Environment and Natural Resources Trust Fund
2019 Request for Proposals (RFP)

Project Title: **ENRTF ID: 090-B**

Sustainable, Integrated Food Waste Treatment and Utilization

Category: B. Water Resources

Sub-Category:

Total Project Budget: $ 1,076,000

Proposed Project Time Period for the Funding Requested: June 30, 2022 (3 yrs)

Summary:

Develop and demonstrate an integrated scalable systems for converting food waste into renewable energy, feed, food, and clean wastewater

Name: Dean Current

Sponsoring Organization: U of MN

Title: Program Director

Department: CFANS/Forest Resources

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Location

Region: Statewide

County Name: Statewide

City / Township:

Alternate Text for Visual:

The visual illustrates a systems approach to complete treatment and utilization of food wastes through multiple biological processes

_____ Funding Priorities	_____ Multiple Benefits	_____ Outcomes	_____ Knowledge Base
_____ Extent of Impact	_____ Innovation	_____ Scientific/Tech Basis	_____ Urgency
_____ Capacity Readiness	_____ Leverage	_____ TOTAL	_____%
____ If under $200,000, waive presentation?			

PROJECT TITLE: Sustainable, integrated food waste treatment and utilization

I. PROJECT STATEMENT

"**America Is Losing up to 40 Percent of Its Food from Farm to Fork to Landfill**" (NRDC, 2017). In addition to the fact that 40% of food production is wasted, there are significant environmental impacts associated with that loss. Food accounts for 21% of municipal solid waste that is often disposed of in landfills and produces 11% of landfill generated methane gas (a powerful greenhouse gas) emissions (NRDC, 2017). Landfills contribute to water quality issues from runoff and leaching of contaminants into Minnesota's surface and groundwater systems. A parallel issue addressed in this project is reducing water use in crop production.

We will develop and demonstrate an integrated facility to convert food waste into renewable energy, feeds, foods, and clean wastewater. This research and demonstration project builds on prior research funded by LCCMR and other sources and will demonstrate the practical application of the research in an inner city and rural Minnesota site. We are currently facing environmental problems related to excessive food waste that is commonly disposed of in landfills, creating greenhouse gases and water pollution. We are also facing issues of insufficient water for crop production. The proposed integrated system will minimize water use while addressing water pollution issues caused by food waste.

Added benefits of the project are the potential for commercialization of this system in rural and urban areas as well as the serving as a unique educational resource for the 15,000 visitors, mostly school children, who visit the Wolf Ridge Environmental Learning Center annually.

The goal of the proposed project is to integrate a series biological processes into a multi-functional system consisting of the following components: (1) bacteria based fermentation processes to produce methane and reduce the nutrient levels to a degree suitable for algae cultivation, (2) algae cultivation to further remove nutrients and produce biomass as feed, (3) black soldier fly larvae culture for feed production, and (4) aquaponic facility to utilize the water and feed to produce vegetables and fish. These components are being developed by the team. With some additional R&D efforts, we will be able to streamline individual processes and components and build an integrated system for evaluation and demonstration.

This project addresses Priority B by developing sustainable technologies to reduce contaminants in ground and surface waters and Priority E by developing technologies to reduce wastes and produce renewable energy.

II. PROJECT ACTIVITIES AND OUTCOMES

Activity 1: *Optimize and streamline key processes and components*

Several key processes will be optimized and quantitative information will be acquired before we streamline and scale individual components. The solid food wastes will be optimized for black soldier fly larvae production. The vacuum thermophilic anaerobic digestion and micro-aeration in biological digestion will be optimized to produce effluent water with chemical oxygen demand (COD) and ammonia levels that can be handled by microalgae. This will involve testing of digestion levels and algae growth at different levels of COD and ammonia level. Similarly, the optimum nutrient levels for vegetable cultivation and cleanness of water for fish culture will also be determined. With these basic data, we will streamline individual components and develop process design.

ENRTF BUDGET: $ 400,000

Outcome	Completion Date
1. Key processes will be optimized	*7/1/2021*
2. Individual processes and components will be streamlined and a process flow diagram will be developed	*7/1/2021*

Activity 2: *Develop the integrated system, evaluate its technical performance, and conduct demonstration*

Individual processes and components will be scaled for the integrated system. We will design and fabricate the system. The performance of the individual components and the entire system will be analyzed.

ENRTF BUDGET: $ 526,000

Outcome	Completion Date
1. All the processes will be scaled to a defined capacity and the integrated system will be designed system design	*10/1/2020*
2. The integrated system will be fabricated – system constructed	*7/1/2021*
3. The technical performance of the system will be evaluated - evaluation	*1/1/2022*
4. The system will be demonstrated to stakeholders – ongoing demonstration	*7/1/2022*

Activity 3: *Conduct economic and environmental analysis of the integrated system*

The data collected from Activity 2 will be used in the economic and environmental analysis. This analysis will provide an assessment of the approach in terms of economic feasibility and environmental impacts.

ENRTF BUDGET: $ 150,000

Outcome	Completion Date
1. Data needed for analysis will be collected and organized – economic data set	*1/1/2022*
2. Techno-economic and environmental impact assessment completed and presented	*7/1/2022*

III. PROJECT TEAM and PARTNERS:

Researchers in Depts. Of Bioproducts and Biosystem Engineering, Center for Biorefining, Center for Integrated Natural Resources and Agricultural Management (CINRAM) at the University of Minnesota will partner with David Abazs of the Wolf Ridge Environmental Learning Center. The team has worked together on an aquaponics project with black soldier fly larvae in the past. The Wolf Ridge Environmental Center provides a unique capability to demonstrate the proposed integrated system to their 15,000 annual visitors.

A. Partners receiving ENRTF funding

Name	Title	Affiliation	Role
Dean Current	Academic Professional	Univ. of Minnesota	PI
R Ruan	Faculty	Univ. of Minnesota	Co PI
P Chen	Research Associate Professor	Univ. of Minnesota	Co PI
David Abazs	Wolf Ridge Organic Farm Mgr. Round River Farm Owner AgroEcology Center Director	Wolf Ridge Environmental Learning Center	Implement and manage demonstration site

IV. LONG-TERM- IMPLEMENTATION AND FUNDING:

The overall goal of the project is to develop and demonstrate a technology that will recycle nutrients and add value to nutrients from food waste to reduce environmental impact through the production of livestock feed. This collaborative project will build on current algal and nutritional activities of the project investigators. The proposed project does not need additional investment other than that requested from the ENRTF. We will seek additional long-term funding to conduct research to integrate this facility in rural and urban areas in MN. **Note**: At the end of the project period, the UMN facilities and equipment will be used for follow-on research and at Wolf Ridge as a demonstration and educational facility serving Minnesota students and educators.

V. TIME LINE REQUIREMENTS:

The proposed period is 3 years from July 1, 2019 through June 30, 2022. This should allow us sufficient time to plan and establish the demonstration site and gather data for over a year to evaluate performance of the system under practical field conditions.

2019 Proposal Budget Spreadsheet

Project Title: Instant On-demand Nitrogen Fixation for Crop Land Applications

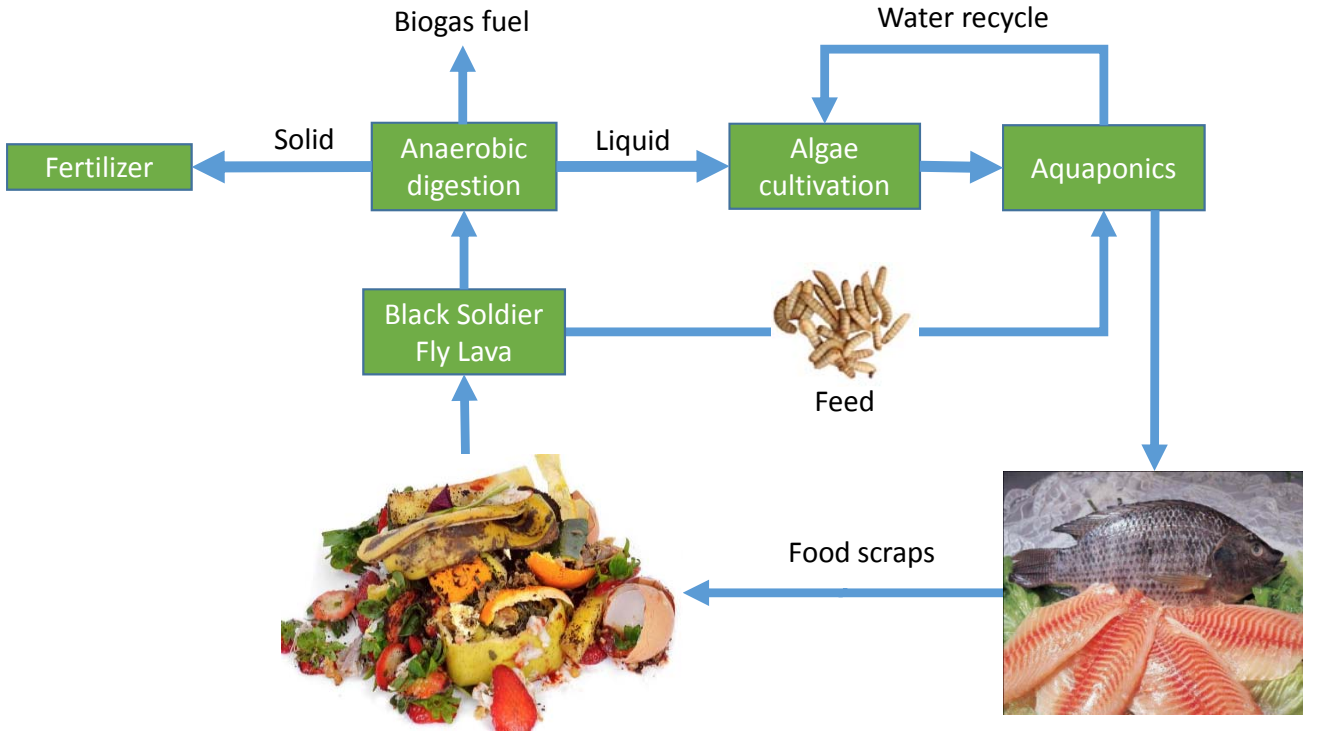
IV. TOTAL ENRTF REQUEST BUDGET [3] years

BUDGET ITEM (See "Guidance on Allowable Expenses")	**AMOUNT**
Personnel: Dean Current, Academic Professional 30% FTE, PI/PD, for 3 years including 33.5% benefits,(75% salary, 25% fringe) responsible for project administration, coordination of demonstration sites, and financial and economic analysis.	105,000
Roger Ruan, Faculty, Co-PI, 8% FTE 1 month/year, 3 years, including 33.5% benefits, (75% salary, 25% fringe) leading and managing project, overlooking R&D, leading demonstration, supervising	65,000
Paul Chen, Research Associate Professor co-PI, 8% FTE 1 month/year, 3 years, including 33.5% benefits, (75% salary 25% fringe) project outreach presentations, reports and papers, helping supervising postdocs and RA	32,000
Graduate Research Asst NRSM., 50% FTE for 3 years including 15% benefits plus tuition (64% salary, 36% fringe), conducting financial and economic analsys of integrated system	142,000
BBE Graduate Research Assistants, 50% FTE, 3yrs, including 15% benefits plus tuitions (64% salary, 36% fringe), conducting R&D, operation, demonstration	142,000
BBE research associate 50% FTE , 3yrs, including 22.40% benefits, conducting R&D, operations, demonstration, data analysis	104,000
Professional/Technical/Service Contracts: Wolf Ridge, David Abazs, Demonstration site coordinator/supervisor	90,000
Wolf Ridge - Construction of demonstration facility , demonstration systems, and modification and installation of all the demonstration systems at Wolf Ridge Environmental Learning Center	50,000
Wolf Ridge - Labor for demonstration site (1 FTE for 3 years @ $10/hr)	63,000
Equipment/Tools/Supplies: Components for Food waste anaerobic digestion system, food waste micro-aeration induced digestion system, algae cultivation system, black soldier fly larvae	80,000
Lab supplies, consumables, minor equipment	30,000
Outside analysis service (labs in different departments within UMN or labs outside the university with MN Company preferred)	15,000
Acquisition (Fee Title or Permanent Easements):	N/A
Travel: In state travel for researchers to travel between campus and demonstration site over the 3yrs project period aprocimatey 33 trips @ 444 miles per trip at $0.545/mile	8,000
Additional Budget Items: Components for fabication of small scale demonstration facility including: nitrogen bubbling/vacuum assisted food waste anaerobic digestion reactor, BSFL production system, microalgae and bacteria cultivation reactor, acquaponics production system, biochar filtration unit, etc.	150,000
TOTAL ENVIRONMENT AND NATURAL RESOURCES TRUST FUND $ REQUEST =	1,076,000

V. OTHER FUNDS *(This entire section must be filled out. Do not delete rows. Indicate "N/A" if row is not applicable.)*

SOURCE OF FUNDS	**AMOUNT**	**Status**
Other Non-State $ To Be Applied To Project During Project Period:	N/A	*N/A*
Other State $ To Be Applied To Project During Project Period:	N/A	*N/A*
In-kind Services To Be Applied To Project During Project Period: Unrecovered Facilities and Administration (54% Modified Total Direct Costs) (96,558)	$ 96,558	*Secured*
Past and Current ENRTF Appropriation:	N/A	N/A
Other Funding History:	N/A	*N/A*

Sustainable integrated food waste treatment and utilization



Project Manager Qualifications and Organization Description

Project Manager Qualifications:

Dr. Dean Current is the Program Manager for the Center for Integrated Natural Resources and Agricultural Management at the University of Minnesota. Dr. Current has a background in Natural Resource Economics, forestry, agroforestry and farmer adoption of improved land use systems. Dr. Current has led interdisciplinary teams in Latin America, South and Southeast Asia and Minnesota. Dr. Current has been working on aquaponics, biomass production and water quality and storage issues in the Minnesota River Basin for the last 17 years. His work involves working with outstate partners, state and federal agencies and local communities. Projects that Dr. Current has led were sponsored by the LCCMR, MPCA section 319, MDA, Xcel Energy's Renewable Development Fund as well as Federal and non-profit sponsors. In 2015 and 2016 Dr. Current was PI for and coordinated the project, "Building an Integrated Aquaponic System to Meet Health, Nutrition and Employment Objectives in Local Minority Communities". That project was funded by the MnDrive Program. The work of Dr. Current and CINRAM has concentrated on water quality and storage in the Minnesota River Basin as well as developing enterprises utilizing markets to promote conservation and local economic development in Minnesota and abroad.

Organization Description:

CINRAM is an interdisciplinary partner-based organization that catalyzes the development and adoption of integrated land use systems. CINRAM links the expertise of the Univ. of Minnesota with the experience and insights of people and organization who work with and have understanding of, opportunities and issues across the landscape.

CINRAM's efforts lead to:

- A more diversified agricultural and natural resource production base
- Increased profitability
- An enhanced environment
- Strengthened rural communities
- Productive landscapes generating income and environmental/ecosystem services

Examples of projects led by Dr. Current as Program Director of CINRAM:

Global Food Ventures, MnDRIVE - Building an Integrated Aquaponic System to Meet Health, Nutrition and Employment Objectives in Local Minority Communities.

Xcel Energy - Lowering the Cost of Bio-energy Feedstocks while Providing Environmental Services – A Win-Win Opportunity. Includes research on payments for environmental services.

MN Board of Water and Soil Resources - Scoping Study: Pricing and contract structure procedures for Minnesota Clean Energy RIM Reserve Program

Central Regional Sustainable Partnership - A Test of Methods for Selling Local Carbon Credits

USDA - Bioenergy Plantings Targeted to Improve/ Enhance Water Quality – Pyrolysis