Environment and Natural Resources Trust Fund

M.L. 2025 Approved Work Plan

General Information

ID Number: 2025-241

Staff Lead: Mike Campana

Date this document submitted to LCCMR: June 9, 2025

Project Title: Foundational Precision Agriculture Data to Reduce Environmental Impacts

Project Budget: $1,255,000

Project Manager Information

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Project Reporting

Date Work Plan Approved by LCCMR: June 24, 2025

Reporting Schedule: March 1 / September 1 of each year.

Project Completion: June 30, 2028

Final Report Due Date: August 14, 2028

Legal Information

Legal Citation: M.L. 2025, First Special Session, Chp. 1, Art. 2, Sec. 2, Subd. 03x

Appropriation Language: $1,255,000 the first year is from the trust fund to the Board of Regents of the University of Minnesota for the West Central Research and Outreach Center at Morris to establish data collection systems and methods at sentinel farm sites, develop and evaluate best management practices, and provide outreach and training to farmers to encourage adoption of precision agriculture technologies that reduce fertilizer and chemical use and improve water and air quality.

Appropriation End Date: June 30, 2028

Narrative

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.

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.

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

Activities and Milestones

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

Activity Budget: $359,560

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: $698,411

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
Model and implement input reductions on over 5000 acres of University Cropland	June 30, 2028

Activity 3: Dissemination of Farmer and Crop Consultant Outreach

Activity Budget: $197,029

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
Have demonstrations and/or displays at least 4 farmshows to include Farmfest and MN AgExpo	January 31, 2028
Finish publication of BMPs	March 31, 2028
Finalize website with all content	June 30, 2028
Conduct an average of 3 tours per year that include precision ag content	June 30, 2028

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.
Activity 3 is dedicated to the dissemination efforts for the project. The highlights of this work (taken from the activity 3 description) are:

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.

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.

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.

We will include the acknowledgment statement and logo in project dissemination efforts.

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

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%	1.05		$105,827
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%	6		$373,212
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%	1.25		$39,548
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	**$715,295**
Contracts and Services								
TBD	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	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								
	Tools and Supplies	Geospatial Imaging Software	We plan to purchase one copy of DJI FlightHub software to track our UAV data and create flight plans. We also anticipate purchasing two copies of Pix4D, a licensed image-processing software. This specialized software will be used to coordinate drone usage and data processing across the three sentinel sites in this project.					$11,150
	Tools and Supplies	General Research Supplies	The supplies will be used for collecting samples, recording data, and working in the field.					$10,865
	Tools and Supplies	Drone consumable supplies and parts	Replacement blades, batteries, and other parts are required to maintain safe drone operations, as mandated by FAA licensing.					$8,250
							Sub Total	**$30,265**
Capital Expenditures								
		Matrix 350 Unmanned Aerial Vehicle	Unmanned area vehicle for high precision imaging, topographcal analysis, and mapping of agriculutral fields. The UAV will be primarily house at the WCROC sentinal location and share among other sentinal locations.	X				$12,000
		Variable rate seeding equipment	We will acquire variable rate planting equipment to test how precision seeding rate changes can impact cropping managmenet plans and best management practices.	X				$200,000
		Precision variable rate fertilizer sprayer	We will acquire variable rate fertilizer application equipment to test how precisely applied synthetic fertilizers impact crop yields and how these impacts can be computer modeled to	X				$110,000

			develope accurate managmenet plans and best management practices.					
		Variable rate solid manure spreader.	We will acquire variable rate, solid manure application equipment to test how precision use of animal wastes can benefit both the cropping system and reduce potential nutrient runoff issues. The findings will be used to make suggested best management practices.	X				$59,500
		Geospatial Workstations- 2 highpower desktop computer systems and large format monitors	The computer systems will be used to processes drone images, creating 3-D maps of crop and weed growth as well as detailed elevation maps for fields. This will be used to precisely map and analyze treatment impacts (yields) based on appliction of inputs..	X				$16,500
		Maveric 3M multispectral UAV	Two agricultural UAVs for imaging and mapping of agriculutral fields. These UAVs will be primarily housed at the RROC and SROC sentinal locations	X				$10,100
		DJI Zenmuse L2 RGB/LiDAR Payload (drone camera)	Hi-resolution camera that is used with DJI Matrix 350 drone to do visible wavelength and Lidar photography.	X				$13,000
		MicaSense RedEdge-P Multispectral Sensor Kit (multispectral drone camera)	This camera is essential for analyzing plant health. By capturing images in the non-visible spectrum, it can reveal signs of plant stress—such as nutrient deficiencies and diseases—before they are visible to the naked eye. It mounts on the Matrix 350 UAV platform.	X				$8,000
							Sub Total	**$429,100**
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	**$1,255,000**

Classified Staff or Generally Ineligible Expenses

Category/Name	Subcategory or Type	Description	Justification Ineligible Expense or Classified Staff Request
Capital Expenditures		Matrix 350 Unmanned Aerial Vehicle	The UAV will be critical to provide imaging and topographical data for modeling and developing prescriptions to apply different rates of inputs to a field based on mapped location. **Additional Explanation :** The equipment will continue to be used at the sentinel ROCs as part of the research and operational activities in the agronomy programs.
Capital Expenditures		Variable rate seeding 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.
Capital Expenditures		Precision variable rate fertilizer sprayer	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.
Capital Expenditures		Variable rate solid manure spreader.	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.
Capital Expenditures		Geospatial Workstations- 2 highpower desktop computer systems and large format monitors	The computer equipment is a key piece of precision agriculture, being able model and develop prescriptions to apply different rates of inputs to a field based on mapped location. **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 5+ years.
Capital Expenditures		Maveric 3M multispectral UAV	The UAV will be critical to provide imaging and topographical data for modeling and developing prescriptions to apply different rates of inputs to a field based on mapped location. **Additional Explanation :** This equipment will be part of our agronomic research and

			production going forward. The normal life of our electronic equipment at these locations is 5-8 years.
Capital Expenditures		DJI Zenmuse L2 RGB/LiDAR Payload (drone camera)	The UAV camera will be critical to provide imaging and topographical data for modeling and developing prescriptions to apply different rates of inputs to a field based on mapped location. **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 5-8 years.
Capital Expenditures		MicaSense RedEdge-P Multispectral Sensor Kit (multispectral drone camera)	This UAV camera will be critical to plant analysis when modeling and developing prescriptions to apply different rates of inputs to a field based on mapped location. **Additional Explanation :** This equipment will be part of our agronomic research and production going forward. The normal life of our electronic equipment at these locations is 5-8 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: $2,056,350

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

Difference between Proposal and Work Plan

Describe changes from Proposal to Work Plan Stage

The revisions from proposal to work plan were implemented to bring the budget to the LCCMR committee recommended funding level. The project team felt that the best approach for the budget reduction was to reduce research staffing at two research locations and have the third location handle more of the computer and data intense research. The two locations with lower research staff would focus on field data collection and operation of precision agricultural equipment in the field rather than the data analysis. This will still allow us to have state-wide coverage (in much of the agricultural area) of knowledgeable precision ag researchers who are available to help with education and outreach events. A minor change to the supply budget was done to get to the exact funding level recommended.

Additional Acknowledgements and Conditions:

The following are acknowledgements and conditions beyond those already included in the above workplan:

Do you understand and acknowledge the ENRTF repayment requirements if the use of capital equipment changes?

Yes

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?

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 project:

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