Environment and Natural Resources Trust Fund

2026 Request for Proposal

General Information

Proposal ID: 2026-101

Proposal Title: Visible Resilience: Soil Health for Land and Water

Project Manager Information

Name: Anna Cates

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

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Project Basic Information

Project Summary: We will provide land managers with visual evidence of resilient agricultural management by evaluating soil response and water movement after intense rain across a gradient of agricultural management.

ENRTF Funds Requested: $574,000

Proposed Project Completion: June 30, 2029

LCCMR Funding Category: Resiliency (A)

Project Location

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

Region(s): SW

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

Region(s): Central, SE, SW,

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.

Resilience to intense storms will be increasingly important across Minnesota's agricultural lands as the frequency of intense rainfall events is expected to increase by midcentury. In cropland, intense rainfall can bring flushes of eroded sediment and nutrients to waterways, as well as delay field work, and reduce or even fully destroy crops. Large amounts of runoff from agricultural lands can also damage local infrastructure such as culverts and roads. We know ground cover reduces erosion, but measuring soil response to rain is challenging and labor-intensive, so the magnitude of flood reduction soil health management systems (SHMS), including reducing tillage and planting cover crops, remains unclear. Local measurements showing and quantifying resilience to large storms could help open eyes of policy-makers.

On the agronomic side, it's challenging to motivate farmers to adopt SHMS for the societal benefits alone, as each farmer faces unique social, economic, and logistical barriers to changing practices. However, we hear anecdotal evidence that SHMS improve water behavior, allowing farmers to get into the field sooner after rain. Quantifying this benefit through field-scale simulation could help land managers see clear on-farm payoffs for cover crops and reducing tillage, justifying the expense and risk associated with new practices.

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 motivate change, we will use local, visual data to tell the story of how soil water movement may be sped or slowed by management, directly addressing the stress of recent wet springs and dry summers. Soil resilience, specifically reduced runoff and strong soil structure after intense rains, directly links soil properties farmers can see, like soil structure, and processes that matter at the local and regional scale, like water transport.

Specifically, we will conduct large-scale rain simulations in working fields, measure runoff and nutrient loss, and follow the soil structure's return to a pre-rain condition as a measure of resilience. Using pore visualization, we can capture whether each system has the ability to move water from the surface to deeper layers, and from large pores to small pores, which will explain runoff outcomes. Adding dye tracers, we both quantify and visualize the travel time of water through the soil system on a field scale. We will integrate these agronomic, soil, and hydrologic outcomes into online, hard copy, and in-person educational materials to disseminate statewide. Building on existing successful Extension programming and partnerships with local and state agencies, we anticipate reaching a wide range of stakeholders and decision-makers.

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?

By visualizing soil resilience to intense rain, we can promote conservation practices to new audiences. We will increase awareness of the impacts of large storms, catalyze local conversations around policy to incentivize transition to conservation practices, and empower landowners to reduce their own risk. This will help retain soil, reduce flooding damage to local infrastructure, and mitigate storm impacts. Specifically, we will target local government staff through Minnesota Office for Soil Health networks and Board of Water and Soil Resources trainings. Local staff can inspire farmers with our high-impact visuals as well as allocate resources based on project findings.

Activities and Milestones

Activity 1: Assess soil structure response to rainfall in contrasting management systems using traditional and novel methods

Activity Budget: $259,273

Activity Description:
To show how soil management can alter landscape resilience, we will perform simulated 200-year rain events in three management systems on the same landscape position and soil type: 1) SHMS, cropland managed with reduced tillage and cover crops, 2) conventional cropland managed with full-width tillage and low diversity rotation and 3) perennial pasture. To observe the resilience of soil structure after these storms, soil samples before, immediately following, 2 and 5 days following will be taken. Aggregate stability, particulate and mineral-associated organic matter will be measured to track organic matter storage, and we will use X-ray micro-computed tomography to visualize the 3D pore structure. Using 3D soil structure data, we will quantify pore size distribution, permeability, connectivity, soil aggregation, and soil organic matter pools. We anticipate that systems in soil health management will have more connections between large pores, which move water, and small pores, which hold water. During rainfall simulation, we will also measure runoff and sediment loss, which we also expect to be lower in soil health systems, reflecting more water capture. Our detailed assessment of soil pore connectivity will help us explain why runoff outcomes differ, and the process of soil recovery after intense rain.

Activity Milestones:

Description	Approximate Completion Date
Select sites representing SHMS cropland, conventional cropland, and pasture on similar soil types	December 31, 2026
Run 10-15 rainfall simulations across sites	November 30, 2027
Analyze soil and water data from rainfall simulations	July 31, 2028
Develop educational materials for Activity 3 outreach based on rainfall simluations	March 31, 2029

Activity 2: Predict water residence time in contrasting management systems

Activity Budget: $259,050

Activity Description:
Building on the simulated storms in Activity 1, we will conduct dye and bromide tracing during simulated rainfall to track how water applied during an intense storm makes its way into the watershed. Specifically, we will install sensors in tile lines below the rainfall simulation in order to evaluate rate of water movement to the edge of the field, and perform destructive sampling under the rainfall simulation space after 5 days in order to estimate tracer movement throughout the soil profile. Both the dye and bromide tracers are well validated detection methods, and by comparing dye and bromide found in runoff, soil at different depths, and tile water across systems, we can estimate soil water residence time in contrasting systems. This will provide a robust estimate of not only cropping system resilience in intense rains, but also how that cropping system will deliver water from an intense rainfall to the edge of field, which will have downstream consequences on peak flow timing and duration. Paired with the soil responses measured in Activity 1, this will allow us to link soil properties (pore features, organic matter, aggregation) with consequential edge-of-field outcomes.

Activity Milestones:

Description	Approximate Completion Date
Select sites representing SHMS cropland, conventional cropland, and pasture on similar soil types	December 31, 2026

Run 3-5 dye and bromide tracer experiments in contrasting management systems	November 30, 2027
Analyze dye and bromide tracer data	July 31, 2028
Develop educational materials based on dye and bromide tracers for Activity 3 outreach	March 31, 2029

Activity 3: Outreach around managing agricultural lands for extreme weather and climate resilience

Activity Budget: $55,677

Activity Description:

Using measurements of soil pores, organic matter and aggregates, and water movement, we will build dynamic, visual representations of soil resilience. These materials will be presented by UMN Extension, University of Minnesota Climate Adaptation Partnership (MCAP), and partners, through multiple outreach formats. For farmer-facing events, we will focus on how soil resilience may alter field working days. Materials and events engaging local policy-makers will leverage dye tracer accounting of water storage to discuss flood planning. We will update the MCAP resilient farm planner tool, which offers guidance on climate risks and long-term farm planning, and use it in adaptation trainings with farmers and advisors.

Specifically, we will host 1-3 weather-resilience field days for farmers and agricultural advisors building our visual measurements into research-backed management tools to protect soil functions in extreme weather conditions. We will host 1-3 trainings for local governmental units, such as sessions at the Board of Soil and Water Resources Academy and Area meetings. To reach the public and stakeholders, we will share videos and photos of the data collection via UMN Extension and MCAP social media pages, generating interest in project outcomes across sectors.

Activity Milestones:

Description	Approximate Completion Date
Update Resilient Farm Planner tool	October 31, 2027
Weather resilience field day	September 30, 2028
Social media posts highlighting project activities and findings	June 30, 2029
1-3 trainings for local government units	June 30, 2029
Farmer adaptation training	June 30, 2029

Project Partners and Collaborators

Name	Organization	Role	Receiving Funds
Dr Peter Kang	University of Minnesota	Co-PI, will lead Activity 2 and pore visualizations in Activity 1 and co-advise graduate student.	Yes
Dr Jessica Gutknecht	University of Minnesota	Co-PI, will assist with Activities 1 and 2 and co-advise a graduate student	Yes
Kyungsoo Yoo	University of Minnesota	Co-PI, will advise on Activities 1 and 2 and co-advise graduate student	Yes
Bailey Tangen	University of Minnesota Extension	Co-PI, assist with field work in Activities 1 and 2, co-lead Activity 3 to develop outreach materials	Yes
Katie Black	University of Minnesota Extension	Co-PI, co-lead Activity 3 to develop outreach materials.	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?

Outreach plans are outlined in objective 3, a collaboration across UMN Extension, Minnesota Climate Adaptation Partnership (MCAP), Minnesota Office for Soil Health (MOSH), and UMN Water Resources Center. MOSH funds Cates' time and travel and outreach activities by Cates and Tangen, so more effort will be expended on implementation and outreach than reflected in the proposal. Cates, Tangen, and Black will present results in their 20-30 annual events during and after the project and integrate visuals into online materials, to reach a broad audience of land managers and local policy makers, beyond targeted events highlighting multimedia project results.

Project Manager and Organization Qualifications

Project Manager Name: Anna Cates

Job Title: Assistant Professor and Extension Specialist in Soil Health

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

Cates leads the MN Office for Soil Health. She works statewide to deliver research-based education on the effects of conservation cropping systems on agronomic and environmental outcomes. Her Extension program encompasses training for local conservation staff at the regional and state level, 20-25 farmer-facing talks per year, and leading the MN Cover Crop Academy. She holds a PhD in Agronomy and MS in Soil Science and Agroecology from UW-Madison. She manages a multi-million dollar research program supervising 4-6 graduate students and staff.

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

Organization Description:

UMN-CFANS is a regional and global leader in research, education and outreach in agriculture and the natural resources.

Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	$ Amount
Personnel								
Faculty researcher-Kang		Will lead Activity 2 and advise graduate student			26.8%	0.06		$13,051
Faculty researcher-Yoo		Will support activities 1 and 2, co-advising graduate students			26.8%	0.06		$14,819
Faculty researcher-Gutknecht		Will support Activity 1 and co-advise graduate student			26.8%	0.06		$12,143
Faculty researcher-Cates		Cates will coordinate all project activities, co-advise soils graduate student			26.8%	0.09		$19,844
Extension Educator-Black		Black will co-manage Activity 3			26.8%	0.06		$6,535
Extension Educator-Tangen		Tangen will assist with all activities, and co-lead Activity 3			26.8%	0.15		$13,438
Research Staff- LaBine		LaBine will support field activities in Activity 1 and 2			24.4%	0.3		$23,420
Research staff- Hallett		Will support field activities in Activity 1 and 2, coordinate lab C and N analysis			24.4%	0.2		$14,524
Research staff- TBD		Researcher in Kang lab will support field and lab work for Activity 2, and core imaging			24.4%	0.3		$22,492
Undergrad research assistant		Undergrad research staff will assist with field work and sample processing			0%	0.54		$17,960
Graduate research assistant-Soils		Graduate RA will assist with experimental design and implementation and lead analysis of Activity 1 results			46%	1.5		$177,928
Graduate Research Assistant-Geology		Graduate RA will assist in experimental design and implementation, and lead analysis of results from Activity 2			45.7%	1.5		$180,156

							Sub Total	**$516,310**
Contracts and Services								
Farmer cooperator payments	Service Contract	Farmers providing land for experimental sites will be compensated $1000 flat fee				0.01		$3,000
Research Analytical Lab	Service Contract	To analyze Bromide in tracer samples from soil water, runoff, and tile lines, $21/sample x 20 samples/treatment x 3 treatments				0		$1,260
Research Analytical Lab	Service Contract	To analyze nitrate and P in runoff samples, approximately 25 samples/rain event x 15 rain events, $30/sample				0		$11,250
X-ray computed tomography scanner fees	Internal services or fees (uncommon)	$150/sample for 75 samples for soil visualization in UMN Geology department				0		$11,250
							Sub Total	**$26,760**
Equipment, Tools, and Supplies								
	Tools and Supplies	Field and lab work supplies for Activities 1 and 2	Buckets, sample bags, sample bottles, rainfall simulator repair items, dyes will be purchased for field work. For lab work, tins and bottles for samples, x-ray machine repair supplies will be purchased.					$12,580
							Sub Total	**$12,580**
Capital Expenditures								
							Sub Total	**-**
Acquisitions and Stewardship								
							Sub Total	**-**
Travel In Minnesota								

	Miles/ Meals/ Lodging	Travel in Minnesota is budgeted to visit field sites first to scope out sites (4 trips in year 1 at estimated at 300 miles/trip, $0.7/mile, total $840) and then to complete field work in year 2 (12 trips at 300 miles/trip, $0.7/mile, plus $1000 to accommodate overnight stays for field staff) total $3520. In year 3, 3 trips to present findings to farmer collaborators and broader audiences are budgeted at 300 miles/trip, total $630. Total Minnesota travel is $4990.	Visiting field sites for data collection					$4,990
							Sub Total	**$4,990**
Travel Outside Minnesota								
	Miles/ Meals/ Lodging	Travel within the US is budgeted for PI Kang and his student to process samples at the University of Georgia, with two people traveling per trip in Years 2 and 3, $3000/year. The budget includes $500 for flight & local transportation, $600 for accommodation, and $400 for per diem per person per trip.	Travel to the University of Georgia is to conduct X-ray computed tomography (XRCT) scanning of soil core	X				$6,000
	Conference Registration Miles/ Meals/ Lodging	Travel in the US is budgeted for 4 individuals (students and PIs) to present results at national conferences in year 3. For each individual trip, we estimate $500 conference registration, $500 flight, $200/night hotel stay for 3 nights, and $240 per diem, $1840/trip, total $7360.	In order to communicate findings and learn about relevant research in other parts of the US, researchers will attend and present findings at conferences	X				$7,360
							Sub Total	**$13,360**
Printing and Publication								
							Sub Total	**-**
Other Expenses								
							Sub Total	**-**
							Grand Total	**$574,000**

Classified Staff or Generally Ineligible Expenses

Category/Name	Subcategory or Type	Description	Justification Ineligible Expense or Classified Staff Request
Travel Outside Minnesota	Miles/Meals/Lodging	Travel within the US is budgeted for PI Kang and his student to process samples at the University of Georgia, with two people traveling per trip in Years 2 and 3, $3000/year. The budget includes $500 for flight & local transportation, $600 for accommodation, and $400 for per diem per person per trip.	Travel to the University of Georgia is to conduct X-ray computed tomography (XRCT) scanning of soil cores, which is an important novel method applied in this study. Travel is limited to minimum days required to complete lab work.
Travel Outside Minnesota	Conference Registration Miles/Meals/Lodging	Travel in the US is budgeted for 4 individuals (students and PIs) to present results at national conferences in year 3. For each individual trip, we estimate $500 conference registration, $500 flight, $200/night hotel stay for 3 nights, and $240 per diem, $1840/trip, total $7360.	In order to communicate findings and learn about relevant research in other parts of the US, researchers will attend and present findings at conferences held in US relevant to fields of agriculture and hydrology.

Non ENRTF Funds

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

Total Project Cost: $574,000

This amount accurately reflects total project cost?

Yes

Attachments

Required Attachments

Visual Component

File: 0f9f68a1-104.pdf

Alternate Text for Visual Component

The image shows how water travels further, and is more dispersed, in a healthy soil under pasture than a tilled cropland soil. A no-till cover cropped soil is in between. The soil structure is visualized by an Xray of soil pores, which are larger and more connected in healthy soil....

Supplemental Attachments

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

Title	File
Board letter of authorization from UMN	3ff6c794-892.pdf
Support letter from MN Dept of Agriculture	1708ab0d-235.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:

Victoria Troxler, UMN Sponsored Projects Administration

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