



# Environment and Natural Resources Trust Fund

## 2025 Request for Proposal

### General Information

**Proposal ID:** 2025-214

**Proposal Title:** Small Farm Challenge in the Root River Basin

### Project Manager Information

**Name:** Kyungsoo Yoo

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

**Office Telephone:** (612) 624-7784

**Email:** kyoo@umn.edu

### Project Basic Information

**Project Summary:** We will conduct mapping analyses of the environmental challenges unique to small farms and examine how vulnerable small farms are to soil and water sustainability in the Root River Basin.

**ENRTF Funds Requested:** \$244,000

**Proposed Project Completion:** June 30, 2027

**LCCMR Funding Category:** Small Projects (H)

**Secondary Category:** Foundational Natural Resource Data and Information (A)

### Project Location

**What is the best scale for describing where your work will take place?**

Region(s): SE

**What is the best scale to describe the area impacted by your work?**

Statewide

**When will the work impact occur?**

In the Future

## Narrative

### **Describe the opportunity or problem your proposal seeks to address. Include any relevant background information.**

SE Minnesota is unique. The region's rugged landscapes are characterized by bluffs, steep slopes, and deep valleys that attract visitors seeking recreational opportunities. People love SE Minnesota's landscapes, which are a mosaic of small farms, forests and rivers. Its complex topography does not support large-scale mechanized industrial agriculture, which is overwhelmingly present in the state. The region has been, and continues to be, a magnet for smallholder farmers.

Unfortunately, small farms are increasingly being left behind as economies of scale advance. Increasing returns to scale from modern agricultural technologies have led to farm consolidation and the increasing dominance of large farms. However, improving the low productivity of small farms and fields requires a first-order analysis of the landscapes, soils, and sustainability of soil and water resources that characterize small farms and fields.

No study has examined the agricultural conditions specific to small farms and fields in Minnesota. We do not yet know what specific soil and water sustainability issues are challenging small farmers. This lack of data is an important problem for securing the economic prosperity and environmental sustainability of Minnesota's small farms.

### **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.**

Our solution to the problem is to conduct mapping and map-based analysis of environmental conditions and impacts of agricultural fields by field sizes.

Our scientific understanding of water and land is largely based on studying them within systems defined by physical boundaries such as watersheds (between boundaries defined by ridges). But this is not how farmers own, sell, buy, rent, and operate farmland. The way agricultural plots or parcels are treated by farmers rarely overlaps with scientists' conceptualization of watersheds. In this project, we will analyze geospatial environmental data within field boundaries.

This LCCMR funding will allow this team of scientists from the University of Minnesota and the Science Museum of Minnesota to use public geospatial data to characterize topographic and soil properties of small farms and fields (relative to larger farms and fields) in the Root River Basin in SE Minnesota. Through geospatial modeling of runoff and soil erosion, we will illustrate the environmental niche of small fields in contrast to large fields and examine whether small farms and fields are more susceptible to environmental degradation such as the formation of rills and gulleys.

### **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?**

The outcomes will include characteristic ranges of slope steepness (limiting tractor use), solar energy (a function of slope and direction, affecting crop growth), drainage density (challenging transportation), soil depth (a result of balance between soil erosion and formation), etc. found in agricultural fields as a function of field size. We will also model runoff, soil erosion, and the frequency of rill and gully formation in smaller vs. larger agricultural fields. These results will inform agencies like the Minnesota Pollution Control Agency, which monitors streamwater quality in SE Minnesota. We will provide foundational data to help smallholders better use their lands.

## Activities and Milestones

### Activity 1: Focus on the Root River Basin

**Activity Budget:** \$24,400

**Activity Description:**

We seek to build long-term research in SE Minnesota (Yoo has an active USDA-SARE-funded research in the region). The Root River is a large watershed that covers 1,064,961 acres in southeastern Minnesota and drains to the Mississippi River. Six counties lie within the Root River watershed. While the basin is primarily rural and agricultural, it is known for offering many recreational opportunities. Springwater streams also provide excellent trout fishing opportunities.

Three distinct landforms are present in the Root River Basin. To the west, thick glacial till covers the underlying carbonate sedimentary rocks. This western upland is flat and its soils have developed from thick glacial deposits. The eastern end of the Root River is less affected by glacial activity, allowing active drainage networks to dissect sedimentary rocks and create complex landscapes of deep valleys, steep hills, and bluffs. Between these two landforms lies the rolling karst topography. Here, the soils are thin, and sinkholes, caves, and disappearing streams are common. Across the three landforms, the land generally becomes steeper from west to east, and the morphology of the landscapes becomes increasingly complex, providing the backdrop for this research project.

**Activity Milestones:**

Description	Approximate Completion Date
Building research network for long-term research presence in the Root River Basin	June 30, 2026

### Activity 2: Mapping and Map-based analyses

**Activity Budget:** \$122,000

**Activity Description:**

We will conduct mapping and map-based analysis. For mapping, we will use agricultural field boundary data from the USDA Agricultural Conservation Planning Framework (ACPF), parcel boundary maps available through Uspatial and MnGeo, a 1-m Digital Elevation Model (DEM) created from Light Detection and Ranging (LIDAR) data, 3-m Planetscope and 0.5-m Skysat satellite imagery available from PlanetScope through UMN Uspatial, and a soil survey map (SSURGO). The high-resolution DEM and satellite imagery allow us to zoom our biophysical analysis down to spatial scales much smaller than the smallest field. This allows us to characterize within-field variability in topographic attributes (i.e., slope, solar radiation energy), soil water attributes (i.e., wetness index, stream power index), and crop productivity (i.e., NDVI from satellite imagery) across the range of field sizes. We will also conduct detailed topographic and soil GIS analyses on select farms on the three distinct landforms in the Root River Basin. Those select farms will be subject to field visits to verify the information from the public geospatial data.

**Activity Milestones:**

Description	Approximate Completion Date
Compilation of public geospatial data and relevant training of a half-time graduate student	December 31, 2025
Mapping and map-based analyses of crop fields by their sizes data and training graduate student	December 31, 2026

### Activity 3: Modeling runoff and soil erosion

**Activity Budget:** \$73,200

**Activity Description:**

We will utilize the map-based analyses to develop a modeling framework to predict hydrology, sheet/rill erosion, and gully erosion from select small and large fields across the three distinct landforms. An ensemble modeling approach will be used whereby several different erosion models will be run concurrently for each field to decrease predictive uncertainty, given the limited availability of calibration data. Ensemble models will be selected based on input data requirements, proven applicability in Basin landscape and climate types, and achieving a mix of physically- and empirically-based formulations. Model scenarios will be developed from a set of representative snowmelt/rainfall events and soil moisture conditions, using a range of crop types and agronomic practices applicable to each field's size, soils, and topographic characteristics. Modeled hydrology/erosion predictions will be validated by comparison to those reported in literature. Modeling uncertainties will be quantified by repeating model runs while varying model parameters across a range of literature values.

**Activity Milestones:**

Description	Approximate Completion Date
Compilation of public geospatial data	December 31, 2025
Modeling runoff and soil erosion of crop fields by their sizes	December 31, 2026

**Activity 4: Presentation and Dissemination of Results**

**Activity Budget:** \$24,400

**Activity Description:**

As the team begins to present results, we will strategize different approaches for the academic, conservation practitioner, and general public audiences. We will seek out speaking opportunities at the Minnesota Water Resources Conference, the Midwest Soil Health Summit, and other related meetings of academics and conservation practitioners. A publication for resource management practitioners will take the form of a bulletin report. We will also publish web-based story maps to communicate our findings to the general public.

**Activity Milestones:**

Description	Approximate Completion Date
Collection of results for presentations and reporting	February 28, 2027
Publication of results via bulletin report and Story Map. Complete final reporting.	June 30, 2027

## Project Partners and Collaborators

Name	Organization	Role	Receiving Funds
Jason Ulrich	Science Museum of Minnesota	Modeling runoff and soil erosion in agricultural lands by farm/field sizes	Yes
Joel Nelson	University of Minnesota	Conducting geospatial analysis and training a graduate student on GIS	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?**

Our goal is to build long-term research in SE Minnesota. With Yoo's current USDA-funded research on vegetable farms in the Driftless Area, we are developing expertise in the region and connections with local farmers and agencies. On the other hand, how small farms in rugged landscapes can balance productivity and environmental sustainability is an ignored research question that is important also at a national scale. The combination of our growing research in SE Minnesota and the broader applicability of our question is a strong asset in our future pursuits of bringing federal funding to study SE Minnesota.

## Project Manager and Organization Qualifications

**Project Manager Name:** Kyungsoo Yoo

**Job Title:** Professor

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

Kyungsoo Yoo is a professor of soil geomorphology in the Department of Soil, Water, and Climate at the University of Minnesota. Yoo's research focuses on the interface between soil genesis, landscape evolution, and invasive earthworms. He has published 53 peer-reviewed journal articles and six book chapters on these research topics. His research has been funded primarily by the National Science Foundation (NSF) and the U.S. Department of Agriculture. He is currently serving as principal investigator on two projects funded by MITPPC and USDA. Yoo is also a recipient of the NSF CAREER grant, which is NSF's most prestigious award to support early-career faculty who have the potential to serve as academic role models in research and education and to lead advances in the mission of their department or organization. Yoo currently serves as associate editor of the Soil Science Society of American Journal and on the editorial board of the journal Geoderma. Yoo's qualifications to lead this project are also based on his decades of experience working on soils on hilly landscapes.

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

**Organization Description:**

The University of Minnesota System is a land grant institution with a mission of world-class education, groundbreaking research, and community-engaged outreach. The University of Minnesota contributes more than \$8.6 billion a year in economic activity to the state. Twelve academic departments and 10 research and outreach centers make up the College of Food, Agricultural, and Natural Resources Sciences (CFANS), along with the Minnesota Landscape Arboretum, the Bell Museum, and dozens of interdisciplinary centers. With a legacy of innovation — both the Honeycrisp apple and the process of artificially inseminating dairy cows were born here — CFANS research has made a difference, both large and small, in many lives.

## Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	\$ Amount
<b>Personnel</b>								
Principal Investigator Kyungsoo Yoo		Lead project and mentor graduate student. Included 3% annual increase.			37.1%	0.1		\$19,377
Graduate Research Assistant		Graduate student will conduct detailed GIS analysis on select small farms.			47%	0.5		\$56,474
Researcher Joel Nelson		Responsible for GIS analysis and for training a graduate student on GIS analysis. Included 3% annual increase.			33%	1		\$102,890
							<b>Sub Total</b>	<b>\$178,741</b>
<b>Contracts and Services</b>								
Science Museum of Minnesota	Sub award	Assist project team with formulating the overall project approach, conducting GIS analyses, and will lead the hydrologic- and soil erosion modeling activities.				0.5		\$54,347
							<b>Sub Total</b>	<b>\$54,347</b>
<b>Equipment, Tools, and Supplies</b>								
	Tools and Supplies	Desktop computer and hard disk for data storage	To conduct GIS analysis	X				\$2,800
							<b>Sub Total</b>	<b>\$2,800</b>
<b>Capital Expenditures</b>								
							<b>Sub Total</b>	-
<b>Acquisitions and Stewardship</b>								
							<b>Sub Total</b>	-

<b>Travel In Minnesota</b>								
	Miles/ Meals/ Lodging	5 day field trip to the Root River Basin for ground-truthing, 2 researchers, 500 miles X 0.67 dollar per mile, \$120 per day for 4 nights per person lodging, per diem: \$70 per person for 3 full days and \$30 per person for 2 half days	To field confirm the satellite data on select small farms.					\$3,670
	Conference Registration Miles/ Meals/ Lodging	Conference trips for 2 researchers. \$450 per person registration, 300 miles X 0.67 dollar per mile, \$120 per day for 3 nights per person lodging, per diem: \$70 per person for 2 full days and \$30 per person for 2 half days	To present the outcomes for water/soil resources managements and farmers meetings.					\$4,442
							<b>Sub Total</b>	<b>\$8,112</b>
<b>Travel Outside Minnesota</b>								
							<b>Sub Total</b>	-
<b>Printing and Publication</b>								
							<b>Sub Total</b>	-
<b>Other Expenses</b>								
							<b>Sub Total</b>	-
							<b>Grand Total</b>	<b>\$244,000</b>

## Classified Staff or Generally Ineligible Expenses

Category/Name	Subcategory or Type	Description	Justification Ineligible Expense or Classified Staff Request
<b>Equipment, Tools, and Supplies</b>		Desktop computer and hard disk for data storage	A well-functioning desktop PC is essential for extensive GIS analysis. High-density geospatial data is the core of this proposed project. \$2,800 is requested for a desktop PC with monitor and large hard disk storage.



Non ENRTF Funds

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

**Total Project Cost: \$244,000**

**This amount accurately reflects total project cost?**

Yes

## Attachments

### Required Attachments

#### *Visual Component*

File: [287197f2-979.pdf](#)

#### *Alternate Text for Visual Component*

Topographic map of the Root River Basin with a photo of a typical small farm in SE Minnesota....

### Supplemental Attachments

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

Title	File
University of Minnesota Support Letter	<a href="#">c1a02cf8-39d.pdf</a>

## Administrative Use

**Does your project include restoration or acquisition of land rights?**

No

**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:**

Sue Kilber <skalenze@umn.edu>