# Environment and Natural Resources Trust Fund

2026 Request for Proposal

## General Information

**Proposal ID:** 2026-585

**Proposal Title:** AI Powered Greenhouses: Strengthening Rural Food Security

## Project Manager Information

**Name:** Karl Anderson

**Organization:** Minnesota State Colleges and Universities - Northwest Technical College

**Office Telephone:** (218) 333-6624

**Email:** karl.anderson@ntcmn.edu

## Project Basic Information

**Project Summary:** This project demonstrates AI-driven greenhouse technology to optimize food production, sustainability, and resource efficiency in rural Minnesota, integrating real-time monitoring, adaptive management, and student training for scalable agricultural innovation.

**ENRTF Funds Requested:** $470,000

**Proposed Project Completion:** June 30, 2029

**LCCMR Funding Category:** Resiliency (A)

## Project Location

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

Region(s): NW

**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.**

Northern Minnesota faces significant barriers to consistent access to affordable, nutritious food, primarily due to the region's harsh climate, short growing seasons, geographic isolation, and economic limitations. These conditions severely complicate traditional agricultural practices, restricting year-round production of fresh, healthy food. Consequently, rural and tribal areas in northern Minnesota experience higher rates of food insecurity, exacerbating health disparities such as obesity and diabetes. Current agricultural practices remain insufficient to overcome these persistent regional barriers, given limited local adoption of advanced technology and ongoing economic constraints. Additionally, unpredictable weather events increasingly jeopardize food production stability, creating heightened vulnerability in already underserved communities.

Addressing these pressing challenges requires innovative, economically feasible agricultural methods tailored specifically to northern Minnesota's unique environment and community needs. There is an immediate and untapped opportunity to leverage cutting-edge Artificial Intelligence (AI) technology to dramatically improve agricultural sustainability, resource efficiency, and food productivity. Implementing AI-driven agricultural solutions in these underserved areas could significantly enhance nutritional outcomes, economic vitality, and community resilience. There is a need to develop a replicable and adaptable agricultural model that empowers rural communities through innovation, equipping them with effective tools and strategies to sustainably tackle persistent food insecurity and economic barriers.

**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 a temporary, AI-enhanced greenhouse demonstration system at Northwest Technical College, specifically designed to address food insecurity and environmental resilience in rural northern Minnesota. Leveraging advanced Artificial Intelligence (AI) technologies, our project integrates automated sensors, cameras, and sophisticated software analytics to optimize critical agricultural parameters including irrigation, nutrient application, pest control, and energy efficiency. Two temporary greenhouse units—one equipped with AI-driven monitoring and automated management, and a second using traditional methods—will be constructed side-by-side to enable rigorous comparative analysis of AI technology's efficacy.

Real-time environmental data gathered by the AI system will be securely transmitted via remote network, providing immediate analysis, remote monitoring capabilities, and actionable insights. These insights will enable precise, adaptive responses, significantly improving greenhouse productivity, sustainability, and resilience in the face of climatic variability. Throughout the project's duration, students directly involved will receive practical, hands-on training in advanced AI technologies, microbiology, and horticultural practices. Project-generated data and techniques will be integrated directly into curricula at Northwest Technical College and Bemidji State University, creating lasting workforce development outcomes and establishing a clear, scalable model for adoption by communities across Minnesota.

**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?**

- Improved Agricultural Productivity: Demonstrate measurable increases in crop yield and resource efficiency in the AI-enhanced greenhouse compared to traditional methods.

- Enhanced Educational Impact: Provide practical, hands-on training in AI technology, microbiology, and horticulture for students directly involved with the project, integrating these practices into classroom instruction.

- Validated Scalable Model: Develop comprehensive materials and data-supported outcomes demonstrating the economic viability and practical replicability of AI-driven greenhouse technology. Disseminate these results to

stakeholders across northern Minnesota, clearly illustrating potential statewide adoption and implementation in similar rural and underserved communities.

## Activities and Milestones

### Activity 1: Greenhouse Construction and AI System Integration (Year 1)

**Activity Budget:** $140,000

**Activity Description:**
Objective: Establish two temporary greenhouses equipped with AI-driven monitoring and management technologies to test their effectiveness in improving sustainable agricultural practices for northern Minnesota's rural food deserts. These structures will serve as demonstration models for integrating AI into controlled agricultural environments while maintaining economic feasibility and energy efficiency.

Tasks:
-Procure temporary polycarbonate greenhouses and materials.
-Complete site preparation, including greenhouse base installation.
-Install HVAC systems, plumbing for irrigation, rainwater catchment, hydroponic systems, raised beds, and temporary solar energy components.
-Deploy AI-driven hardware, including environmental sensors, cameras, and data processors for automated monitoring.
-Configure AI software for adaptive greenhouse management and automated decision-making.
-Conduct full system calibration, initial testing, and validation to ensure operational readiness.

**Activity Milestones:**

| Description | Approximate Completion Date |
|---|---|
| Greenhouse materials and AI system components procured | August 31, 2026 |
| Completion of greenhouse, AI system installation, and additional preparation | October 31, 2026 |
| AI software and hardware fully deployed and operational | December 31, 2026 |

### Activity 2: Comparative Agricultural Management and Data Collection (Years 1-3)

**Activity Budget:** $219,500

**Activity Description:**
Objective: Conduct a systematic comparison between AI-managed and conventionally managed greenhouses to evaluate their efficiency, sustainability, and productivity under identical environmental conditions. This activity will generate data to refine AI-driven adaptive agricultural strategies and provide evidence for future scalability.

Tasks:
-Implement controlled comparative agricultural trials in AI-managed and conventional greenhouses.
-Continuously monitor and record environmental variables, energy consumption, water usage, crop growth, weed/pest infestation, and soil conditions.
-Conduct regular microbiological and nutrient assessments of soil and water samples.
-Analyze collected data, refining AI algorithms to optimize growing conditions and resource efficiency.
-Assess AI-driven predictive modeling performance in responding to climate variability.

**Activity Milestones:**

| Description | Approximate Completion Date |
|---|---|
| Initial data collection and monitoring systems operational | June 30, 2026 |
| Growing seasons completed with AI and conventional management comparison | October 31, 2028 |
| AI algorithm refinements based on preliminary findings | January 31, 2029 |

## Activity 3: Educational Integration, Stakeholder Engagement, and Dissemination (Years 2-3)

**Activity Budget:** $110,500

**Activity Description:**

Objective: Integrate project findings into academic curricula and disseminate results to key stakeholders, ensuring that the knowledge gained from this study informs future agricultural policy and investment in AI-driven farming solutions.

Tasks:

-Develop AI greenhouse integration modules for coursework at Northwest Technical College and Bemidji State University.

-Provide hands-on training for students working on AI agriculture applications and environmental data analysis.

-Compile detailed reports and best practice guidelines based on research outcomes.

-Organize presentations and public outreach efforts to share results.

-Publish findings in relevant scientific and agricultural journal(s) to support statewide scalability.

**Activity Milestones:**

| Description | Approximate Completion Date |
|---|---|
| AI-integrated greenhouse curriculum piloted at NTC and BSU | May 31, 2028 |
| Public dissemination events and presentations completed | June 30, 2029 |
| Final research findings published and presented to stakeholders | June 30, 2029 |

## Project Partners and Collaborators

| Name | Organization | Role | Receiving Funds |
|---|---|---|---|
| Baozhong Tian | Bemidji State University | Co-PI, Artificial Intelligence (AI) expert, data collection/interpretation, AI curriculum development | Yes |
| Gus Vettleson | Northwest Technical College | Co-PI, NTC Faculty and Extension Master Gardener, greenhouse plant oversight, curriculum development. | Yes |
| NTC Trades Faculty Member, NTC Plumbing Faculty Julian Dreher | Northwest Technical College | Co-PI(s), Greenhouse setup, solar installation, plumbing, hydroponics installation | Yes |

## 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 temporary greenhouses will serve as research/demonstration units, designed for easy relocation and replication. Data and educational materials developed through this project will be fully integrated into existing curricula at Northwest Technical College and Bemidji State University, ensuring sustained educational impacts. Sustainability will be supported through local partnerships, widespread dissemination of AI methodologies, and strategic pursuit of future funding. Clear documentation and outreach to regional stakeholders will facilitate widespread replication and adoption, significantly contributing to Minnesota's long-term agricultural resilience and food security objectives.

## Other ENRTF Appropriations Awarded in the Last Six Years

| Name | Appropriation | Amount Awarded |
|---|---|---|
| Exploring Minnesota's Wetlands: Our Resource For Future Medicine | M.L. 2021, First Special Session, Chp. 6, Art. 6, Sec. 2, Subd. 03k | $210,000 |

## Project Manager and Organization Qualifications

**Project Manager Name:** Karl Anderson

**Job Title:** Biology Faculty

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

Karl Anderson (M.S., Ph.D.-candidate) has over 12 years of experience in higher education and research, bringing a strong interdisciplinary background that bridges microbiology, environmental science, agriculture, and AI-driven technology. Growing up on his family farm, he developed a deep understanding of agricultural challenges, which he has since combined with his expertise in microbiology and environmental sustainability. His work with the USDA and various state agencies has equipped him with a broad skill set in applied research, field studies, and policy engagement, all of which are directly applicable to this project.

As a biology faculty member and division chair at Northwest Technical College (NTC), Karl has successfully designed and implemented multiple applied research projects incorporating student training, diverse team collaboration, and cutting-edge scientific methodologies. His ability to secure and manage funding demonstrates his capacity to navigate competitive grant-funded research and translate innovative ideas into real-world solutions for environmental and

agricultural sustainability.

Karl's expertise spans soil microbiome dynamics, antibiotic resistance, environmental contaminants, and agricultural resilience, all of which align with this project's goals. His strong background in microbial community analysis and soil health assessments will play a crucial role in understanding how AI-driven greenhouse management impacts plant growth, soil biodiversity, and water efficiency. His experience in mentoring students in hands-on applied research aligns directly with the project's education and workforce training objectives, ensuring that students gain valuable experience in AI-enhanced agricultural techniques.

Beyond academia, Karl's expertise in cross-disciplinary collaborations, stakeholder engagement, and technology makes him uniquely qualified to lead this innovative, scalable greenhouse project aimed at addressing food security in rural

**Organization:** Minnesota State Colleges and Universities - Northwest Technical College

**Organization Description:**
Northwest Technical College (NTC) is a two-year technical college located in Bemidji, Minnesota, dedicated to providing hands-on, career-focused education that prepares students for high-demand industries. As part of the Minnesota State system, NTC offers a range of certificate, diploma, and associate degree programs in areas such as health sciences, business, construction, manufacturing, and environmental technologies.

NTC emphasizes applied learning, industry partnerships, and workforce development, ensuring graduates are well-prepared for immediate employment or further academic pursuits. The college integrates state-of-the-art technology, industry-relevant curriculum, and small class sizes, allowing for personalized instruction and student success.

With a strong commitment to community engagement and innovation, NTC collaborates with local businesses, government agencies, and tribal organizations to address regional workforce needs. The college also prioritizes sustainability initiatives, including renewable energy and environmental science programs that align with Minnesota's growing demand for green technologies.

By providing accessible, affordable, and high-quality technical education, NTC plays a crucial role in economic development and workforce training in northern Minnesota. Its emphasis on practical skills, industry-aligned training, and community partnerships makes it a leader in technical education and innovation across the region.

## Budget Summary

| Category / Name | Subcategory or Type | Description | Purpose | Gen. Ineligible | % Benefits | # FTE | Classified Staff? | $ Amount |
|---|---|---|---|---|---|---|---|---|
| **Personnel** | | | | | | | | |
| Karl Anderson | | PI - Project manager; project planning, greenhouse oversight, data collection, curriculum development, microbiology. Stipend for time/effort provided off MSCF contract duty days (3 months during summer, academic year weekends as necessary): $25,000/yr via stipend | | | 31% | 0.75 | | $75,000 |
| Baozhong Tian | | Co-PI, BSU; Artificial Intelligence (AI) expert, data collection/interpretation, AI curriculum development Stipend for time/effort provided off IFO contract duty days (3 months during summer, academic year weekends as necessary): $25,000/yr via stipend | | | 31% | 0.75 | | $75,000 |
| Gus Vettleson | | Co-PI, NTC; NTC Faculty and Extension Master Gardener, greenhouse plant oversight, curriculum development. Stipend for time/effort provided off MSCF contract duty days (3 months during summer, academic year weekends as necessary) $15,000/yr via stipend | | | 31% | 0.75 | | $45,000 |
| NTC Electrical Trades Faculty Member, NTC Plumbing Faculty - Julian Dreher | | Co-PI(s), NTC; Greenhouse setup, solar installation, plumbing, hydroponics installation. Stipend for time/effort provided off MSCF contract duty days (3 months during summer, academic year weekends as necessary) $15,000/yr via stipend(s) | | | 31% | 0.75 | | $45,000 |
| Undergraduate Assistants | | NTC Students will assist in greenhouse maintenance, produce care, and AI systems.; BSU Computer Science Student will assist in AI systems, data acquisition, analysisNTC Students: 2 students, summer stipends (up to 20hrs/wk x 12 wks per yr for 3 yrs): $16,000 ; BSU Student: 1 student yearly, stipend (10hrs/wk x 40 wks for 3 yrs): $19,000 | | | 0% | 1.29 | | $35,000 |
| | | | | | | | **Sub Total** | **$275,000** |
| **Contracts and Services** | | | | | | | | |

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| | | | | | | | **Sub Total** | **-** |
| **Equipment, Tools, and Supplies** | | | | | | | | |
| | Tools and Supplies | Temporary treated wood foundation and anchoring system $2,000; Pavers (concrete or brick) for temporary greenhouse floor (400sqft) $2,500; leveling sand/gravel $1,000 | Provides stable and clean interior surfaces for operational safety and sanitation. | | | | | $6,000 |
| | Equipment | Hydroponics & Raised Beds: 2x horizontal hydroponics systems $3,500/ea; Installation materials $500; pH & EC monitoring sensors $2,000; 4x 2'x8' galvanized raised beds $2,000/total; Starting soil and compost $1,000 | Comparative growth platforms for diverse agricultural methods. | | | | | $9,000 |
| | Tools and Supplies | Seeds, Soil, Fertilizers: Soil and compost $1,500; Coco Coir & Perlite $700; Soil amendments $300; Hydroponics nutrient solutions $1,200; Slow release organic fertilizers $800; Microbial soil enhancers (beneficial bacteria) $500; Variety of crop seeds (leafy greens, tomatoes, peppers, squash, strawberries) $600; Seed Trays and Germination Supplies $1,000 | These materials are essential for establishing and maintaining optimal plant growth in both the hydroponic systems and raised beds. A diverse range of crops to be tested, supporting AI-driven optimization of water, nutrient, and environmental conditions for sustainable agriculture. | | | | | $6,600 |
| | Equipment | AI Hardware & Software: AI Data Collection and Processing hardware (general) – $4,900 Cloud-Based Data Storage & Processing (3 years) – $4,800 Network Connectivity Hardware (routers, extenders, secure data transfer equipment) – $4,300; Soil & Environmental Sensors: Soil Moisture & Nutrient Sensors (multi-point data collection across greenhouse beds) – $4,800 Air Temperature, Humidity, and $CO_2$ Sensors (to optimize greenhouse climate control) – $4,800; AI-Driven Greenhouse Management Software (automation, predictive modeling, and remote control tools) – $3,400 Data Visualization & Predictive Analytics Software – $3,500; High-Resolution Optical Cameras (growth tracking, early disease detection, and security monitoring) – $4,900 Thermal & Multispectral Cameras (for plant stress diagnostics and automated health tracking) – $4,900 Camera Mounting & Data Processing Hardware (supports AI-based analysis of images) – $800 | Core technology for automated greenhouse monitoring, management, and data analysis. | | | | | $41,100 |

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|---|---|---|---|---|---|---|---|---|
| | Tools and Supplies | Horticulture & Laboratory Consumables: Greenhouse & Horticulture Supplies: Seedling Trays, Pots, and Propagation Materials (for plant starts and controlled growth trials) – $2,000 Pruning Tools, Trellises, and Support Structures (for plant maintenance and growth optimization) – $1,500 Protective Gear (gloves, lab coats, safety goggles for handling soil, fertilizers, and microbial samples) – $1,000; Laboratory Consumables: Petri Dishes, Culture Tubes, and Microbiological Growth Media (for studying soil and plant microbes) – $2,000 Chemical Reagents & Test Kits (for soil pH, nutrient analysis, and microbial identification) – $1,500 Sterile Filtration & Pipettes (for precision sample collection and contamination control) – $500; Replacement filters, tubing calibration kits, labels, storage containers - $1,500 | Horticulture and laboratory consumables are necessary for plant cultivation, greenhouse maintenance, and scientific analysis. They support seedling propagation, plant care, soil and microbial testing, and AI sensor calibration to ensure accurate data collection and optimal greenhouse performance. These materials will be used throughout the project for research, student training, and curriculum integration, reinforcing both the agricultural and scientific goals of the study. | | | | | $10,000 |
| | Tools and Supplies | Microbiology/Natural Sciences Laboratory Supplies: Microbiological Analysis & Culturing Supplies ($4,500) Agar Plates, Culture Tubes, and Growth Media (for microbial isolation and analysis) – $2,500 Sterile Loops, Pipettes, and Inoculation Tools (for handling bacterial and fungal cultures) – $1,500 Autoclave Bags & Sterilization Supplies (for safe disposal and contamination prevention) – $500; Soil and Water Testing Kits (for microbial activity, pH, and nutrient levels) – $2,000 Reagents & Chemical Buffers (for microbial identification and biochemical assays) – $1,000 Microscopy Slides, Stains, and Cover Slips (for microbial and plant tissue examination) – $500; Sample Tubes, and Freezer Boxes (for long-term microbial and soil sample storage) – $1,500 Labeling and Data Logging Materials (for proper sample identification and tracking) – $500 | These laboratory supplies enable classroom education related to microbial, soil, and water analysis to assess the environmental impact of AI-driven greenhouse systems. They support sample collection, microbial culturing, chemical testing, and long-term data storage, ensuring the project's scientific accuracy and research integrity. | | | | | $10,000 |
| | Equipment | Irrigation & Hydroponics System: Hydroponics water system (tubes, valves, pumps, emitters) $5,500; Gutter & Downspout system for both greenhouses $2,000; Outside water storage $2,000; Distribution pumps and overflow controller $1,000; Water storage tanks and filtration $3,000; | Sustainable irrigation and water collection/reuse, plumbing needed to reach greenhouses, necessary for plant growth. | | | | | $17,000 |

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|---|---|---|---|---|---|---|---|---|
| | | Automated controllers & sensors $2,500; Installation materials $1,000; | | | | | | |
| | Equipment | HVAC Systems: Ventilation fans & louvers $3,500; Heaters for cool weather use $3,000; Reflective film and cooling shade for heat management $2,000; Humidity control sensors and dehumidifiers $3,000, Installation materials $2,800 | The HVAC system ensures optimal temperature, humidity, and airflow regulation for greenhouse operation. It integrates smart greenhouse technology to maintain stable growing conditions, reduce energy consumption, and enhance AI-driven climate control for improved plant productivity and sustainability. | | | | | $14,300 |
| | Equipment | Solar Power Generation: Solar Panels, up to ten 400W monocrystalline units $4,500; Mounting Racks and Supports $3,000; Charge controllers $2,500; Installation wiring (connectors, inverters, supplies) $3,500 | The system ensures consistent power supply, reducing reliance on external electricity and improving sustainability. | | | | | $13,500 |
| | Equipment | Battery Storage & Power Management: Lithium-Ion Battery array $4,500; Inverter system (converts DC to AC power) $3,000; AI-Integrated energy monitor $2,500; Backup Power System (connection to sustained power if needed, generator) $3,500 | These materials are necessary for powering greenhouse components, including AI-integrated energy monitoring to store and regulate power for greenhouse operations.Continuous energy availability is ensured, optimizing efficiency and providing backup support during low sunlight conditions. | | | | | $13,500 |
| | | | | | | | **Sub Total** | **$141,000** |
| **Capital Expenditures** | | | | | | | | |
| | | Two 10'x20' polycarbonate greenhouses @ $6,500 each | Temporary greenhouses for experimental use during the project. Economic replicability. | X | | | | $13,000 |
| | | High-performance laboratory refrigerator | Sample preservation, plant/microbe culturing, and reagent storage. | X | | | | $15,000 |
| | | Laboratory Freezer | Preservation of microbiological samples, laboratory reagents, and horticulture supplies. | X | | | | $13,000 |
| | | | | | | | **Sub Total** | **$41,000** |
| **Acquisitions and Stewardship** | | | | | | | | |

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| | | | | | | | **Sub Total** | **-** |
| **Travel In Minnesota** | | | | | | | | |
| | | | | | | | **Sub Total** | **-** |
| **Travel Outside Minnesota** | | | | | | | | |
| | Conference Registration Miles/ Meals/ Lodging | 2 Regional or National Conferences. Funding for 2 faculty and 2 student presentations. | Presentation of findings to a wider audience. | | | | | $8,000 |
| | | | | | | | **Sub Total** | **$8,000** |
| **Printing and Publication** | | | | | | | | |
| | Printing | Printing of reports for stakeholders | Dissemination of data and protocols | | | | | $500 |
| | Publication | Article page charges for Open Access | Dissemination of project findings to a wider audience via peer reviewed journal(s). | | | | | $4,500 |
| | | | | | | | **Sub Total** | **$5,000** |
| **Other Expenses** | | | | | | | | |
| | | | | | | | **Sub Total** | **-** |
| | | | | | | | **Grand Total** | **$470,000** |

## Classified Staff or Generally Ineligible Expenses

| Category/Name | Subcategory or Type | Description | Justification Ineligible Expense or Classified Staff Request |
|---|---|---|---|
| **Capital Expenditures** | | Two 10'x20' polycarbonate greenhouses @ $6,500 each | The two $6,500 polycarbonate greenhouses are a necessary and integral component of this research project, serving as the experimental platform for AI-driven and traditional greenhouse comparisons. Although LCCMR typically classifies capital infrastructure as ineligible, these structures are temporary, modular, and directly tied to research objectives, making them essential for data collection and project success.<br><br>-Core to Research and Data Collection – The greenhouses provide controlled environments where AI-driven precision agriculture and traditional methods will be tested side by side, ensuring accurate experimental comparisons and real-world validation of AI integration in greenhouse systems.<br><br>-Temporary and Reusable Structures – Unlike permanent infrastructure, these modular greenhouses can be disassembled and relocated for future research projects, ensuring their long-term value while aligning with LCCMR's guidelines for temporary infrastructure investments.<br><br>-Directly Supports Educational and Workforce Training – The greenhouses provide hands-on learning opportunities for students and researchers in sustainable agriculture, AI-based automation, and environmental monitoring, aligning with the project's educational and workforce development goals.<br><br>Given these factors, the explicit approval of these greenhouse costs is essential to achieving the project's objectives and generating data-driven insights into sustainable, AI-assisted agriculture for Minnesota's rural food systems.<br>**Additional Explanation :** The two $6,500 polycarbonate greenhouses will serve as temporary research structures for the duration of this project, enabling a controlled environment for AI-driven agricultural studies, comparative crop management, and student training. These structures are designed for easy disassembly and relocation, ensuring the potential for continued use beyond the initial grant period.<br>After project completion, the greenhouses will remain available for additional research initiatives at Northwest Technical College (NTC) and its academic partners. Future projects may focus on advanced hydroponic systems, alternative growing techniques, climate-adaptive agriculture, or expanded AI applications in precision farming. The ability to dismantle, transport, and reassemble the greenhouses ensures the potential viability for ongoing scientific study and workforce training.<br>Additionally, the greenhouses can be integrated into future educational programs, allowing students to gain hands-on experience with controlled-environment agriculture and sustainability practices. Their continued use could support curriculum expansion, faculty research, and collaborative studies with other institutions or industry partners, |

| | | | |
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| | | | maximizing the impact of this investment for years to come. |
| **Capital Expenditures** | | High-performance laboratory refrigerator | High-Performance Refrigerator ($15,000) – Essential for sample preservation, plant/microbe culturing, and storage, ensuring that microbial and environmental research components remain viable. This equipment is directly tied to long-term project success, allowing for accurate microbial monitoring and plant studies beyond the initial grant period.<br>**Additional Explanation :** The $15,000 high-performance refrigerator will be a critical long-term asset for research, education, and sustainable agriculture initiatives at Northwest Technical College (NTC). This equipment will support sample preservation, plant and microbial culturing, and storage, ensuring the continuity and expansion of research efforts related to AI-driven greenhouse systems, soil microbiome health, and sustainable agriculture.<br><br>Beyond the initial grant period, the refrigerator will continue to serve multiple ongoing and future research projects at NTC. It will remain an integral component of biology, microbiology, and environmental science courses, allowing students to engage in hands-on laboratory training in microbial isolation, plant tissue culture, and experimental greenhouse studies. Additionally, the equipment will facilitate collaborative projects with Bemidji State University and other regional partners, supporting workforce development in biotechnology, agricultural research, and climate-adaptive food production.<br><br>NTC has the necessary facilities, faculty expertise, and institutional commitment to maintain and utilize the incubator/refrigerator beyond the project's duration. Routine maintenance and proper storage protocols will ensure its long-term functionality, making it a sustained resource for scientific discovery and student engagement in environmental and agricultural research for years to come. |
| **Capital Expenditures** | | Laboratory Freezer | The laboratory-grade -20°C freezer is a necessary capital expense. It is directly related to and essential for the successful execution of this project, ensuring proper preservation of microbiological samples, plant materials, and laboratory reagents used in AI-driven greenhouse research.<br><br>Preservation of Microbiological and Plant Samples – The freezer is necessary to store and maintain microbial isolates, soil microbiome samples, and plant tissues collected from the AI greenhouse project. These samples require long-term storage at stable -20°C conditions to ensure viability for analysis throughout the project and beyond.<br><br>Storage of Laboratory Reagents – The freezer is critical for maintaining enzymes, molecular reagents, and microbial media necessary for conducting soil and plant microbiology research. These materials are essential for studying microbial interactions, plant health, and AI-driven environmental optimization in the greenhouse systems. |

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| | | | **Additional Explanation :** The laboratory-grade -20°C freezer is a critical long-term asset that will support microbiological sample preservation, storage of laboratory reagents, and ongoing environmental and agricultural research at Northwest Technical College (NTC). This equipment ensures that collected microbial and plant samples remain viable for extended analysis, allowing for longitudinal studies on soil microbiomes, plant-microbe interactions, and AI-driven agricultural optimization.<br><br>Beyond the initial grant period, the freezer will remain an integral part of laboratory instruction and research at NTC. It will support microbiology, environmental science, and biotechnology coursework, providing students with hands-on experience in sample processing, microbial culturing, and molecular analysis. Additionally, it will enable future research collaborations with Bemidji State University and other regional partners, ensuring that microbiological and environmental data continue to be analyzed and leveraged for climate-adaptive agricultural innovations.<br><br>NTC has the necessary laboratory infrastructure, faculty expertise, and institutional commitment to maintain and utilize the freezer throughout its useful life. Proper storage protocols, routine maintenance, and responsible use will ensure its continued functionality, making it a sustained resource for scientific research, education, and agricultural sustainability efforts well beyond the scope of this project. |

## Non ENRTF Funds

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

**Total Project Cost: $470,000**

**This amount accurately reflects total project cost?**

Yes

## Attachments

### Required Attachments

*Visual Component*

File: d0776413-d15.docx

*Alternate Text for Visual Component*

Illustration of the proposed AI-integrated greenhouse system featuring two identical temporary greenhouses. One greenhouse will incorporate AI-driven monitoring and automation, while the other will operate using traditional methods for comparative analysis. Both greenhouses will include hydroponic systems and raised garden beds to evaluate different growing techniques....

## 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 Commissioner's Plan 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:**

Karl Anderson - NTC, Bemidji, MN

**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