RuFaS
Ruminant Farm Systems Model

The Next Generation of Whole Farm Modeling

December 2021 Update

What is RuFaS?

A Next-Generation, Whole-Farm, Dairy Sustainability Simulation Model

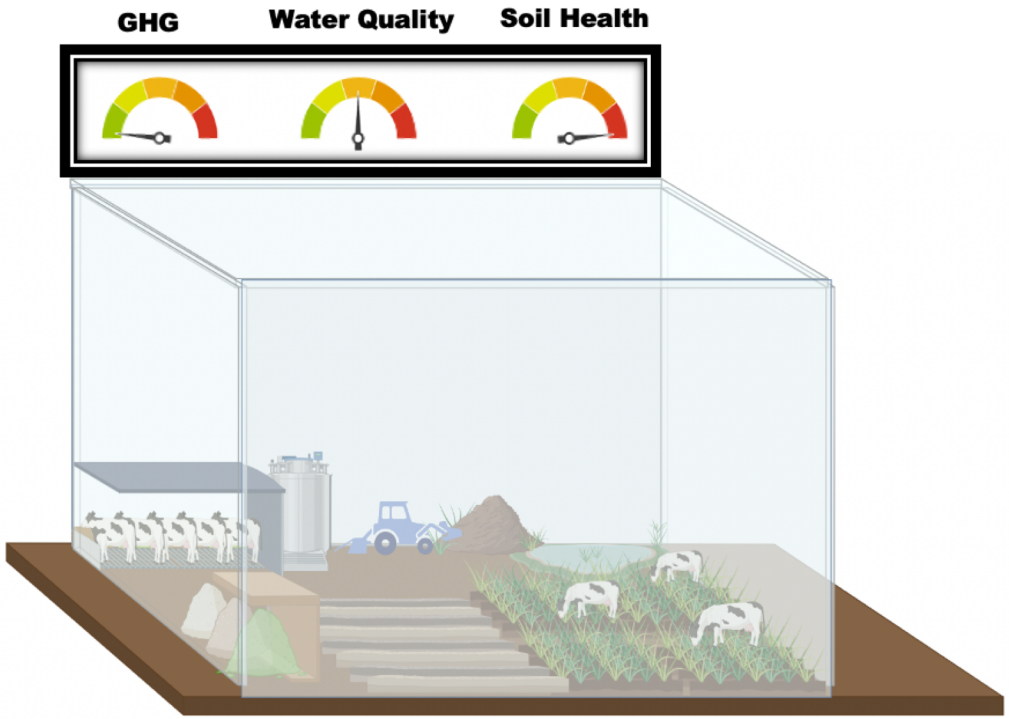
- Simulates dairy farm production and environmental impact
- Identifies ways to improve efficiency and sustainability
- Has a range of applications, from a research tool for scientists to a decision-aid tool for the dairy industry
- Coding emphasizes transparency and accessibility to ensure model flexibility, clarity, adaptability, and persistence

Environmental Impacts of Dairy Production

Dairy production currently accounts for 2-4% of US GHG emissions

Using current technology, we can reduce GHG intensity of milk from 1.9 kg CO_2-eq/kg to zero

Using existing practices, we can reduce nitrogen & phosphorous losses per kg of milk by 20-40%



Created with BioRender.com

Many models are already out there

- Dairy contributions to climate change are widely discussed but difficult to measure.
- Companies and NGOs need tools to quantify dairy farm emissions and help suppliers achieve net zero emissions.
- Existing models do not capture the complex dynamics on dairy farms, so confusion and mistrust has arisen among dairy industry users.

TRUTERRA

CFT

DSSAT

AMTS

Integrated Farm System Model
Version 4.5

USDA / Agricultural Research Service
Pasture Systems and Watershed Management Research Unit
University Park, Pennsylvania

FARM Environmental Stewardship
Version 2 Updates

SWAT Soil & Water Assessment Tool

COMET Farm | USDA United States Department of Agriculture Natural Resources Conservation Service | Colorado State University

Whole Farm and Ranch Carbon and Greenhouse Gas Accounting System.

RuFaS Goals

Interoperable

Documented

Open Source

Sustainable

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Participatory Modeling

- Involves stakeholders in all parts of the model development
  - 2020: Stakeholder Advisory Council
- Creates a shared understanding of the system, the problem and the solutions
- Increases stakeholder ownership of the research outcomes

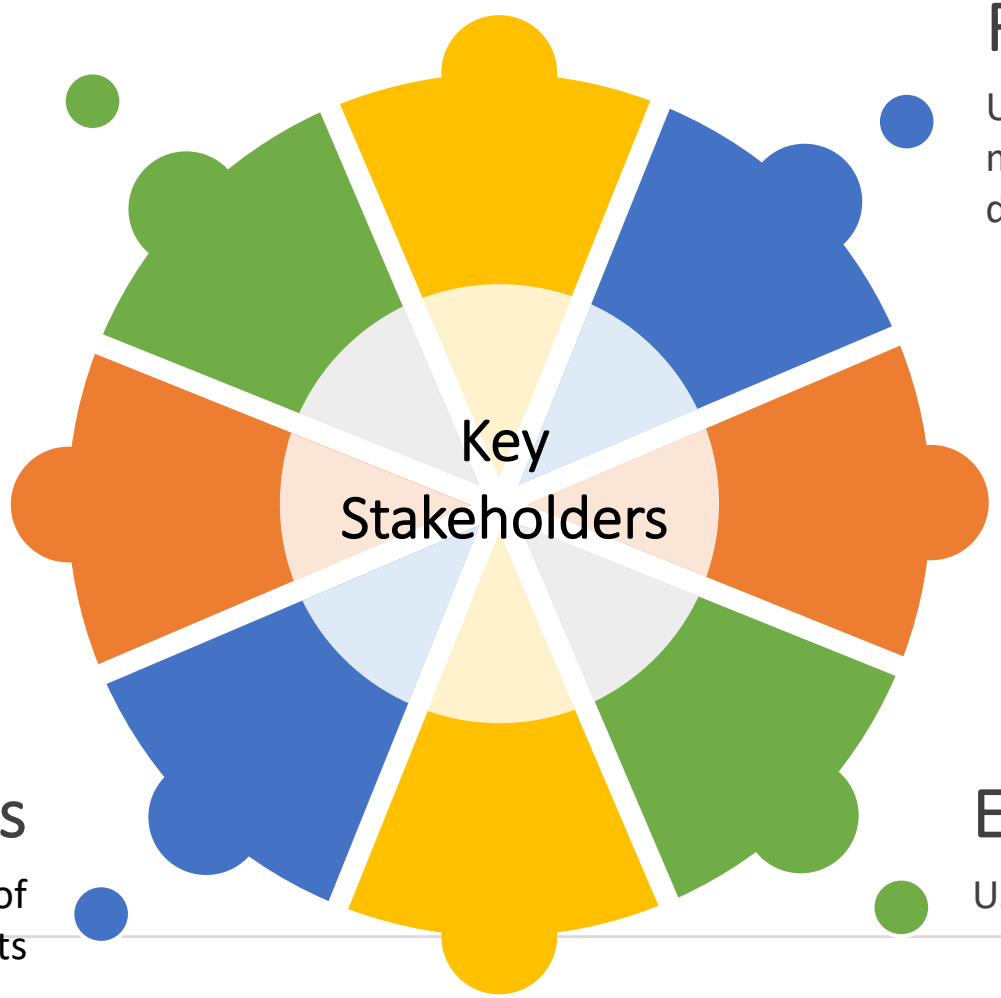
RuFaS Informs Decision-Makers

Extension Specialists

Use RuFaS to compare system impacts of proposed management practices before implementation

Farmers and Consultants

Use RuFaS to track progress of different management practices and inform future decisions



CAFO Planners

Use RuFaS to compare proposed management impacts on nutrient management plans before implementation

Dairy Processors

Use RuFaS to verify that claims meet company standards

NGO Project Planners

Use RuFaS to compare system impacts of proposed projects

Ecosystem Service Markets

Use RuFaS to quantify ecosystem services

Founders

Key Stakeholders

USDA

Cornell University

University of Arkansas

UC Davis University of California

University of South Dakota

Innovation Center for U.S. Dairy
Healthy People • Healthy Products • Healthy Planet

University of Wisconsin-Madison

The Nature Conservancy

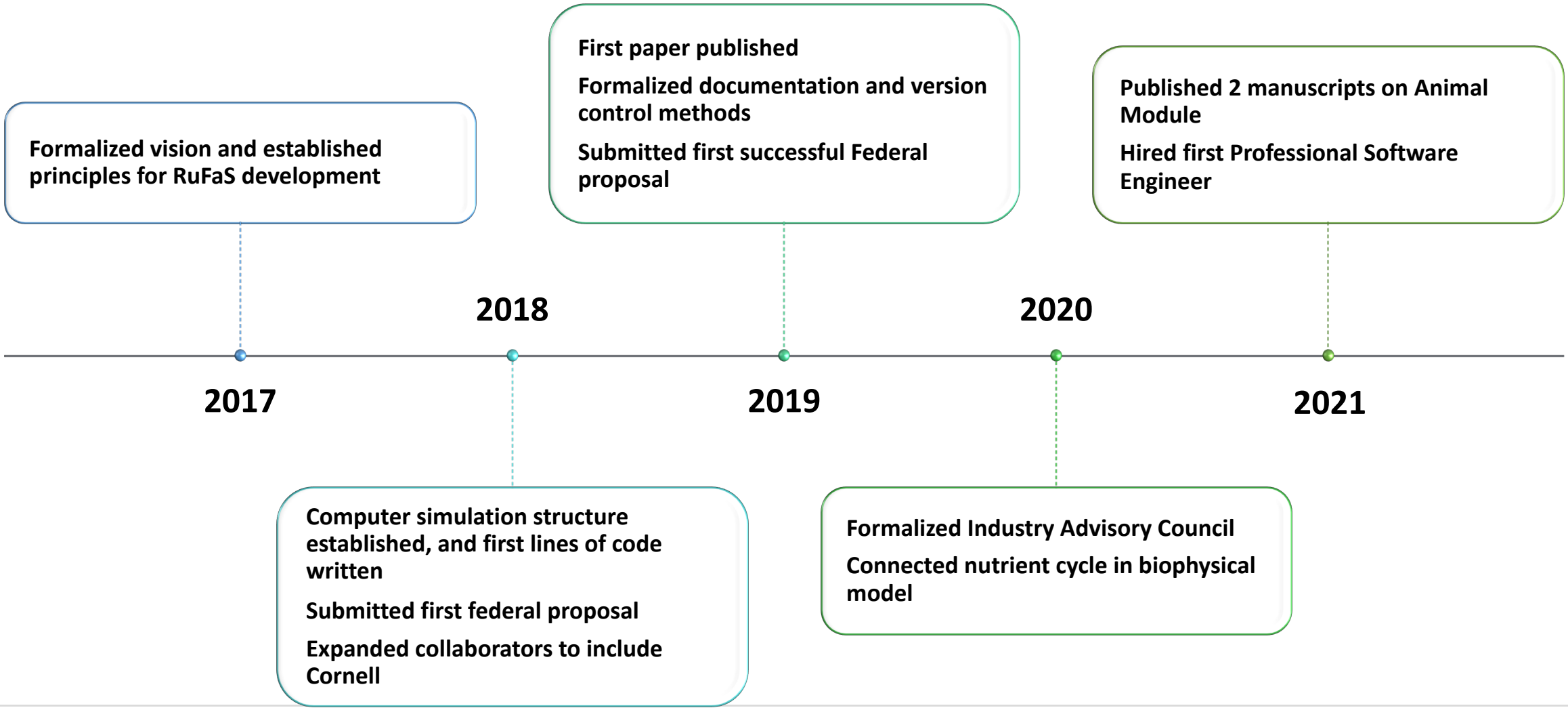
WWF

NEAFA Northeast Agribusiness & Feed Alliance
Advocate · Educate · Collaborate

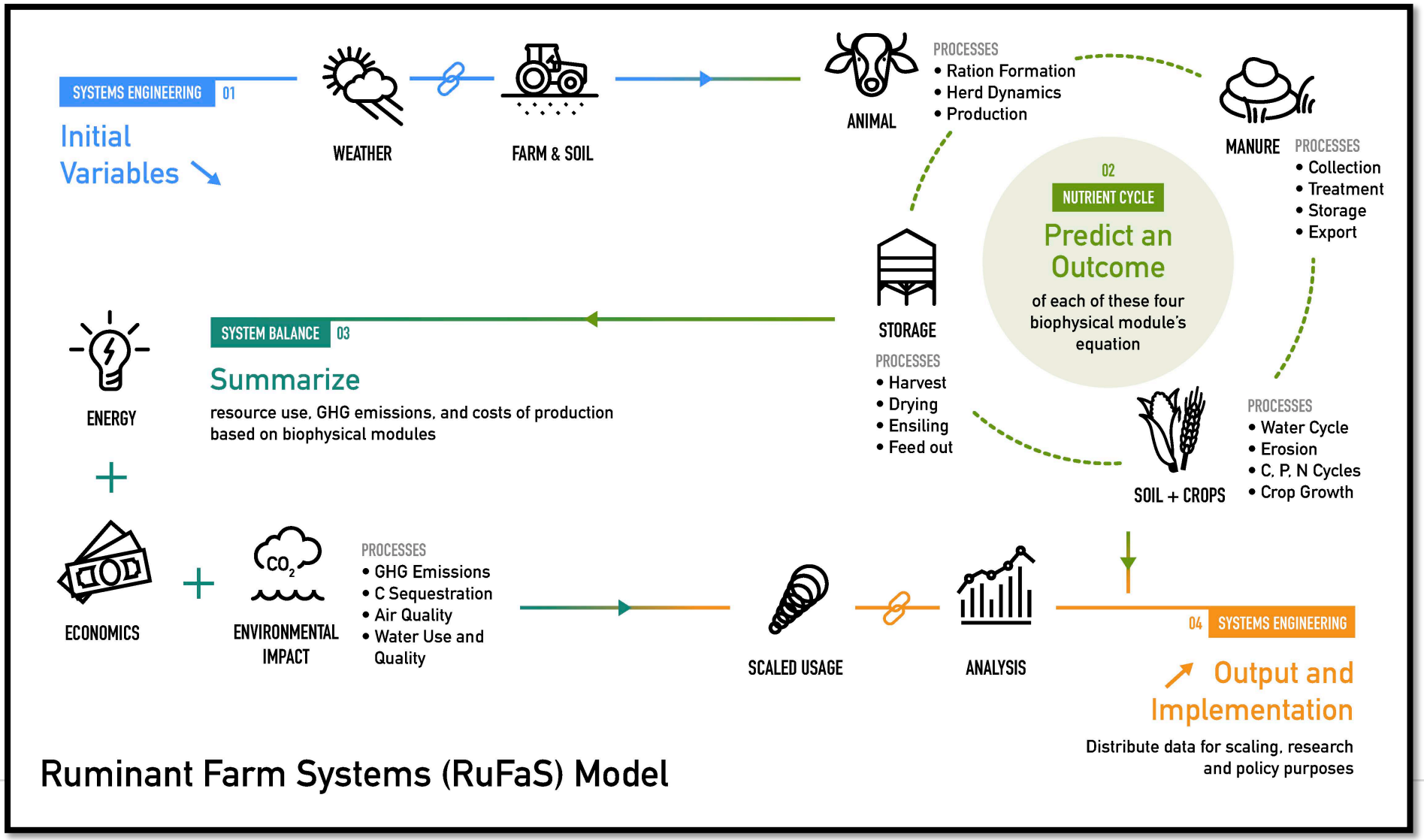
General Mills
Making Food People Love

DMI Dairy Management Inc.™

Evolution

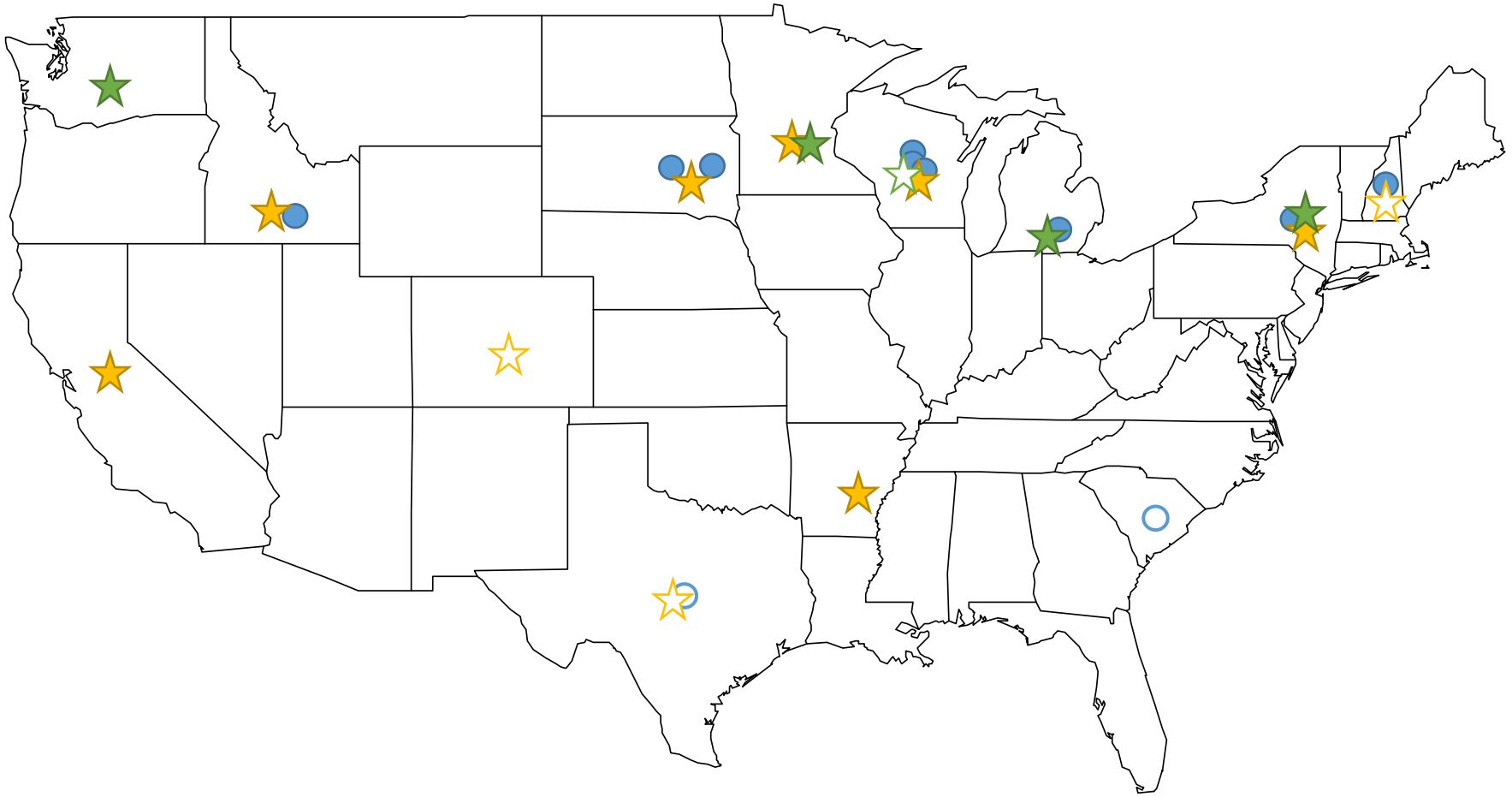

Formalized vision and established principles for RuFaS development
2017
2018
Computer simulation structure established, and first lines of code written
Submitted first federal proposal
Expanded collaborators to include Cornell
First paper published
Formalized documentation and version control methods
Submitted first successful Federal proposal
2019
2020
Formalized Industry Advisory Council
Connected nutrient cycle in biophysical model
Published 2 manuscripts on Animal Module
Hired first Professional Software Engineer
2021

How Does RuFaS Work?



Ruminant Farm Systems (RuFaS) Model

Geographic Footprint



Team Members

Pilot Farms

Experimental Data

Progress to Date

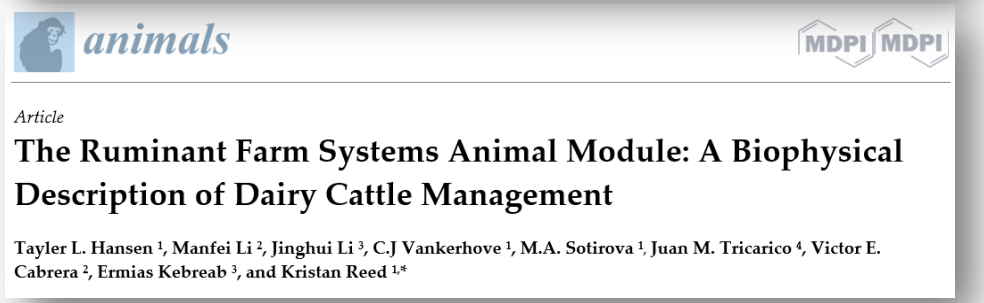
Funding	
USDA Tech Transfer	$10,000
USDA-ARS / UVM Post Doc	$200,000
Jersey Association	$10,000
DMI	$1,300,000
General Mills	$300,000
NIFA IDEAS grant	$1,000,000
UW Madison Hatch Funding	$146,000
NEAFA	$100,000
Smith-Lever	$120,000

Scholarship

Feature Article

A new modeling environment for integrated dairy system management

Ermias Kebreab,[†] Kristan F. Reed,[‡] Victor E. Cabrera,[§] Peter A. Vadas,[#] Greg Thoma,[‖] and Juan M. Tricarico[¶]

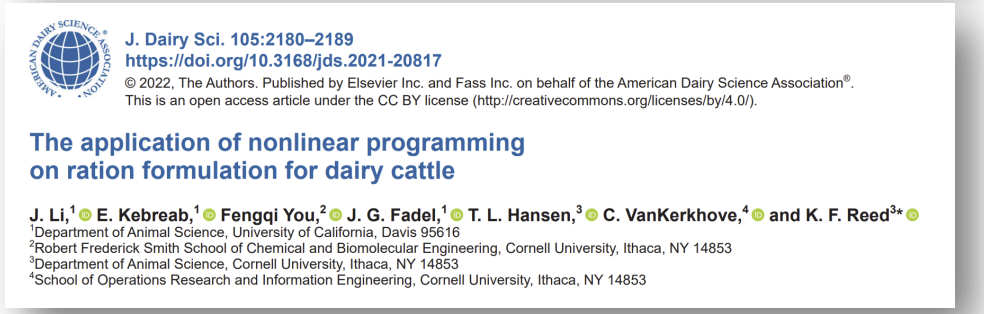


animals MDPI MDPI

Article

The Ruminant Farm Systems Animal Module: A Biophysical Description of Dairy Cattle Management

Tayler L. Hansen [1], Manfei Li [2], Jinghui Li [3], C.J Vankerhove [1], M.A. Sotirova [1], Juan M. Tricarico [4], Victor E. Cabrera [2], Ermias Kebreab [3], and Kristan Reed [1,*]



J. Dairy Sci. 105:2180–2189
https://doi.org/10.3168/jds.2021-20817

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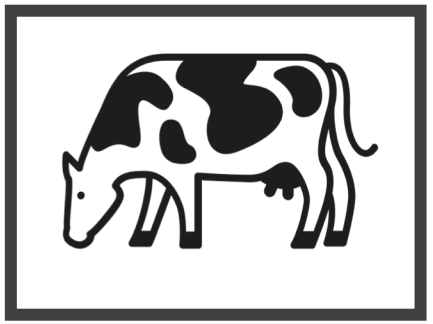
The application of nonlinear programming on ration formulation for dairy cattle

J. Li,[1] E. Kebreab,[1] Fengqi You,[2] J. G. Fadel,[1] T. L. Hansen,[3] C. VanKerkhove,[4] and K. F. Reed[3]*
[1]Department of Animal Science, University of California, Davis 95616
[2]Robert Frederick Smith School of Chemical and Biomolecular Engineering, Cornell University, Ithaca, NY 14853
[3]Department of Animal Science, Cornell University, Ithaca, NY 14853
[4]School of Operations Research and Information Engineering, Cornell University, Ithaca, NY 14853

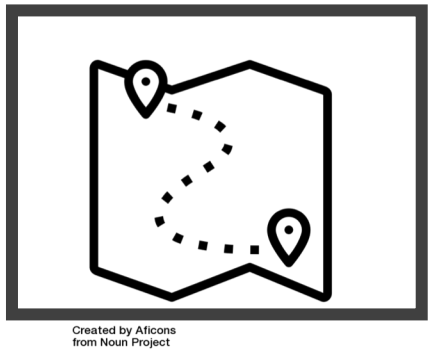
9 abstracts and conference proceedings

Vision of Success



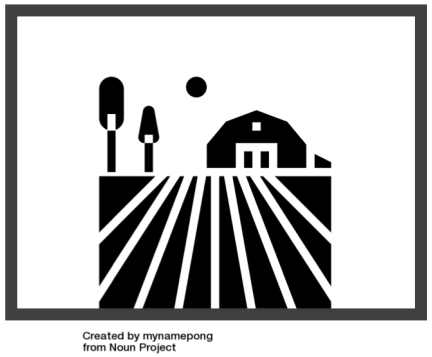
Footprinting

Calculate baseline estimates of current farm outputs and environmental outcomes



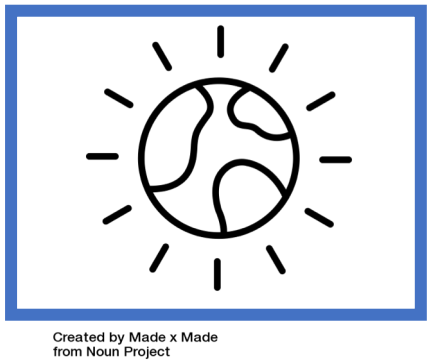
Planning

Identify management practices that will generate progress towards your sustainability goals



Implementation

Implement management plan, track progress, strive for continuous improvement



Impacts

Achieve industry-wide progress towards sustainable dairy production

Acceleration Plan 2021-22

1

Software engineer prepares model for pilot testing

Timeline: Early Fall 2021, new features by Summer 2022

2

RuFaS team develops grazing module

Timeline: Begin Summer 2021, target initial version by Fall 2022

3

Post-docs evaluate existing RuFaS model

Timeline: Begin Summer 2022

Currently funded

4

RuFaS team start pilot testing in North East and Michigan with partners

When: Begin Spring 2022

5

Link to other pilots and initiatives

When: Ongoing

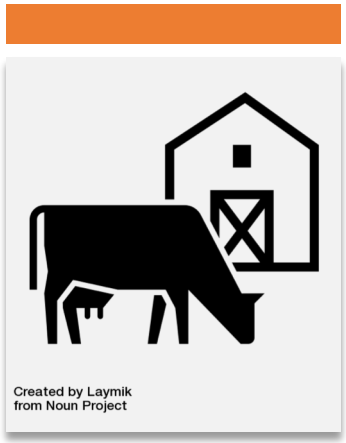
6

Gather input and develop user interface

When: Winter 2021 – Winter 2022

Opportunities for Collaboration

Partners



Pilot Sites

Data

Funding

For more information contact:

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kfr3@cornell.edu
(530) 402-5682

THANK YOU