Environment and Natural Resources Trust Fund

2027 Request for Proposal

General Information

Proposal ID: 2027-449

Proposal Title: Vitivoltaics: Integrating Renewable Energy with Minnesota Grape Production

Project Manager Information

Name: Soon Li Teh

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

Office Telephone: (361) 246-0050

Email: teh@umn.edu

Project Basic Information

Project Summary: Vitivoltaics integrates Minnesota's new cold-hardy table grapes with solar arrays, creating a 'climate shield' to mitigate winter injury while maximizing land-use efficiency, renewable energy production, and economic resilience for growers.

ENRTF Funds Requested: $525,000

Proposed Project Completion: June 30, 2030

LCCMR Funding Category: Energy (E)

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.

Minnesota's grape industry faces a critical turning point. Traditional wine grape markets are struggling, yet the recent release of three groundbreaking, cold-hardy seedless table grapes offers a high-value lifeline for local growers. Simultaneously, Minnesota's shift toward renewable energy creates land-use competition between solar arrays and productive farmland.

This project addresses these dual challenges through "Vitivoltaics," which is the strategic integration of solar energy and viticulture. We hypothesize that solar overheads can act as a climate shield by mitigating extreme winter injury and frost, which are the primary barriers to grape survival in Minnesota.

Currently, no data exists on how these specific new cultivars perform under solar canopies in cold climates. By evaluating vine health, resource efficiency, and microclimate buffering, this project transforms solar sites from lost land into high-efficiency nurseries for a burgeoning fruit industry. We will move beyond theory to provide actionable guidelines that protect Minnesota's soil, diversify farm income, and accelerate the state's clean energy transition. This dual-use approach positions Minnesota as a national leader in climate-resilient agriculture and ensures that our pursuit of renewable energy strengthens rather than displaces our specialty crop heritage.

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 first dedicated Vitivoltaic research site in Minnesota to evaluate three novel cold-hardy table grape cultivars under elevated solar arrays. This project investigates whether solar panels can function as a protective overhead canopy, reducing the frost and winter bud damage that historically limits grape production in our climate.

Our team will conduct comprehensive field trials comparing these new cultivars in agrivoltaic systems against traditional open-field vineyard conditions. We will quantify how the solar microclimate affects light availability, soil temperature, and water use efficiency. Furthermore, we will measure vine productivity and fruit quality to ensure that solar-integrated grapes meet commercial standards.

In collaboration with energy developers and viticulturists, we will perform economic and environmental life-cycle assessments to determine the true cost-benefit of dual-use land management. The primary deliverable is a set of evidence-based guidelines for Minnesota growers and solar developers. By validating this model, we provide a scalable solution that protects specialty crops from climate volatility while generating renewable energy on the same acre. This work transforms underutilized solar land into high-value agricultural space, securing a resilient future for Minnesota's fruit industry and clean energy sector alike.

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 directly enhances Minnesota's land and water resources by validating high-efficiency, dual-use farming. Key outcomes include improved water conservation through reduced evapotranspiration under solar canopies and the preservation of topsoil via perennial viticulture. By mitigating winter injury for new grape cultivars, we reduce crop loss and chemical input needs following extreme weather. Our science-based guidelines will enable solar developers to integrate high-value specialty crops rather than displacing productive soil. Ultimately, these "Vitivoltaic" systems protect Minnesota's agricultural heritage while accelerating a carbon-neutral energy transition, ensuring long-term resilience for the state's natural and economic landscapes.

Activities and Milestones

Activity 1: Quantify Vitivoltaic Performance: Evaluating Table Grape Production and Solar Efficiency

Activity Budget: $284,000

Activity Description:
This activity leverages existing solar infrastructure at the University of Minnesota West Central Research and Outreach Center in Morris to evaluate the viability of vitivoltaics for cold-hardy seedless table grapes. Through a replicated field trial, we will compare the performance of three new grape cultivars grown under solar arrays against those in traditional open-field conditions.

Our team will quantify the climate shield effect by measuring winter bud survival, vine growth, and fruit quality indices. We will monitor critical environmental variables, including light intensity and microclimate temperature, to determine how solar shading impacts grapevine phenology. Simultaneously, we will track solar panel energy generation efficiency to ensure that the presence of high-value crops does not compromise renewable energy goals.

By analyzing the synergy between energy capture and viticulture, this activity provides the empirical data needed to integrate grape production with solar systems in cold climates. These findings will identify the optimal configurations for maximizing both agricultural yield and clean energy output. This work establishes a baseline for climate-resilient specialty crop production, proving that Minnesota's solar sites can double as productive, high-value vineyards.

Activity Milestones:

Description	Approximate Completion Date
Plant grapes under solar and conventional systems	June 30, 2027
Install trellis systems and energy meters	June 30, 2028
Evaluate vine performance under solar and conventional systems	October 31, 2029
Investigate energy capture and generation	December 31, 2029

Activity 2: Quantify Resource Efficiency and Environmental Sustainability of Vitivoltaic Systems

Activity Budget: $215,000

Activity Description:
This project will quantify the environmental performance of vitivoltaic systems using a Life Cycle Assessment (LCA) framework, integrating field measurements of water use, soil health, and microclimate modification with system-level sustainability metrics. We will compare vitivoltaic and conventional open-field vineyard systems to assess tradeoffs and net environmental benefits across production, operation, and management phases.

Water-use efficiency will be evaluated through continuous monitoring of soil moisture, vine water status, and irrigation inputs. Soil health will be assessed using indicators including organic matter content, microbial activity, aggregate stability, and nutrient dynamics. Microclimate regulation will be quantified through measurements of canopy temperature, solar radiation, and humidity to determine impacts on heat stress mitigation and climate resilience.

These data will be incorporated into an LCA model to estimate carbon footprint, energy and water use efficiency, and land-use efficiency of dual-use vitivoltaic systems relative to traditional vineyard and standalone solar systems. By capturing both agricultural and energy-production impacts, this analysis will provide a comprehensive evaluation of environmental sustainability. Outcomes will inform best practices for integrating renewable energy into cold-hardy grape production systems while maximizing environmental and economic benefits in Minnesota’s climate.

Activity Milestones:

Description	Approximate Completion Date
Install sensors for soil moisture, microclimate, and vine water status	September 30, 2028
Quantify water use efficiency and irrigation requirements	September 30, 2028
Assess soil health indicators	September 30, 2028
Evaluate microclimate regulation and cold stress mitigation	April 30, 2029
Quantify carbon footprint, water, energy, and land-use efficiency	December 31, 2029

Activity 3: Translate Vitivoltaic Research into Actionable Guidelines for Minnesota Growers

Activity Budget: $26,000

Activity Description:
This activity transforms our field data into a statewide roadmap for Vitivoltaic adoption. We will synthesize findings on vine performance, resource efficiency, and environmental resilience to create the first comprehensive best practices for integrating solar arrays with cold-hardy grape production in the Midwest.

Our guidelines will provide specific technical parameters for panel spacing, canopy management, and microclimate optimization to maximize the climate shield effect. Crucially, these recommendations will offer strategies to mitigate winter injury and frost, providing a stabilized revenue stream for growers transitioning from the struggling wine industry.

By collaborating with the Minnesota Wine and Grape Alliance (MWGA) and clean energy developers, we will ensure these deliverables reach the stakeholders who need them most. We will produce accessible toolkits for growers, policymakers, and energy firms to streamline the implementation of dual-use systems. These science-based recommendations will position Minnesota as a national leader in climate-resilient agriculture, providing the necessary framework to scale Vitivoltaics across the state. Ultimately, this activity ensures that our research drives immediate economic development while preserving Minnesota's long-term agricultural and energy security.

Activity Milestones:

Description	Approximate Completion Date
Present results at statewide and regional conferences	June 30, 2030
Host a site demonstration during Midwest Farm Energy Conference	June 30, 2030
Develop a guidebook on grape agrivoltaic systems	June 30, 2030
Submit peer-reviewed research articles	June 30, 2030
Submit semi-annual reports and a comprehensive final report	June 30, 2030

Project Partners and Collaborators

Name	Organization	Role	Receiving Funds
Bradley Heins	University of Minnesota WCROC	Provides executive assistance and expertise on agrivoltaics logistics, execution, and data collection	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.
Public outreach will be carried out in partnership with University of Minnesota Extension, where annual field days will be hosted at the Chaska and Morris research sites. These events will offer the public, students, and the media a first-hand look at how the ENRTF is supporting climate-resilient agriculture. All project updates and final toolkits will be hosted on a dedicated UMN Extension webpage, ensuring free, permanent access for all Minnesotans.

We will engage with various stakeholders through presentations at the Minnesota Wine and Grape Alliance (MWGA) annual conference and the Gateway to Solar Conference. These presentations will target the specific communities (e.g., farmers and energy developers), who can utilize our data to improve land management and diversify rural income.

We will also publish scientific results in peer-reviewed journals and Extension publications to solidify Minnesota's position as a national leader in agrivoltaic innovation.

Our overall dissemination strategy ensures that Vitivoltaic research directly reaches the Minnesota stakeholders best positioned to implement change. By demonstrating the "climate shield" effect, we will provide the evidence necessary to move solar developers away from "brownfield only" mindsets and toward dual-use viticulture. This promotes the conservation of Minnesota's productive soils while accelerating the state's transition to clean energy.

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?
Results will be implemented through a permanent Vitivoltaic digital toolkit hosted by UMN Extension and disseminated via Minnesota Wine and Grape Alliance workshops. This ensures growers have immediate, public access to our climate-shielding protocols. Post-project, the established Morris research site will serve as a long-term demonstration plot for continued field days. To scale these findings, we will pursue federal funding through USDA-SARE and the Department of Energy's "Foundational Agrivoltaic Research" program. Ongoing industry partnerships with Minnesota solar developers will provide the private-sector investment necessary to transition these research-backed models into large-scale commercial vineyard installations.

Project Manager and Organization Qualifications

Project Manager Name: Soon Li Teh

Job Title: Assistant Professor

Provide description of the project manager's qualifications to manage the proposed project.
Dr. Teh is an Assistant Professor and Director of the Grape Breeding Program at the University of Minnesota. With over

seven years of experience in grape research, his program is nationally recognized for developing cold-hardy wine and table grape cultivars. As an Extension Specialist, he collaborates closely with the Minnesota Wine and Grape Alliance to host workshops, outreach events, and regional conferences.
The project team also includes two viticulturists and Dr. Heins, a faculty member at the UMN West Central Research and Outreach Center, where the agrivoltaics trial will be conducted. Dr. Heins has extensive experience evaluating agrivoltaic systems and energy use on dairy farms, providing valuable expertise for this project. His knowledge will help adapt agrivoltaic strategies for grape production in Minnesota's cold climate.

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

Organization Description:
The University of Minnesota is the primary organization, with its nationally recognized grape breeding program based at the Horticultural Research Center (Chaska) and the agrivoltaics field trial planned at the West Central Research and Outreach Center (WCROC) in Morris. Since 1878, the UMN grape breeding program has released 16 grape varieties, driving the development of cold-climate grape and wine industries in Minnesota, the Dakotas, Wyoming, Montana, and Vermont. The WCROC, a 1,100-acre agricultural experiment station, specializes in applied research and hosts a robust renewable energy program, including 600 kW of solar photovoltaic systems.

Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	$ Amount
Personnel								
Lead investigator		Oversees the project, submit semi-annual reports, a final comprehensive report			36.6%	0.18		$34,067
Co-investigator		Provides executive assistance on agrivoltaics			36.6%	0.12		$29,115
Researcher 6		Conducts system testing, project management, data collection, and result dissemination			36.6%	0.75		$98,818
Graduate student research assistantship		Assists in all aspects of project execution and data collection			24.2%	3		$190,343
Research Professional 1		Viticulturist to help with grape planting, production, and trellis setup			32.3%	0.99		$83,324
							Sub Total	**$435,667**
Contracts and Services								
Solar maintenance	Service Contract	Maintenance of solar and agrivoltaic component system				0.09		$10,000
Soil sampling and analysis	Service Contract	Soil health indicators of agrivoltaic vs conventional systems				0.18		$20,000
UMN WCROC Horticulture	Internal services or fees (uncommon)	Support for grape testing under agrivoltaic and conventional systems. Services include planting, routine plot management, and regular monitoring. This is internal to the UMN WCROC.				0.45		$20,000
UMN Horticultural Research Center	Internal services or fees (uncommon)	Greenhouse space for grape seedlings. Services include space use, monitoring and watering.				0.1		$3,998
							Sub Total	**$53,998**
Equipment, Tools, and Supplies								

	Tools and Supplies	Energy meters (9)	To monitor agrivoltaic voltage systems					$4,500
	Tools and Supplies	Tensiometer (1)	Soil moisture monitoring and water use efficiency					$4,850
	Tools and Supplies	Field supplies	General field supplies include pots, trellis wires, posts, bamboos, plot markers, sampling bags, and others					$9,985
							Sub Total	**$19,335**
Capital Equipment								
							Sub Total	**-**
Acquisitions and Stewardship								
							Sub Total	**-**
Travel In Minnesota								
	Conference Registration Miles/ Meals/ Lodging	3 trips per year for one presenting person (investigator or graduate student), 230 averaged miles per trip, $0.725 per mile, per diem meals of $140 per trip, overnight stay of $250 per trip	Travel, lodging, and meals necessary for formal presentations at statewide and regional conferences within Minnesota	X				$5,000
							Sub Total	**$5,000**
Travel Outside Minnesota								
							Sub Total	**-**
Printing and Publication								
	Printing	Extension and Outreach Printing Supplies	Printing of manual/guides, production of weather-resistant field signage, laminated station guides, educational handouts, large-format posters and banners, decision-support worksheets and resource binders					$5,000
	Publication	Peer Reviewed Publications (2)	Research publication in open access journals					$6,000

							Sub Total	**$11,000**
Other Expenses								
							Sub Total	**-**
							Grand Total	**$525,000**

Classified Staff or Generally Ineligible Expenses

Category/Name	Subcategory or Type	Description	Justification Ineligible Expense or Classified Staff Request
Travel In Minnesota	Conference Registration Miles/Meals/Lodging	3 trips per year for one presenting person (investigator or graduate student), 230 averaged miles per trip, $0.725 per mile, per diem meals of $140 per trip, overnight stay of $250 per trip	These expenses will be used by either the Project Investigator or the presenting graduate student to disseminate project findings at state conferences, workshops, and seminars, which are necessary for public outreach and broader education in Minnesota.

Non ENRTF Funds

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

Total Project Cost: $525,000

This amount accurately reflects total project cost?

Yes

Attachments

Required Attachments

Visual Component

File: 38ee0bf3-5eb.pdf

Alternate Text for Visual Component

Infographic comparing traditional vineyards with Vitivoltaic systems. The left panel shows unprotected vines suffering winter crop loss. The center panel illustrates a solar 'climate shield' providing a thermal buffer for grapevines. The right panel highlights three project wins: crop resilience, energy efficiency, and $80 million in regional economic growth....

Supplemental Attachments

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

Title	File
UMN Approval Letter	3e6c19d4-b88.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:

Dave La Fave, Nic Allyn and Sarah Hulke at the 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

Yes, I understand