Environment and Natural Resources Trust Fund
2017 Request for Proposals (RFP)

Project Title: **ENRTF ID: 141-E**

Feed Additive for Reducing Climate-Damaging Methane Emissions from Cattle

Category: E. Air Quality, Climate Change, and Renewable Energy

Total Project Budget: $ 372,485

Proposed Project Time Period for the Funding Requested: 3 years, July 2017 - June 2020

Summary:

A valuable central Minnesota collaborative project that reduces greenhouse gas emissions from Minnesota cattle will have far reaching impacts on climate in Minnesota and beyond.

Name: Chris Kvaal

Sponsoring Organization: St. Cloud State University

Address: 720 Fourth Ave S

St. Cloud MN 56301

Telephone Number: (320) 308-4138

Email cakvaal@stcloudstate.edu

Web Address

Location

Region: Statewide

County Name: Statewide

City / Township:

Alternate Text for Visual:

Graphs, Data, Pictures

_____ Funding Priorities	_____ Multiple Benefits	_____ Outcomes	_____ Knowledge Base
_____ Extent of Impact	_____ Innovation	_____ Scientific/Tech Basis	_____ Urgency
_____ Capacity Readiness	_____ Leverage	_____ TOTAL	_____%

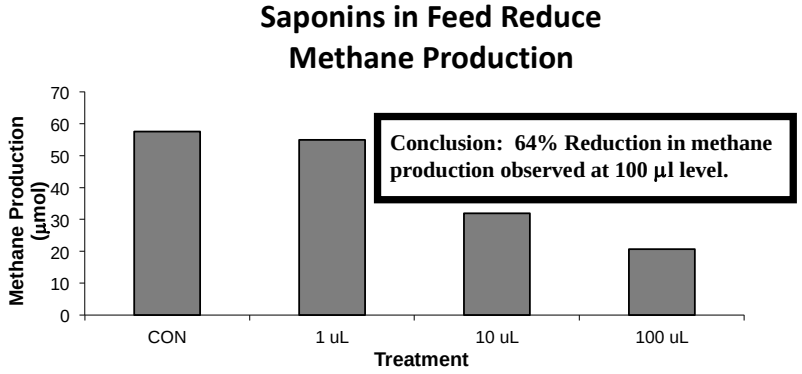
PROJECT TITLE: Feed additive for reducing climate-damaging methane emissions from cattle.

I. PROJECT STATEMENT

- *Methane is the second most damaging greenhouse gas because of its ability to capture solar radiation and hold it in the atmosphere. Although the EPA calculates that there is currently 200 times more carbon dioxide than methane in the earth's atmosphere, methane contributes 28 percent of the observed global warming effect. It is well established that cows are the major producer of methane in the environment. Minnesota is home to about 2.4 million dairy and beef cattle, which emit methane as a by-product of their ruminant digestive process. Methane is produced when rumen protozoa interact with methane producing bacteria.*
- *We have already determined that killing rumen protozoa reduces methane output in cattle and increases growth rate of the cattle. The reduction in rumen protozoa is accomplished by a feed additive containing a plant chemical called saponin. Saponins are toxic to rumen protozoa and are used to increase mass quickly in cattle. The current limitation on the feed additive is the action of bacteria in the rumen breaking down the feed additive saponin.*
- *We propose a chemical modification to saponins to retain its weight gain benefits and protect it from destructive enzymes. The resulting non-GMO saponins would be a cattle-feed additive capable of reducing emission of the climate-damaging greenhouse gas methane for a much longer period of time.*
- *We propose a research project in which we chemically protect a select group of saponin compounds from ruminal enzymes and thereby maximize their efficacy for reducing methane production in ruminants. The saponins that we will use are naturally occurring plant compounds that are approved for feeding to cattle. We will investigate several potential molecular agents to protect the carbohydrate structure of the saponins from degradation by ruminal bacterial enzymes and test their efficacy at killing rumen protozoa.*

II. PROJECT ACTIVITIES AND OUTCOMES

This activity will involve the selection and testing of various chemical modifications of saponins in feed supplements for cattle. The modifications will prolong the methane reducing effects of the feed additive, reducing costs to farmers using the feed additive for weight gain. We will monitor the outcome of each experiment by testing methane production and protozoan survival in rumen fluid purchased from the U of MN.



In-vitro study using a 4mL sample of rumen fluid treated with different amounts of pure Yucca Shidigera Saponin extract supplied by SarTec Corporation. This type of assay will be used to repeatedly test the methane reduction potential of modified saponins.

Outcome SarTec Partner	Completion Date
1. Isolate Saponins – Yucca Schidigera plant material will be extracted with n-butanol to capture the saponin fraction. This will result in purified yucca saponins.	*10/2017*
2. Molecularly Protect Saponins - the saponins from #1 will be mixed with a minimum of 5 different protectants and analyzed with NMR instrument purchased in this proposal.	*6/2018*

Outcome Saint Cloud State University	Completion Date
1. Rumen Fluid Collection – Rumen fluid will be purchased from the University of Minnesota.	*12/2017*
2. Each protected saponin species will be tested in viable rumen fluid to determine its ability to lyse protozoa and reduce methane production. This work will involve staining the protozoa and using a Sedgewick/Rafter counting cell and optical microscope.	*12/2019*
3. The results from #2 will be tabulated and analyzed to determine the most effective agent.	*6/2020*

III. PROJECT STRATEGY

A. Project Team/Partners

Saint Cloud State University will provide the infrastructure in the ISELF building to test the efficacy of the chemically modified non-genetically modified saponins. SCSU has a wide array of microscopy tools as well as chemical instrumentation to use in this project. The budget request is to supply the consumables and disposables and to administer and collaborate with SarTec.

SarTec Corporation is a small business located in Minnesota with over 30 years of experience utilizing the many properties of saponins. This company is the only entity in the world that can perform the chemical modifications proposed here. The budgetary item for SarTec will fund 3 years of chemistry modifications to the feed additive. The chemistry and industrial environment is a unique asset to this project, not available anywhere else.

B. Project Impact and Long-Term Strategy

Climate change caused by methane and other greenhouse gases is predicted to contribute to an increase in droughts, severe storms, and toxic algal blooms in the Midwest. The successful completion of this project will result a feed additive with a long lasting ability to decrease methane production in ruminants directly reducing the output of greenhouse gases. Reduction of methane in ruminants in MN as well as across the nation will have a direct positive impact on MN ecosystem, agriculture and natural resources. In combination with the environmental benefits saponins have other beneficial properties including increasing cattle gain and dairy production. If successful this project would put Minnesota on the map as an agricultural pioneer in greenhouse gas reduction.

C. Timeline Requirements

3 years. Lessons learned from each experiment will be applied in an iterative process to improve the experiment and identify the chemical protections that prolong the life of saponins in ruminant fluid, reducing methane production.

2017 Detailed Project Budget

Project Title: Feed additive for reducing climate-damaging methane emissions from cattle

IV. TOTAL ENRTF REQUEST BUDGET *3* **years**

BUDGET ITEM	AMOUNT
Personnel:	
Chris Kvaal, Ph.D. Professor (78% salary, 22% fringe); 4 weeks summer annually	$ 34,975
1 Graduate Research Assistant, will assist in the maintaining the instructmentation, preparing samples for the instrumental analysis. (60% Salary, 40% Fringe); 20 hrs/wk for 30 wks per year	$ 33,600
2-3 Undergraduate Students, will prepare slides from ruminate before and after saponin exposure (100% Salary); 333 hours per year for 2 years	$ 6,000
Professional/Technical/Service Contracts:	
Liquid chromatography–mass spectrometry service Contract: This instrument is owned and in place at St. Coud State University. The budget item covers 2 years of usage.	$ 20,000
Sartec Inc.; industry partnership, Chemistry of Saponins, $60,000 in direct materials cost associated with Chemistry and $150,000 in redirected technican labor over 3 years to perform experiments. SarTec is the only place with the expertise and existing equipment that can perform this chemistry. Their technicans and equipment are essential to this project. This Service Contract will be governed and monitored by the standard terms and conditions of any service contract with the state of Minnesota via the Office of Research and Sponsored Programs at St. Cloud State University.	$ 210,000
Equipment/Tools/Supplies:	
Glassware, Chemicals, Disposables related to microsopy, NMR, and Chromatography at St. Cloud State University.	$ 6,500
picoSpin™ 80 Series II NMR Spectrometer	$ 60,000
Travel: Travel between St. Cloud State University and Sartec Inc.; 15 round trips per year (100 miles per round trip, 0.47/per mile)	$ 1,410
TOTAL ENVIRONMENT AND NATURAL RESOURCES TRUST FUND $ REQUEST =	$ 372,485

V. OTHER FUNDS

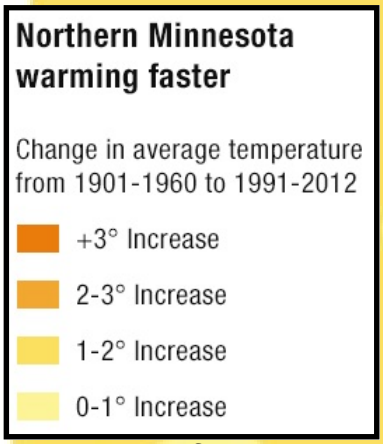
SOURCE OF FUNDS	AMOUNT	Status
Other Non-State $ To Be Applied To Project During Project Period:	N/A	
Other State $ To Be Applied To Project During Project Period:	N/A	
In-kind Services To Be Applied To Project During Project Period: *12% indirects*	$ 44,698	*Secured*
Funding History: *Indicate funding secured but to be expended prior to July 1, 2016, for activities directly relevant to this specific funding request, including past and current ENRTF funds. State*	N/A	
Remaining $ From Current ENRTF Appropriation:	N/A	

Reducing Greenhouse Gas Emissions from Minnesota Cattle

Methane

- **A Minnesota Dairy Cow can produce 70 gallons of methane a day.**
- **Minnesota is home to 2,330,000 dairy and beef cattle.**
- **Our project focuses on reducing methane produced in MN dairy and beef cattle.**

50% less Methane



Source: Natural Climate Association

05/07/2016

Project Manager:

Christopher Kvaal, Ph.D.
Professor of Biology
Department of Biological Sciences
St. Cloud State University
St. Cloud, MN 56301

Ph.D. and Post doctoral work in protozoan pathogenesis and biology. As a manager Dr. Kvaal has been the PI or co-PI on funded proposals from USDA, NIH, NSF, and the state of Minnesota. Dr. Kvaal will oversee the project starting with purchase of rumen fluid from the University of Minnesota School of Veterinary Medicine to the mixing of rumen fluid with chemically modified saponins and processing at SarTec to the protozoan biology at St. Cloud State University.

St. Cloud State University
Dr. Kvaal has been at SCSU since 2002 and works with protozoan biology. Success of the project is defined by long life of saponins in rumen fluid. Long life saponins in rumen fluid will be assayed by protozoan survival. SarTec provides the chemical expertise to modify saponins (already shown to reduce protozoans in rumen fluid). These modification will result is more dead protozoans and less greenhouse gas. The health of protozoans in rumen fluid is assayed via microscopy and culture at St. Cloud State University.