Environment and Natural Resources Trust Fund

2027 Request for Proposal

General Information

Proposal ID: 2027-085

Proposal Title: Agroforestry Systems for Soil, Water, Habitat and Bioenergy

Project Manager Information

Name: Dean Current

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

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Project Basic Information

Project Summary: This project will develop a framework evaluating agroforestry systems and forest residues as biomass sources for sustainable aviation fuels while improving ecosystem services, environmental quality, and rural economic resilience.

ENRTF Funds Requested: $598,000

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?

In the Future

Narrative

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

Minnesota faces growing challenges in protecting soil health, water quality, and wildlife habitat while expanding renewable energy production and maintaining resilient rural economies. Perennial agroforestry systems incorporating short-rotation woody crops can improve soil stability, enhance water quality, increase carbon sequestration, and provide wildlife habitat while producing renewable biomass. Combined with woody residues generated through forest management activities these systems represent a potentially significant and underutilized source of sustainable biomass. Despite this potential, landowners, policymakers, and market actors lack integrated tools to evaluate the environmental and economic impacts of deploying these biomass resources across Minnesota landscapes. Existing research provides insights into biomass productivity and ecosystem services, but spatially explicit frameworks that integrate agroforestry systems, woody residues, environmental outcomes, and emerging markets such as sustainable aviation fuels remain limited.

This project will develop a scalable, data-driven framework to evaluate the potential of agroforestry plantings with short-rotation woody crops combined with forest-derived woody residues. The framework will estimate biomass supply, environmental benefits, and economic outcomes applicable across Minnesota landscapes under different adoption scenarios. Results will provide science-based guidance supporting land management strategies that enhance soil health, protect water resources, increase habitat value, and contribute to renewable energy development while strengthening rural economic resilience.

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.

This project will develop a scalable framework to evaluate integrated biomass systems that improve the natural resource base and enhance habitat while supporting renewable energy production and rural economic vitality across Minnesota. The framework will assess systems that combine short-rotation woody crops in agroforestry plantings with woody residues generated through forest management activities.

The work will proceed through four integrated components linking landscape analysis, economic feasibility, ecosystem modeling, and stakeholder engagement. First, we will map existing and potential agroforestry systems using short-rotation woody crops and assess the availability of woody residues across Minnesota landscapes. Satellite remote sensing, LiDAR data, machine learning, and field observations will be used to identify areas where integrated biomass systems can deliver environmental and economic benefits.

Second, we will evaluate economic feasibility through geospatial modeling that incorporates biomass productivity, production costs, transportation logistics, and potential market revenues. Techno-economic analysis will assess system financial performance, while life-cycle assessment will estimate greenhouse gas emissions and environmental impacts.

Third, ecosystem modeling will estimate potential effects on soil health, water quality, carbon storage, and habitat under different adoption scenarios.

Fourth, stakeholder engagement will refine implementation pathways and ensure the framework provides practical guidance for landowners, resource managers, and policymakers.

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 project will produce high-resolution maps identifying landscapes where integrated agroforestry systems using short-rotation woody crops and woody residues can protect, conserve, and enhance Minnesota's natural resources. Outcomes include improved assessments of the associated soil health, water quality, carbon sequestration, and habitat benefits. A decision-support tool will provide landowners, planners, and policymakers with science-based guidance for implementing sustainable land-use strategies that support renewable biomass production while protecting soil and water resources. By promoting sustainable use of marginal lands, the project will reduce soil erosion, improve water quality, increase carbon storage, enhance biodiversity, and support long-term stewardship of Minnesota's working landscapes.

Activities and Milestones

Activity 1: Landscape & Resource Assessment - Identify where short-rotation woody crops and woody residues can be sustainably sourced.

Activity Budget: $185,000

Activity Description:
The University of Minnesota, in collaboration with the Natural Resources Research Institute, will evaluate historical and current productivity, land-use compatibility, and environmental implications of woody biomass systems across Minnesota to support future renewable biofuel development. The analysis will consider both short-rotation woody crops in agroforestry systems and woody residues generated through forest management activities such as timber harvests, thinnings, and vegetation management.
Using historical soil property data, climate measurements, and Sentinel satellite and LiDAR imagery, the project team will develop machine learning models within Google Earth Engine to identify historical and existing short-rotation woody biomass plantings and monitor seasonal growth patterns. Ground-truth data from the Minnesota Department of Natural Resources, combined with datasets and analytical support from the Natural Resources Research Institute, will be used to validate model performance and improve classification accuracy.
Integrated spatial and temporal analyses will identify key biotic and abiotic drivers influencing biomass productivity and site suitability across Minnesota landscapes. Outputs will include validated, high-resolution statewide maps identifying existing biomass resources and landscapes suitable for short-rotation woody crops and woody residue supply. These datasets will support economic modeling in Activity 2, ecosystem service analyses in Activity 3, and stakeholder outreach in Activity 4.

Activity Milestones:

Description	Approximate Completion Date
Compile historical soil, climate, Sentinel satellite, and LiDAR datasets and preprocess them for statewide analysis.	December 31, 2027
Develop and validate machine learning models in Google Earth Engine	June 30, 2028
Identify key biotic and abiotic drivers of woody biomass productivity and land-use suitability	December 31, 2028
Deliver validated, high-resolution statewide maps of current and potential woody biomass distribution	June 30, 2029

Activity 2: Economic Feasibility - Evaluate landowner adoption economics, system costs, and market viability

Activity Budget: $164,000

Activity Description:
This activity will develop economic and feasibility frameworks to evaluate integrated biomass systems that combine short-rotation woody crops in agroforestry plantings with woody residues from forest management. The analysis will assess economic viability across the biomass supply chain while also evaluating the financial costs and benefits for farmers and landowners considering adoption of agroforestry systems.

Building on spatial outputs from Activity 1, the project team will develop geospatial economic models that incorporate biomass productivity, establishment and management costs, harvesting operations, transportation logistics, and potential market revenues. The analysis will estimate potential biomass supply under different adoption scenarios that integrate agroforestry plantings with forest-derived woody residues across Minnesota landscapes.

A techno-economic analysis will evaluate financial performance from biomass production through conversion to

renewable fuels, including sustainable aviation fuels. In addition, farm-level economic analysis will estimate establishment costs, management costs, potential revenues, and risk factors influencing landowner adoption of agroforestry systems.

Economic modeling will be integrated with ecosystem service assessments in Activity 3 to incorporate both conventional financial metrics and emerging valuation approaches for ecosystem services such as carbon sequestration and water-quality benefits. Outputs will include regional biomass supply estimates, adoption scenarios, and economic feasibility assessments to inform landowners and industry partners.

Activity Milestones:

Description	Approximate Completion Date
Develop a comprehensive techno-economic model to evaluate the financial viability of sustainable aviation fuel (SAF)	December 31, 2027
Incorporate capital/operational costs and revenue streams from SAF and ecosystem service markets	June 30, 2028
Quantify environmental impacts and land-use compatibility of integrated biomass to SAF systems	December 31, 2028
Translate research into practical tools for stakeholders to enable implementation, through developing interactive web-based tools	June 30, 2029

Activity 3: Develop an Integrated Ecosystem–Economic Modeling Framework and scenario analysis to optimize woody biomass production

Activity Budget: $122,000

Activity Description:
We will develop and apply an agroforestry module within the Energy Exascale Earth System Land Model (ELM) to simulate growth and environmental impacts of short-rotation woody crops in integrated biomass systems. Model development will incorporate species-specific traits such as biomass allocation, root dynamics, and harvest cycles to realistically represent biomass accumulation and carbon dynamics in agroforestry systems.
Initial analyses will focus on a representative landscape in northern Minnesota where data availability and landscape conditions allow detailed evaluation of integrated biomass systems combining short-rotation woody crops and woody residues. Field data/existing research datasets will be used to calibrate and validate model performance for biomass growth, soil carbon dynamics, and ecosystem responses.
Using land-use data generated in Activity 1, we will simulate biomass productivity, carbon sequestration, and ecosystem service outcomes under different climate, management, and land-use scenarios. The ecosystem model will be coupled with the economic framework developed in Activity 2 to evaluate tradeoffs among productivity, environmental benefits, and economic performance.
Deliverables will include a coupled ecosystem–economic modeling framework and scenario-based projections of biomass production, carbon storage, and environmental outcomes. The framework will be designed for adaptation to other regions of Minnesota with appropriate adjustments to landscape and economic parameters.

Activity Milestones:

Description	Approximate Completion Date
Develop the agroforestry-specific ELM module representing short-rotation-woody crops with species traits and flexible harvest regimes	June 30, 2028
Validate the ecosystem model with field data to ensure accurate simulations of biomass growth	September 30, 2028
Perform projected analyses of woody biomass growth to determine the most efficient production pathways	December 31, 2028

Integrate ecosystem and economic models, perform sensitivity and uncertainty analyses, and generate outputs	June 30, 2029

Activity 4: Stakeholder Engagement & Decision Tools - Translate results into implementation guidance and decision-support tools

Activity Budget: $127,000

Activity Description:

This activity will support real-world implementation by engaging stakeholders across Minnesota's bio-based economy to identify adoption opportunities, address barriers, and ensure that results inform practical land-use and renewable energy development decisions. The project will collaborate closely with the Minnesota Sustainable Aviation Fuel Hub (SAFH) to convene stakeholders from agriculture, forestry, energy, industry, conservation organizations, and state agencies.

The project will begin with a stakeholder mapping exercise to identify key actors across the biomass supply chain, including landowners, agricultural and forestry professionals, biofuel producers, industry representatives, policymakers, and conservation organizations. This analysis ensures outreach activities include diverse perspectives and project results address real-world implementation challenges.

The SAFH will organize two stakeholder workshops and establish an advisory group representing public and private sector partners. Stakeholder input gathered through workshops, advisory group discussions, and a landowner survey will directly inform economic modeling (Activity 2) and ecosystem scenario development (Activity 3), ensuring analyses reflect real-world management practices, market conditions, and policy environments.

Project findings will be translated into a publicly accessible decision-support toolkit and user guides to help landowners, planners, and policymakers evaluate opportunities for sustainable biomass production while protecting soil health, improving water quality, enhancing habitat, and sustaining Minnesota's working landscapes.

Activity Milestones:

Description	Approximate Completion Date
Identifying stakeholders (farmers, industry, policymakers, researchers, NGOs) using institutional data and developing relational network maps	September 30, 2027
Establish advisory group and convene first stakeholder workshop to identify biomass adoption opportunities and barriers	December 31, 2027
Conduct second workshop and survey to gather input informing economic modeling and ecosystem scenario development	June 30, 2028
Release a public decision-support toolkit and user guides supporting sustainable biomass production and landscape planning	June 30, 2029

Project Partners and Collaborators

Name	Organization	Role	Receiving Funds
John DuPlissis	Natural Resources Research Institute	Support with determining potential supply of biomass from forest waste, thinnings and removal of vegetation for fire control as well as potential biomass supply from short rotation woody crops planting in agroforestry systems. John will also help identify appropriate locations for agroforestry plantings based on his previous research.	Yes
Eric Singsaas	Natural Resources Research Institute	Eric Singsaas will assist the project helping to identify appropriate processing technologies and the feasibiity and cost of applying those technologies to the processing of woody biomas from forest thinnings, forest waste and short rotation woody crops into sustainable aviation fuels.	Yes
Julia Silvis	Greater MSP Partnership - MN Sustainable Aviation Fuel Hub	Julia Silvis will assist with outreach to public and private sector partners from the Sustainable Aviation Fuels Hub and the establishment of an advisory group from the SAF Hub to advise the project on relevant markets, policies, and incentives and developments impacting the feasibility of SAF production from woody biomass.	Yes

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.
Project results will be broadly disseminated to landowners, industry partners, conservation organizations, and policymakers through multiple complementary channels. Outputs will include high-resolution statewide maps of biomass resource potential, an interactive web-based decision-support tool, and a practical toolkit designed to help landowners and planners evaluate site-specific opportunities for agroforestry-based biomass production and utilization of woody residues. Technical reports and peer-reviewed scientific publications will document the analytical framework and research findings. Stakeholder workshops and presentations organized in collaboration with the Minnesota Sustainable Aviation Fuel Hub will further communicate results and gather feedback from agricultural, forestry, energy, and conservation communities. All tools, datasets, and reports will be publicly accessible through the University of Minnesota to ensure long-term availability and support informed decision-making that advances renewable energy development while protecting Minnesota's natural resources.

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 project's framework and decision-support tools will be disseminated to farmers, landowners, biofuel producers, and policymakers through targeted outreach and partner networks. Continued development will be supported through follow-on funding from state and federal research programs, including future proposals to the LCCMR, and federal grants and private investment informed by the project's techno-economic analysis. Emerging ecosystem service markets may further support adoption. All project data, models, and tools will be hosted by the University of Minnesota to ensure long-term public access and guide land management practices that protect soil, improve water quality, enhance habitat, and sustain Minnesota's working landscapes.

Other ENRTF Appropriations Awarded in the Last Six Years

Name	Appropriation	Amount Awarded

Restoring Forests and Savannas Using Silvopasture - Phase2	M.L. 2023, , Chp. 60, Art. 2, Sec. 2, Subd. 08h	$674,000

Project Manager and Organization Qualifications

Project Manager Name: Dean Current

Job Title: Director

Provide description of the project manager's qualifications to manage the proposed project.
Dr. Current, Director of the Center for Integrated Natural Resources and Agricultural Management (CINRAM), has more than 40 years of professional experience in forestry, agroforestry, and natural resource economics. He has worked extensively in Minnesota as well as internationally, leading interdisciplinary research and applied projects focused on improving natural resource management while strengthening rural economies and community resilience.
Dr. Current has extensive experience managing complex, collaborative research initiatives involving scientists, landowners, public agencies, and private-sector partners. His work integrates environmental, economic, and social analysis to develop practical land management strategies enhancing environmental outcomes while remaining economically viable for farmers and landowners.
Under Dr. Current's leadership, CINRAM has conducted research directly relevant to this project, evaluating impacts of agroforestry systems on soil health, water quality, and water storage; how market-based incentives can encourage improved stewardship of natural resources; identifying barriers farmers and landowners face when adopting more sustainable land-use practices; and developing strategies that connect rural producers with markets supporting sustainable land management.
Much of Dr. Current's work has been conducted at the landscape scale. In Minnesota, he led research and stakeholder engagement efforts in the Minnesota River Basin examining how agroforestry and biomass production systems improve water quality, enhance water storage, and the resilience of agricultural landscapes. This work has involved collaboration with farmers, landowners, and natural resource professionals to evaluate practical approaches for integrating perennial systems into working lands.
Dr. Current also has more than 20 years of experience working across the Maya Biosphere Reserve in Guatemala, collaborating with rural forest communities to develop sustainable timber and non-timber forest product markets that support conservation and livelihoods.
Together, this experience positions Dr. Current to effectively lead the proposed project, coordinate partners, and ensure the delivery of science-based information to support improved management of Minnesota's soil, water, and habitat resources.

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

Organization Description:
The Center for Integrated Natural Resources and Agricultural Management (CINRAM) is a partner-based organization drawing on expertise from the University of Minnesota as well as public and private sector partners to address sustainable natural resource management challenges. CINRAM conducts interdisciplinary research and applied projects focused on improving environmental outcomes while supporting resilient rural economies.
CINRAM integrates environmental, social, and economic analyses to develop practical solutions for landowners, natural resource managers, and policymakers. The center draws on faculty and researchers from across CFANS and the University of Minnesota, and a statewide network of public and private partners enabling CINRAM to address complex land management challenges using integrated approaches.
Over the past two decades, CINRAM has successfully led and managed collaborative research projects in Minnesota examining the environmental and economic performance of agroforestry and perennial biomass systems. This includes research in the Minnesota River Basin evaluating the potential of these systems to improve water quality, enhance water storage, and increase the resilience of working landscapes.

Through its research capacity, collaborative partnerships, and experience translating science into practical guidance, CINRAM is well positioned to manage the proposed project and deliver science-based information to support improved management of Minnesota's soil, water, and habitat resources.

Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	$ Amount
Personnel								
Faculty (Summer salary)		Dr. Ruan is an expert in technologies to convert biomass to fuels and other products. He will assist the project to identify technologies for conversion of woody biomass to sustainable aviation fuels. He will also supervise a researcher who will be assisting with conversion technologies and generating inputs for the techno economic and life cycle analyses.			27%	0.04		$12,325
Professional/Administration - Center Director		Dr. Current will be responsible for overall management of the project, coordination with partners and stakeholders, and advising the graduate research assistant working on the project on Activity 2.			27%	0.06		$10,000
Professional Administrative - Post Doc		Fenghui Yuan will be responsible for developing the framework/model to evaluate and predict the social, environmental, and economic impacts of the different scenarios identified for analysis.			27%	2		$221,838
Post Doc Research Specialist		This research specialist will be supervised by Dr. Ruan and will assist other project researchers by providing data on conversion technologies that will be evaluated through the techno-economic and life cycle analyses.			21%	0.5		$41,020
Graduate Research Assistant		The graduate research assistant (GRA) will be responsible for gathering information for and carrying out the life cycle and techno-economic analyses. The GRA will be supervised by Dr. Current and will coordinate closely with other members of the project team to gather the required data to carry out the analyses.			47%	2		$118,529
Other Professional - NRRI		John Duplissis from NRRI will be responsible for determining the sustainable amount of			27%	0.1		$26,037

		biomass economically available from a designated landscape in Minnesota from forest and wood waste from forest management operations and processing facilities. He will also be estimating the potential amount of biomass from short rotation woody crops in agroforestry systems that could be supplied to process woody biomass into sustainable aviation fuels. In addition to that he will be carrying out an analysis of potential planting sites for agroforestry systems that have the potential to supply a facility processing woody biomass into sustainable aviation fuels while enhancing Minnesota Natural Resources.						
Other Professional - NRRI		Eric Singsaas from NRRI will assist the project to identify viable processing options for converting woody biomass to sustainable aviation fuels and the practical aspects of implementing a facility to make the conversions including questions related to scale, investment required, and economic feasibility.			27%	0.1		$36,848
Researcher 6		Will carry out a stakeholder analysis and mapping of stakeholders in the public and private sectors as well as agencies involved with natural resource management and economic development			27%	0.3		$32,000
Researcher 6		This researcher will prepare and carry out a survey of landowners and stakeholders to better understand constraints to adoption of short rotation woody crop agroforestry systems for bioenergy including willingness to adopt. The stakeholder survey will explore how different stakeholders might be willing to participate in a sustainable aviation fuel initiative with woody biomass.			27%	0.3		$29,000
							Sub Total	**$527,597**
Contracts and Services								

Greater MSP Partnership	Subaward	Julia Silvis will coordinate an advisory board based on the Sustainable Aviation Fuel Hub and organize at least two stakeholder meetings to discuss the project.				0.2		$50,000
							Sub Total	**$50,000**
Equipment, Tools, and Supplies								
	Tools and Supplies	Survey printing and postage for mailing	We will be surveying farmers/landowners to gauge willingness to adopt short rotation woody crop systems for the production sustainable aviation fuels and stakeholders to gauge support for a sustainable aviation fuel initiative utilizing woody residues and agroforestry systems including potential incentives for farmer/landowner participation.					$10,000
							Sub Total	**$10,000**
Capital Equipment								
							Sub Total	**-**
Acquisitions and Stewardship								
							Sub Total	**-**
Travel In Minnesota								
	Miles/ Meals/ Lodging	Budgeted for six day trips to St Paul	Project coordination					$4,403
	Miles/ Meals/ Lodging	20 trips in Minnesota with average distance of 300 miles	Project coordination with stakeholders, interviews and site visits					$6,000
							Sub Total	**$10,403**
Travel Outside Minnesota								
							Sub Total	**-**
Printing and Publication								

							Sub Total	**-**
Other Expenses								
							Sub Total	**-**
							Grand Total	**$598,000**

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				
			State Sub Total	**-**
Non-State				
			Non State Sub Total	**-**
			Funds Total	**-**

Total Project Cost: $598,000

This amount accurately reflects total project cost?

Yes

Attachments

Required Attachments

Visual Component

File: f0528ac0-290.pdf

Alternate Text for Visual Component

The visual demonstrates the different steps and disciplines involved in developing a framework for estimating the social, economic and environmental benefits of using woody residues and short rotation woody crops to produce sustainable aviation fuels....

Supplemental Attachments

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

Title	File
FP00015016 Current LCCMR	430d3c3c-f10.pdf
Letter of Support MN SAF Hub	c06fc3c3-6f9.docx

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?

No

Does the organization have a fiscal agent for this project?

Yes, Sponsored Projects Administration

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:

Dr. Fengui Yang, University of Minnesota, Dennis Mugambi, University of Minnesota, Juer Li and Dr. Roger Ruan, University of Minnesota, Dr. David Wilsey, University of Minnesota.

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