Environment and Natural Resources Trust Fund
2025 Request for Proposal

General Information

Proposal ID: 2025-241

Proposal Title: Foundational Precision Agriculture Data to Reduce Environmental Impacts

Project Manager Information

Name: Joel Tallaksen

Organization: U of MN - WCROC

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Project Basic Information

Project Summary: Foundational data from sentinel farms, BMPs, and training will be developed to support adoption of precision agricultural technologies. These optimize fertilizer and chemical input use, improving water and air quality.

ENRTF Funds Requested: $1,457,000

Proposed Project Completion: June 30, 2028

LCCMR Funding Category: Foundational Natural Resource Data and Information (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.

Precision agriculture technologies have the potential to revolutionize agriculture by reducing the over-application of fertilizers, chemicals, and water in cropping systems, which will dramatically lower agriculture's impacts on the environment. Despite the growing availability of these precision technologies, many farmers have not fully adopted them due to unclear financial benefits, a need for unbiased performance information, and limited guidance on implementation.

Precision agriculture leverages high-resolution mapping of farm fields and many pieces of crop, soil, and plant data to determine the appropriate inputs and management for specific sections of a field. By tailoring their inputs to the needs of specific areas, farmers can reduce the overuse of inputs. Excess fertilizer and chemicals often leach from the field and contaminate nearby soil and water bodies. Excess irrigation can put stress on aquifers and promotes surface and sub-surface runoff of chemical inputs.

Traditional whole-field fertilization and chemical application rates are supported by a comprehensive set of best management practices (BMPs), developed using long-term Minnesota-specific farm trial data. However, no such data set or BMPs exist for precision agriculture. This lack of foundational information presents a significant obstacle to develop BMPs for farmers who might transition to this more environmentally friendly technology.

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 propose establishing the University of Minnesota's agricultural Research and Outreach Centers (ROCs) as sentinel agricultural data collection points for the vital foundational information required to advance precision agriculture adoption. Over the past century, ten ROCs have gathered foundational climate data across Minnesota's agricultural and forestry lands, which has greatly contributed to current regional climate models. Three of these regional ROCs, Southern (Waseca), Rosemount, and West-Central (Morris), are well position to serve as a sentinel network of farms to collect precision agricultural data as they represent much of Minnesota's diverse cropping systems, soils, and micro-climates.

Agronomy researchers at these locations will create the data collection systems necessary to combine satellite imaging, drone spectral analysis, crop performance data, soils data and GIS information into a data set to develop precision agriculture best management practices (BMPs). The project team will compare these recommendations with conventional management, by conducting ground-truthing using standard field-based scouting and soil testing.

This work will answer critical questions like 'how much can precision agriculture reduce fertilizer usage?' and 'what are the potential improvements to our critical groundwater and aquatic habitats from these reductions?'. The ROCs will craft and disseminate related outreach content for our stakeholder community.

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 long-term goal of this effort is to protect the State's land and water resources from over-application of agricultural inputs. To meet that goal,The broad objective of this project is developing the foundational information to hasten adoption of precision technologies. The specific outcomes are 1) collection of modeling data for precision agriculture, 2) developing BMPs with the data, and 3) educating farmers about precision technologies and why they are beneficial for the state's 25 million acres of cropland. Another direct outcome is that the sentinel ROC farms will reduce inputs on up to 5000 acres of University owned land.

Activities and Milestones

Activity 1: Establishing Foundational Data Collection Systems at Sentinel Farm Sites

Activity Budget: $437,258

Activity Description:
Developing the foundational data set will initially involve identifying the software and methods needed to collect and manage data from different sources, import it into a unified data set, and make it so that researchers can effectively access and use the massive data set. This data will contain high resolution pictures (photometry) from drones and commercial satellites, tractor and agricultural implement GIS data, which links to yield data from combines and silage harvesters, and soil sensing data from various farming implements. The research team will need to evaluate how data with different formats, resolution, and overall quality can be combined and what information is most important for meeting environmental and farmer goals. Data from this work will be permanently stored in the University's archival records system, which allows secure but accessible storage.

During this process, the team will review other commercial and research precision agriculture data sets to gauge the performance that others have observed in different precision technologies and the relative strengths and weaknesses noted. The research team will also examine how differences in equipment, field or crop conditions, or available data from the sentinel sites could impact the ability to develop statewide cropping guidance.

Activity Milestones:

Description	Approximate Completion Date
Establish initial data collection systems	December 31, 2025
Test technologies, data accuracy and data collection systems	December 31, 2027
Final report on data collection, collection equipment, and methods	June 30, 2028

Activity 2: Development and Optimization of BMPS, Financial Data, and Environmental Impacts.

Activity Budget: $782,500

Activity Description:
The research team will develop and test prescriptive cropping recommendations for the sentinel farms using data from activity 1. These recommendations will be implemented at the sentinel sites using specialized variable rate precision agricultural implements which can vary seed rates, fertilizer rates, and pesticide application across the field. The recommendations will be ground truthed using soil grid sampling, traditional scouting, and yield analysis.

With this data and ground truthing efforts, we will record and model the potential reductions in inputs when implementing precision technologies. The input reductions will be used to predict likely changes to Minnesota's total fertilizer and chemical inputs and how broad adoption of the technology will improve Minnesota's water quality. The input reductions will also be used to examine how greenhouse gas emissions and fossil energy use are impacted by employing precision technology. As a final step, the financial savings from these input reductions will be calculated.

All of this information will be used to create a set of best management practices (BMPs) for precision agriculture in Minnesota. These will include specific information on the different types of technologies, where farmers can acquire commercial data, and how to best integrate the technology and data into their operations.

Activity Milestones:

Description	Approximate Completion Date
Review commercial and scientific literature	June 30, 2026
Analyze data and create Initial BMPs	December 31, 2026
Final Report with financial findings and BMPs	June 30, 2028

Activity 3: Dissemination of Farmer and Crop Consultant Outreach

Activity Budget: $237,242

Activity Description:

BMPs and other knowledge gained in activity 2 will be developed into outreach content that highlights the practical, economic, and environmental impact issues surrounding precision agriculture technologies. While farmers are the primary target of these dissemination efforts, the outreach will also inform researchers, policy makers, and the general public. Developed in a farmer-friendly tone, this outreach information will likely need to be introduced in a somewhat less technical format to begin discussions with farmers. As these farmers engage more, detailed technical considerations can be covered. We will particularly emphasize the 'how-to' of integrating a farmer's cropping equipment and data into a precision agriculture system and the mindset for using the information. A highly effective method we will develop is a well laid out case study that highlights the data that our sentinel farms have collected, the way we have used our yield, financial, and input data, and the estimated financial savings.

Communication with farm audiences will be primarily via tours of our facilities, web pages, fact sheets, and workshops. We will also interact with our audiences at regional and national farming conferences, including the Midwest Farm Energy Conference and Farm Fest.

Activity Milestones:

Description	Approximate Completion Date
Develop initial materials to guide farmers	June 30, 2026
Finish publication of BMPs	March 31, 2028
Finalize website with all content	June 30, 2028

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?

This proposal is an important first step for developing the data collection systems to help evaluate and implement precision agriculture technologies. We intend that work be self-sustaining after the groundwork has been developed. Data would be collected during our regular farming operations. Research findings and updates to management recommendations would be posted on our website and at outreach events.

However, research on further precision technologies or increasing the number of sentinel farms collecting data may benefit from additional funding. Based on the future directions, we could seek out funding from a number of sources including the USDA, MDA, or LCCMR.

Other ENRTF Appropriations Awarded in the Last Six Years

Name	Appropriation	Amount Awarded
Mitigation Strategies for Agroplastic PFAS and Microplastic Contamination	M.L. 2022, , Chp. 94, Art. , Sec. 2, Subd. 04j	$169,000

Project Manager and Organization Qualifications

Project Manager Name: Joel Tallaksen

Job Title: Plant Sciences Research Manager

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

Dr. Tallaksen's current efforts examine a wide array of strategies for improving the resiliency of farming, with a primary focus on environmental and energy issues in agriculture. His goal is to reduce or optimize farm inputs, such as energy or fertilizer, in ways that create productive systems that use fewer resources and have fewer environmental impacts. These are core topics of agricultural resilience, which looks at the long-term viability of agriculture in the context of soil and environmental health, economic well-being, and human capital of our farming communities. Making improvements to farm systems often involves working in combination with farmers, policy makers, businesses, and the public to balance the competing interests and responsibilities. Working with a diverse team of animal and crop farmers, researchers, Extension staff, and students, Dr. Tallaksen can examine complex agriculture problems and disseminate the results to the diverse audiences he works with. Much of his research uses modeling techniques to evaluate the environmental, energy, and economic aspects of the system he studies. One important research tool he uses is life-cycle analysis (LCA), which examines the energy required and greenhouse gases emitted in a variety of livestock and cropping systems. However, the diverse nature of his work relies on data and methods from various fields

Recent Projects involving Dr. Tallaksen:
• Improving alfalfa-based livestock forage production systems using life cycle assessment.
• Breaking barriers to organic swine transition: Utilizing cover crops as feed ingredients to reduce feed cost.
• Evaluate different energy sources for renewable ammonia fertilizer production using life cycle methods.
• Integration of renewable and efficient energy technologies into green energy consumed in the agricultural production system.
• Environmental Footprints for Regional Swine Production Systems: Now and in the Future – A Demonstration

Pilot Project.
- Optimizing Renewable Electricity Generation on Minnesota Dairy Farms.

Organization: U of MN - WCROC

Organization Description:
The University of Minnesota is a world class educational and research institution with campuses and research centers throughout the state. The combination of exceptional faculty and staff knowledge with the latest in research facilities and equipment gives the University of Minnesota the ability to consistently conduct ground-breaking research.
The West Central Research and Outreach Center is one of the University's living laboratories where agricultural research can be demonstrated at scale and it serves as a regional center for agricultural stakeholders to discuss current issues in agriculture with a variety of field experts. The decades of farm research that WCROC has conducted has built working relationships with farmers and stakeholders that allow us to work on their farms and get honest feedback from them. Recently, the resilience of Minnesota farms has been tested as farmers are asked to provide food, feed, and fuel for the nation at the same time they are being asked to do it at a low cost, with a small environmental footprint. WCROC and its research partners have been developing a number of tools and strategies to increase the economic and environmental resilience of the state's farm communities to meet these challenges.

Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	$ Amount
Personnel								
Research Manager/Project Director		Direct project Activities, review all research activities, and coordinate activities between the sentinel ROC locations.			37.1%	0.9		$90,709
Agronomy Managers (3)		Agronomy managers at each site will direct on-site project activities. Examine farm impacts and help develop and review BMPs.			35.9%	1.8		$175,014
Researchers		Precision Ag researchers will be located at each site and do the day to day work of building databases, reviewing commercial and scientific literature, and working with the agronomy team to develop useful precision agriculture systems for their Sentinel Location.			33.5%	9		$559,819
Student Research Intern		Interns will assist the researchers in literature review and field work. We would select candidates interested in agricultural technologies as part of developing a skilled cohort.			0%	2.25		$72,690
Communications professional		The communication professional will work on website, audio, and video for activities for our educational outreach and dissemination.			33.5%	0.25		$21,694
							Sub Total	$919,926
Contracts and Services								
TBD	Professional or Technical Service Contract	The entity(ies) selected would provide satellite imaging data for the project. This is typically a flat per acre of land per year costs. It is digital and does not require labor.				0		$12,000
TBD	Professional or Technical Service Contract	Agronomic testing service to perform soil mapping at sentinel sites. This service is typically charge based on a flat per acre fee that varies with the resolution of mapping.				0		$40,000
U of M soil Testing Lab	Internal services or fees (uncommon)	Agronomists and researchers will send soil samples to the testing lab to evaluate performance of precision agriculture modeling efforts.				0		$14,000

								Sub Total	$66,000
Equipment, Tools, and Supplies									
	Equipment	Unmanned Aerial vehicles and supplies for each sentinel location	Purchase of unmanned aerial vehicles (UAV or drone) and related high resolution, multiple spectrum imaging equipment, plus equipment and replacement parts needed for operation.						$47,000
	Equipment	Geospatial Imaging Computer Workstations and Software	These workstations (one for each location) are needed to process the large imaging and soil datasets needed for precision agriculture work. This would also include the software licenses/fees for necessary geo-image analysis.	X					$32,000
	Tools and Supplies	General Research Supplies	The supplies will be used for collecting samples, recording data, and working in the field.						$8,234
								Sub Total	$87,234
Capital Expenditures									
		Variable rate agricultural Equipment	We will acquire three pieces of variable rate cropping equipment (sprayer, fertilizer spreader, and manure wagon) to test the managmenet plans and best management practices developed as part of the research.	X					$369,500
								Sub Total	$369,500
Acquisitions and Stewardship									
								Sub Total	-
Travel In Minnesota									
	Miles/ Meals/ Lodging	Estimated 6400 miles over 3 years at $0.67 per mile	Travel between research sites and outreach events						$3,840

	Conference Registration Miles/ Meals/ Lodging	Estimated 5 trips (1 person) at $1500, including mileage, lodging, meals for 3-day conference.	These conference/event expenses will support our dissemination efforts at events like FarmFest, Ag Expo, and the Minnesota Organic Conference.						$7,500
								Sub Total	**$11,340**
Travel Outside Minnesota									
-								**Sub Total**	-
Printing and Publication									
	Printing	Printing of outreach materials and posters	This printing would support our dissemination efforts by having handouts for our stakeholders.						$3,000
								Sub Total	**$3,000**
Other Expenses									
-								**Sub Total**	-
								Grand Total	**$1,457,000**

Classified Staff or Generally Ineligible Expenses

Category/Name	Subcategory or Type	Description	Justification Ineligible Expense or Classified Staff Request
Equipment, Tools, and Supplies		Geospatial Imaging Computer Workstations and Software	Processing imaging data is generally done on specialized computers that are faster, have better graphics capabilities, and more memory than standard workstations. These would need to be special ordered to meet the project's needs.
Capital Expenditures		Variable rate agricultural Equipment	The added equipment is a key piece of precision agriculture, being able to selectively apply different rates of inputs to a field. Each piece of equipment fills a specific role that is needed to analyze precision agricultural recommendations. **Additional Explanation :** This equipment will be part of our agronomic research and production going forward. The normal life of our equipment at these locations is 15+ years.

Non ENRTF Funds

Category	Specific Source	Use	Status	Amount
State				
In-Kind	University of Minnesota Indirect Costs	The University of Minnesota is forgoing the typical 55% federally negotiated indirect cost recovery normally associated with research grants. This funding covers facilities, support staff, and other University activities that are not directly part of the research, but must be present to support research activities.	Pending	$801,350
			State Sub Total	**$801,350**
Non-State				
-			**Non State Sub Total**	-
			Funds Total	**$801,350**

Total Project Cost: $2,258,350

This amount accurately reflects total project cost?

    Yes

Attachments

Required Attachments
Visual Component
File: f7648930-863.pdf

Alternate Text for Visual Component
The graphic has three panel- The location of the sentinel sites in Minnesota, Nitrates in drinking water in the state, and an example of how precision agriculture works for pesticide management....

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

Title	File
U of M Resolution Letter Tallaksen Precision Ag	f091c610-8a2.pdf

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?

No

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:

The project manager was assisted in proposal completion by staff at the University of Minnesota- Sponsored Projects Administration.