Environment and Natural Resources Trust Fund

2024 Request for Proposal

General Information

Proposal ID: 2024-069

Proposal Title: Reduced Ecosystem Impacts through Solar Powered Container Farming

Project Manager Information

Name: Joel Tallaksen

Organization: U of MN - WCROC

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Project Basic Information

Project Summary: Long-distance shipping of imported produce into Minnesota has significant environmental impacts. Containerized farming, incorporating solar energy, could mitigate environmental, energy, and climate challenges in Minnesota's urban and rural food supply.

Funds Requested: $998,000

Proposed Project Completion: June 30, 2027

LCCMR Funding Category: Air Quality, Climate Change, and Renewable Energy (E)

Project Location

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

Region(s): Central

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.

Growing produce in modified shipping containers has the potential to reduce the environmental footprint of food production on Minnesota's ecosystems while promoting a local food supply. However, the sustainability of existing energy intense container systems is not ideal.

For several decades, Minnesota has relied on food production from distant states and countries, which are now experiencing both short and long-term water and climate issues. There is a growing interest, particularly in urban communities, for fresh, local produce. Containerized farms can supply produce without the need for long-distance, fossil-fuel based transportation, while using less land and water. This hyper-local production system meets growing consumer interest in resilient local food supplies.

While container farms are able to produce food using less land and water, the concentrated lighting, heating, and cooling requires more electricity than conventional crops, increasing the energy and related carbon footprint per pound of food. There is currently little guidance for farmers on how to reduce energy impacts nor optimize crop production in containerized systems. As this emerging technology becomes more common, there is a greater need for research-based knowledge on how to reduce the impacts of these systems on our environment.

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 containerized systems enhanced with solar electric and thermal energy systems to power the food production process. Our project focuses on three primary research/demonstration goals: reducing energy and water impacts, optimizing cropping production with energy conservation measures, and developing a knowledgebase of sustainable options and practices for container farmers and consumers.

Environmental impact testing will examine energy, greenhouse gas, and water inputs of containerized farms as they would be operated in Minnesota. Renewable solar equipment will be installed to reduce or eliminate the dependence on grid electricity or fossil energy. The renewable energy systems will be engineered to limit the container's spatial footprint to fit in urban environments where space is at a premium.

Horticultural testing will evaluate crops that minimize energy and water impacts while maximizing income for producers. We will focus on growing high-value crops by optimizing plant production environments during Minnesota's harsh off-seasons. Research will also examine how operational differences, such as lighting, can be optimized in climate-controlled environments for certain crops.

Development of best management practices and resources for farmers will guide Minnesota’s future container farming industry towards reduced environmental impacts as it delivers local, sustainable, fresh foods to Minnesota’s communities.

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:

- Reduce energy demands for food production by designing solar powered container farms.
- Conduct environmental footprinting to identify the potential of this technology to reduce fossil energy use and greenhouse gas emissions.
- Compare ecosystem impacts of enhanced container food production with shipping produce to Minnesota.
- Develop best practice guide to reduce the ecosystem impact of existing or planned container farm businesses.
- Educate producers and consumers about food production efforts to conserve resources and protect the environment.
- Increase Minnesotan's access to fresh, local, and out of season produce with lower environmental footprints.

Activities and Milestones

Activity 1: Develop and Deploy Container Farming Systems Powered by Renewable Energy

Activity Budget: $500,000

Activity Description:
Design a solar energy/battery system, including energy monitoring equipment, with a novel mounting system that integrates with a pre-manufactured container growing system. Commercial container growing systems will be procured and installed on prepared sites at the WCROC. Once onsite, renewable energy equipment will be mounted and electrically tied to the container. The container will be commissioned to ensure proper function before beginning horticultural operations. Energy use will be monitored continually for the duration of the project. It is expected that changing crops and management practices will lead to differences in energy consumption. For instance, ideal growing temperature, hours of light per day, physical space required per plant, etc., will all likely affect total energy consumption for a given crop. Energy data will be collected from commercial container farming operations and compared to results from this project. Results will shed light on several important questions, including:

- The capability of the installed solar energy systems to power the container growing operations in relation to crop selection and weather.
- Optimizing solar energy collection to meet seasonal energy loads including space requirements for multiple containers.
- Battery system design considerations to make the container weather resilient or to allow off-grid operation.

Activity Milestones:

Description	Approximate Completion Date
Design solar energy systems, order premade cropping container, site prep and permitting	June 30, 2025
Install containers and mount energy systems on containers	July 31, 2025
Commission containers for planting	August 31, 2025
Energy tracking and data analysis	April 30, 2027
Final summary of energy use and renewable performance	June 30, 2027

Activity 2: Optimizing Horticultural Operations and Crop Selection to Reduce the Energy and Environmental Footprint for Containerized Farming

Activity Budget: $250,000

Activity Description:
Analysis of crop production will examine heating/cooling and lighting requirements for crops grown at non-traditional times of year. Potential crops that minimize energy and water inputs while providing sustainable income for the producers will be considered. The winter cropping focus will be in-demand (high market value) produce for the winter season, such as strawberries, which need heating. While summer cropping will focus on cool-season crops, such as greens, which traditionally have performed poorly during the heat of summer. Direct comparisons of production in two containers will be used to fully consider the optimal energy required based on variations of plant growth conditions like light and temperature levels. Energy efficient led lights will be examined with different wavelength lights that can be specifically tailored to leafy green crops versus fruiting crops. Water use and quality data will also be collected and compared with outdoor cropping systems. Inputs and transportation for the hyper-local crops grown in the container will be compared with out-of-state import of produce for supplying produce to Minnesota's urban and rural communities.

Activity Milestones:

Description	Approximate Completion Date
Initial seedling production for transplant to container farm	June 30, 2026
Testing of summer production	September 30, 2026
Testing of winter production	March 31, 2027
Final cropping report for produce grown in container farm	April 30, 2027

Activity 3: Cultivating the Knowledge Base to Support Sustainable Container Food Systems

Activity Budget: $248,000

Activity Description:

Findings from activities 1 and 2 will be translated into actionable management practices for container farmers. Life cycle assessment methodology will be used to calculate environmental footprints from the energy and cropping data generated. Environmental measures will also evaluate water and land requirements for the produce grown. Footprints will be compared to long-haul produce and summer field-grown produce, along with a final assessment incorporating economics to evaluate best practices for sustainable container production. Results and recommendations will be published in a "MN Container Farming Best Practices" manual that will be freely available to the public. The best management practices manual will be distributed to existing container farmers, as well as those inquiring about how to start a container farming enterprise. The enhanced solar container farming concept will be disseminated at regional and national farming conferences including the Midwest Farm Energy Conference and Minnesota Farmfest. This knowledge will also be communicated via tours of the facilities, web pages and print media, fact sheets, and workshops.

Activity Milestones:

Description	Approximate Completion Date
Conduct life cycle assessment (LCA) and data analysis	April 30, 2023
Develop factsheets, web pages, and brochures that help others to convey best management practices	May 31, 2027
Report integrating LCA, energy, cropping geared to producers	June 30, 2027
Final project report modeling container farms ecosystem impacts compared with long haul produce imports	June 30, 2027

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?

Implementation of this work relies on container farmers adopting the energy saving measures identified. For established growers, this would mean adjusting their production systems to meet energy optimization goals or incorporate renewable energy into existing containers. For those exploring container farming, the information would provide an entry point as they consider the resilient, energy efficient systems they envision.

The project will also be developing both physical capabilities and human capital to continue studies of energy, lighting, crops, and other environmental issues in Minnesota-based container cropping. Future work would likely be funded by the USDA or interested horticultural groups.

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: 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 less resources and have less 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 is able to 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 of the important research tools he uses is life-cycle analysis (LCA), which examines the amount of energy needed and greenhouse gases emitted in a variety of livestock and cropping systems. But the diverse nature of his work relies on data and methods from a number of 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 to green energy consumed in agricultural production system
- Environmental Footprints for Regional Swine Production Systems Now and in the Future – A Demonstration Pilot Project.
- Optimizing Renewable Electric 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 Universities' living laboratory 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 allows us to work on their farms and get honest feedback from them. Recently, the resiliency 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 states' farm communities to meet these challenges.

Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	$ Amount
Personnel								
Joel Tallaksen		Project Director/LCA Lead			36.8%	0.66		$64,293
Esther Jordan		Horticultural Lead-Communications Lead			32%	0.69		$46,716
Eric Buchanan		Energy Lead			36.8%	0.51		$59,852
Technical Staff		Fabrication of equip, planting harvesting, energy collection data			32%	3.75		$241,695
Student Interns/workers		General labor			0%	1.56		$48,600
							Sub Total	**$461,156**
Contracts and Services								
TBD- Solar Engineering Contractor	Professional or Technical Service Contract	Verify engineering plans for solar systems meet relevant codes for safety.				0		$18,000
TBD- Electrician	Professional or Technical Service Contract	The licensed electrical contractor would perform the electrical connects between the electric supply lines on site and the growing containers.				0		$26,000
TBD- excavation contractor	Professional or Technical Service Contract	Site grading and gravel pad installation for setting containers on				0		$7,000
TBD-solar installer	Professional or Technical Service Contract	Install solar panels to meet engineering diagrams and code requirements				0		$28,000
TBD- Foam Insulation contractor	Professional or Technical Service Contract	The insulation contractor would install additional insulation on the containers to increase the energy efficiency of the growing system.				-		$24,000
							Sub Total	**$103,000**
Equipment, Tools, and Supplies								

	Equipment	Energy Monitoring Sensors and Logger	This includes the sensors and data loggers needed to accurately record energy and water use. It also includes the additional parts to install, calibrate, and maintain the equipment.					$12,500
	Tools and Supplies	Greenhouse supplies	Supplies for plant germination, production, and harvesting. Plant related supplies for maintinaing cleanliness and operations fo the container farms.					$8,000
	Tools and Supplies	Specialized energy footprinting software and databases	The databases used for energy footprint are required to conduct the environmental footprint of agricultural produce. These databases are licensed products that are paid for on yearly basis.					$2,000
							Sub Total	**$22,500**
Capital Expenditures								
		Purchase of 2 container growing systems	These systems will allow us to comparison test food production under different conditions.					$325,000
		Solar and Battery Systems	Produce energy to power container growing system					$80,000
							Sub Total	**$405,000**
Acquisitions and Stewardship								
							Sub Total	**-**
Travel In Minnesota								
	Miles/ Meals/ Lodging	10 trips averaging 375 miles	Travel to visit other container farm installations around Minnesota to gather data on their operations and energy/water use.					$2,500
	Conference Registration	Conference to Support outreach of container growing an agricultural energy conference at	Funds to support an agricultural energy outreach workshop at WCROC in Morris, MN that will feature					$2,500

	Miles/ Meals/ Lodging	WCROC in Morris, MN that will feature container growing as	container growing as a means to reduce energy use in agriculture and participation at minnesota farm related events such as Farmfest					
							Sub Total	**$5,000**
Travel Outside Minnesota								
							Sub Total	**-**
Printing and Publication								
	Printing	Brochure/Handout Printing	Printing of guidebooks with best manangement practices or other useful information for producers or the public.					$1,344
							Sub Total	**$1,344**
Other Expenses								
							Sub Total	**-**
							Grand Total	**$998,000**

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				
In-Kind	University of Minnesota in kind funds	The University of Minnesota is forgoing the typical 54.5% 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	$544,267
			Non State Sub Total	**$544,267**
			Funds Total	**$544,267**

Attachments

Required Attachments

Visual Component

File: 8edd2256-a45.pdf

Alternate Text for Visual Component

Container Farming:
A new field for agriculture
Shipping containers with integrated heating and cooling can produce the fresh produce and specialty crops consumed in Minnesota. The images show crops grown in existing Minnesota containers and the inside layout of containers. Also shown is schematic of a solar enhanced container....

Optional Attachments

Support Letter, Photos, Media, Other

Title	File
Board Of Regents, University of Minnesota, Proposal Resolution	da8847f9-389.pdf

Administrative Use

Does your project include restoration or acquisition of land rights?

No

Does your project have potential for royalties, copyrights, patents, or sale of products and assets?

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 design, construction, or renovation of a building, trail, campground, or other capital asset costing $10,000 or more?

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?

No