlled flume experiments to assess the effectiveness of cover crops in reducing soil erosion under various hillslope and soil conditions. This experiment leverages the agricultural expertise and experimental farms at the St. Paul campus and the world-renowned hydraulic testing capacity at the Saint Anthony Falls Laboratory (SAFL). Cover crops (cereal rye or winter wheat) will be grown at different densities in pots with representative soils at St. Paul. After reaching different growth stages, plants and soil will be transferred to the flume at SAFL, where slope and rainfall simulations will be conducted. We will evaluate cover crop performance in reducing soil erosion under different species, densities, and planting strategies. Erosion rates will be measured using a laser topography sensor, sediment transport through a sediment trap, and flow rate with an Acoustic Doppler Velocimeter. Infiltration and saturated hydraulic conductivity will also be measured using a constant-head permeameter. This data will help identify the most effective cover crop treatments for mitigating soil erosion, and we will develop an empirical equation to predict erosion rates, which will be incorporated into soil erosion prediction models in subsequent tasks.

Activity Milestones:

Description	Approximate Completion Date
Controlled flume experiments at St. Anthony Falls Laboratory	June 30, 2027
Publish the results in a journal article	March 31, 2028

Activity 2: Predict Soil Erosion Using WEPP Models and Develop Precision Cover Crop Planting Strategy

Activity Budget: $153,912

Activity Description:
We will utilize remote sensing, the Ag Conservation Practice Framework, and the Water Erosion Prediction Project (WEPP) models to identify erosion-prone areas in the paired watersheds in the Blue Earth watershed, Faribault County, MN. Currently, WEPP estimates the impact of cover crops on soil erosion by accounting for crop biomass above and below ground, affecting soil detachment and transport. To enhance this model, we will integrate a new soil erosion equation developed from laboratory flume experiments (Activity 1), which accounts for both cover crop biomass and infiltration on soil loss. This integration will enable more accurate erosion predictions in both watersheds, incorporating cover crops in one watershed. Based on these predictions, we will develop an optimal cover crop planting strategy for the treatment watershed to reduce soil erosion. The integrated model will assess the impact of different planting strategies, offering valuable insights into effective erosion control practices tailored to local conditions.

Activity Milestones:

Description	Approximate Completion Date
Modification of WEPP model to account for both cover crop biomass and infiltration	December 31, 2028
WEPP and ACPF simulations of soil loss with and without cover crops in Blue Earth	March 31, 2029
Publish the results in a journal article	June 30, 2029

Activity 3: Implement Cover Crop Strategy in One of Two Paired Watersheds and Compare Soil Erosion Outcomes

Activity Budget: $139,790

Activity Description:
We will design and implement a precision erosion control strategy in one of two paired watersheds in Faribault County based on the WEPP model and findings from the flume experiments. First, we will identify high-risk erosion areas using slope and sediment type maps. Then, we will develop targeted strategies for cover crop species, planting densities, and placement in these high-risk zones. The precision erosion control strategies will be applied to one watershed (CD 30), while the other (CD 62) will serve as a control. We will measure topography before and after several rainfall events using a terrestrial LiDAR scanner and assess turbidity at both watershed outlets with installed sensors. Erosion rates and suspended sediment flux will be calculated based on these measurements and the WEPP model. Results will be compared between the treated and control watersheds to evaluate the effectiveness of cover crops in reducing soil erosion in various hillslope and soil conditions. Our results will offer a scalable approach for mitigating erosion in Minnesota's corn-soybean systems.

Activity Milestones:

Description	Approximate Completion Date
Implement precision cover crop planting in watershed CD 30	June 30, 2028
Evaluate the impact of cover crops on soil erosion in CD 30 compared to CD	March 31, 2029
Publish the results in a journal article	June 30, 2029

Project Partners and Collaborators

Name	Organization	Role	Receiving Funds
Dr. Yuxin Miao	University of Minnesota	Dr. Yuxin Miao will lead field investigations in the two paired watersheds, using precision agriculture and remote sensing. He will ensure accurate data collection, collaborate with local farmers to implement cover crop strategies, and disseminate results for improved soil erosion management and sustainable agricultural practices.	Yes
Dr. Kyungsoo Yoo	University of Minnesota	Dr. Kyungsoo Yoo will select and characterize soil materials for the flume experiment and determine soil-related model parameters. He will assist in analyzing results, developing models, and characterizing soils and erosion rates in field experiments. Yoo will also contribute to data interpretation, result writing, and advising graduate students.	Yes
Dr. David Mulla	University of Minnesota	Dr. David Mulla, an expert in soil erosion, will lead the integration of lab results into the Water Erosion Prediction Project (WEPP) model. He will identify erosion-prone regions in the two paired watersheds, utilizing remote sensing and modeling techniques to enhance erosion predictions and guide the development of precision erosion	Yes
Dr. Eduardo Luquin Oroz	University of Minnesota	Dr. Luquin, an expert in soil erosion models, will assist in implementing the WEPP model and identifying erosion-prone regions in the two paired watersheds. He will apply remote sensing and modeling techniques to enhance erosion predictions and support the development of precision erosion control strategies.	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?

The results of this project will include an empirical equation for predicting soil erosion in regions with cover crops, along with an improved WEPP model. The WEPP model, widely used by the USDA, will enhance erosion prediction and mitigation efforts. After completion, we plan to submit a proposal to USDA's AFRI and NIFA to implement the model and support national erosion efforts. The AFRI program manager has expressed strong interest in our research, and the data generated will support broader USDA proposals, contributing to ongoing state-wide erosion prediction and mitigation efforts in Minnesota.

Other ENRTF Appropriations Awarded in the Last Six Years

Name	Appropriation	Amount Awarded
Mitigating Cyanobacterial Blooms and Toxins Using Clay-Algae Flocculation	M.L. 2022, , Chp. 94, Art. , Sec. 2, Subd. 04c	$326,000

Project Manager and Organization Qualifications

Project Manager Name: Judy Yang

Job Title: McKnight Land-Grant Assistant Professor

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

Dr. Judy Yang, the Principal Investigator (PI), is a McKnight Land-Grant Assistant Professor with expertise in fluid mechanics, sediment transport, and vegetation. With over a decade of experience conducting flume experiments, Dr. Yang specializes in sediment transport, particularly the role of vegetation in these processes. Her research on wetland sediment transport was recognized by the American Geophysical Union as a groundbreaking study that "shifts the

paradigm of coastal sediment modeling" (https://eos.org/research-spotlights/new-study-shifts-paradigm-of-coastal-sediment-modeling). Dr. Yang's lab conducts experiments using water-recirculating flumes at the Saint Anthony Falls Laboratory, which will be instrumental in studying soil erosion in this project. In the proposed LCCMR project, Dr. Yang will oversee the experimental design, implementation, and flume experiments to optimize cover crop use for reducing erosion. Co-investigators Drs. Yuxin Miao and Kyungsoo Yoo are experts in field investigations of agricultural farms and have established connections with local farmers. Dr. Miao also has access to the two watersheds included in this study. Co-investigators Drs. David Mulla and Luquin bring expertise in remote sensing and soil erosion modeling to predict and map soil erosion. Together, the team will co-mentor two half-time graduate students and design precision erosion control strategies tailored to reduce erosion in Minnesota's corn-soybean farms.

Organization: U of MN - St. Anthony Falls Laboratory

Organization Description:
St. Anthony Falls Laboratory (SAFL) is an interdisciplinary fluid mechanics research center known for its advanced facilities. It is equipped with water-recirculating flumes that simulate natural water systems. For this study, we will use the 15-meter-long tilting flume (https://cse.umn.edu/safl/tilting-bed-flume) at SAFL to investigate the role of cover crops in reducing soil erosion. The flume is equipped with a sediment trap to collect eroded soil and measure soil erosion rate, as well as a fully-automated data carriage that can move the sensors to any location in the flume. In addition, SAFL houses key instruments for the study, including Acoustic Doppler Velocimetry for flow velocity, cameras for particle tracking, and chemical sensors for temperature, pH, and salinity. SAFL also features a fully equipped machine and fabrication shop for the construction of custom research equipment and components. This shop is equipped with construction tools, scrap materials, protective equipment, workspaces, and vehicle access, supporting the development and modification of experimental setups as well as the proposed field work.

Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	$ Amount
Personnel								
Judy Yang		Project PI			36.6%	0.06		$13,416
Kyungsoo Yoo		Co-PI			36.6%	0.09		$14,818
Yuxin Miao		Co-PI			36.6%	0.09		$12,084
D. Mulla		Co-PI			36.6%	0.09		$20,616
Graduate Students		Two Graduate Students, total of .50			23.2%	1.5		$164,766
PostDoc Scholar		Postdoc Scholar for years 1 and 2 of the project			25.9%	0.2		$32,541
Undergraduate Research Assistant		Sample water and measure pathogens and microplastics in the stormwater ponds			0%	0.75		$58,650
James Tucker		One facility engineer for 10 hours per week to support in the fabrication and maintenance of floating treatment wetlands and help with the lab work and field work.			32.3%	0.75		$56,201
							Sub Total	**$373,092**
Contracts and Services								
							Sub Total	**-**
Equipment, Tools, and Supplies								
	Tools and Supplies	Laboratory materials and supplies	Costs for generating rainfall conditions, cultivating plants and supplies					$56,408
							Sub Total	**$56,408**
Capital Expenditures								
							Sub Total	**-**

Acquisitions and Stewardship								
							Sub Total	**-**
Travel In Minnesota								
	Other	Field work travel, including transportation and meals for the PI, 4 co-PIs, one senior personnel, two grad students and one undergraduate student	Field work to complete the project					$7,500
							Sub Total	**$7,500**
Travel Outside Minnesota								
							Sub Total	**-**
Printing and Publication								
	Publication	Publication costs	We expect 3 papers to be published					$3,000
							Sub Total	**$3,000**
Other Expenses								
							Sub Total	**-**
							Grand Total	**$440,000**

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				
In-Kind	Unrecovered F&A	Unrecovered F&A in the amount of 54%, minus tuition	Secured	$218,157
			State Sub Total	**$218,157**
Non-State				
			Non State Sub Total	**-**
			Funds Total	**$218,157**

Total Project Cost: $658,157

This amount accurately reflects total project cost?

Yes

Attachments

Required Attachments

Visual Component

File: 315ed8f8-9ee.pdf

Alternate Text for Visual Component

Visual Art...

Supplemental Attachments

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

Title	File
UMN SPA Letter	12e968ea-4c3.pdf
Letter of Support from Farmers	a46254a0-a0a.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:

Angela Boutch, St. Anthony Falls Laboratory

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