



# Environment and Natural Resources Trust Fund

## 2021 Request for Proposal

### General Information

**Proposal ID:** 2021-263

**Proposal Title:** The Carbon Sequestration Potential of a Perennial Grain

### Project Manager Information

**Name:** Jessica Gutknecht

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

**Office Telephone:** (612) 626-8435

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### Project Basic Information

**Project Summary:** We will quantify the carbon sequestration potential of a new perennial grain crop, Kernza, and will research and communicate implementation strategies for both economic and environmental gain in Minnesota.

**Funds Requested:** \$219,000

**Proposed Project Completion:** 2023-12-31

**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?**

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.**

Carbon sequestration in agricultural lands is an exciting avenue for the mitigation of greenhouse gases, as demonstrated by the increasing focus of Minnesota state agencies (MPCA, 2019) and the expanding idea of “carbon farming” (ex. [www.nori.com](http://www.nori.com)). Converting farmland to perennial covers, such as crop idling, perennial pasture, or forage grasses, is currently the most promising way of sequestering carbon on farms, possibly resulting in over a ton of carbon stored per hectare per year (MPCA, 2019). However, these options are not as profitable as productive annual row crops.

The first economically viable perennial grain crop, Kernza® could sequester as much carbon as prairie plantings and it is already being grown in Minnesota. With Kernza’s high biomass production and deep extensive root system, it also confers ecosystem benefits such as wildlife habitat and nitrate mitigation. The critically important advantage of Kernza is that it can support MN agriculture through high-value grain production and other value-added end uses (e.g. forage and bioenergy). Kernza is developing at a remarkable pace, creating actionable economic opportunities. Quantifying, communicating, and marketing the full carbon sequestration potential of Kernza will drive improvements in Minnesota’s environmental quality and will stimulate local economies.

### **What is your proposed solution to the problem or opportunity discussed above? i.e. What are you seeking funding to do? You will be asked to expand on this in Activities and Milestones.**

To address these challenges, we will conduct a detailed Life Cycle Analysis (LCA) based quantification of the carbon sequestration potential of Kernza, and link these results directly to Kernza production and economic opportunities. Our team – as one of the premier integrated research and implementation groups in the US focusing on this novel crop – is well poised to carry out this interdisciplinary project. We have spent several years studying how much Kernza grain and root biomass is produced in MN and the associated environmental benefits including soil improvement and nitrate mitigation.

This project will also feed into a platform we are building to deliver ecosystem service payments to growers, thus we have an incredible opportunity to quantify and potentially market carbon sequestration as its own ‘product,’ allowing Minnesota’s agricultural community to aid in reducing the state’s carbon footprint. Our partners range from global food industry leaders to local farmers and food businesses, all eager to market the carbon sequestration potential of Kernza to consumers. This rare opportunity to perform a comprehensive LCA based on many factors within and beyond the farm will also contribute to state efforts to understand the carbon sequestration potential of land management practices 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?**

This project has three concrete outcomes: We will 1) quantify the carbon sequestration potential of a novel perennial grain crop that offers multiple benefits and economic opportunities for farmers in Minnesota, using an LCA approach 2) determine which MN watersheds are ideally suited for the multiple environmental improvement opportunities of Kernza based on carbon sequestration and nitrate mitigation data, and 3) Effectively communicate Kernza’s carbon sequestration potential to industry and consumers through reports and events, and conduct market research to facilitate product development and increased demand. Together these outcomes will ultimately drive awareness, demand and environmentally beneficial landscape change.

## Activities and Milestones

### Activity 1: Quantify the carbon sequestration potential of Kernza based on life cycle analysis

**Activity Budget:** \$67,208

**Activity Description:**

We will conduct a Kernza Life Cycle Analysis (LCA) to determine its carbon sequestration potential. LCA addresses changes in soil and plant carbon and other greenhouse gas emissions of a product along each step of its creation, from “field to fork”. With LCA one can ask: What are the total carbon costs per calorie or per unit of land, of bread or meat produced? Carbon and energy costs of a given crop can vary with several factors, such as diesel fuel or fertilizer used for field operations in a given geographical region. The biomass carbon and yield production of Kernza can also be accounted for, followed by an assessment of the carbon costs of processing for various end uses including forage or animal feed, bioenergy, or foods such as beer or bread (See proposal figure). We will compare Kernza LCA results to those of other systems, for example prevailing corn/soybean rotations or perennial pasture.

Because of farmers and other partners growing Kernza around Minnesota in different ways, with different end users, we are developing both localized and large-scale markets and processing chains. These factors will feed into a comprehensive LCA, designed to readily support marketing, communication, and implementation.

**Activity Milestones:**

| Description   | Completion Date |
|---|-----------------|
| A report quantifying the carbon sequestration potential of Kernza based on a comprehensive LCA. | 2022-03-31      |

### Activity 2: Mapping Kernza production locations to optimize carbon storage, watershed conservation and local economic opportunities

**Activity Budget:** \$18,796

**Activity Description:**

Activity 1 will identify the most impactful locations and end uses of Kernza compared to more widespread corn/soybean systems, with regard to carbon sequestration potential. In this activity, we will leverage that information with additional data on nitrate mitigation potential of Kernza across multiple state wellhead protection areas. We will predict which watersheds in Minnesota have the greatest C sequestration and nitrate mitigation potential of this new crop. We will then use these predictions to engage partners in those areas with the market research described below, potentially focusing ecosystem service payments, grower outreach, and guiding Kernza commercialization efforts in these areas of high environmental impact.

In this sense, this proposal will act to support and revitalize the economies in rural areas that also are the most vulnerable to environmental degradation- creating win-wins for our Minnesota communities.

**Activity Milestones:**

| Description  | Completion Date |
|--|-----------------|
| A report detailing the geographical best implementation and investment of Kernza on the landscape. | 2022-06-30      |

### Activity 3: Conduct market research to best communicate the environmental benefits of Kernza to consumers and disseminate project results

**Activity Budget:** \$132,996

#### **Activity Description:**

Our food industry partners, including several small Minnesota businesses, are eager for LCA results to inform further investment in Kernza products. The commercial success and environmental benefits of this crop hinge on effective communication and marketing that will drive consumer demand. We will first conduct market research using surveys, interviews, and focus groups targeted to identify key industry and consumer audiences, value drivers, and effective marketing strategies for Kernza’s carbon sequestration potential and environmental benefits.

We will communicate the carbon sequestration potential and other environmental benefits of Kernza to food industry partners, consumers, growers, and other stakeholders via reports and dynamic community events, including one event specific to Minnesota communities and one drawing a national Kernza audience. These events will align where possible with existing high-visibility events such as film fests, food fairs, and national gatherings. The events will demonstrate how partnerships and product innovations drive the message of Kernza’s environmental benefits to consumers.

This market-driven strategy of advancing commercial production of an innovative perennial grain crop will require intentional marketing of Kernza’s environmental benefits. Strong demand will drive landscape change, ultimately delivering multi-faceted environmental quality benefits and new economic opportunities for Minnesota growers and rural communities.

#### **Activity Milestones:**

| Description  | Completion Date |
|--|-----------------|
| Market research to identify target audiences and key messaging to convey Kernza’s environmental benefits.              | 2022-10-31      |
| MN-based community outreach event showcasing Kernza’s economic, social and environmental benefits.                     | 2022-10-31      |
| Print and web materials to deliver LCA and market research results to targeted audiences.                              | 2023-05-31      |
| Nationally-focused Kernza event hosted in MN promoting MN leadership in cropping system innovation and implementation. | 2023-07-31      |

## Project Partners and Collaborators

| Name              | Organization                         | Role  | Receiving Funds |
|-------------------|--------------------------------------|---|-----------------|
| Peter Ciborowski  | Minnesota Pollution Control Agency   | Oversee the process of Life Cycle Analysis based determination of Kernza carbon sequestration potentials. His contribution will ensure that this project can contribute to and inform the carbon sequestration goals of Governor Walz and the State of Minnesota. | No              |
| Ben Penner        | Ben Penner Farms and Aestiv, LLC     | Conduct market and implementation research on Kernza economic opportunities   | Yes             |
| Constance Carlson | University of Minnesota, Twin Cities | Coordinate outreach events and other communication activities   | Yes             |
| Colin Cureton     | University of Minnesota, Twin Cities | Oversee geographic analysis and implementation strategies   | Yes             |
| Jacob Jungers     | University of Minnesota, Twin Cities | Oversee dataset curation for Life Cycle Analysis based determination of Kernza carbon sequestration potentials  | No              |

## 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 be funded?**

Results of this project will directly be applied to implementation goals of the Kernza enterprise, with a goal of increasing planted acreage across the state, especially in wellhead protection areas. We will also use LCA results to continue monitoring the actual carbon sequestration and other greenhouse gas emissions related to Kernza growth and production systems. We expect this work to keep developing quickly in the next decade, and will continue to seek external funding where needed to do so.

## Other ENRTF Appropriations Awarded in the Last Six Years

| Name  | Appropriation   | Amount Awarded |
|---|---|----------------|
| Using Perennial Grain Crops in Wellhead Protection Areas to Protect Groundwater | M.L. 2018, Chp. 214, Art. 4, Sec. 2, Subd. 04j                      | \$250,000      |
| Accelerating Perennial Crop Production to Prevent Nitrate Leaching              | M.L. 2019, First Special Session, Chp. 4, Art. 2, Sec. 2, Subd. 04k | \$440,000      |
| Assessing Release of Mercury and Sulfur on Aquatic Communities                  | M.L. 2017, Chp. 96, Sec. 2, Subd. 04i                               | \$300,000      |

## Project Manager and Organization Qualifications

**Project Manager Name:** Jessica Gutknecht

**Job Title:** Assistant Professor

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

I am a soil ecologist, and I use knowledge about soils and soil nutrient cycling to explore how our decisions about land management can lead to improved outcomes both for people and the environment, especially in the context of improved carbon storage and soil related ecosystem services. I am interested in facilitating collaborative groups such as

this to achieve integrated, high impact outcomes. I am involved in two complementary LCCMR projects: Assessing Release of Mercury and Sulfur on Aquatic Communities (Nater): ML2017, chp.96, sec.2, subd. 04i; and Preventing Nitrate Contamination of Groundwater Using Perennial Grains (Wagner): ML2018, chp.214, art. 4, sec.2, 04j.

#### Professional Experience

University of Minnesota, Twin Cities, St. Paul, MN; Assistant Professor, Department of Soil, Water, and Climate (2014-present); responsible for leading an extramurally-funded research program in soil nutrient cycling and ecology, teaching undergraduate and graduate courses, advising graduate students.

Helmholtz Centre for Environmental Research-UFZ, Halle, DE; Senior Scientist Department of Soil Ecology (2009-2013); led an extramurally and intramurally funded departmental working group on microbial functional ecology, teaching undergraduate practical courses, and advising graduate students.

University of California-Santa Cruz, Santa Cruz, CA; Postdoctoral Research Associate, Department of Environmental Science; (2008-2009)

#### Education

University of Wisconsin-Madison, Madison, WI; Ph.D., Soil Science; (2004-2007)

University of Wisconsin-Madison, Madison, WI; M.S., Soil Science; (2001-2003)

Oregon State University, Corvallis, OR; B.S., Microbiology/cert. applied ethics; (1996-2000)

#### Relevant publications

Docherty, K. and J. Gutknecht. 2019. Microbial community structure alters the resilience of restored prairies to climate change. *Ecological Applications*. e01858

Schmidt, J., Fester, T., Schulz, E., Michalzik, B., Buscot, F., and Gutknecht, J.L.M. 2017. Effects of plant-symbiotic relationships on the living soil microbial community and microbial necromass in a long-term agro-ecosystem. *Science of the Total Environment*, 581-2: 756-765

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

#### **Organization Description:**

The University of Minnesota is a hub for education and research in Minnesota, and entities within it such as the Institute for the Environment are dedicated to “a future in which people and the environment prosper together”. The University of Minnesota, as the flagship land grant university in the state, is dedicated to the missions of research and education that serves the public. We serve tens of thousands of students each year, and have top rated research programs with which to serve the public. Within the University, College of Food, Agricultural and Natural Resource Sciences where this project will take place is also dedicated to that mission. The University of Minnesota is a leader in the development of Kernza as a perennial grain crop. This institution hosts research programs on the food science; genomics and breeding; agronomic, environmental quality, and public outreach aspects of Kernza. This mission, and the facilities and educational programs within the university will ensure the success of this proposed project.

## Budget Summary

| Category / Name                            | Subcategory or Type                        | Description  | Purpose  | Gen. Ineligible | % Benefits | # FTE | Classified Staff? | \$ Amount        |
|--|--|--|--|-----------------|------------|-------|-------------------|------------------|
| <b>Personnel</b>                           |  |  |  |                 |            |       |                   |                  |
| Postdoctoral Researcher                    |  | The postdoctoral researcher will be responsible for conducting the Life Cycle Analysis in coordination with the entire research team. This pertains to activity 1, Life Cycle Analysis of Kernza's carbon sequestration potential.   |  |                 | 25.4%      | 1     |                   | \$65,208         |
| Commercialization specialist 1             |  | The first commercialization specialist, Colin Cureton, will oversee the geographic analysis and will coordinate project deliverables regarding market analysis. This pertains to activity 2, geographic analysis and activity 3, market research.  |  |                 | 36.5%      | 0.3   |                   | \$37,592         |
| Commercialization Specialist 2             |  | The second commercialization specialist, Constance Carlson, will oversee implementation of LCA, geographic, and market analysis into outreach materials. She will also coordinate outreach activities with PD Gutknecht and the entire project team. This pertains to Activity 3, coordinating outreach materials and events |  |                 | 36.5%      | 0.45  |                   | \$56,634         |
|  |  |  |  |                 |            |       | <b>Sub Total</b>  | <b>\$159,434</b> |
| <b>Contracts and Services</b>              |  |  |  |                 |            |       |                   |                  |
| Ben Penner (Ben Penner Farms, Aestiv, LLC) | Professional or Technical Service Contract | Ben Penner (Ben Penner Farms, Aestiv, LLC) will carry out surveys, interviews, and focus groups on the marketing of C sequestration and other environmental benefits of Kernza. This pertains to activity 3, market research.  |  |                 |            | 0.3   |                   | \$29,000         |
|  |  |  |  |                 |            |       | <b>Sub Total</b>  | <b>\$29,000</b>  |
| <b>Equipment, Tools, and Supplies</b>      |  |  |  |                 |            |       |                   |                  |
|  | Equipment                                  | A desktop computer   | One computer is requested for the postdoctoral associate | X               |            |       |                   | \$2,000          |

|                                     |                       |   |   |   |  |  |  |                  |                 |
|-------------------------------------|-----------------------|---|---|---|--|--|--|------------------|-----------------|
|                                     | Tools and Supplies    | Outreach event materials and supplies   | For the first event in fall of 2022, \$7,500 are requested for general supplies, catering, product samples, outreach and event materials (programs -- design, printing, shipping), space and furniture/accommodations rental, and panelist/speaker stipends. For the larger event drawing a national audience in 2023, \$15,000 are requested for supplies as with the small event, but with higher costs and higher speaker stipends for this larger number of people. | X |  |  |  |                  | \$22,500        |
|                                     |                       |   |   |   |  |  |  | <b>Sub Total</b> | <b>\$24,500</b> |
| <b>Capital Expenditures</b>         |                       |   |   |   |  |  |  |                  |                 |
|                                     |                       |   |   |   |  |  |  | <b>Sub Total</b> | -               |
| <b>Acquisitions and Stewardship</b> |                       |   |   |   |  |  |  |                  |                 |
|                                     |                       |   |   |   |  |  |  | <b>Sub Total</b> | -               |
| <b>Travel In Minnesota</b>          |                       |   |   |   |  |  |  |                  |                 |
|                                     | Miles/ Meals/ Lodging | Travel = \$2836 (2500 miles to/from St. Paul and project event locations @ \$0.575/mile, 12 nights lodging at event locations @ \$91/night, 6 days per diem for fieldwork and travel @ \$51/day). | The purpose is for project personnel to travel and prepare for outreach events, pertaining to activity 3.   |   |  |  |  |                  | \$2,836         |
|                                     |                       |   |   |   |  |  |  | <b>Sub Total</b> | <b>\$2,836</b>  |
| <b>Travel Outside Minnesota</b>     |                       |   |   |   |  |  |  |                  |                 |
|                                     |                       |   |   |   |  |  |  | <b>Sub Total</b> | -               |
| <b>Printing and Publication</b>     |                       |   |   |   |  |  |  |                  |                 |
|                                     | Printing              | All deliverables will include printed materials in the form of scientific publications, reports, and web and printed outreach materials to promote  | This printing pertains to all three project activities for printed outreach materials and reports.  |   |  |  |  |                  | \$3,230         |



|                       |  |   |  |  |  |  |                    |                  |
|-----------------------|--|---|--|--|--|--|--------------------|------------------|
|                       |  | C sequestration and other environmental and economic benefits of Kernza cropping systems. |  |  |  |  |                    |                  |
|                       |  |   |  |  |  |  | <b>Sub Total</b>   | <b>\$3,230</b>   |
| <b>Other Expenses</b> |  |   |  |  |  |  |                    |                  |
|                       |  |   |  |  |  |  | <b>Sub Total</b>   | <b>-</b>         |
|                       |  |   |  |  |  |  | <b>Grand Total</b> | <b>\$219,000</b> |

## Classified Staff or Generally Ineligible Expenses

| Category/Name                         | Subcategory or Type | Description                           | Justification Ineligible Expense or Classified Staff Request   |
|---------------------------------------|---------------------|---------------------------------------|--|
| <b>Equipment, Tools, and Supplies</b> |                     | A desktop computer                    | Because the majority of the work involved in this project is based on data organizing, analysis, and modeling, a computer is requested for use by the postdoctoral associate hired for this project.   |
| <b>Equipment, Tools, and Supplies</b> |                     | Outreach event materials and supplies | Although catering is usually ineligible, in this case catering to support food innovations at outreach events are a crucial part of our work. This allows us to demonstrate a range of food products, innovations, and types of food businesses supporting Kernza perennial grain. |

Non ENRTF Funds

| Category         | Specific Source | Use | Status                     | Amount |
|------------------|-----------------|-----|----------------------------|--------|
| <b>State</b>     |                 |     |                            |        |
|                  |                 |     | <b>State Sub Total</b>     | -      |
| <b>Non-State</b> |                 |     |                            |        |
|                  |                 |     | <b>Non State Sub Total</b> | -      |
|                  |                 |     | <b>Funds Total</b>         | -      |

## Attachments

### Required Attachments

#### *Visual Component*

File: [b3b17f67-673.pdf](#)

#### *Alternate Text for Visual Component*

The visual shows details of the Life Cycle Analysis (LCA) approach to quantify the carbon sequestration potential of Kernza perennial grain. The visual also shows how the results of LCA will feed into the geographic implementation, economic research analysis, and communication aspects of this proposal.

### Optional Attachments

#### *Support Letter or Other*

| Title                                   | File                             |
|---|----------------------------------|
| MPCA Climate Director letter of support | <a href="#">50120efb-cd2.pdf</a> |

## Administrative Use

**Does your project include restoration or acquisition of land rights?**

No

**Does your project have patent, royalties, or revenue potential?**

No

**Does your project include research?**

Yes

**Does the organization have a fiscal agent for this project?**

Yes, Sponsored Projects Administration

# Life Cycle Analysis to Quantify the Kernza® Carbon Sequestration Potential in Minnesota

PI: Dr. Jessica Gutknecht

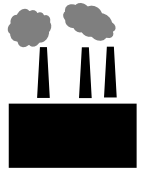
**On-farm  
inputs and  
emissions**

**Processing  
inputs and  
emissions**

**End-use  
inputs and  
emissions**

**Cultivation &  
harvest**

- Fuels, fertilizer
- Machinery
- N<sub>2</sub>O
- CO<sub>2</sub>



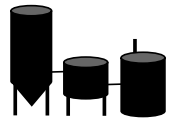
**Flour mills**

- Fuels
- Materials
- Machinery
- CO<sub>2</sub>



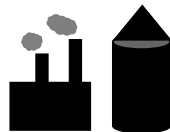
**Livestock farms**

- Energy
- Machinery
- CH<sub>4</sub> from cows
- N<sub>2</sub>O from manure



**Breweries**

- Electricity
- Chemicals
- CO<sub>2</sub> from fermentation



**Biorefineries**

- Fuels
- Chemicals
- Machinery
- CO<sub>2</sub>



**Bakeries**

- Electricity
- Materials
- Machinery

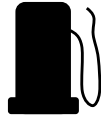


**Meat  
processing**

- Electricity
- Materials
- Machinery

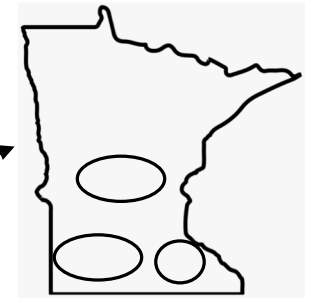
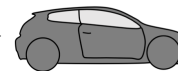


**Gas  
stations**



**Vehicle  
operation**

- CO<sub>2</sub>
- N<sub>2</sub>O
- CH<sub>4</sub>



**Best Landscape Placement**



**Market Research on  
Economic Opportunities**



**Multi-stakeholder  
Communication events**

