

## ZOOM Protocols

- Please rename yourselves using your first name, last name, and organization (i.e., *Jane Doe – CCP*),
- All participants are asked to mute themselves
- If you have a question or want to make a comment, please insert it in the “Chat” or “Q&A” sections.
- If you are called on to speak, please mute your line following any questions/comments to reduce background noise
- Note: Meeting is being recorded

# Manure Recycling and Innovative Products (MRIP) Task Force

## Meeting #8

June 7, 2023

California Department of Food and Agriculture



# Welcome and Introductory Remarks

Karen Ross

Secretary of the California  
Department of Food and  
Agriculture

# Meeting Agenda

MRIP – Where We've Been and Next Steps

Incentive Programs and Funding  
Opportunities

Questions and Answers

Update on Specific MRIP Recommendations

Emerging Solutions/New Opportunities

Wrap-up and Next Steps

# Meeting Agenda

**MRIP – Where We've Been and Next Steps**

**Incentive Programs and Funding  
Opportunities**

**Questions and Answers**

**Update on Specific MRIP Recommendations**

**Emerging Solutions/New Opportunities**

**Wrap-up and Next Steps**



## MRIP Goals

- **Increase the understanding** of the scale and distribution of nitrogen surplus on dairies and potential demand from other crops for nitrogen and other manure nutrients.
- **Identify research, technical and policy actions** that encourage innovations to recycle surplus nutrients for use in agriculture; creating a circular fertilizer/soil amendment economy that builds healthy soils, conserves and protects water, and makes our state's agriculture more sustainable.
- **Organize short, mid, and long-term potential solutions and create a roadmap** for continued progress, including estimates of time and resources necessary to achieve research, policy, technology development, and education/outreach objectives.

# MRIP Members

Title	First	Last	Organization
Dr.	Rizaldo	Aldas	California Energy Commission
Mr.	Michael	Boccardo	Dairy Cares
Dr.	Martin	Burger	California Department of Food and Agriculture
Mr.	J.P.	Cativiela	Central Valley Dairy Representative Monitoring Program
Mr.	Scott	Couch	State Water Resources Control Board
Mr.	Ryan	Flaherty	Sustainable Conservation
Mr.	Justin	Gioletti	Robert Gioletti and Sons Dairy
Mr.	Matt	Harrison	California Air Resources Board
Mr.	Caleb	Harper	Dairy Management, Inc.
Dr.	Sean	Hurley	California Polytechnic University
Mr.	Kyle	Jones	Community Water Center
Dr.	Steven	Kaffka	University of California, Davis
Mr.	Chris	Kopman	Newtrient
Ms.	Manjeet	McCarthy	GoBiz
Ms.	Jennifer	Morales	California Department of Water Resources
Mr.	Ramon	Norman	San Joaquin Valley Air Pollution Control District
Mr.	Greg	Norris	Natural Resources Conservation Service
Mr.	Clay	Rodgers	Central Valley Regional Water Quality Control Board
Ms.	Renee	Pinel*	Western Plant Health Association
Ms.	Emily	Rooney*	Agricultural Council
Mr.	Paul	Sousa	Western United Dairies
Ms.	Sarah	Standiford	California Department of Food and Agriculture
Mr.	Aaron	Wickstrom	Wickstrom Dairies/Valsigna Farms

\*Unable to participate after the first MRIP meeting on October 26, 2021, or participate in subsequent recommendation development, discussion, or polls.

# MRIP Timeline





# MRIP Final Report



CALIFORNIA DEPARTMENT OF  
FOOD & AGRICULTURE



## FOREWORD

BY CDFA SECRETARY KAREN ROSS

Livestock manure handling can utilize technology and innovation to capture its nutrients, mitigate environmental impacts and recover value-added products to improve the financial viability of our family-owned dairies. Improved manure management is an excellent example of a smart resource recovery strategy as the basis of a circular economy. I am grateful to the volunteers who have served on this task force to identify the possibilities of turning the challenges of manure management into opportunities.

Dairy manure is a valuable resource. However, the excess of some nutrients in manure is a critical concern that must be addressed for the safety of our communities and our environment. The collaboration of our California farmers, academia, and public partners, through the Manure Recycling and Innovative Products (MRIP) Task Force, has positioned us to protect our local communities, preserve our land, water, and air, and improve the sustainability of our food production system by delivering these important nutrients where they are needed most.

The work presented in this report is the result of highly qualified people from academia, the private sector, public agencies, and non-governmental organizations working together for more than 15 months to find feasible and innovative nutrient management solutions for California's diverse dairy operations. This task force explored conventional strategies, compost strategies, nitrogen capture, denitrification and treatment, and the potential for existing and emerging strategies to address nutrient surplus, all while considering the environmental, social, regulatory, and economic impacts.

The Manure Recycling and Innovative Products (MRIP) Task Force has succeeded in developing recommendations for strategies to capture **and enhance the value** of dairy manure. The value highlighted by these strategies includes building healthy soils and sequestering carbon, offsetting industrial fertilizer use, protecting water and air quality, and reducing agriculture's carbon footprint in California. These benefits impact not just farmers, but the state, our consumers, and our environment.

*This task force has helped develop an initial roadmap, and I look forward to the continued work of this group and our progress toward making a circular fertilizer economy a reality. Together, we are creating transformational change. I am so grateful to be a part of it, and I thank you all for your willingness to rise to this challenge.*

*Karen Ross*

# MRIP Final Report

## Recommendations Organized by Solution Type:

1. Conventional Strategies
2. Compost
3. Denitrification
4. Nutrient Capture and Treatment

# Conventional Strategies

1. Implement Summary Representative Monitoring Report (SRMR) reporting structure
2. Increase industry and extension/training programs to promote understanding of conventional strategy application
3. Conduct near-term studies to better understand conventional strategy potential for addressing nitrogen

# Compost

1. Develop a new APCD VOC emissions factor specific to dairy manure compost that reflects the most up-to-date research.
2. Develop dairy manure composting scenarios using San Joaquin Valley APCD calculator
3. Conduct an economic and supply/demand analysis of dairy manure compost
4. Develop a tool/flowchart to educate dairy producers on the permitting requirements and control technologies needed to increase dairy manure compost production
5. Conduct a study/literature review to evaluate existing information and research gaps on environmental, transportation, and food safety impacts



# Denitrification

1. Conduct economic and environmental outcomes studies on existing vermifiltration pilot facilities
2. Construct two vermifiltration pilot projects in California: one with and one without a digester
3. Conduct a communications campaign on the availability of Alternative Manure Management Program (AMMP) funding for vermifiltration systems
4. Construct a full-scale algae raceway on an existing California dairy *with* a digester.



# Nitrogen Capture and Treatment

- Recap of Recommendations:
  1. Fund construction of an evaporative liquid waste processing project in California based on specific criteria
  2. Conduct crop trials using processed manure / ammoniated liquid extract from an existing evaporative liquid waste processing facility
  3. Conduct environmental and economic studies of an evaporative liquid waste processing system to ensure its viability in California
  4. Conduct environmental and economic studies of existing polymer separation/flocculant-based systems
  5. Work with developers to develop a concept and budget to construct a full-scale polymer separation/flocculant-based California pilot facility

# New MRIP Website

The screenshot shows a web browser window with the address bar displaying [cdfa.ca.gov/oefi/mrip/](http://cdfa.ca.gov/oefi/mrip/). The website header includes the CDFA logo and navigation links for Programs, Services, Meetings, Laws/Regs, Statistics, Publications, and Search. A large banner image of a green field is overlaid with the text "THE OFFICE OF ENVIRONMENTAL FARMING & INNOVATION" and "manure recycling and innovative products task force".

Below the banner, the page title is "Manure Recycling and Innovative Products Task Force". The main content area contains a paragraph: "CDFA convened the Manure Recycling and Innovative Products Task Force (MRIP) to develop recommendations on how to recapture and enhance the value of dairy manure while supporting healthy soils, protecting water quality, and reducing agriculture's carbon footprint in California. The task force met between late 2021 and 2022, producing their final report in December 2022. The task force resolved to continue periodic meetings to monitor progress and efforts following the recommendations, share information on new opportunities, and to broaden the conversation."

The "Upcoming Meetings" section lists a meeting on Wednesday, June 7, 2023, from 1:30 to 4:30 P.M. at the CDFA Main Auditorium, 1220 N Street, Sacramento, CA 95814. It provides a link for virtual attendance registration: [https://us02web.zoom.us/join/zoom/register/WN\\_rIKDuG6ArluG\\_0-WU-0zPB6/](https://us02web.zoom.us/join/zoom/register/WN_rIKDuG6ArluG_0-WU-0zPB6/) and a link to the agenda.

The "Task Force Documents" section includes a link to the "MRIP Final Report" and a paragraph: "In close alignment with the MRIP effort and to have preliminary technical background available for policy recommendations, the California Biomass Collective at the University of California, Davis, conducted research to provide an overview of the amount and location of surplus nutrients within California's dairy sector and evaluate selected manure treatment technologies capable of recovering manure nutrients in useful form or otherwise reducing surpluses safely. This research report was completed in October 2022 and shared with the MRIP." A link is provided for the report: [Manure Nutrient Recovery, Removal, and Reuse on California Dairies](#).

On the right side of the page, there are three widgets: "Email Subscriptions" with a "Sign up for email notifications" button; "Follow Us" with a link to "@CDFAClimateNews on Twitter"; and "Tweets from @CDFAClimateNews" showing a tweet from May 26, 2023, thanking Mike Schager for his experiences with DEFI environmental scientist Dana Young and Healthy Soils Initiative On-Farm Compost Resources. The tweet includes a link to [cdfa.ca.gov/healthypoils/](http://cdfa.ca.gov/healthypoils/).

[www.cdfa.ca.gov/oefi/mrip/](http://www.cdfa.ca.gov/oefi/mrip/)

## Purpose & Goals Going Forward

- Continue to serve as a forum where industry, policymakers, regulators, researchers, entrepreneurs and NGOs:
  - Share information on progress for known and new strategies
  - Discuss research needs
  - Make recommendations to improve business case (markets, incentives, financing options)
  - Address regulatory, permitting or other barriers
- Meet 2-3x yearly
- Your suggestions for informational topics and presentations welcome!
- Sign up for meeting notices at <https://www.cdfa.ca.gov/oefi/mrip/>

## Why MRIP Remains Important

- Dairy industry remains under significant, growing pressure to improve water quality while reducing climate footprint
  - *Nitrate Control Program*
  - *Dairy General Order*
  - *High prices for fertilizer and other inputs*
- Innovations in manure management technology and practices continue to show promise for providing economic and environmental opportunities
- Collaboration across sectors is critical to seizing this opportunity



# Disclaimer

- Today and in future from time to time, we intend to invite private sector companies to present information on their progress and share their point of view
- This does not constitute an endorsement of any company or technology by CDFA or MRIP, and is for informational purposes only
- Any company who wishes to present at a future MRIP forum should contact the co-chairs to discuss

# Meeting Agenda

MRIP – Where We've Been and Next Steps

**Incentive Programs and Funding  
Opportunities**

Questions and Answers

Update on Specific MRIP Recommendations

Emerging Solutions/New Opportunities

Wrap-up and Next Steps



# CDFA's California Livestock Methane Measurement, Mitigation, and Thriving Environments Research Program- Awards Announcement



**Charles Brooke**

Office of Environmental Farming and Innovation (OEFI)

Manure Recycling and Innovative Products Meeting

June 7, 2023



# California Livestock Methane Measurement Mitigation and Thriving Environments - Research Program

## Research Impact Areas and Allocation

**\$1.6 Million**

**Verification of  
Methane Reduction  
Strategies**

**\$500K**

**Alternative  
Methane Reduction  
Strategies**

**\$2 Million**

**Manure Recycling and  
Innovative Products  
Development**







# California Livestock Methane Measurement Mitigation and Thriving Environments - Research Program

## Verification of Methane Reduction Strategies

\$1.6 Million dollars for verifying Alternative Manure Management (AMMP) and Dairy Digester Research and Development (DDRDP) practices.

- Greenhouse gas and criteria and non-criteria air pollutant measurements
- Analysis of Co-benefits and Co-products
- Environmental and Community benefits/impacts



# Impact Area 1 - Verification of Methane Reduction Strategies

## Bubbleology Research International

### Cutting Edge Technology Development

BRI pushes state of the art to develop  
new capabilities for atmospheric and  
oceanic measurement based on  
demand driven science needs.



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# Impact Area 1 - Verification of Methane Reduction Strategies

## Bubbleology Research International

**Project Title: “Evaluating the New Smart, Climate-friendly California Dairy: Measuring the Climate and Environmental Air Emissions Footprint of Improved Manure Management Practices.”**

Brief Summary: This project aims to improve CDFA’s ability to assess the benefits and co-benefits of the Department’s greenhouse gas reduction incentive programs through more comprehensive greenhouse gas and air quality data from the dairy industry. The project will assemble this new data using a unique mobile air quality lab, airborne remote sensing, and data mining.



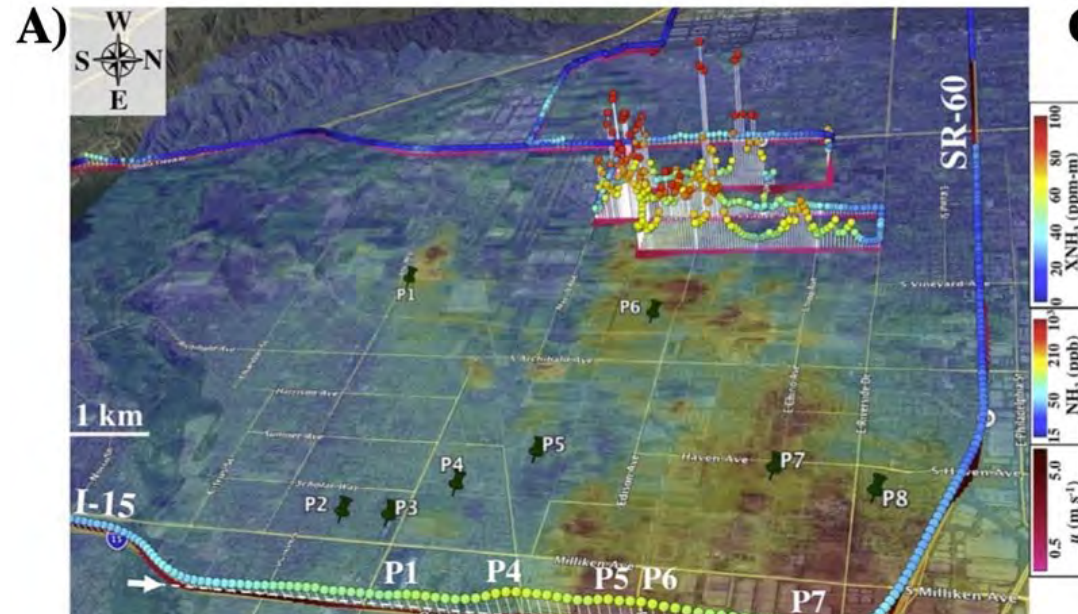
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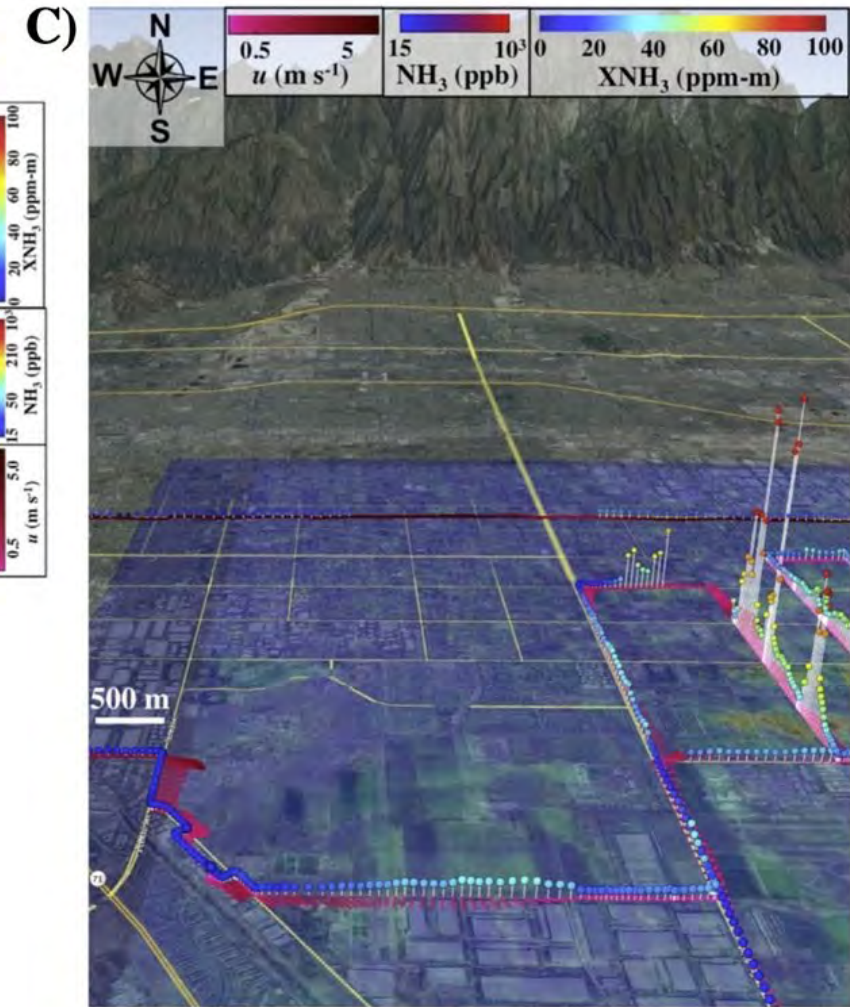


# Impact Area 1 - Manure Recycling and Innovative Products Development - Bubbleology Research International

1. *Airborne campaign* (validation and spatial characterization).
2. *Non-airborne spatial surveys* (seasonal, spatial heterogeneity).
3. *Longitudinal surveys* (temporal variability on monthly scales).
4. *Data mining*
5. *Water and Solids Sampling Techniques and Validation*
6. *Outreach*



Measureable at highway Speeds:  
CH<sub>4</sub>, N<sub>2</sub>O, NH<sub>3</sub>, H<sub>2</sub>S, O<sub>3</sub>, SO<sub>2</sub>, NO<sub>2</sub>, NO, CO,  
C<sub>2</sub>H<sub>6</sub>, and C<sub>3</sub>H<sub>8</sub> (CO<sub>2</sub>, H<sub>2</sub>O at ppm), and  
aerosols (PM<sub>0.1</sub>, PM<sub>2.5</sub>, PM<sub>10</sub>, etc.)



# Impact Area 1 - Manure Recycling and Innovative Products Development - Bubbleology Research International

## *Water, lagoon, solids sampling and analysis*

**Correlate air emissions results with the history of flush water application to the lagoon since the last sludge clean-out**

**Water samples** will correspond to air emissions, such as total and volatile solids (aka suspended organic matter), salinity by electrical conductivity and/or total dissolved solids to differentiate from total solids, carbonaceous 5-day biochemical oxygen demand (cBOD5, an indicator of readily biodegradable biomass), total ammonia nitrogen (NH<sub>3</sub>+NH<sub>4</sub><sup>+</sup>), total nitrogen, dissolved sulfides (related to H<sub>2</sub>S emissions), dissolved CH<sub>4</sub> (headspace equilibrium method), pH, alkalinity, matrix temperatures, oxidation-reduction potential (ORP), and dissolved oxygen in the field.

**Solids samples** (screenings, piles, soils, etc.) will be composited and analyzed for constituents related to air emissions: total ammonia nitrogen, pH, organic matter, and determinations such as total Kjeldahl nitrogen, N mineralization potential, salinity, and VOCs Methods will be finalized in consultation with Cal Poly Soil Science Prof. Charlotte Decock and the Cal. Poly Soil Science Analytical Laboratory.



# Impact Area 1 - Manure Recycling and Innovative Products Development - Bubbleology Research International

*Technical Advisory Committee*

*Study design, components, results*

*Clean Air Dairy Consortium*





# California Livestock Methane Measurement Mitigation and Thriving Environments - Research Program

## Alternative Methane Reduction Strategies

\$500K for research of alternative methane reduction strategies.

- Feed additives and Rumen Microbiome Modulators
- Genetics
- Nutrition
- Lagoon treatments



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# Impact Area 2 - Alternative Methane Reduction Strategies

## Mooteric Inc

The screenshot shows the Mooteric website with a large white plus sign overlaid on the left side, indicating a partnership or collaboration. The website header includes the Mooteric logo and the Dairy Experts logo with the tagline "expediting innovation". The navigation menu includes "About Us", "Contact Us", "Clients", "Resources", "RESEARCH", "LABORATORIES", "CONSULTING", and "TRAINING". The main content area features a section titled "CONTRACT RESEARCH ORGANIZATION (CRO)" with the text "Highest QUALITY in-vivo GCP/GLP studies in cattle" and "DairyExperts end-to-end solutions range from proof-of-concept studies to large pivotal clinical trials." A "LEARN MORE" button is located below this text. The background of the website features a photograph of a dairy farm with cows in a milking parlor.



# Impact Area 2 - Alternative Methane Reduction Strategies

## Mooteric Inc

### **Project Title: “Feeding Seaweed to Accelerate Enteric Methane Emissions Reductions in Central Valley Dairies.”**

Brief Summary: This project aims to conduct on-farm feeding trials to verify the methane-mitigating benefits of seaweed-based feed additives within the regular feed rations of Central Valley dairy cows. The project will also work to establish long-term economical supply chain development for seaweed-based products and conduct financial modeling of implementation for California dairies to assess business feasibility.



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# Impact Area 2 - Alternative Methane Reduction Strategies

## Mooteric Inc

- 1) Conduct rigorous on-farm feeding trials to verify the methane-mitigating qualities of different seaweed-based feed additives within the regular feed rations of Central Valley dairy cows
- 2) Establish long-term economical supply chain development for *Asparagopsis*-related products
- 3) Conduct extensive financial modeling for California dairies to foster acceptability



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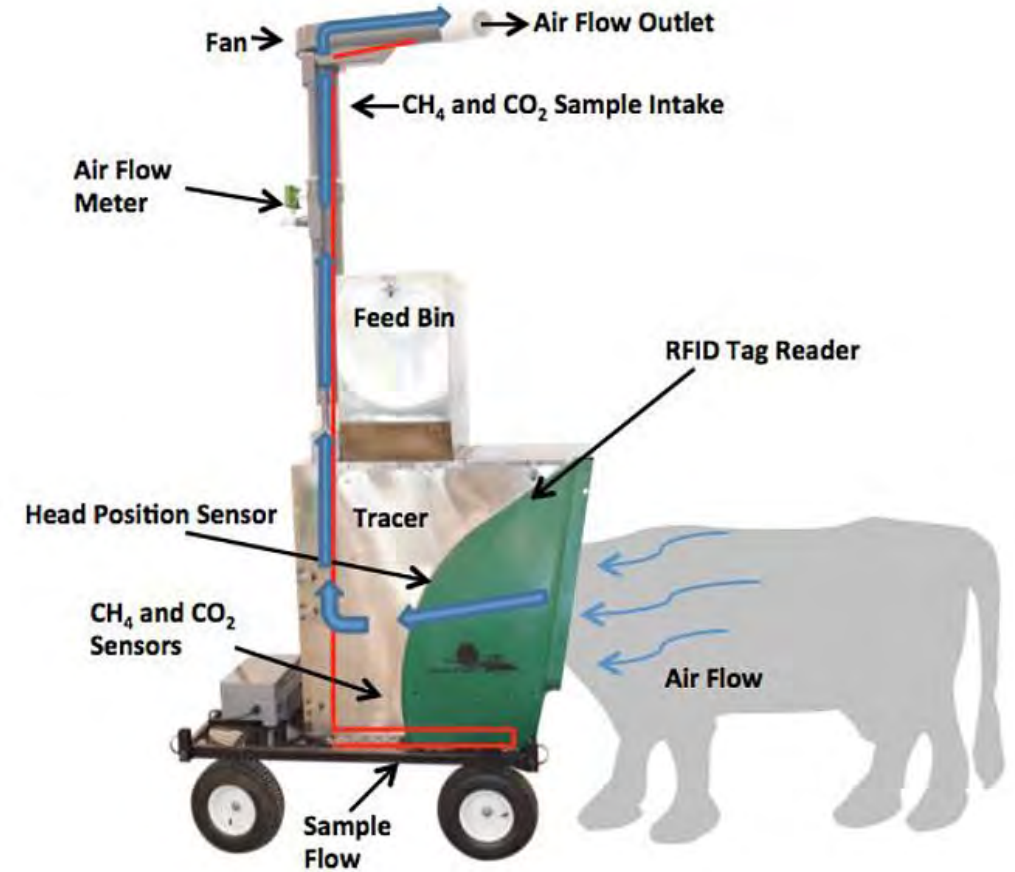
# Impact Area 2 - Alternative Methane Reduction Strategies

## Mooteric Inc

1. ***Asparagopsis taxiformis*** (20 or 30 cows): Total mixed ration (TMR) will be supplemented with a powder form of *Asparagopsis taxiformis* provided by project partner Greener Grazing
  2. **Biochemically designed seaweed product** (20 or 30 cows): TMR will be supplemented with a powder form of seaweed that is biochemically designed to mimic *A. taxiformis*, provided by project partner Alga Biosciences.
  3. **CONTROL** (20 to 30 cows)
- This study will last 63 days.**

Efficacy outcomes:

- Individual cow intake (DMI) (daily).
- Individual cow milk yield (2x day).
- Individual cow milk fat, protein and lactose (2x day).
- Feed efficiency (energy corrected milk / dry matter intake) (daily).
- Body weight and body condition score (bi-weekly).





# California Livestock Methane Measurement Mitigation and Thriving Environments - Research Program

## Manure Recycling and Innovative Products Development

\$2 Million to study nutrient management solutions via manure recycling and innovative products development

- Physical Demonstration and Research Projects
- Economic and Environmental analysis of available technologies





# Impact Area 3 - Manure Recycling and Innovative Products Development

## FYTO Inc

FYTO

[What We Grow](#)

[About](#)

[News](#)

[Careers](#)

**The world's most  
productive plants**

Unlocked by automation



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# Impact Area 3 - Manure Recycling and Innovative Products Development

## FYTO Inc

### **Project Title: “Aquatic Crop Production as a Nutrient-to-Food Solution for California Dairies”.**

This project will demonstrate the installation of a commercial-scale, automated aquatic crop farm in Modesto, CA. When complete, the proposed farm will function as a nutrient management technology that efficiently recycles manure effluents into valuable agricultural inputs. FYTO, academic, and dairy industry partners will jointly validate the environmental impact, economic feasibility, and product efficacy of aquatic crops grown on different effluent types as a high-protein dairy feed ingredient.



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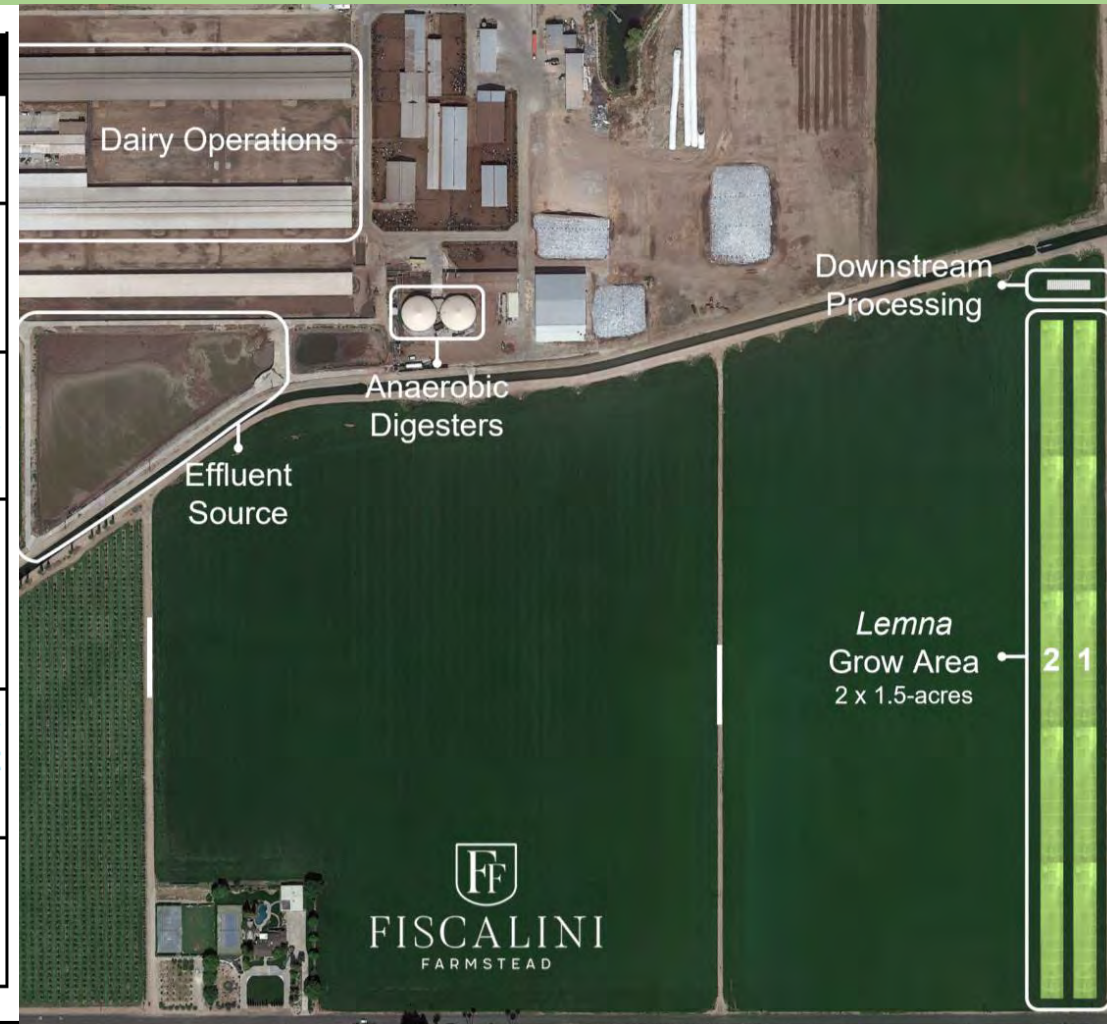




# Impact Area 3 - Manure Recycling and Innovative Products Development

## FYTO Inc

Topic Area	Objective Description
1. Commercial Dairy Operability	Demonstrate that <i>Lemna</i> can be reliably grown, processed, and used at a commercial scale on a California dairy operation
2. <i>Lemna</i> Yield & Composition	Measure, analyze, and independently validate the yield and composition of <i>Lemna</i> grown on dairy lagoon effluent and anaerobic digester effluent
3. Product Safety & Efficacy	Measure, analyze, and independently validate the safety and efficacy of <i>Lemna</i> grown on dairy lagoon effluent and anaerobic digester effluent for use as high-protein dairy feed
4. Environmental Impact	Measure, analyze, and independently validate the air quality, water quality and use-efficiency, nutrient management, and overall life cycle impact of farming <i>Lemna</i> on a California dairy operation
5. Economic Feasibility	Conduct and independently validate a techno-economic analysis and economic benefits assessment of on-dairy <i>Lemna</i> farming at different scales and locations in California
6. Producer Engagement	Develop and implement a producer outreach program that fosters bilateral discussion about aquatic crop farming with California dairies through farmer-centric events and services



# Impact Area 3 - Manure Recycling and Innovative Products Development

FYTO Inc

## Project Partners





# THANK YOU!



## CDFA Office of Environmental Farming and Innovation Dairy and Livestock Methane Team

Roberta Franco, Methane Reduction Programs Supervisor  
Harsimran (Rosie) Gill (DDRDP)  
Alyssa Louie (AMMP)  
Charles Brooke (SB 1383, CLIM3ATE)  
Dana Yount (AB 1891, Organic Waste Composting)

Email notifications: <https://www.cdfa.ca.gov/oefi/>  
<https://www.cdfa.ca.gov/subscriptions/MailChimp-signup.html>



**Dairy Digester Research and  
Development Program**

CDFA OFFICE OF ENVIRONMENTAL FARMING & INNOVATION



**Alternative Manure  
Management Program**

CDFA OFFICE OF ENVIRONMENTAL FARMING & INNOVATION





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# Climate Smart Grant- Dairy PLUS Program



Manure Recycling and Innovative Products  
Task Force Meeting  
June 7, 2023

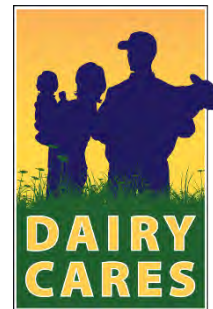
Denise Mullinax, CDRF & CDQAP  
Roberta Franco, Ph.D., CDFA



# USDA Climate Smart Program = \$85 Million for CA Dairy Sector



Partnering To Invest In and Build Markets for California's Climate-Smart Dairy Producers



# Four Major Components



1 Implementation of Climate-Smart Dairy Practices

2 Measure, Quantify and Verify Carbon, GHG & Nitrogen Benefits

3 Outreach & Education

4 Develop Climate-Smart Product Markets





DairyPlus PROGRAM

41

**MILLIONS OF DOLLARS AVAILABLE TO CALIFORNIA DAIRY PRODUCERS TO AUGMENT ADVANCED MANURE MANAGEMENT PROJECTS!**

### New CDEA Dairy PLUS+ Program Grant Funds Coming in Spring

Start planning your Advanced Manure Management project TODAY!



The Dairy PLUS+ Program adds millions of dollars in new incentives to the existing AMMP and DDRDP Programs!

Details of the AMMP PLUS+ and DDRDP PLUS+ programs to be announced in Spring 2023.



**Get ready for your AMMP PLUS+ and DDRDP PLUS+ projects NOW.**

Dairy Plus+ Program incentives are in addition to AMMP and DDRDP grants and are planned to be provided on a per-cow basis. Advanced manure management practices include:

- Vermifiltration
- Evaporative liquid waste processing systems
- Subsurface drip fertigation using liquid manure
- Weeping walls
- Aerated static compost piles
- and others

Start gathering your information now: Talk with other producers, consultants, advisors, banks, vendors, and permit departments. Research the different manure management practices and find out now what can work best for you!

**QUESTIONS? Contact your trade association, processor, or UC Cooperative Extension.**



Sign up here for program announcements!



[www.cdafa.com/commodities-grants](http://www.cdafa.com/commodities-grants)



Sign up here for program announcements!



[www.cdafa.com](http://www.cdafa.com)

Funded by a U.S. Department of Agriculture (USDA) Partnership for Climate-Smart Commodities grant, and provided through the California Department of Food and Agriculture (CDFA), the Dairy PLUS+ Program serves to:

- Provide financial incentives for dairy producers to adopt advanced climate-smart manure management practices
- Build climate-smart dairy markets
- Utilize partnerships designed to market climate-smart milk
- Leverage matching funds from non-federal sources.

# What is the Dairy Plus Program?

- New incentive funding in addition to and leveraging AMMP and DDRDP grants – able to support a more comprehensive or advanced manure management projects
- Projects can be eligible for State funding and up to \$1,250,000 (up to \$750/cow) in Federal funding for the advanced practice portion



# Program Overview

- **GOAL:** To award competitive grants to CA dairy farms for the implementation of **advanced** manure management practices that address **both** methane emissions and nutrient surplus.
- **Funding:** \$75 Million directly to project implementation (~60 projects)
- **Builds on CDFA's AMMP and DDRDP programs**
- **Eligibility:**
  - CA Producers/Dairy Farmers (can't be foreign person or entity)
  - New or Previous (successfully completed) AMMP Project
  - New or Previous (successfully completed) DDRDP Project
- **Number of Years offered: 3**
- **Producer Project Grant Duration: 24 months**

# Eligible Practices



For new 2023 or previous **AMMP projects**:

- A. **Vermifiltration** - must be implemented in conjunction with an existing or new primary mechanical separator.
- B. Solid separation of manure solids through **Weeping Wall** – the system must have a minimum of at least three cells.
- C. Advanced solid-liquid separation assisted by **flocculants and/or bead filters** - must be implemented in conjunction with an existing or new primary mechanical separator.
- D. Practices above (A, B, or C) AND **Subsurface drip irrigation/fertigation (SDI)** using liquid manure.
- E. Practices above (A, B, or C )AND **Aerated Composting**, as follows:
  - i. Composting in vessel (composting in an enclosed vessel, with forced aeration and continuous mixing);
  - ii. Composting in aerated static pile (composting in piles with forced aeration but no mixing);
  - iii. Composting in intensive windrows (with regular turning for mixing and aeration);
  - iv. Composting in passive windrows (with infrequent turning for mixing and aeration).



# Eligible Practices



For new 2023 or previous **DDRDP projects**:

- A. **Post-digester Vermifiltration** - must be implemented after the anaerobic digestion of manure.
- B. **Post-digester Advanced solid-liquid separation assisted by flocculants and/or bead filters** - must be implemented after the anaerobic digestion of manure.
- C. Practices above (A or B) AND **Subsurface drip irrigation/fertigation (SDI)** using liquid manure digestate.

## IMPORTANT!

Dairy Plus Program funds **cannot** be used to fund the implementation or maintenance of, including but not limited to, anaerobic digesters, biogas cleanup equipment, biogas upgrading equipment, pipelines, electricity generators, and all systems related to anaerobic digestion and biogas end-use.

# Funding Scenarios\*

Up to \$1.25 M per project  
(max of \$750/cow)

Program/System	State Funding (CDFA)	Federal Funding* (USDA)	Total Funding	Matching Funds Required
<b>For Dairies That <b>Have Not</b> Previously Received AMMP or DDRDP Funds</b>				
<b>AMMP Dairy Plus</b> a) Vermifiltration b) Polymer flocculant-based solid separation c) Weeping wall (min of 3 cells) d) Practices above (a, b, or c) AND aerated composting e) Practices above (a, b, or c) AND subsurface drip fertigation using liquid manure	Up to \$750,000	Up to \$1.25 M (\$750 cow)	Up to \$2 M	NA
<b>DDRDP Dairy Plus</b> a) Post-digester vermifiltration b) Post-digester polymer flocculant-based solids/liquids separation c) Above practices (a or b) AND subsurface drip fertigation using liquid manure	Up to \$1.6 M	Up to \$1.25 M (\$750 cow)	Up to \$2.85 M	50/50 match – up to \$1.6M

\* Subject to change

# Funding Scenarios\*

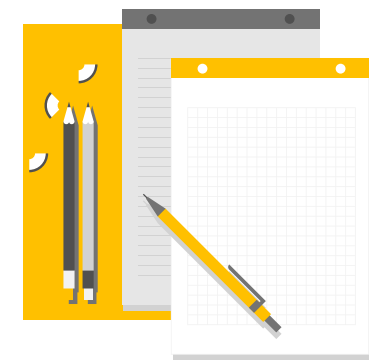
Up to \$1.25 M per project  
(max of \$750/cow)

Program/System	State Funding (CDFA)	Federal Funding* (USDA)	Total Funding	Matching Funds Required
<b>For Dairies That Have Previously Received AMMP or DDRDP Funds</b>				
<b>DDRDP Dairy Plus for Previous AMMP</b> a) Post-digester vermifiltration b) Post-digester polymer flocculant-based solids/liquids separation c) Above practices (a or b) AND subsurface drip fertigation using liquid manure	Up to \$1.0 M	Up to \$1.25 M (\$750 cow)	Up to \$2.25 M	50/50 match – up to \$1.0M
<b>Dairy Plus for Previous AMMP**</b> a) Vermifiltration b) Polymer flocculant-based solid separation c) Weeping wall (min of 3 cells) d) Practices above (a, b, or c) AND aerated composting e) Practices above (a, b, or c) AND subsurface drip fertigation using liquid manure	NA	Up to \$1.25 M (\$750 cow)	Up to \$1.25 M	50/50 match – up to \$1.0M
<b>Dairy Plus for Previous DDRDP</b> a) Post-digester Vermifiltration b) Post-digester polymer flocculant-based solids/liquids separation c) Above practices (a or b) AND subsurface drip fertigation using liquid manure	NA	Up to \$1.25 M (\$750 cow)	Up to \$1.25 M	50/50 match – up to \$1.0M

\* Subject to change

# 2023 Tentative Program Timeline\*

Item	Timeframe
Draft RGA Public Comment Period	May 12- May 23, 2023
Finalize RGA	June 2023
Release of Solicitation	Mid-late June 2023
Grant Applications Due	August 2023
Review Process	August – November 2023
Announce Award Funding	November – December 2023
Project Term Begins	March 2024



\* Dates subject to change



# More Information and Resources



## CDFA Website:

<https://www.cdfa.ca.gov/oefi/dairyplus/>

CDFA Home | OEFI | Dairy PLUS Program

### Dairy PLUS Program

The Dairy Plus Program is a new program under CDFA's Office of Environmental Farming and Innovation (OEFI). This program will award competitive grants to California dairy farms for the implementation of advanced manure management practices that reduce both methane emissions and nutrient surplus.

The California Dairy Research Foundation (CDRF), in collaboration with CDFA and several other organizations, was awarded \$85 million in funding by the U.S. Department of Agriculture (USDA) under the Partnerships for Climate-Smart Commodities program in 2022. Over the next five years, this project will work to provide incentives to producers to adopt advanced climate-smart manure management practices along with outreach and technical assistance, measure greenhouse gas and nitrogen benefits associated with implemented practices, and develop markets for climate-smart commodities. Approximately \$75 million of the total awarded amount will support the implementation of advanced manure management practices, and be administered through the Dairy Plus Program starting in 2023.

**Draft Solicitation Documents for Public Comment**

The California Department of Food and Agriculture accepted public comments on a draft Request for Grant Applications (RGA) for the Dairy Plus Program between May 12 and May 23, 2023. The feedback received through this

## CDRF/CDQAP Websites:

<https://cdrf.org/climate-smart-commodities-grant-info/>

<https://cdqap.org/ammp-outreach-project/>

CALIFORNIA DAIRY RESEARCH FOUNDATION  
Science for a Sustainable Future

HOME ABOUT CDRF PROGRAMS & PROJECTS DAIRY PLUS+ PROGRAM GRANT INFO CDRF NEWS CONTACT

### DAIRY PLUS+ PROGRAM: CLIMATE-SMART GRANT INFORMATION

**SIGN UP FOR PROGRAM NEWS!**

**WHAT'S REQUIRED TO APPLY?**

**INFORMATION ABOUT AVAILABLE PRACTICES**

**APPLICATION ASSISTANCE**

**Climate-Smart PLUS+ Programs: Partnerships and investments in research and incentives to further advance the development of climate-smart dairy farm practice.**

Webinar Series: Producer AMMP Experiences

Managing Manure: Complementing FUM...  
Managing Manure Series: How to Use A...  
Modifying Manure Stream Flow: Comp...

**Program Updates @ Future MRIP Meetings**





Questions ?



# Meeting Agenda

MRIP – Where We've Been and Next Steps

Incentive Programs and Funding  
Opportunities

Questions and Answers

Update on Specific MRIP Recommendations

Emerging Solutions/New Opportunities

Wrap-up and Next Steps

# Meeting Agenda

MRIP – Where We've Been and Next Steps

Incentive Programs and Funding  
Opportunities

Questions and Answers

**Update on Specific MRIP Recommendations**

Emerging Solutions/New Opportunities

Wrap-up and Next Steps



# Conventional Strategies

1. Implement Summary Representative Monitoring Report (SRMR) reporting structure
2. Increase industry and extension/training programs to promote understanding of conventional strategy application
3. Conduct near-term studies to better understand conventional strategy potential for addressing nitrogen

# Compost

1. Develop a new APCD VOC emissions factor specific to dairy manure compost that reflects the most up-to-date research.
2. Develop dairy manure composting scenarios using San Joaquin Valley APCD calculator
3. Conduct an economic and supply/demand analysis of dairy manure compost
4. Develop a tool/flowchart to educate dairy producers on the permitting requirements and control technologies needed to increase dairy manure compost production
5. Conduct a study/literature review to evaluate existing information and research gaps on environmental, transportation, and food safety impacts

# San Joaquin Valley Air Pollution Control District's New Dairy Manure Composting Emission Factors



Manure Recycling and Innovative Products Task Force (MRIP) Meeting

June 7, 2023

Ramon Norman, Senior Air Quality Engineer,  
San Joaquin Valley Air Pollution Control District

# Valley Air District's Previous Manure Composting Emission Factors

Operation Type	Emission Factors	
	VOC	NH <sub>3</sub>
Biosolids, Manure, and Poultry Litter, and Co-Composting*	1.78 lb/wet ton	2.93 lb/wet ton

\*Emission factors represent the entire composting cycle, i.e. start of the active phase through completion of the curing phase.

Previous Air District manure emission factors based primarily on studies of co-composting of biosolids and/or manure with other materials

# Valley Air District's New Dairy Manure Composting Emission Factors (Adopted March 21, 2023)

Operation Type	Emission Factors	
	VOC	NH <sub>3</sub>
Manure Only – Separated Solids*	0.041 lb/wet ton	0.011 lb/wet ton
Manure Only – Corral Scrapings*	0.25 lb/wet ton	1.53 lb/wet ton

\*Emission factors are applicable to operations the only compost dairy manure without other materials.

Current Air District manure emission factors based on control piles in study for composting of manure for emergency management of mortality



# Comparison of Current and Previous Air District Dairy Manure Composting Emission Factors

- Dairy Manure Composting VOC Emissions with new emission factors 86% to 98% lower compared to previous value
- Dairy Manure Composting NH<sub>3</sub> Emissions with new emission factors 48% to over 99% lower compared to previous value
- Reduced emissions from Dairy manure composting will help to facilitate permitting of commercial dairy manure composting operations

# Future Updates to Dairy Manure Composting Emission Factors

- When additional information becomes available or is provided to the District, the District will review and update the manure composting emission factors, as appropriate, using the best information available.

# General Permit Requirements for Manure Composting Operations

- Authority to Construct (ATC) permits required prior to any construction or modification
- New Manure Permitting Operations subject to Best Available Control Technology (BACT)
  - (e.g. covering active compost piles with finished compost after turning)
- Commercial Manure Permitting Operations subject to Mitigation Measures in District Rule 4565 – Biosolids, Animal Manure, and Poultry Litter Operations
  - (e.g. Maintain a minimum oxygen concentration of at least five percent (5%), by volume, in the free air space of every active and curing compost pile)
- Health Risk Assessment (HRA) for emission increases

## Compost: Next Steps

1. Develop a new APCD VOC emissions factor specific to dairy manure compost that reflects the most up-to-date research.
2. Develop dairy manure composting scenarios using San Joaquin Valley APCD calculator
3. Conduct an economic and supply/demand analysis of dairy manure compost
4. Develop a tool/flowchart to educate dairy producers on the permitting requirements and control technologies needed to increase dairy manure compost production
5. Conduct a study/literature review to evaluate existing information and research gaps on environmental, transportation, and food safety impacts

# Denitrification

1. Conduct economic and environmental outcomes studies on existing vermifiltration pilot facilities
2. Construct two vermifiltration pilot projects in California: one with and one without a digester
3. Conduct a communications campaign on the availability of Alternative Manure Management Program (AMMP) funding for vermifiltration systems
4. Construct a full-scale algae raceway on an existing California dairy *with* a digester.



# An Update on Vermifiltration: A Regenerative Agriculture and GHG Emission Reduction Manure Management Solution

CDFA: Manure Recycling and Innovative  
Products (MRIP) Task Force

June 7, 2023

Steven Rowe  
BioFiltro – President  
(206) 963-0123  
srowe@biofiltro.com



**BIOFILTRO**

worm powered wastewater solutions







## Vermifiltration: A climate solution with positive economic, social, and environmental benefits.



BioFiltro USA, headquartered in Davis, CA.

Vermifiltration is a cost effective and sustainable solution for wastewater treatment in the food processing, sanitation, and livestock sectors.

Vermifiltration systems have been proven in more than 200 projects worldwide and currently operating at 17 sites in California.

Vermifiltration permanently prevents the formation of greenhouse gases that would otherwise be emitted from manure lagoons.

Vermifiltration also generates commercial volumes of a microbial rich fertilizer alternative and soil health amendment.

# Vermifiltration treats liquid manure and simultaneously serves as a

Solid-liquid separator,

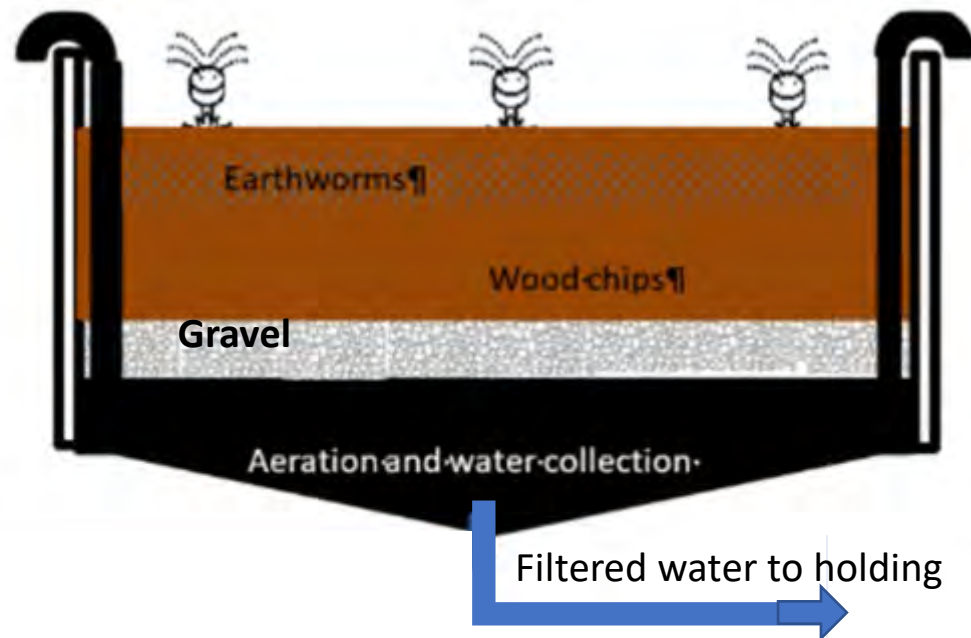
Solids treatment system

Nutrient removal and recovery system,

Nitrification/denitrification treatment system,

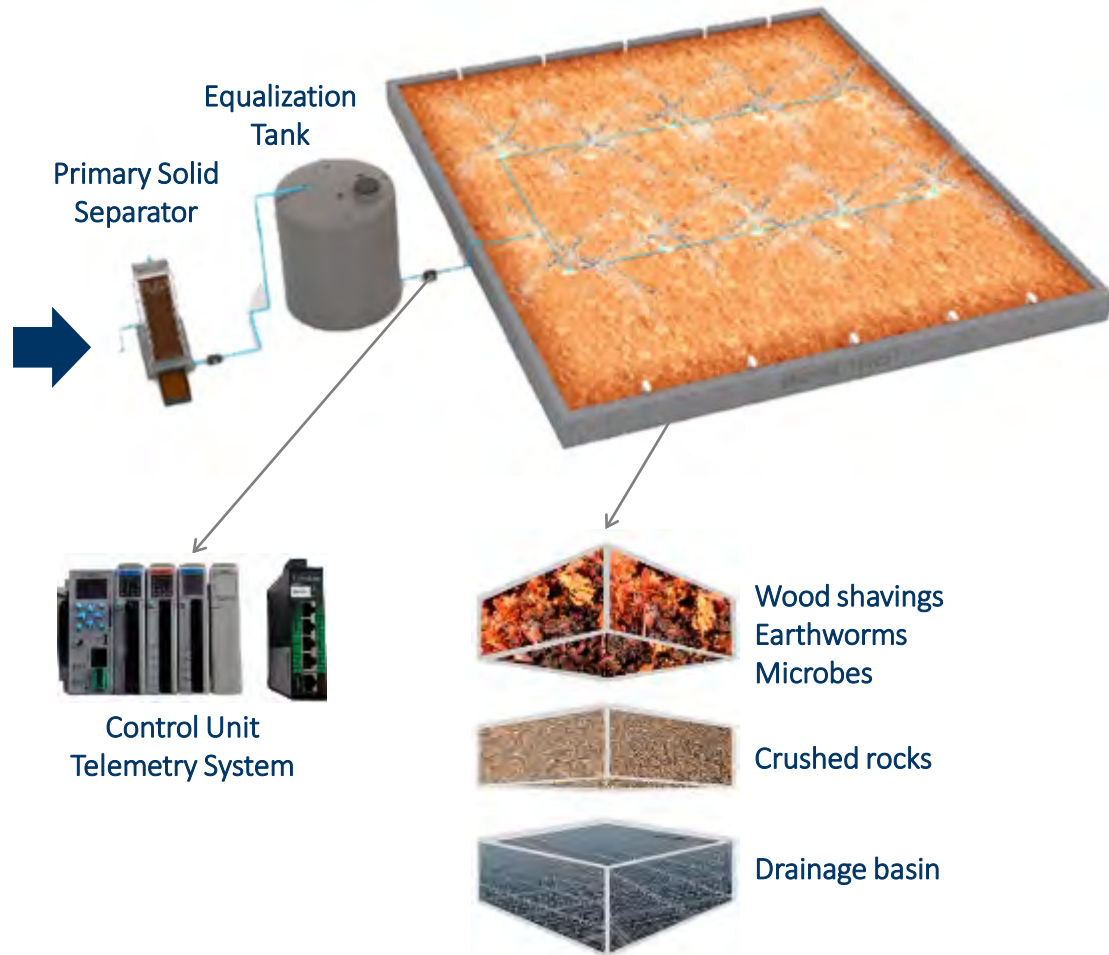
GHG emissions avoidance technology, and

Soil health amendment production system.



# Vermifiltration - Simplicity at the service of nature

The essential operating system is simple but robust, relying on natural processes to generate powerful results



- 1 Water flows from the source point and through a **solids separator** before arriving to an **equalization tank**.
- 2 In the **control unit** the **telemetry system** monitors the water's characteristics, adjusts pH if necessary, and triggers the intermittent irrigation system.
- 3 The **irrigation system** disperses the water evenly across the surface of the natural wood chip media, worms and microbes.
- 4 As the water percolates down through the various media layers, microbes form a **robust and dynamic biofilm** that captures and converts components of the manure which is further **transformed by the worms** into a **microbial and nutrient rich soil amendment**.
- 5 Within **four hours** a very high percentage (80% to 99%) of BOD and TSS<sup>1</sup> and a high percentage of nitrogen, ammonia and phosphorous are removed. The water can be used for **irrigation, barn flushing, and other on-farm uses with much greater flexibility than traditional, untreated manure water**.

1. BOD: Biochemical oxygen demand. Is the amount of oxygen it takes to degrade organic matter.  
TSS: Total suspended solids. Is the total amount of suspended materials.





**BIOFILTRO**  
worm powered wastewater solutions

## Transformational Results

The farm's anaerobic lagoon is transformed into a filtered water pond.





## Challenges

Manure management represents the largest source of methane emissions from the CA livestock sector

Ammonia air emissions

Nitrate releases to groundwater

Increasing water scarcity

Regional soil health deterioration

On-farm economics make environmental investments difficult

## Vermifiltration Deliverables

Permanently prevents >80% of lagoon GHG emissions

Prevents ammonia emissions

Reduces fugitive nitrogen losses to air and water

Upcycles 15,000 – 45,000 gallons of water per year per cow

Produces commercial quantities of a microbial and nutrient rich soil amendment

System income streams allows most installation and long-term operations to be free to the farm.

Total N 40-90%

NH<sub>4</sub>-N 70-97%

Total Phosphorus 75-95%

Total Suspended Solids 90-99%

Volatile Solids 75-95%





Increases supply of macro- and micro-nutrient

Increased plant growth and crop yield

Increases microbial population, beneficial enzymes, hormones and plant growth regulators

Protect plants from an array of pests

Improves soil porosity, aggregate stability, increased water retention, and carbon storage

Nitrogen plays a complex role on the farm. Proper amounts are critical to crop yield and health. Excess amounts can lead to GHG emissions, and air and water pollution.

A vermifilter N removal rate of 40-90% does not correspond to the same reduction in plant-available N.

The vermifilter N removal impacts fugitive N.

The vermifilters' N removal rate can be regulated with the vermifilter design and/or operation.



## Deployment updates of note

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Grown team

Built out in-house laboratory

Working to assure federal EQIP funding

Participating in Gates Foundation genomics testing

Developing second generation irrigation and tilling systems

Broke ground on second large scale dairy & preparing early-stage analyses of 5 more

Advancing vermifiltration-specific GHG methodology with American Carbon Registry

Significant R&D underway to improve outcomes and cost efficiencies

## Grants and Studies

---

USDA-CIG grant awarded for on-farm vermicompost applications. UC-Davis, U of Spigo (Spain) & Aggrego LLC

### Awaiting announcements

- UC Climate Action Initiative grant to study various aspects of vermicompost use from landfill diversion waste. Awaiting announcement.
- USDA-FPEP grant regarding vermifiltration as commercial alternative to synthetic fertilizers
- FFAR grant with UC-Davis regarding proper N management, GHG emissions reductions, vermifilters effluent as irrigation/fertigation water.
- USDA Climate Smart Commodities grants: Participating recipient in some and awaiting additional announcements for others.

- CDFA
  - AMMP
  - Dairy Plus
- CDRF, USDA, CDFA and CA cooperatives
  - Partnerships for Climate-Smart Commodities
- UC Davis
  - CIG grant award and multiple others in process or awaiting announcements
- Federal Congressional and Administration Support
  - 48C tax incentives
  - EQIP eligibility
- NGO support
- Carbon Credit Purchasers
- Vermiproduct Offtake Partners

Actively seeking farms to participate in AMMP and Dairy Plus. Calling on all interested parties to raise awareness and encourage participation.

Currently working with key dairy supply chain partners who are actively looking for supply chain GHG reductions of 1 million MTCO<sub>2</sub>eq / year.

Estimated vermifiltration GHG benefit in California is over 3 million MTCO<sub>2</sub>eq / year.



# An Update on Vermifiltration: A Regenerative Agriculture and GHG Emission Reduction Manure Management Solution

CDFR: Manure Recycling and Innovative  
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June 7, 2023

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srowe@biofiltro.com



**BIOFILTRO**  
worm powered wastewater solutions



# Nitrogen Capture and Treatment

- Recap of Recommendations:
  1. Fund construction of an evaporative liquid waste processing project in California based on specific criteria
  2. Conduct crop trials using processed manure / ammoniated liquid extract from an existing evaporative liquid waste processing facility
  3. Conduct environmental and economic studies of an evaporative liquid waste processing system to ensure its viability in California
  4. Conduct environmental and economic studies of existing polymer separation/flocculant-based systems
  5. Work with developers to develop a concept and budget to construct a full-scale polymer separation/flocculant-based California pilot facility

# SEDRON BACKGROUND

CONFIDENTIAL  
INFORMATION



**SEDRON**<sup>®</sup>  
TECHNOLOGIES





Peter Janicki  
CEO & Founder



- ✓ Founded 1993
- ✓ Aerospace Parts
- ✓ Advanced Composites
- ✓ Complex Tooling
- ✓ 5-Axis CNC Machining
- ✓ 1,100+ Employees



ORION CREW MODULE



JOINT STRIKE FIGHTER



- ✓ Founded 2014
- ✓ Water & Sanitation
- ✓ 140+ Employees



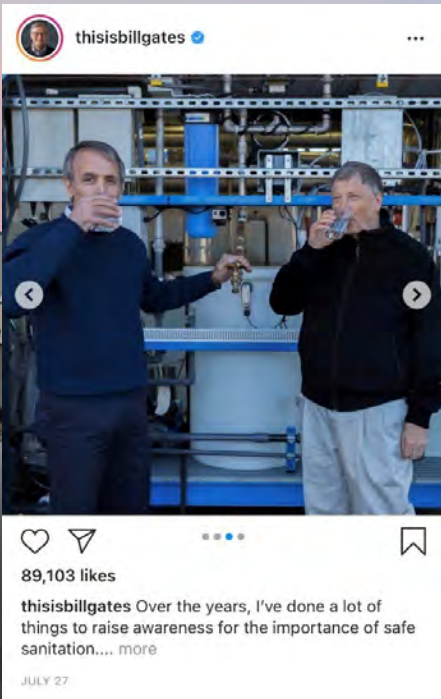
JANICKI OMNI PROCESSOR



VARCOR SYSTEM



FIRELIGHT TOILET



Janicki wins, Boeing loses in Northrop contracts for Air Force B-21 bomber



# Ongoing Commitment to Innovation



CONFIDENTIAL  
INFORMATION



# STRONG ENGINEERING TEAM



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INFORMATION

# THE VARCOR™ SYSTEM

CONFIDENTIAL  
INFORMATION



**SEDRON**®  
TECHNOLOGIES



# VARCOR™ SYSTEM

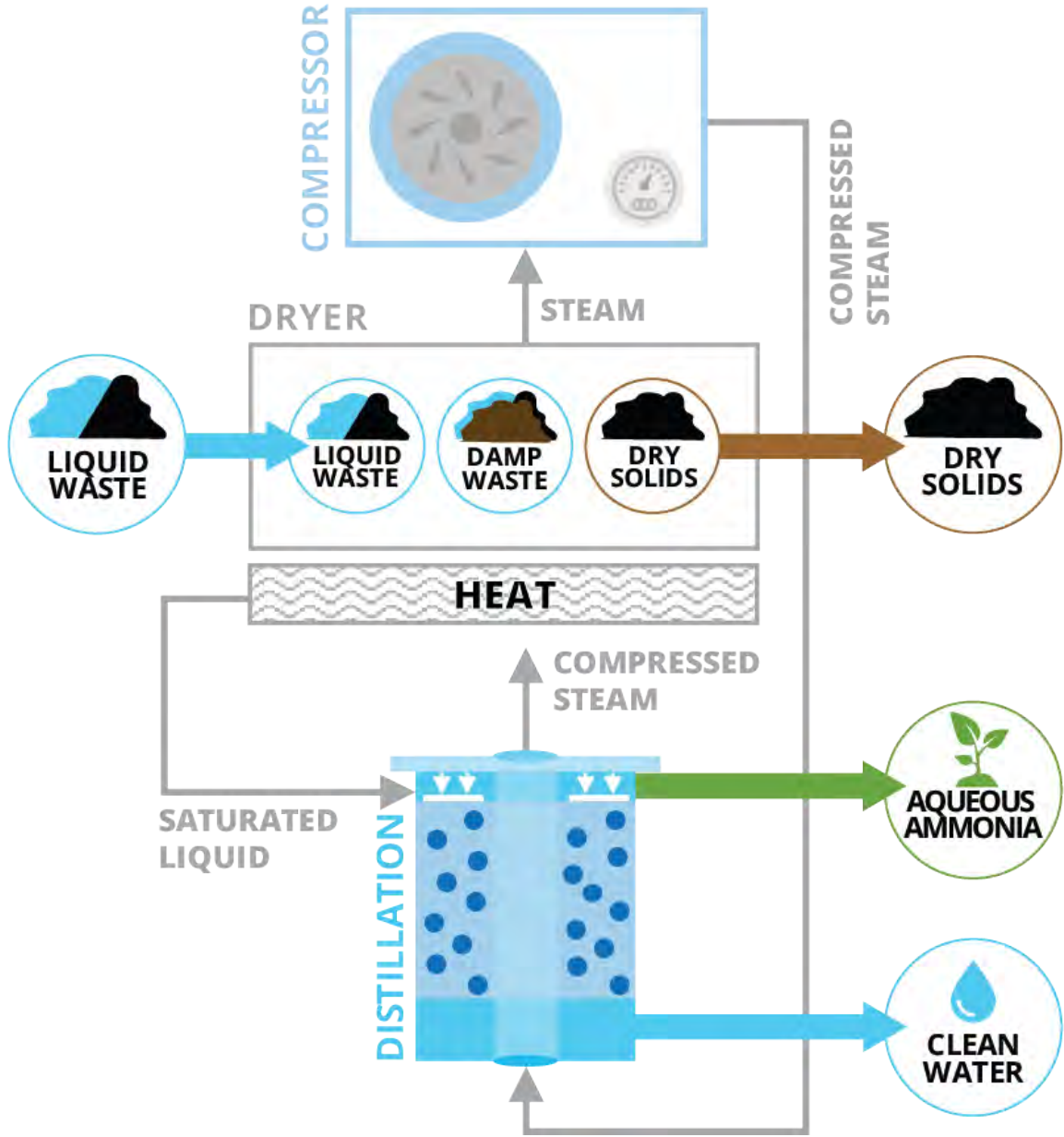
## A COMPLETE, HOLISTIC LIQUID WASTE HANDLING SYSTEM

- ✓ Combined dewatering and drying
- ✓ Solids recovery for beneficial use
- ✓ Very clean steam stripped condensate



# VARCOR™

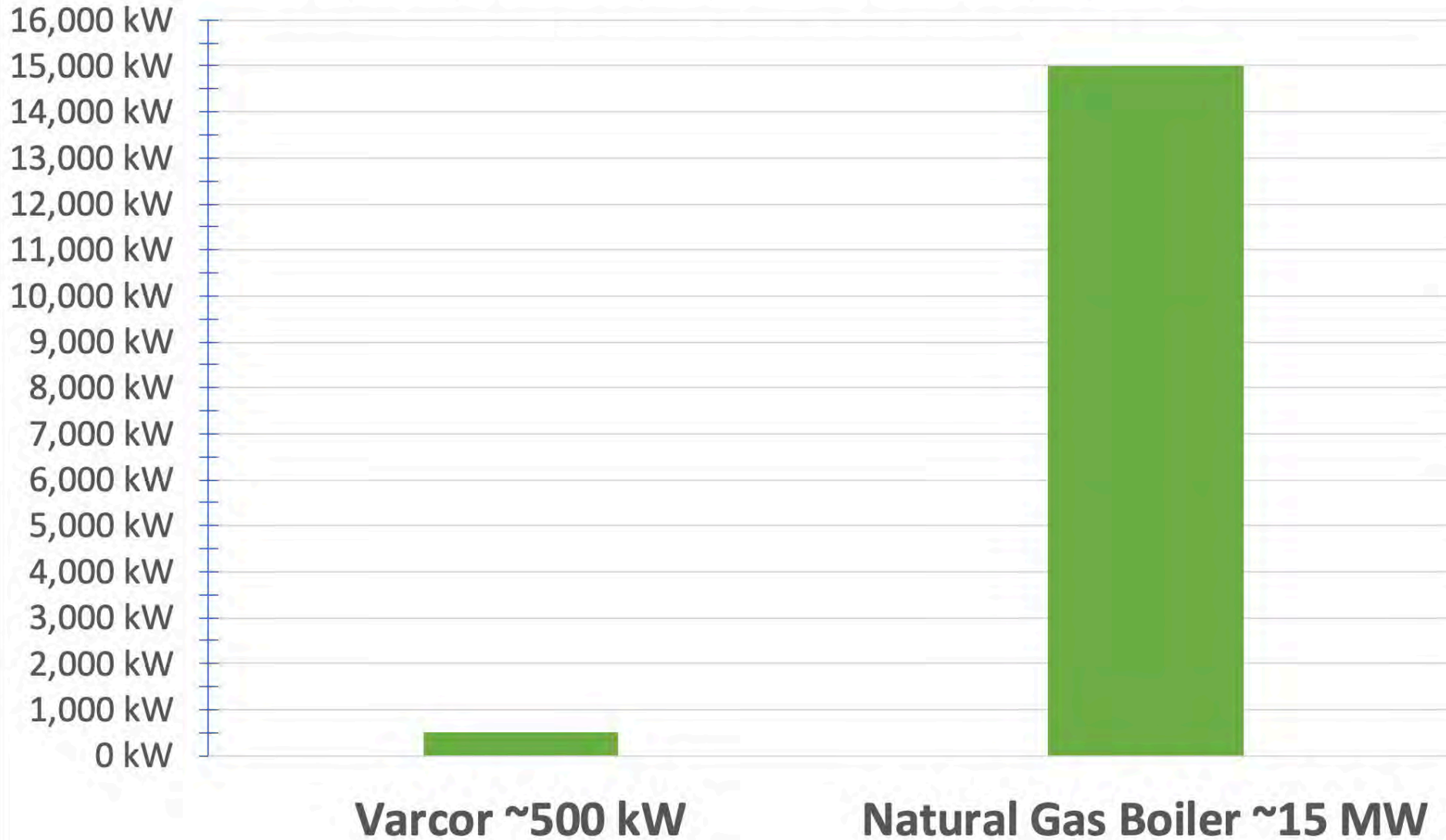
What it Does





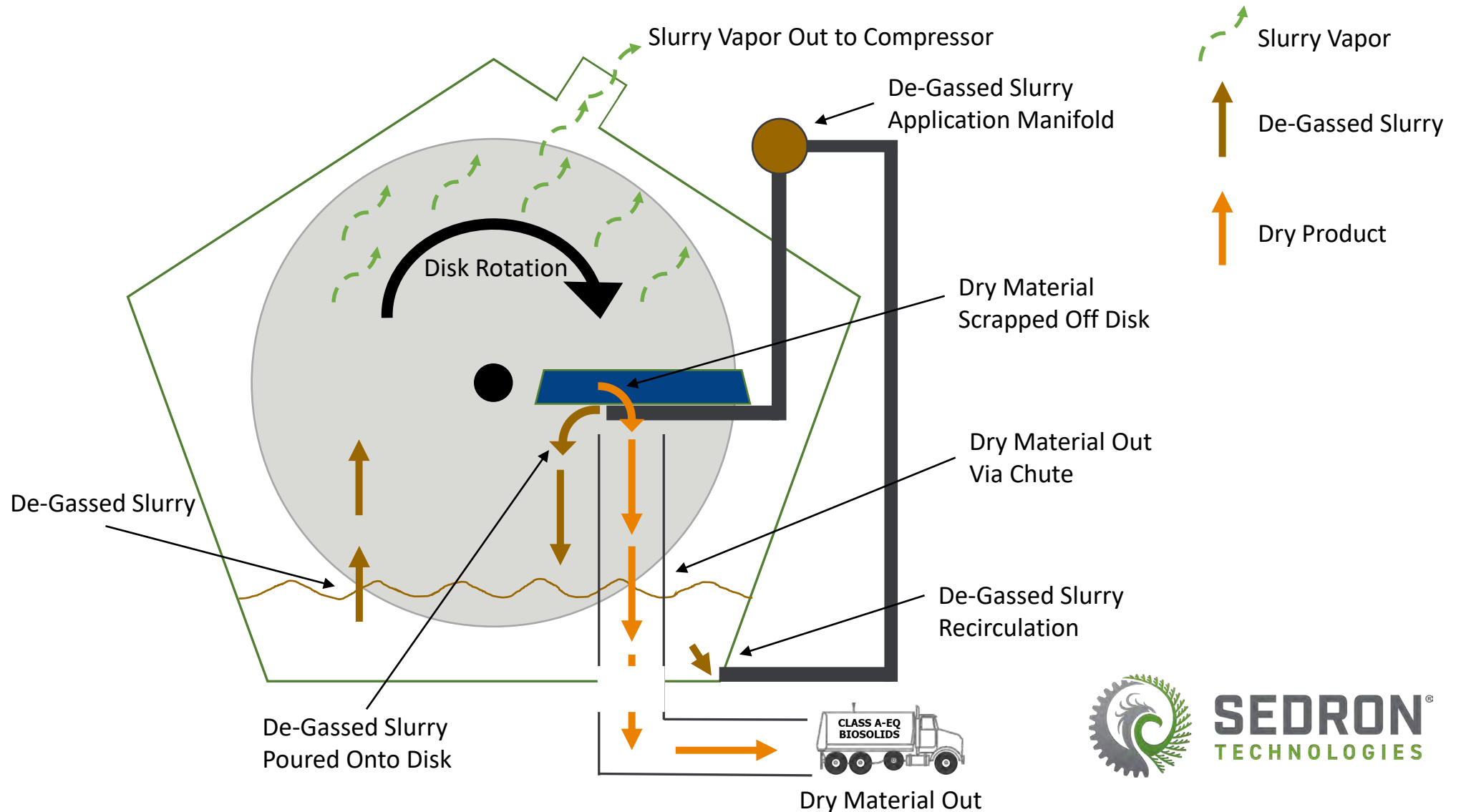
# VARCOR™ Energy Input vs Traditional Methods

Energy Required to Evaporate 370 Litres / Minute of Water

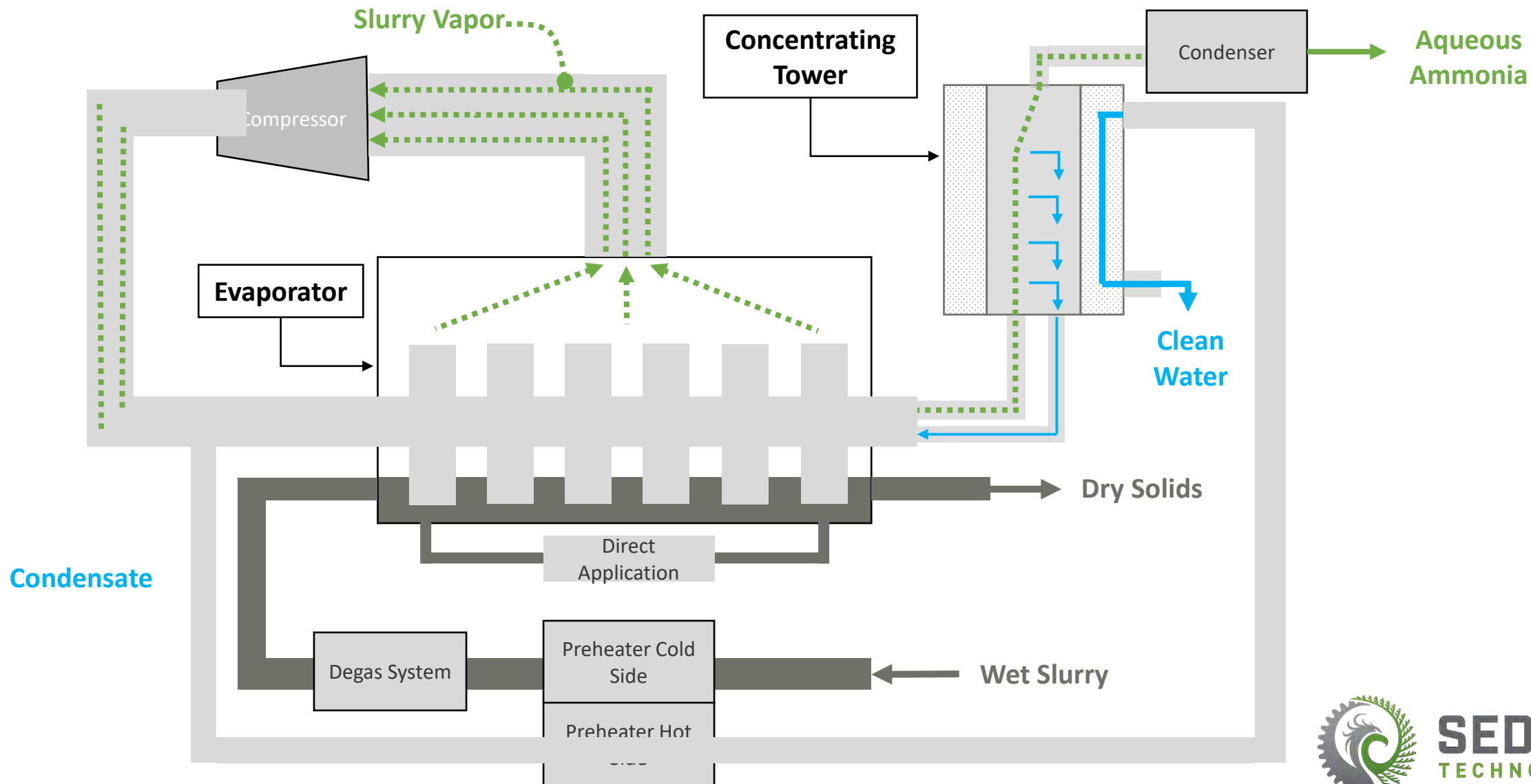


**SEDRON**  
TECHNOLOGIES

# VARCOR Slurry Application & Thin Film Drying



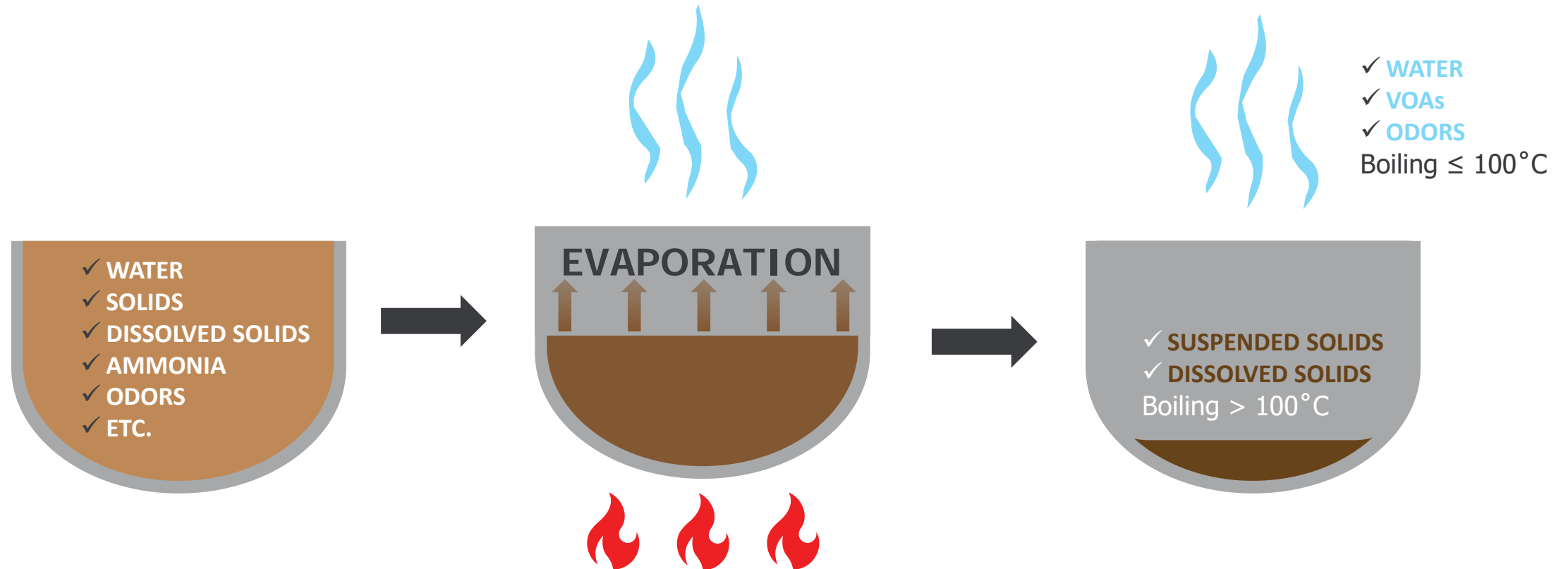
# VARCOR™ Detailed Process Flow



# VARCOR™

Why is Varcor so effective?

1. When you apply heat, evaporation separates the solids from the other components.

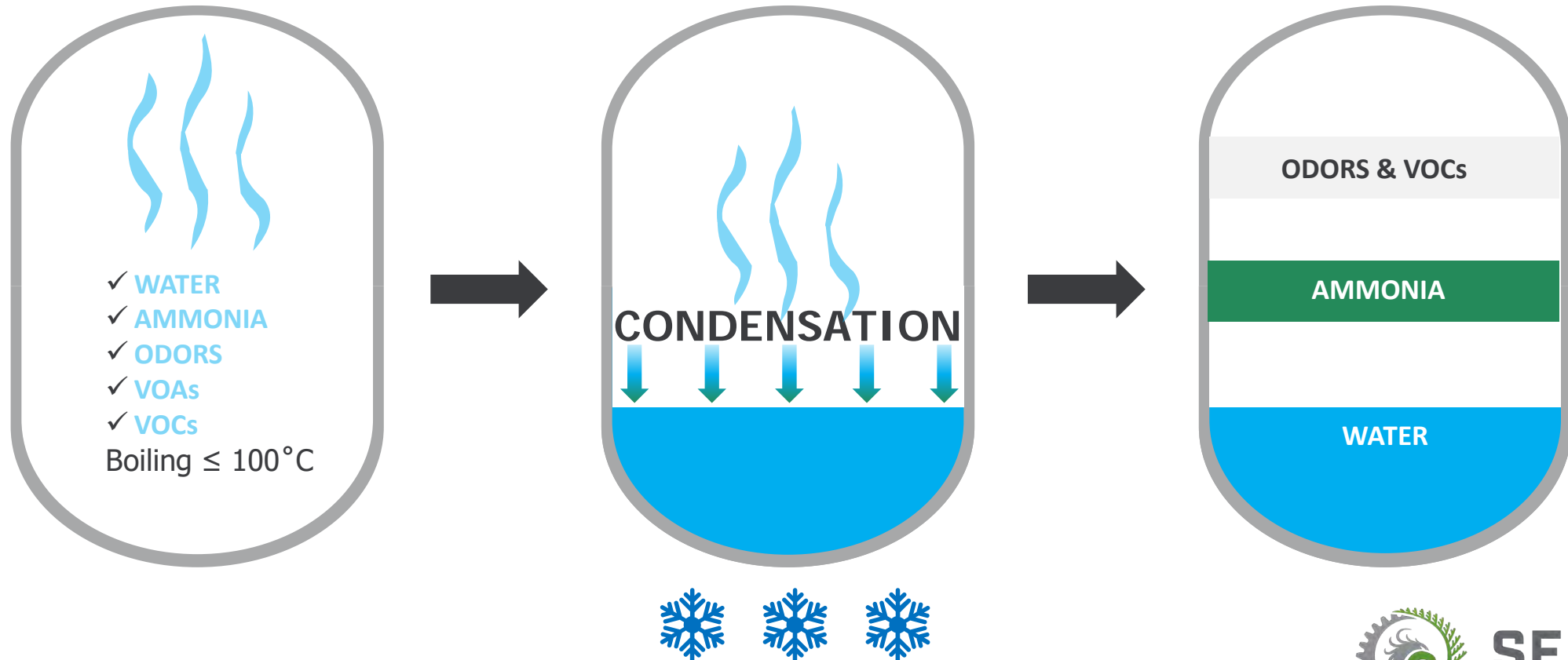




# VARCOR™




Why is Varcor so effective?

2. As the vapor cools & condenses, it releases each component at a different temperature through distillation.



# VARCOR™

## Separation & Recovery Overview

COMPONENT IN SLURRY	BOILING POINT > 100 CELSIUS?	END PRODUCT
		
		
		

# CLEAN WATER

WATER  
PRODUCT  
FOR RE-USE



**SEDRON**<sup>®</sup>  
TECHNOLOGIES



# DRY SOLIDS

AG:

- ✓ OMRI Listed
- ✓ Dry
- ✓ Pathogen Free





# AQUEOUS AMMONIA

ORGANIC  
HIGH  
NITROGEN  
PRODUCT

OMRI LISTED



# USE CASES

CONFIDENTIAL  
INFORMATION



**SEDRON**<sup>®</sup>  
TECHNOLOGIES



# CORE BUSINESS MODEL: INFRASTRUCTURE AS A SERVICE (IaaS)





# MANURE MANAGEMENT



Vacuum



Scrape

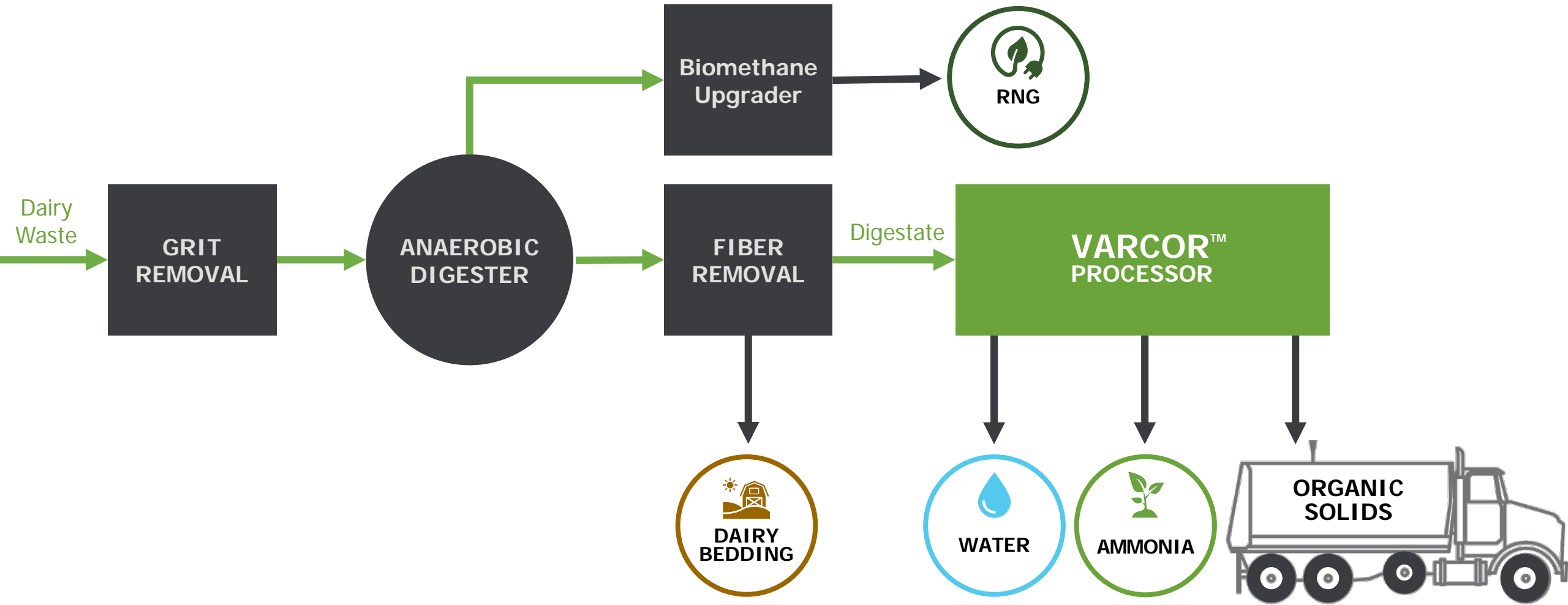


Flush

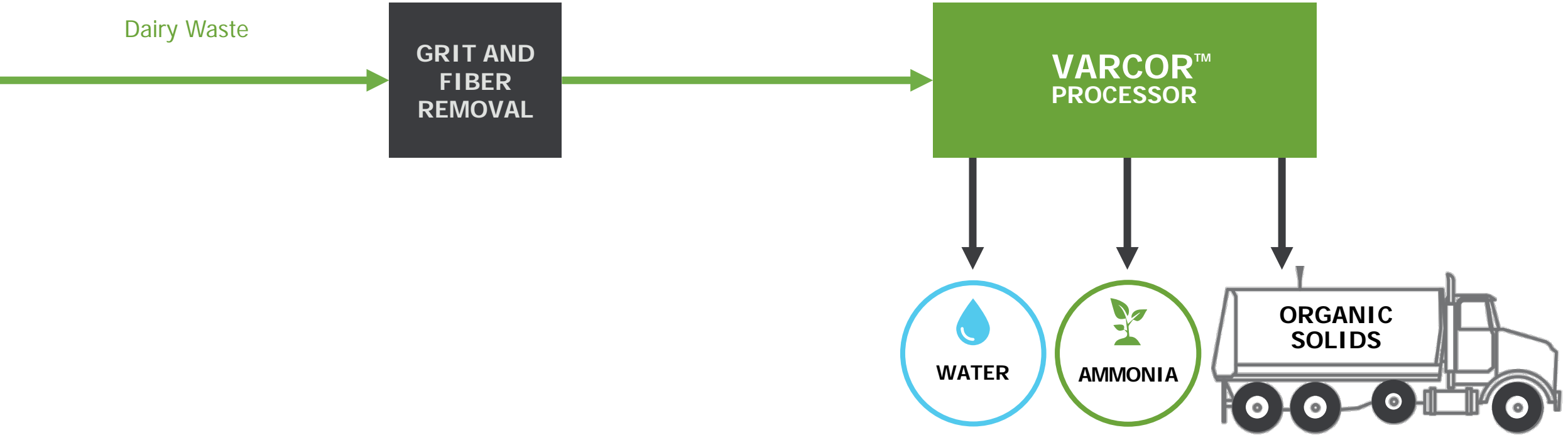




# DAIRY FACILITY WITH DIGESTER



# DAIRY FACILITY W/O DIGESTER



THANK YOU!



SEDRON<sup>®</sup>  
TECHNOLOGIES

# Meeting Agenda

MRIP – Where We've Been and Next Steps

Incentive Programs and Funding  
Opportunities

Questions and Answers

Update on Specific MRIP Recommendations

**Emerging Solutions/New Opportunities**

Wrap-up and Next Steps





# Pelletization of Composted Manure

**UC DAVIS**

**BIOLOGICAL AND AGRICULTURAL  
ENGINEERING**



# Biofertilizer Production from Dairy Manure

Ruihong Zhang, Hamed El Mashad, Abdolhossein Edalati

Department of Biological and Agricultural Engineering

University of California, Davis

Email: [rhzhang@ucdavis.edu](mailto:rhzhang@ucdavis.edu)

June 7, 2023



## Pelletized Manure Products

- Nutrient and organic rich
- Consistent physical, chemical and biological characteristics
- Free of pathogens, weed seeds, odor and dust
- Easy to store and transport
- Convenient and economical to apply to crops and trees
- Slow and gradual release of nutrients



# UC Davis Research: Dairy Manure Biofertilizer Production and Application (2015-2023)

**Goal:** Transforming dairy manure into high value biofertilizer products for wide distribution and application to grow food crops and trees.

## **Accomplishment:**

- Developed new technologies for manure processing
- Created pelletized products from anaerobically digested manure and composted manure
- Tested the products for producing corn, tomatoes and almonds





# Biofertilizers from Composted Dairy Manure

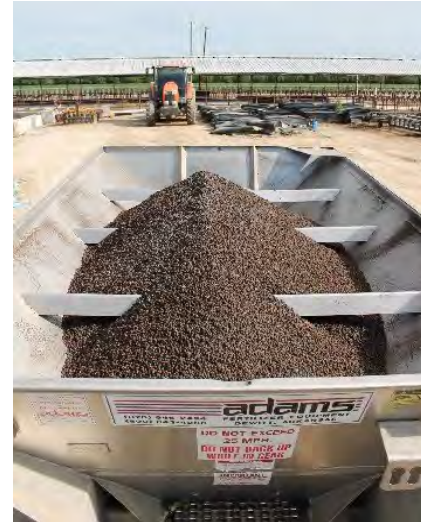
- Produced and characterized pelletized manure compost products
- Applied the products in almond orchard and measured soil organic carbon and nutrients, greenhouse gas emissions, tree growth and almond yield and safety.
- Estimated the cost of pellets made from composted manure.

Project Sponsors:

California Department of Food and Agriculture (CDFA)

California Dairy Research Foundation (CDRF)

Almond Board of California (ABC)



Pelletized Manure Compost



Compost Application  
In Almond Orchard



Manure Solids – Compost – Pellets



# Pelletization of Manure Compost



**Abdolhossein Edalati working on the pelletization of compost**



**Pellets coming out of the pelletizer and collected in a Macro Bin**

# Dairy Manure Compost and Pellets

## Composition

- Pelletization doubled bulk density of manure compost and reduced the volume by 50%
- Higher bulk density means that more pellets can be loaded into the applicator and fewer trips.

Parameter	Units	Manure Compost	Pelletized Manure Compost
Bulk Density	lb/cu ft	26	50
C:N Ratio (C:N)	Ratio	17:1	17:1
Total Nitrogen (TN)	% db	1.20	1.33
Total Phosphorus (TP)	% db	0.31	0.39
Potassium (K)	% db	0.76	1.00
Organic Matter (OM)	% db	36.3	39.2
Sodium (Na)	% db	0.25	0.29
Sulfur (S)	% db	0.35	0.32
Calcium (Ca)	% db	1.50	1.70
Magnesium (Mg)	% db	0.44	0.48
Sodium (Na)	% db	0.25	0.29



# Orchard Application of Manure Pellets





# Commercial-Scale Demonstration

- Equipment purchased from CME
- Capacity: 1.1 ton per hour
- HMS **Hammermill** with 30 HP Motor
- Millennium R30 **Pellet mill** w/30HP Motor; 6 mm die
- CPM Vertical **Cooler**
- Millennium R30 Force **Feeder**
- **Bucket Elevator**
- **Control Panel**

Project Sponsor:  
CDFA Alternative Manure Management  
Program (AMMP)



# Commercial-Scale Demonstration





# Wickstrom Dairy California Dairy Farm



Aaron Wickstrom



Field Day, March 2023



# Cost Analysis of Pellets Production

- Capital costs:
  - Equipment
  - Building
  - Installation
- Operational Costs
  - Labor
  - Electricity
  - Maintenance
- Daily operational time
  - One to three shifts



CME, Hammer mill



CME, MILL-R30  
Pellet Mill



# Cost Analysis of Pellets Production

## Model Inputs

Total Capital costs	\$255,000
Interest rate	8%
Annualized capital cost	\$29,792/year
Number of working days	260 day/year
Pellet mill throughput	1.1 ton/hour

## Estimated costs

	One shift	Two shifts	Three shifts
Number of working (hours per day)	8	16	24
Operational cost per year	\$ 67,472	\$134,944	\$ 202,416
Total yearly cost	\$97,264	\$164,736	\$232,208
Pellets Production (ton/year)	2,364	4,727	7,091
Cost per ton of pellets	\$ 41	\$35	\$ 33

# Business Case

A dairy farm with 2,400 milking cows,

- Pelletized compost production: 4,358 dry ton per year
- Potential income: \$218,000 per year
- Potential profit: \$ 65,000 per year

Assumptions:

- Cost of pelletization: \$35 per dry ton
- Sale price of pellets: \$50 per dry ton

## Fine solids:

24,211 wet ton  
5,275 dry ton  
Moisture 78%



## Compost:

6,226 wet ton  
4,358 dry ton  
Moisture 30%



## Pelletized compost:

4,358 dry ton



# Moving Forward

## Manure Pellet Production

- Create and characterize pellets from different types of manure
- Determine the pellet requirement and best application practices for different crops
- Scale up the pelletization system to 5-10 ton/hour capacity
- Demonstrate and evaluate stand-alone and centralized biofertilizer systems



# Moving Forward

## **Market Development**

- Quantify agronomic, economic, and environmental benefits of manure pellets as biofertilizer and soil amendment products
- Develop markets for various applications, such as agriculture, horticulture, and gardening

# Research Personnel and Collaborators

## Investigators at UC Davis

### **Biological and Agricultural Engineering Dept.**

Ruihong Zhang, Hamed El-Masha,  
Abdolhossein Edalati, Allan Chio, Yike Chen,  
Tyler Barzee, Ian Nielsen

### **Animal Science Dept.**

Frank Mitloehner

### **Plant Science Department**

Sat Darshan S. Khalsa, Patrick Brown

### **Population Health & Reproduction Dept.**

Pramod Pandey

## Research and Industry Collaborators

**Wickstrom Dairies LP**

**California Dairy Farm**

**Van Ruler Orchards**

**JPT Composting and Spreading**

**Nichols Custom Ag Services**

**Silva & Sons Custom Spreading**

# Research Sponsors

- California Department of Food and Agriculture
- California Dairy Research Foundation
- Almond Board of California
- University of California, Davis



# Thank you

Contact:

Dr. Ruihong Zhang, Professor, UC Davis

[rhzhang@ucdavis.edu](mailto:rhzhang@ucdavis.edu)

**Research information can be found on YouTube Channel:** <https://bit.ly/HSP-YouTube-Playlist>



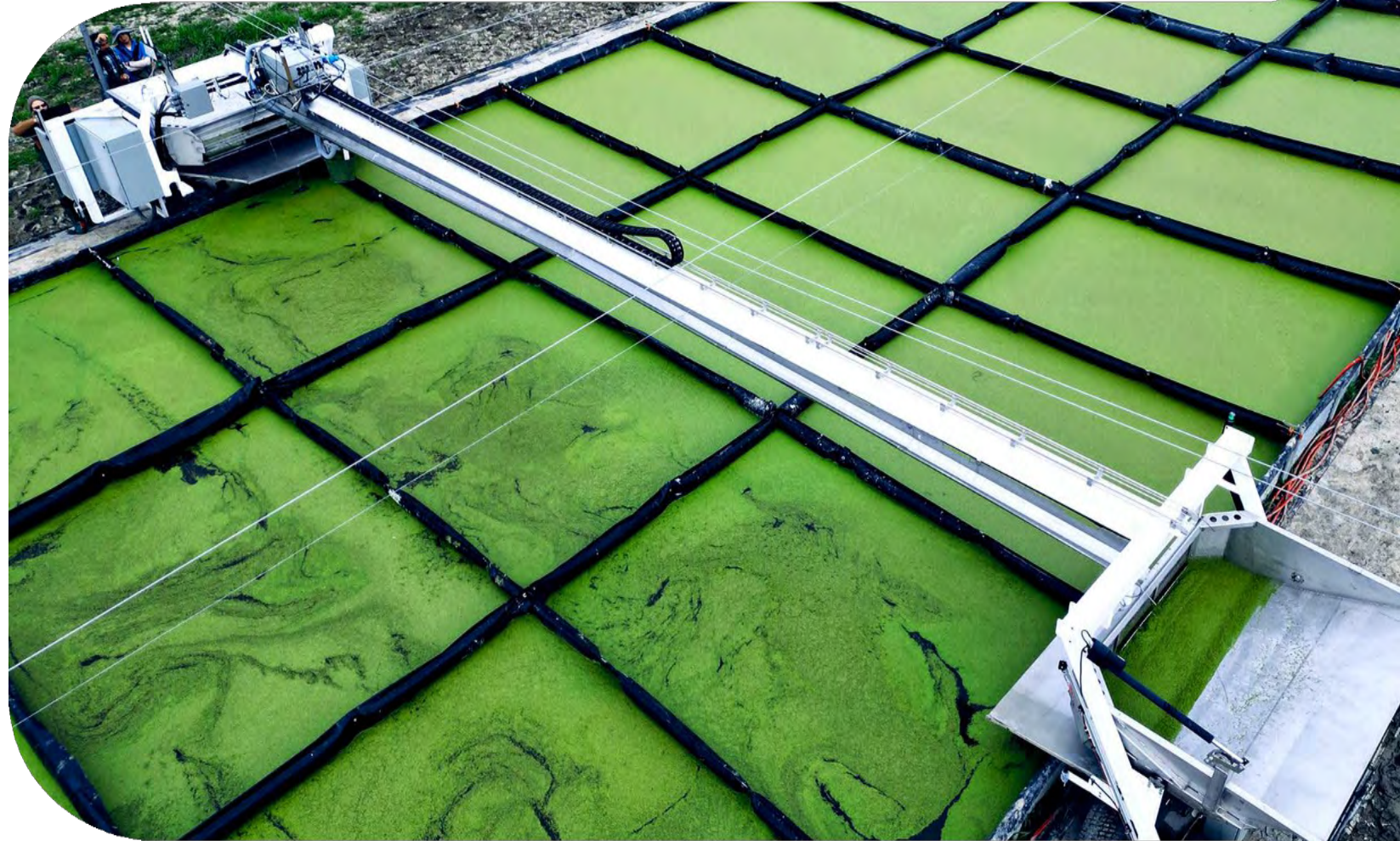




# Using Liquid Manure to Grow Duckweed



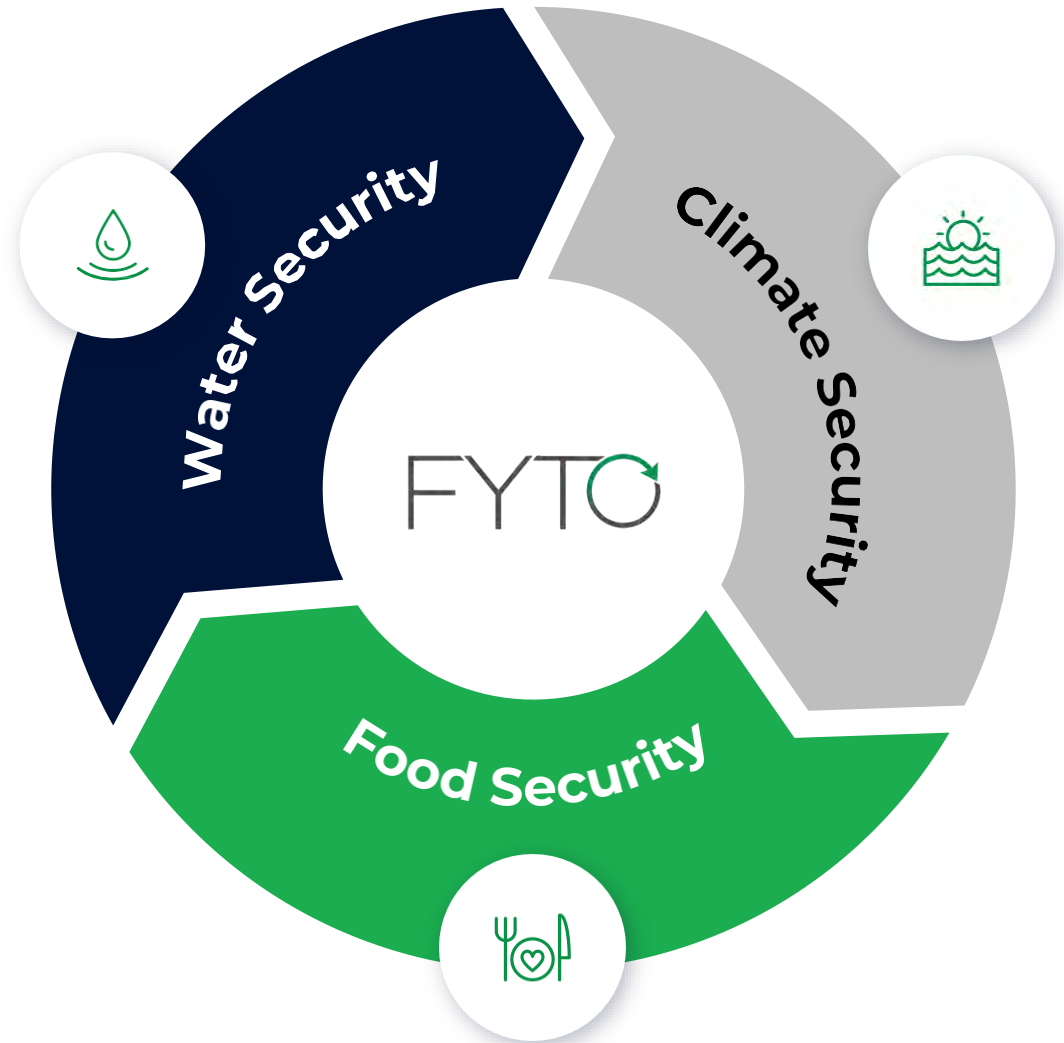
Converting  
nutrient  
management  
challenges into  
sustainable feed  
solutions with  
aquatic plants



# Fyto is focused on the interface of 3 massive problems



Humanity needs to double food production in the next 30 years while significantly reducing greenhouse gas emissions and water consumption



## Brief Intro to Fyto

- Startup spun out of MIT in 2019
- HQ in Petaluma, CA with 18 employees and counting
  - R&D team is combination of plant scientists and engineers
  - Commercial team has significant experience in bio-energy, food and agriculture
- Focused on CA market to collaborate with innovators in dairy and agricultural policy
- Company raised a Series A investment round in 2022

Fyto is backed by leading investors in climate and agricultural technology





# We grow specialized aquatic plants in a novel cropping system



## **Nutrient-dense**

Complete and digestible protein with key amino acids, starch, minerals, vitamins, fatty acids, etc.



## **Highly productive**

Mass doubling every three days, potentially year-round. Entire plant is valuable/no wasted byproducts.



## **Ultra resource efficient**

Order of magnitude lower land, water, and energy use. No synthetic fertilizer, herbicide, pesticide, etc. Grows effectively on dairy lagoon effluent and digestate

# What is Fyto trying to prove?

Fyto's aims to realize the potential of lemna to valorize liquid nutrients into protein with attractive economics. Specifically, we aim to demonstrate:

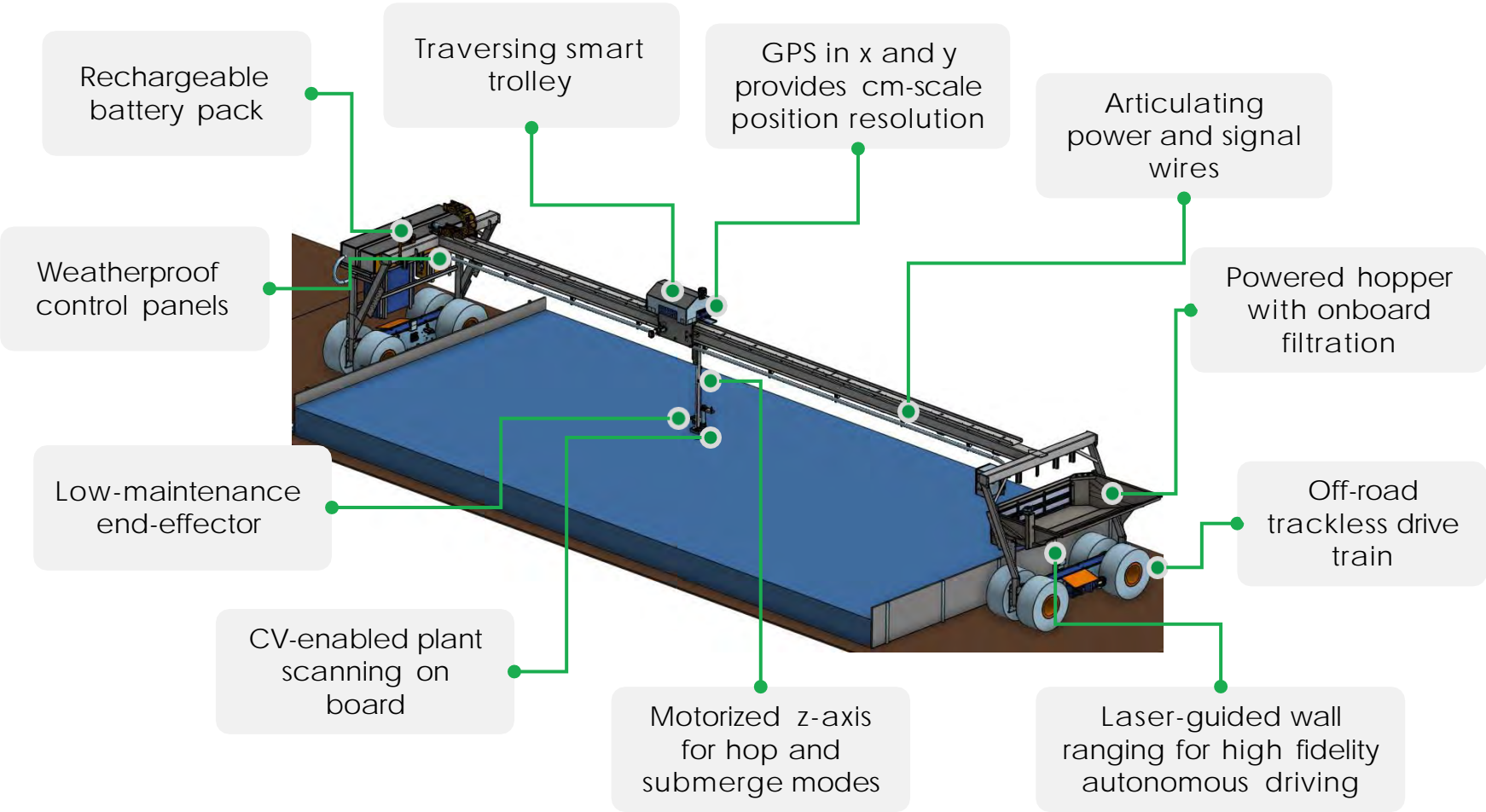
- Yields of  $\geq 20$  tons dry matter per acre per year of a crop that is 38-40% crude protein
- Nitrogen uptake of 3000-4000 pounds per acre per year
- Significantly lower water consumed per pound of protein produced compared to conventional forage and protein crops
- Significantly reduced overall GHG emissions associated with production, nutrient management, and avoided transport
- Cost of production that allows producers to achieve feed, labor, and nutrient management savings by working with Fyto



# Fyto's core technology is solving for scaled, automated, economical farming of aquatic crops



Fyto has developed an electrified smart-harvesting platform to farm these unique crops







**Fyto views automation as the key enabler to scalable aquatic plant farming**

**FYTO**





# Fyto is driven by data – from producers, plants, and cows



We're currently working with 20+ dairies in California to understand producer needs, grow test crops, and measure dairy cow performance



# Fyto awarded 2023 CDFA CLIM<sup>3</sup>ATE-RP Grant

Critical support to deepen techno-economic analysis and accelerate commercialization



**Title: Aquatic Crop Production as a Nutrient-to-Feed Solution for California Dairies**

Timeline	
Project Begins	Q3 2023
Test Plots, Site Design, and Permitting	Q3-Q4 2023
Construction of FytoFarm On-dairy	Q1 2024
Multi-acre operations & data collection	Q2 2024-Q2 2025
Feeding Trial	Q3 2024
Economic Analysis	Q4 2024-Q2 2025
Complete Final Report	Q3 2025

Project Partners	
 Dairy Impl. Site	 Engineering / Construction
 Research Support	 Research Support
 Feeding Trial	 Industry Outreach
 Nutrient Management	 Air Quality
 Life Cycle Assessment	 Techno-Economic Analysis



# Commercialization Plans and Areas for Support

Fyto has 16+ projects under evaluation and broad engagement across California's dairy ecosystem



## Fyto aims to break ground in Q3 2023

- Multiple term sheets signed for commercial dairy operations in Central Valley
- Generated a deep backlog of prospective, high-quality projects representing 50,000+ cows and 10,000+ acres of opportunity across the Valley
- Engaging with public and private sector leaders to de-risk and accelerate commercialization
- Working with regional and State regulatory agencies for project approvals

## Key areas for support

- Streamlined regulatory processes for innovations that differ from regulatory precedent
- Future funding mechanisms that help facilitate early adoption and enhance economics for producers (including carbon markets and grant opportunities)

FYTO™

[www.fyto.us](http://www.fyto.us)







# Applying Liquid Manure to Non-Feed Acreage

# Subsurface Application of Liquid Manure to Almonds & Tomatoes



Addressing Surplus Manure Nitrogen  
Presentation to the MRIP Taskforce  
June 7, 2023



# Existing System: Feed Crops





United States Department  
of Agriculture,

Natural Resources  
Conservation Service

Conservation Innovation  
Grant 69-3A75-17-53

# Subsurface Drip Irrigation System

# Utilizing Dairy Manure Effluent



Sustainable Conservation



United States  
Department of  
Agriculture

Natural Resources Conservation Service

UNIVERSITY OF CALIFORNIA  
Agriculture and Natural Resources

UC Cooperative Extension









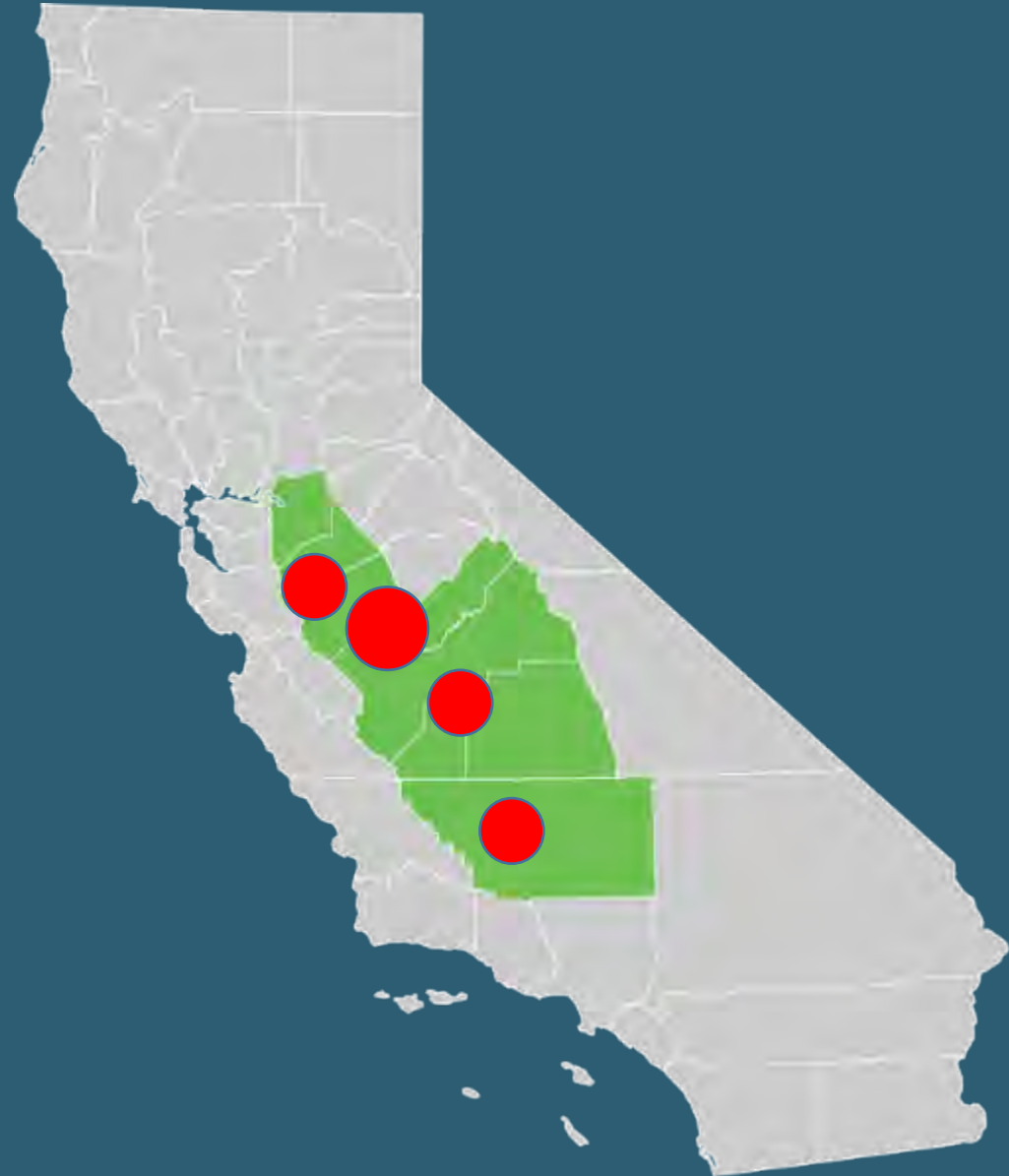
# Results

- Increases yields +2.5%
- Increases water use efficiency
- Reduces overall water use
- Increases nutrient use efficiency
- 9+ years of testing with proven results
- Automated system
- Cost share funding available
- Commercially available

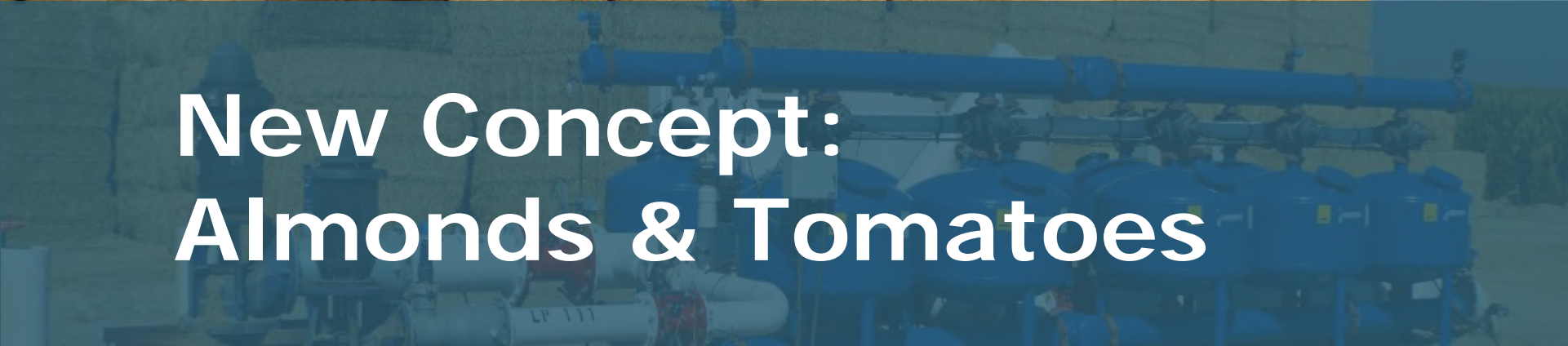


# *Current Systems*

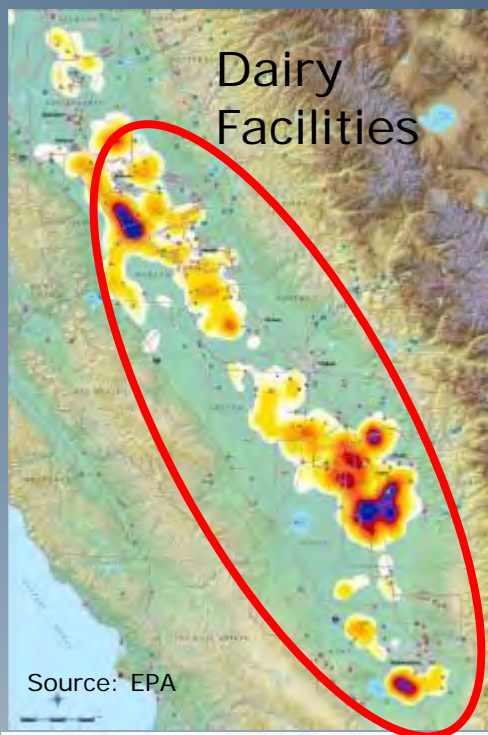
24 systems across  
3,262 acres in CA







# New Concept: Almonds & Tomatoes

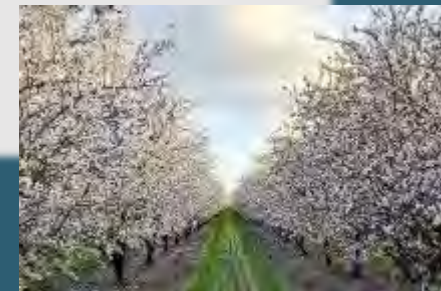






# *Proposed Project*

- Implement Dairy SDI to irrigate established almonds and processed tomatoes with blended dairy nutrient water
  - Tomatoes:
    - 55-acre trial field vs. 55-acre control field
  - Almonds:
    - 74-acre trial field vs. adjacent 72-acre control conventional freshwater field
    - Variety - 50% Nonpareil, 25% Butte, 25% Aldridge
- 2 cropping seasons
- 3-year project – 2024, 2025, 2026
- Chowchilla, Merced County
- De Jager Farms



# *Project Hypothesis*

Food safety and foodborne pathogen risk can be managed when irrigating almonds and processed tomatoes with subsurface drip irrigation utilizing blended dairy lagoon water and fresh water (Manure SDI).



# Monitoring

- Food safety
- Water
- Soils
- Tissue
- Yields
- Farmer experience

**Almond Water Analysis:**

Type	Analysis
Source Water	pH, EC, Ca, Mg, K, Na, SAR, SARadj, Cl, B, CO <sub>3</sub> , HCO <sub>3</sub> , Fe, Mn, SO <sub>4</sub> , NO <sub>3</sub> -N, L.I., Salmonella, E. Coli O157, Generic E Coli, STEC, Listeria
Manure Water	pH, EC, NO <sub>3</sub> -N, NH <sub>4</sub> -N, TKN, TP, TK, TDS, Ca, Mg, Na, Cl, CO <sub>3</sub> , HCO <sub>3</sub> , SO <sub>4</sub> , Salmonella, E. Coli O157, Generic E Coli, STEC, Listeria
Blended Water	pH, EC, NO <sub>3</sub> -N, NH <sub>4</sub> -N, TKN, TP, TK, TDS, Ca, Mg, Na, Cl, CO <sub>3</sub> , HCO <sub>3</sub> , SO <sub>4</sub> , Salmonella, E. Coli O157, Generic E Coli, STEC, Listeria (at inlet to irrigation system and at end of drip hose)

**Almond Tissue Analysis**

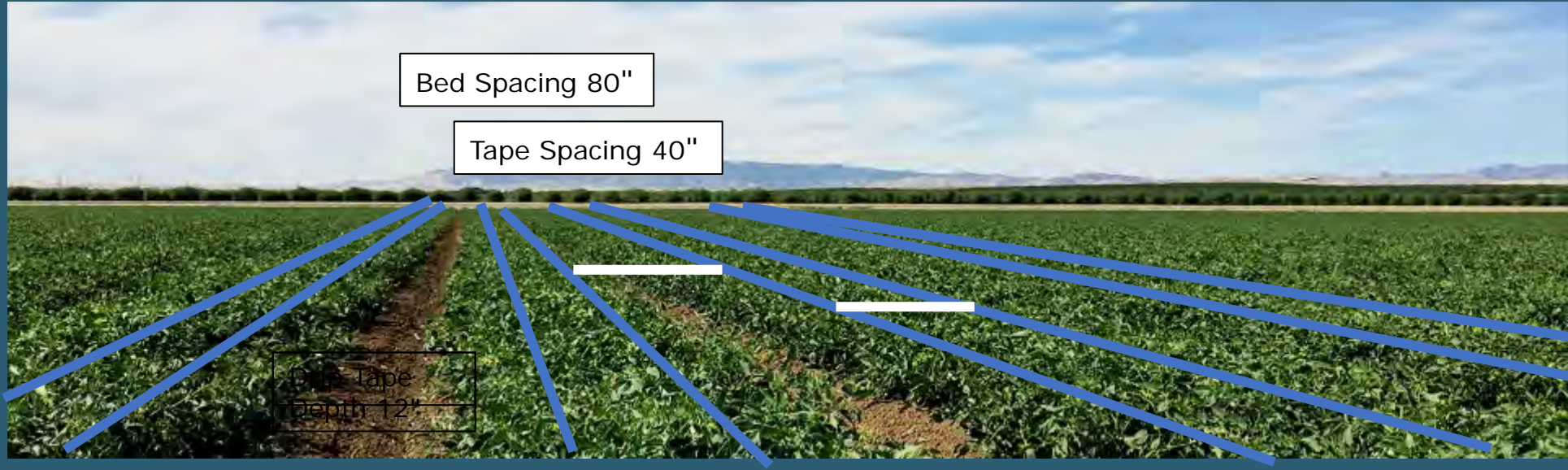
Type	Analysis
Leaf: L3	N, P, K, Zn, Mn, Na, B, Ca, Mg, Fe, Cu, Cl
Leaf: TN	N Only
Hulls	Boron

**Almond Soil Analysis:**

Type	Analysis
FA1+Cl	SP, pH, EC, Ca, Mg, Na, ESP, B, GR or LR, NO <sub>3</sub> -N, PO <sub>4</sub> -P, K, Zn, Cl, OM
Pathogens	Salmonella, E. Coli O157, General E. Coli, STEC, Listeria

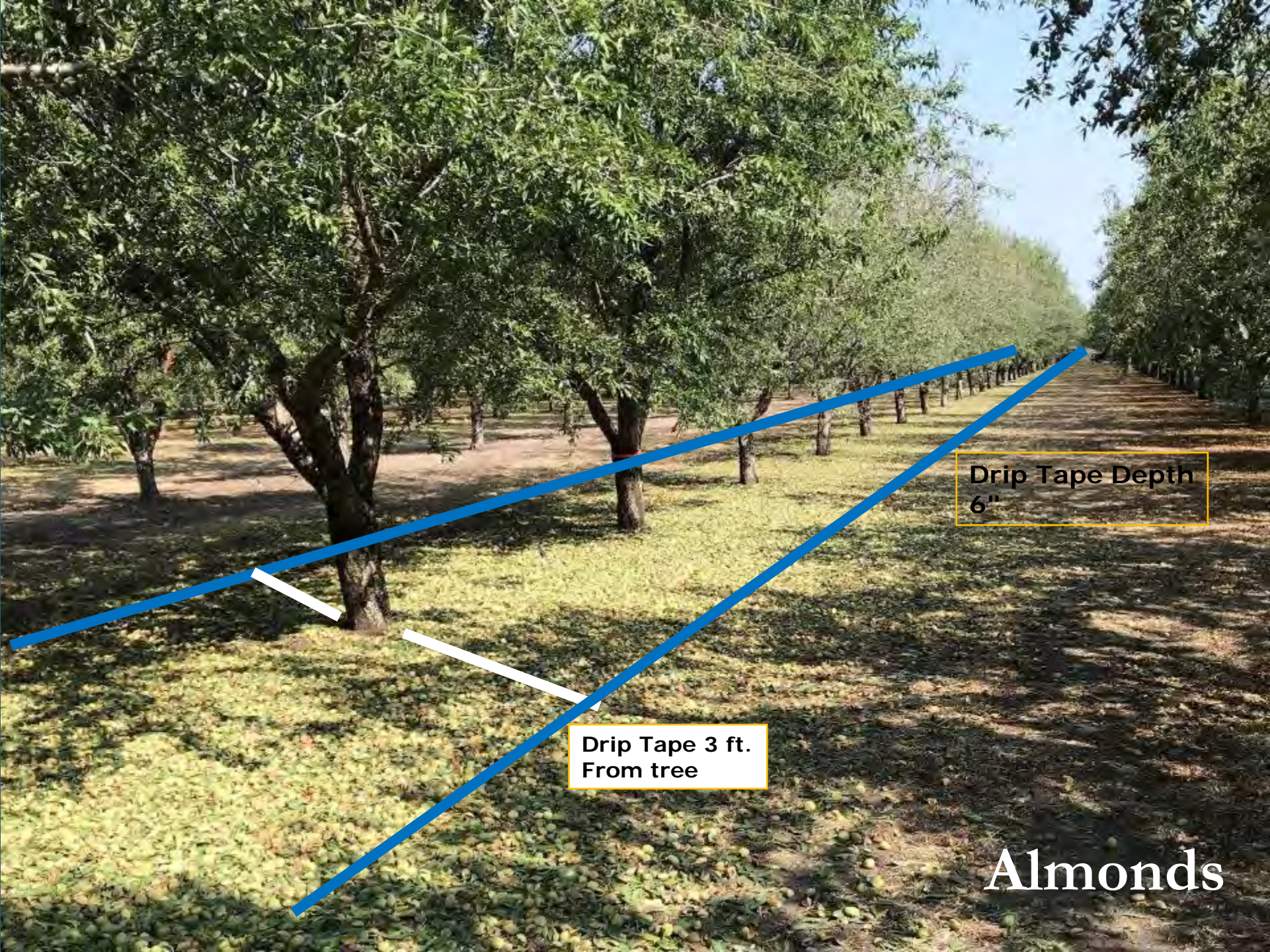
**Almond Harvest Product Analysis**

Type	Analysis
Hulls	Salmonella, E. Coli O157, General E. Coli, STEC, Listeria
Shells	Salmonella, E. Coli O157, General E. Coli, STEC, Listeria
Meats	Salmonella, E. Coli O157, General E. Coli, STEC, Listeria



Tomatoes





Drip Tape Depth  
6"

Drip Tape 3 ft.  
From tree

Almonds



# *Key Performance Indicators*

- Food Safety
  - E-Coli levels
  - Salmonella levels
  - Listeria levels
  - SOP
- Agronomics
  - Crop Yields
  - Nutrient Use Efficiency
  - Water Use Efficiency
  - Salt Loading
  - Soil Health
- Economics



# *Implementing Partners*



## *Budget*

- Total \$2.8 million
- Match \$1.4 million

# *Why?*

- Environmental Benefits
  - Nitrate Leaching
  - GHG Reductions
  - Soil health
- Policy/Regulatory Pressures
  - Water quality
  - GHGs
- Economics
  - Alternative to high fertilizer costs



**John Cardoza**  
**Project Director**  
jcardoza@suscon.org

**Reports available at**  
[www.suscon.org/technical-resources](http://www.suscon.org/technical-resources)

# Meeting Agenda

MRIP – Where We've Been and Next Steps

Incentive Programs and Funding  
Opportunities

Questions and Answers

**Update on Specific MRIP Recommendations**

Emerging Solutions/New Opportunities

Wrap-up and Next Steps



# Conventional Strategies

1. Implement Summary Representative Monitoring Report (SRMR) reporting structure
2. Increase industry and extension/training programs to promote understanding of conventional strategy application
3. Conduct near-term studies to better understand conventional strategy potential for addressing nitrogen

# **Benchmarking & Describing CA Dairy Sustainability Metrics**

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**Jennifer Heguy** – UC Cooperative Extension  
**Deanne Meyer** – UC Ag & Natural Resources & UC Davis

# Environmental Stewardship

Net Zero Initiative ~ Water Conservation ~ Improved Nitrogen Management



**Energy Use**



**Water Use**



**Nitrogen Balances**



# Nitrogen Balances



Understand utility of lower cost nitrogen management techniques: pipeline extension or change in collection for transport



# Objectives & Outputs

Evaluate **nutrient management mitigation options** to improve farm nitrogen use

Methods:

1. Industry wide survey, all producers
2. Farm evaluations, smaller population

Outputs:

**Info to address CA dairy's nitrogen surplus**

- Conventional strategies' potential
  - Extending pipelines & flush to scrape



# Objective & Progress

Evaluate **nutrient management mitigation options** to improve farm nitrogen use

## Methods:

1. Industry wide survey, all producers
2. Farm evaluations, smaller population

## Outputs:

### **Info to address CA dairy's nitrogen surplus**

- Conventional strategies' potential
  - Extending pipelines & flush to scrape



**Current state of info**

**Survey ready**



**University of California**  
Agriculture and Natural Resources

Making a Difference for California



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**University of California**  
Agriculture and Natural Resources



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**Deanne Meyer**  
[dmeyer@ucdavis.edu](mailto:dmeyer@ucdavis.edu)

# Meeting Agenda

MRIP – Where We've Been and Next Steps

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Questions and Answers

Update on Specific MRIP Recommendations

Emerging Solutions/New Opportunities

Wrap-up and Next Steps



## Wrap-up & Next Steps

- Thanks again to our presenters, CDFA and those attending today
- Between meetings we will:
  - Continue to follow progress of projects described today and others
  - Attend to housekeeping to update charter and member lists (member organizations should reach out with any updates)
- We plan to schedule the next meeting during 4<sup>th</sup> quarter of 2023 (~October)
- Go to the website to sign up for meeting notices: <https://www.cdfa.ca.gov/oefi/mrip/>
- Contact co-chairs or CDFA staff with ideas for agenda items or to request to present

# THANK YOU!

<b>NAME</b>	<b>ORGANIZATION</b>	<b>EMAIL</b>
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Roberta Franco	California Department of Food and Agriculture	<u><a href="mailto:Roberta.franco@cdfa.ca.gov">Roberta.franco@cdfa.ca.gov</a></u>
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