EBL Laboratory

SDSU | San Diego State University

CSU Water Conference 2024

EFFECTS OF ASPARAGOPSIS TAXIFORMIS ON MANURE MANAGEMENT SYSTEMS

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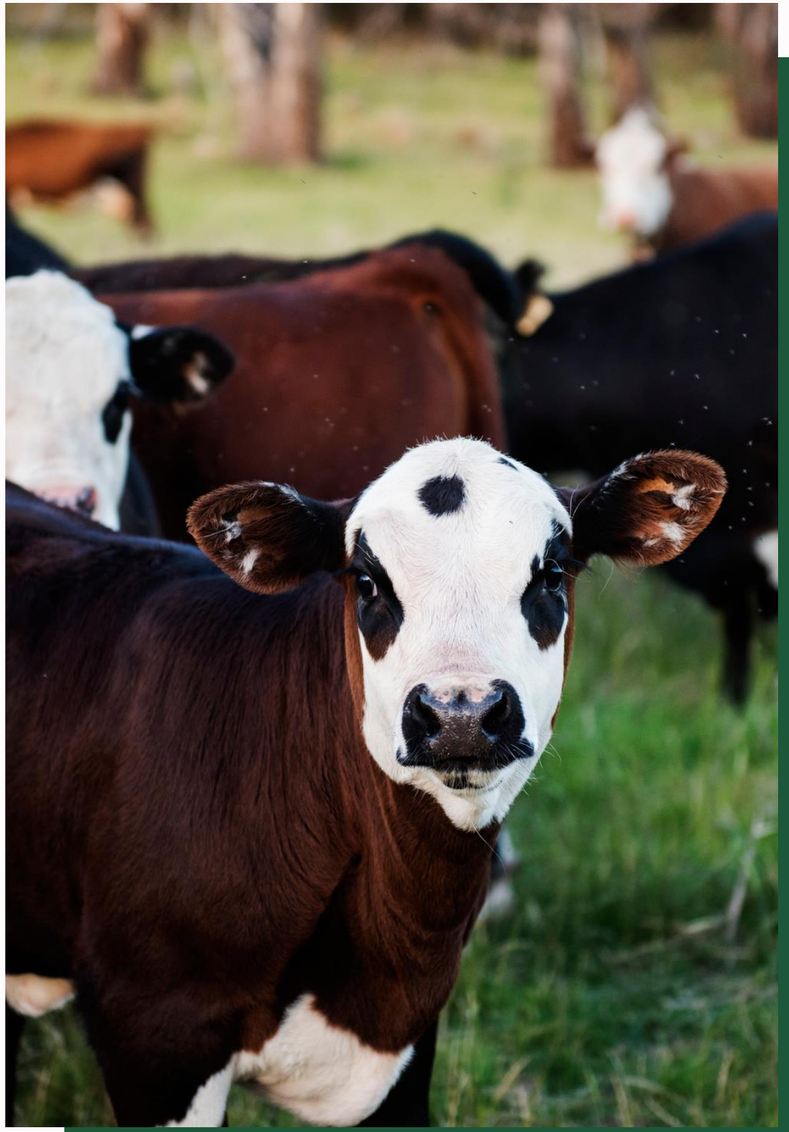
April 19th, 2024

Content



Impact

CH_4 is a GHG with 22 times the impact of CO_2

01

Enteric CH4 194.9 MMT of CO_2 eq./yr
Beef and Dairy cattle made up 97%

02

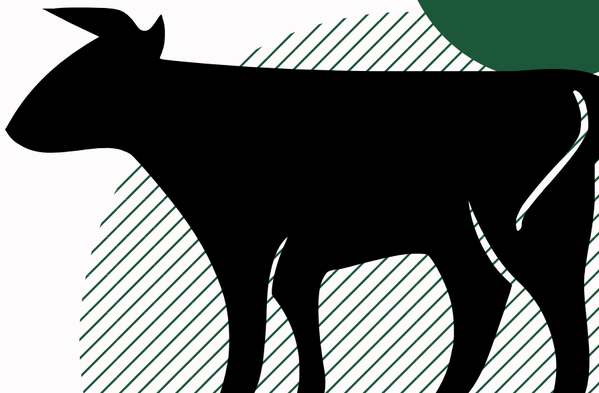
Paris Agreement: reduce CH_4
11-30 % by 2030 and 24-47% by 2050
(compared to 2010 levels)

03

Asparagopsis taxiformis supplements decrease enteric methane emissions by 45%- 68%

04

How will adoption of *A. taxiformis* affect manure management systems?



ASPARAGOPSIS TAXIFORMIS

What is it?

A **red algae** found in tropical to warm waters including Australia, pacific islands and southern Coasts of California.

How it inhibits enteric CH_4

A. taxiformis produces **bromoform**, which inhibits the last step of methanogenesis by competitively binding with coenzyme M methyltransferase. Other compounds may also contribute to inhibition.

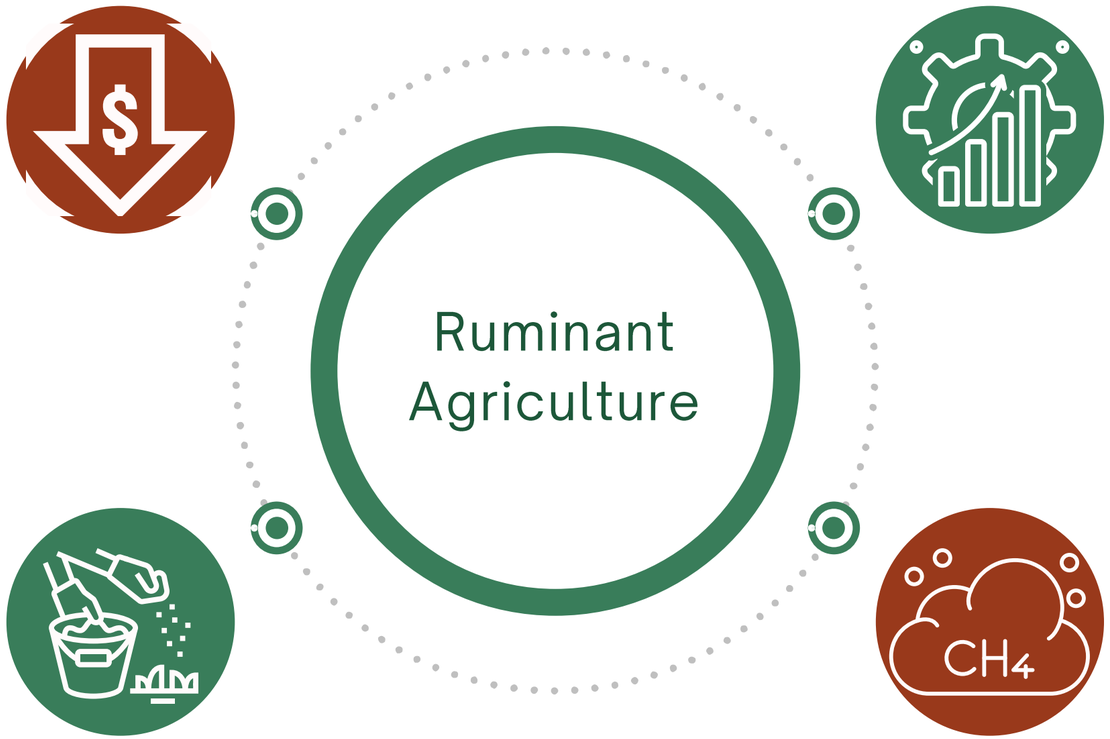
Inhibition is **reversible**.

Manure Management

Produced 66.0 MMT CO_2 eq. of CH_4 in 2021

Solid

Small systems



Liquid/Slurry

Large systems

Dilution of CH_4 inhibitors

Research Question

How will adoption of *A. taxiformis* as a ruminant supplement affect liquid manure management systems?

- Will open systems emit more or less CH_4?
- Will anaerobic digester performance be impacted by inhibitors?

Scope

Through Characterization, Experimental observation, and Microbial Analysis, the potential emissions of manure from treated cattle will be established.

Manure Characterization

pH, COD, VFA,s

16S - rRNA Sequencing

Microbial populations before and after methane inhibition and digestion

Bio-Methane Potential

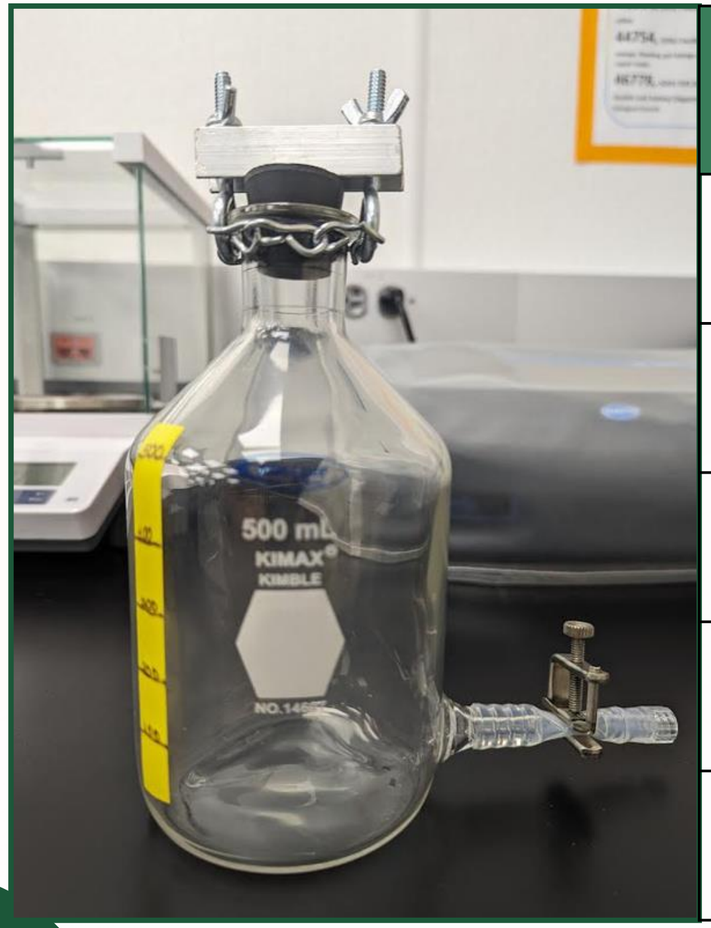
Anaerobic digestion of manure for cumulative methane comparison

GHG Potential

Potential impact to emissions based on gathered data

METHODS

Bio Methane Potential (BMP) Setup



Bottle/Series	Inoculum (mL)	Anaerobic Media (mL)	Dextrin/ Peptone Substrate	Manure (g)
Seed Blank	X	X		
Dextrin/Peptone Control	X	X	X	
Control, Medium Forage	X	X		X
Low Dose, Medium Forage	X	X		X
High Dose, Medium Forage	X	X		X

Experimental Conditions

- N_2 headspace to maintain anaerobic conditions
- 35 ± 2 °C
- 8 week incubation

BMP Monitoring and Data Collection

- Pressure measured with a pressure transducer
- Temperature was recorded
- Gas chromatography with thermal conductivity detector (TCD) was used to measure the relative percentage of gas in headspace

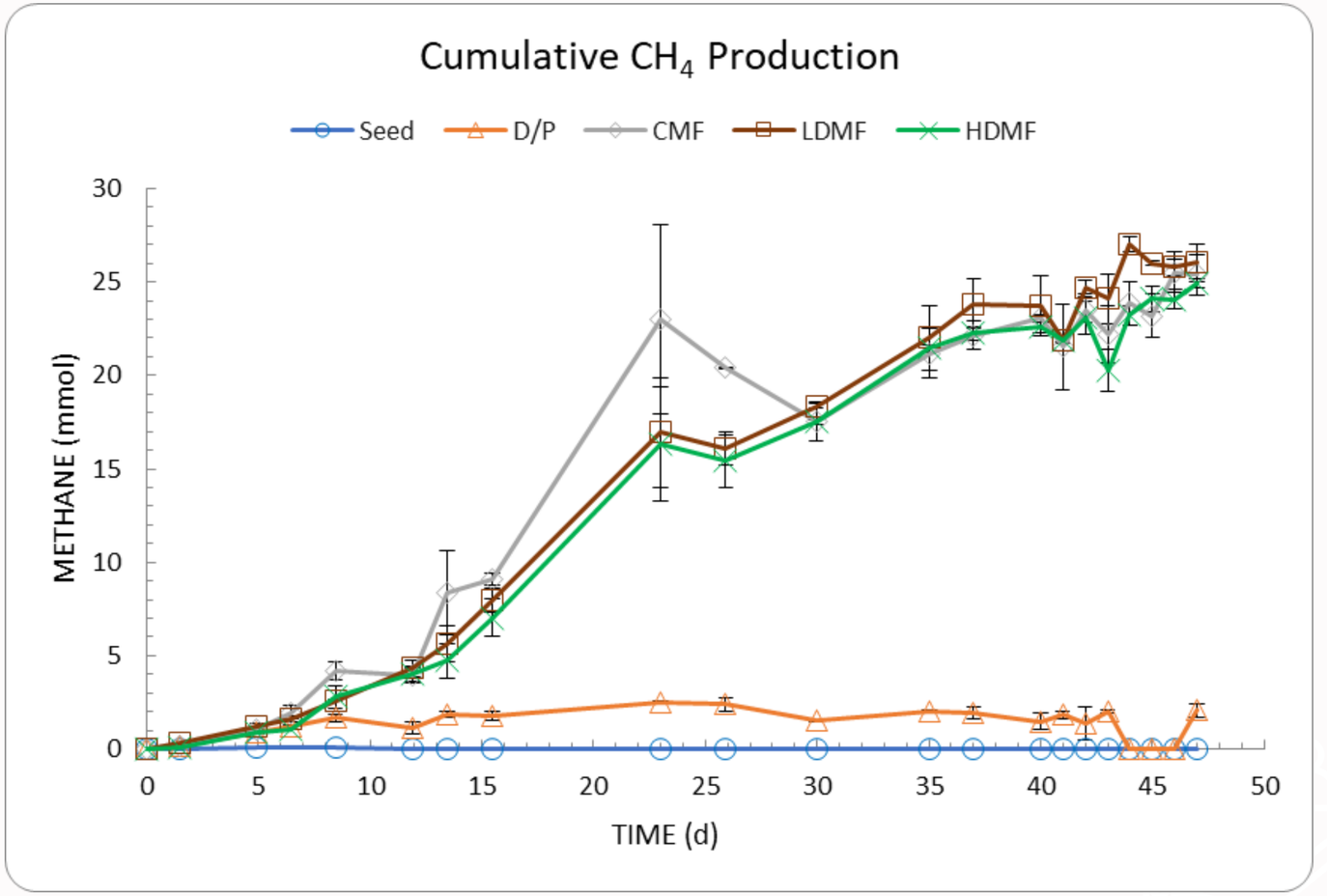
$$n_{CH_4} = C_{CH_4} * \frac{P * V_{headspace}}{R * T}$$

n_{CH_4} - moles of methane gas in headspace
C_{CH_4} - Concentration of total gas in headspace as percent
P – Absolute pressure in headspace
$V_{headspace}$ - Volume of headspace, (272 mL)
R – Ideal Gas Constant, (0.08206 L-atm/K-mol)
T – Temperature (K)

Results

BMP Results

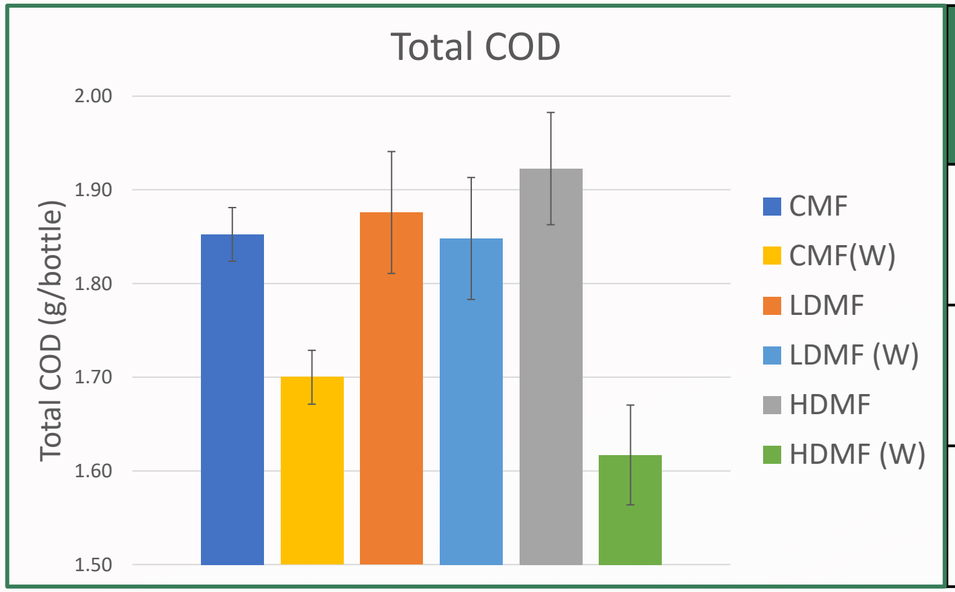
- Cumulative Methane produced equilibrated between the MF series.
- Initial rate of production, around day 8, the control had an observably and statistically higher rate of methane production



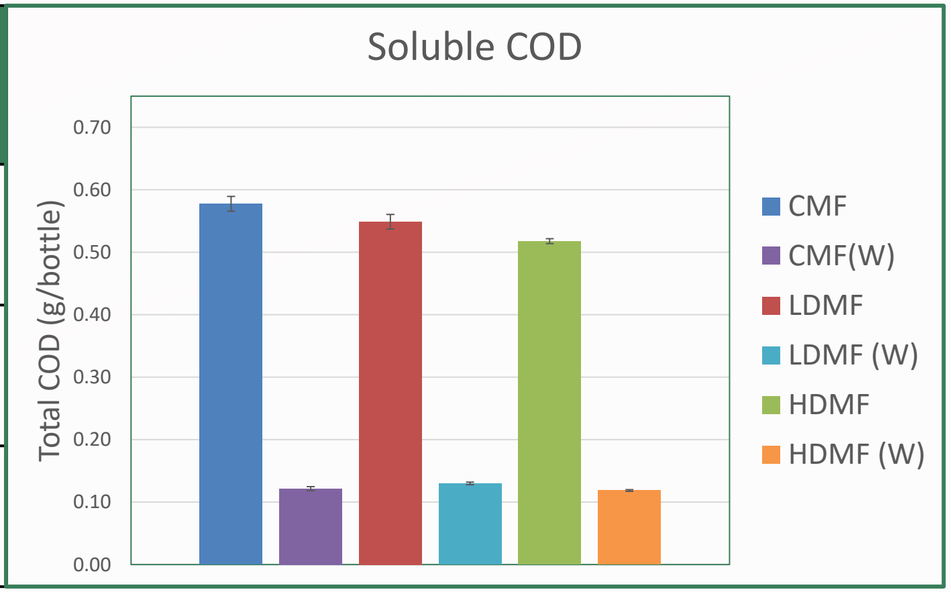
Seed is the inoculant from laboratory anaerobic digestor, D/P is a substrate control fed a mixture of dextrin and peptone, CMF, LDMF, and HDMF stand for Control, Low Dose, and High Dose for the medium forage series.

COD Balance

Medium Forage Series



Sample	Total Methane Produced (mmol)
Control	**25.4**
Low Dose	**26.0**
High Dose	**24.9**



CMF, LDMF, and HDMF stand for Control, Low Dose, and High Dose for the medium forage series. (W) Indicates the data was from the BMP bottle waste at the end of digestion

Conclusion

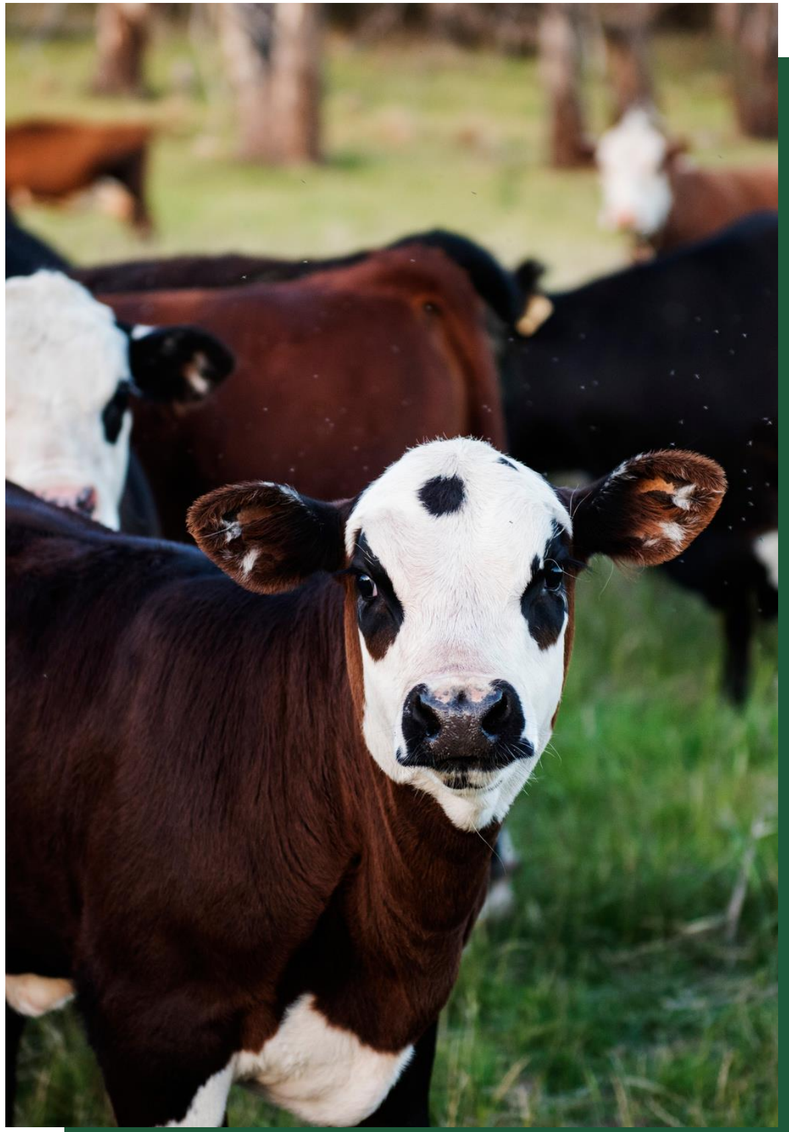
Will open systems emit more or less CH_4?

Unlikely, but future work needed.

Will anaerobic digester performance be impacted by inhibitors?

No

- Cumulative methane yield was within 2.4% across treatment groups
- Soluble COD consumption across the different treatment groups remained the same



Future Work

01 - DNA Sequencing

16s RNA genetic diversity
to compare microbial populations

02 - VFA Analysis

High Performance Liquid Chromatography (HPLC) will be used to identify VFAs

03 - “Live” Manure Digestors

Separate from the BMP series, larger digestors will be fed in a batch system with fresh manure with additions of Asparagopsis and bromoform standard to observe potential changes

Our Team

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Questions

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Resources

EPA (2023) Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2021. U.S. Environmental Protection Agency, EPA 430-R-23-002. https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks-1990-2021.

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