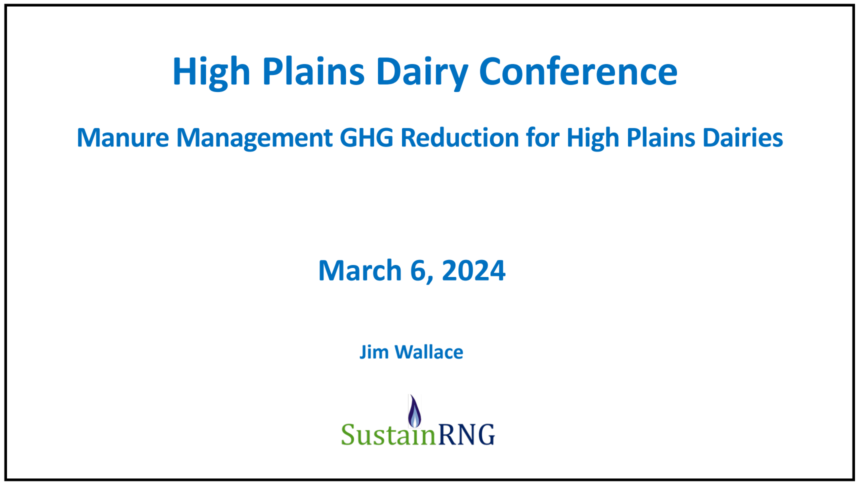


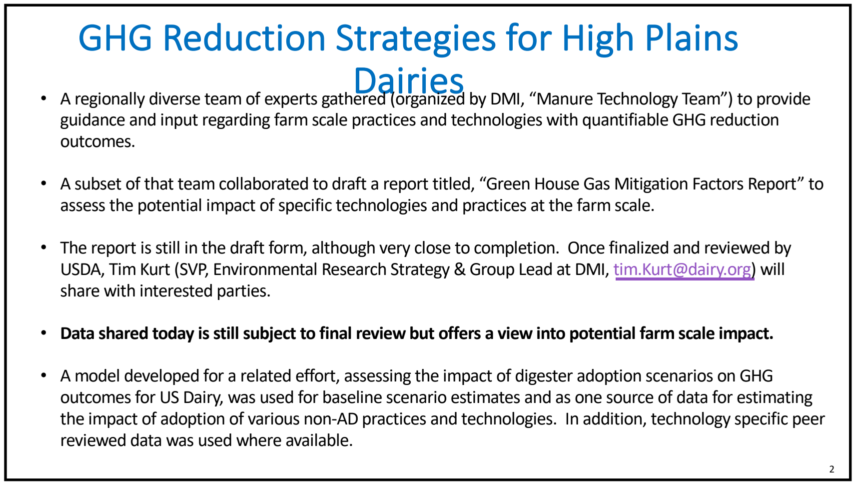
High Plains Dairy Conference

Manure Management GHG Reduction for High Plains Dairies

March 6, 2024

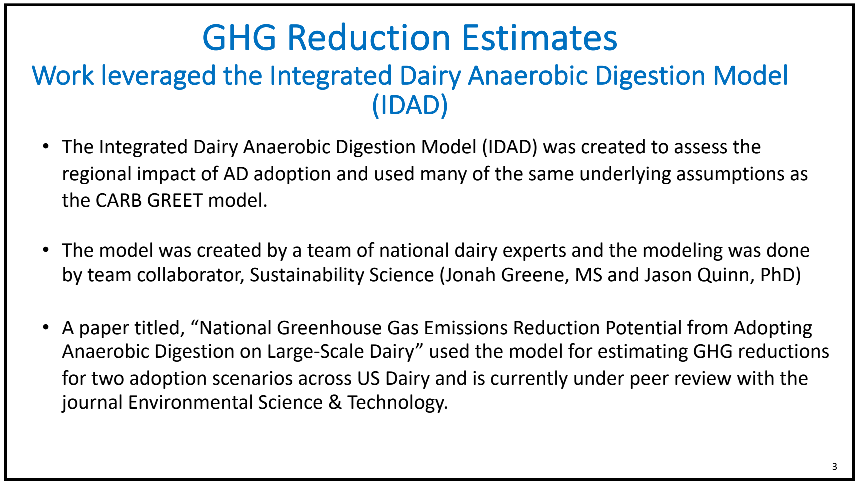
Jim Wallace

SustainRNG



GHG Reduction Strategies for High Plains Dairies

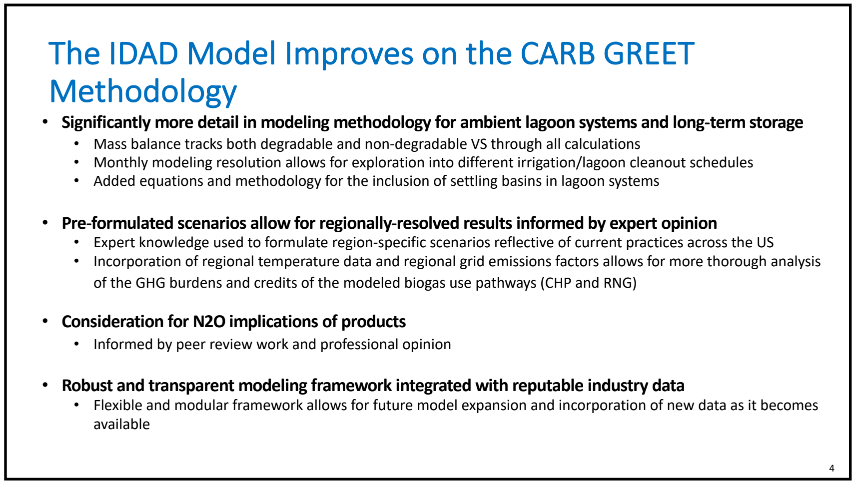
- A regionally diverse team of experts gathered (organized by DMI, "Manure Technology Team") to provide guidance and input regarding farm scale practices and technologies with quantifiable GHG reduction outcomes.
- A subset of that team collaborated to draft a report titled, "Green House Gas Mitigation Factors Report" to assess the potential impact of specific technologies and practices at the farm scale.
- The report is still in the draft form, although very close to completion. Once finalized and reviewed by USDA, Tim Kurt (SVP, Environmental Research Strategy & Group Lead at DMI, tim.Kurt@dairy.org) will share with interested parties.
- **Data shared today is still subject to final review but offers a view into potential farm scale impact.**
- A model developed for a related effort, assessing the impact of digester adoption scenarios on GHG outcomes for US Dairy, was used for baseline scenario estimates and as one source of data for estimating the impact of adoption of various non-AD practices and technologies. In addition, technology specific peer reviewed data was used where available.



GHG Reduction Estimates

Work leveraged the Integrated Dairy Anaerobic Digestion Model (IDAD)

- The Integrated Dairy Anaerobic Digestion Model (IDAD) was created to assess the regional impact of AD adoption and used many of the same underlying assumptions as the CARB GREET model.
- The model was created by a team of national dairy experts and the modeling was done by team collaborator, Sustainability Science (Jonah Greene, MS and Jason Quinn, PhD)
- A paper titled, "National Greenhouse Gas Emissions Reduction Potential from Adopting Anaerobic Digestion on Large-Scale Dairy" used the model for estimating GHG reductions for two adoption scenarios across US Dairy and is currently under peer review with the journal Environmental Science & Technology.



The IDAD Model Improves on the CARB GREET Methodology

- **Significantly more detail in modeling methodology for ambient lagoon systems and long-term storage**
  - Mass balance tracks both degradable and non-degradable VS through all calculations
  - Monthly modeling resolution allows for exploration into different irrigation/lagoon cleanout schedules
  - Added equations and methodology for the inclusion of settling basins in lagoon systems
- **Pre-formulated scenarios allow for regionally-resolved results informed by expert opinion**
  - Expert knowledge used to formulate region-specific scenarios reflective of current practices across the US
  - Incorporation of regional temperature data and regional grid emissions factors allows for more thorough analysis of the GHG burdens and credits of the modeled biogas use pathways (CHP and RNG)
- **Consideration for N2O implications of products**
  - Informed by peer review work and professional opinion
- **Robust and transparent modeling framework integrated with reputable industry data**
  - Flexible and modular framework allows for future model expansion and incorporation of new data as it becomes available

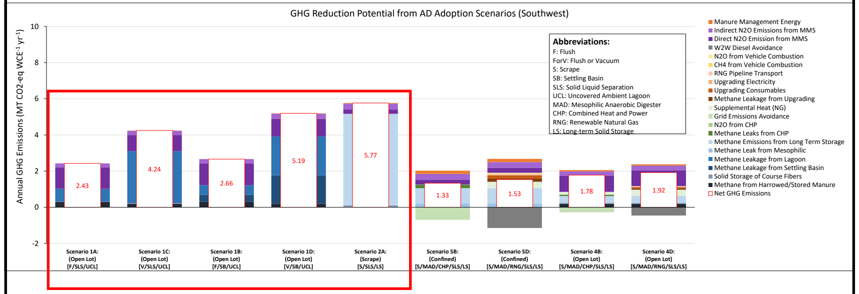
Manure Technology Team

Supported Development of the IDAD Model, Industry AD Projections and Implications of Non-AD Technologies at the Farm Scale

Name	Affiliation	Email
April B. Leytem	USDA ARS, Kimberly, ID	april.leytem@usda.gov
Robert B. Williams	California Biomass Collaborative, University of California, Davis	rbwilliams@ucdavis.edu
Stephen R. Kaffka	California Biomass Collaborative, University of California, Davis	srkaffka@ucdavis.edu
C. Alan Rotz	USDA ARS, University Park, PA	al.rotz@usda.gov
Mark Stoermann	Newtrient, LLC	mstoerm@newtrient.com
Robert Hagevoort	New Mexico State University	dairydoc@nmsu.edu
James M. Wallace	Sustain RNG, LLC	jim.wallace@jwallaceconsult.com

Practices and Technologies	
Categories for GHG Assessment	**Practices and Technologies to Reduce Manure Emissions**
Biogas collection and management	Anaerobic Digestion
	Cover manure storage and flare
Manure storage/treatment manure handling	Acidification
	Convert flush to scrape. A key element of this conversion is the elimination of liquid storage
Solid liquid separation	Coarse fiber separation (could be screw press, slope screen or rotary drum)
Advanced treatment	Chemical flocculation followed by dewatering
	centrifugation
	Evaporation
	Vermifiltration
Composting	Windrow (conversion from liquid manure storage to composting such that all manure managed in the solid form)

IDAD Model Results for the Southwest



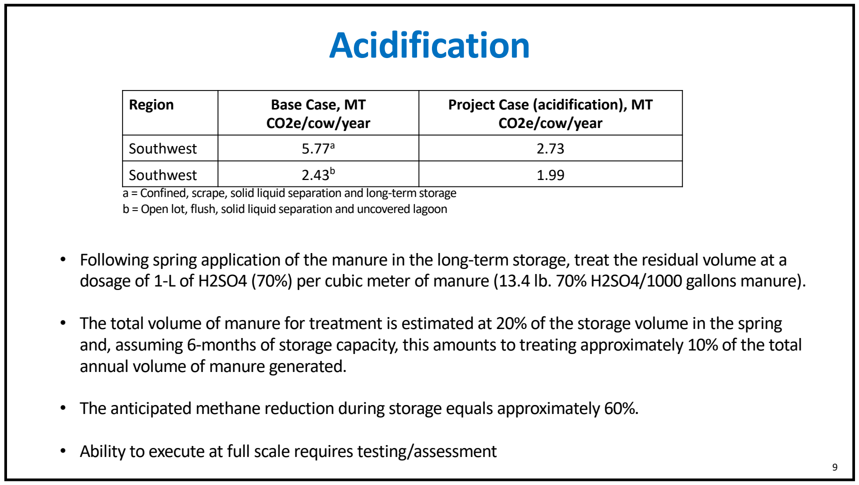
Please this note work is in review and not yet publicly available

Cover Manure Storage and Flare

Region	**Base Case, MT CO2e/cow/year**		**Project Case (cover manure storage and flare), MT CO2e/cow/year**
Southwest	5.77[a]		1.49
Southwest	2.43[b]	2.66[c]	1.85

a = Confined, scape, solid liquid separation and long-term storage
b = Open lot (assumption that 10% of manure managed as a liquid), flush, solid liquid separation and uncovered lagoon
c = Open lot (assumption that 10% of manure managed as a liquid), flush, settling basin and uncovered lagoon

- Objective of "cap and flare" is to capture CH4 and oxidize it via combustion to CO2, significantly lowering its GHG impact.
- Assumes solid liquid separation is either existing or integrated with practice.
- Analysis assumes the flare is operational 81% of the time (Wightman and Woodbury, 2016).

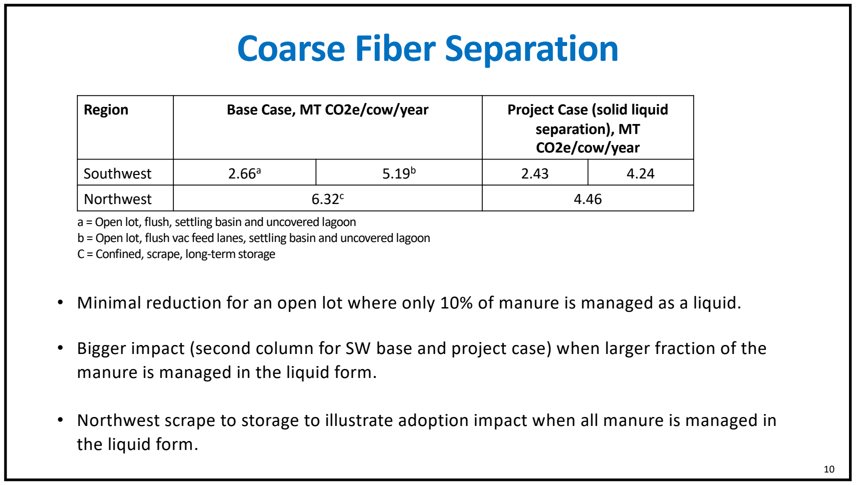


Acidification

Region	Base Case, MT CO2e/cow/year	Project Case (acidification), MT CO2e/cow/year
Southwest	5.77[a]	2.73
Southwest	2.43[b]	1.99

a = Confined, scrape, solid liquid separation and long-term storage
b = Open lot, flush, solid liquid separation and uncovered lagoon

- Following spring application of the manure in the long-term storage, treat the residual volume at a dosage of 1-L of H_2SO_4 (70%) per cubic meter of manure (13.4 lb. 70% H_2SO_4/1000 gallons manure).
- The total volume of manure for treatment is estimated at 20% of the storage volume in the spring and, assuming 6-months of storage capacity, this amounts to treating approximately 10% of the total annual volume of manure generated.
- The anticipated methane reduction during storage equals approximately 60%.
- Ability to execute at full scale requires testing/assessment

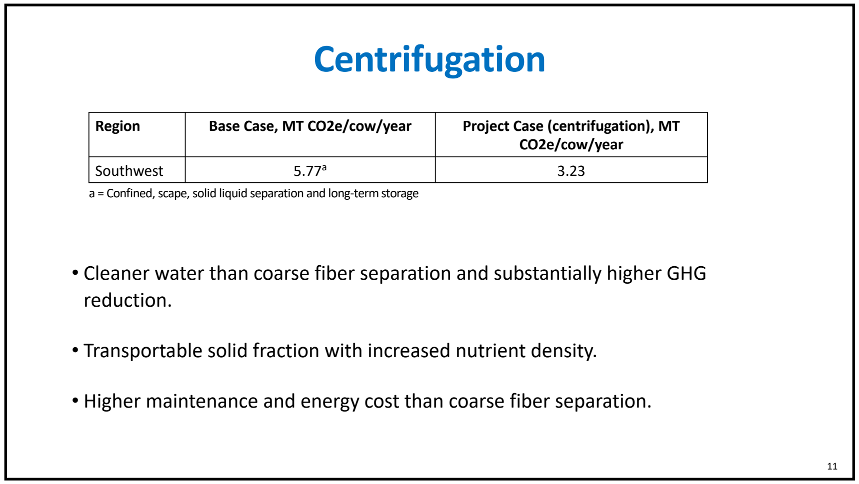


Coarse Fiber Separation

Region	Base Case, MT CO2e/cow/year		Project Case (solid liquid separation), MT CO2e/cow/year	
Southwest	2.66[a]	5.19[b]	2.43	4.24
Northwest	6.32[c]		4.46	

a = Open lot, flush, settling basin and uncovered lagoon
b = Open lot, flush vac feed lanes, settling basin and uncovered lagoon
C = Confined, scrape, long-term storage

- Minimal reduction for an open lot where only 10% of manure is managed as a liquid.
- Bigger impact (second column for SW base and project case) when larger fraction of the manure is managed in the liquid form.
- Northwest scrape to storage to illustrate adoption impact when all manure is managed in the liquid form.

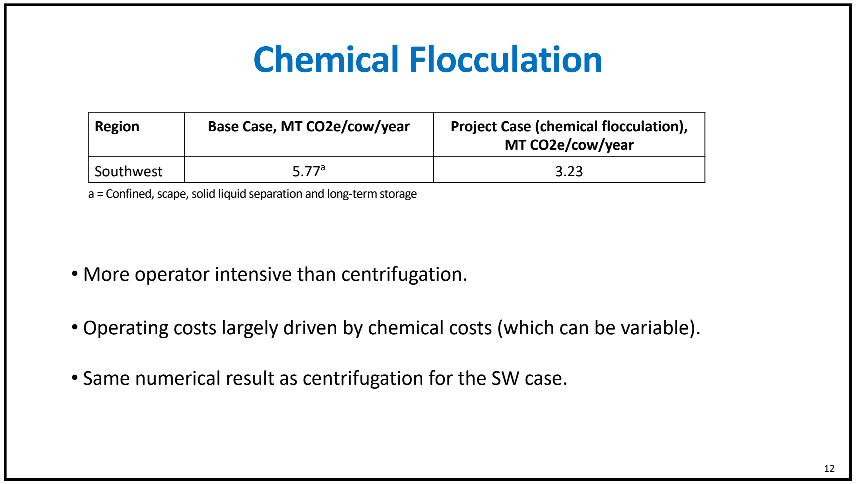


Centrifugation

Region	Base Case, MT CO2e/cow/year	Project Case (centrifugation), MT CO2e/cow/year
Southwest	5.77[a]	3.23

a = Confined, scape, solid liquid separation and long-term storage

- Cleaner water than coarse fiber separation and substantially higher GHG reduction.
- Transportable solid fraction with increased nutrient density.
- Higher maintenance and energy cost than coarse fiber separation.

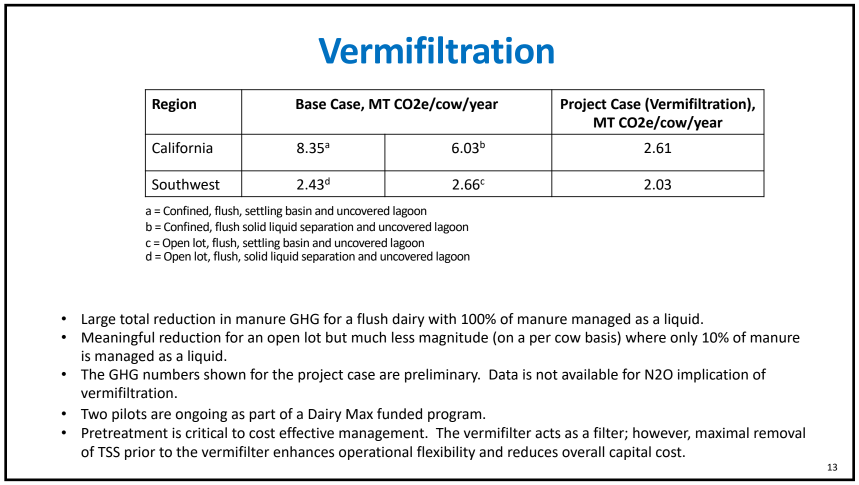


Chemical Flocculation

Region	Base Case, MT CO2e/cow/year	Project Case (chemical flocculation), MT CO2e/cow/year
Southwest	5.77[a]	3.23

a = Confined, scape, solid liquid separation and long-term storage

- More operator intensive than centrifugation.
- Operating costs largely driven by chemical costs (which can be variable).
- Same numerical result as centrifugation for the SW case.

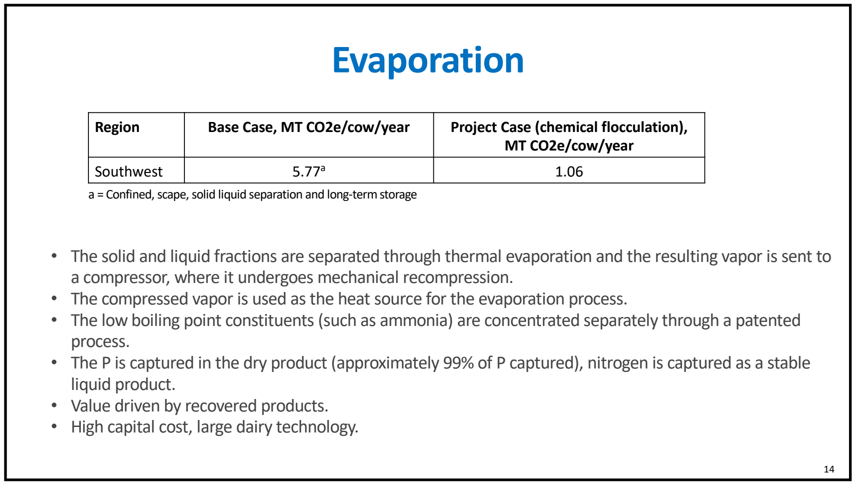


Vermifiltration

Region	Base Case, MT CO2e/cow/year		Project Case (Vermifiltration), MT CO2e/cow/year
California	8.35[a]	6.03[b]	2.61
Southwest	2.43[d]	2.66[c]	2.03

a = Confined, flush, settling basin and uncovered lagoon
b = Confined, flush solid liquid separation and uncovered lagoon
c = Open lot, flush, settling basin and uncovered lagoon
d = Open lot, flush, solid liquid separation and uncovered lagoon

- Large total reduction in manure GHG for a flush dairy with 100% of manure managed as a liquid.
- Meaningful reduction for an open lot but much less magnitude (on a per cow basis) where only 10% of manure is managed as a liquid.
- The GHG numbers shown for the project case are preliminary. Data is not available for N2O implication of vermifiltration.
- Two pilots are ongoing as part of a Dairy Max funded program.
- Pretreatment is critical to cost effective management. The vermifilter acts as a filter; however, maximal removal of TSS prior to the vermifilter enhances operational flexibility and reduces overall capital cost.



Evaporation

Region	Base Case, MT CO2e/cow/year	Project Case (chemical flocculation), MT CO2e/cow/year
Southwest	5.77[a]	1.06

a = Confined, scape, solid liquid separation and long-term storage

- The solid and liquid fractions are separated through thermal evaporation and the resulting vapor is sent to a compressor, where it undergoes mechanical recompression.
- The compressed vapor is used as the heat source for the evaporation process.
- The low boiling point constituents (such as ammonia) are concentrated separately through a patented process.
- The P is captured in the dry product (approximately 99% of P captured), nitrogen is captured as a stable liquid product.
- Value driven by recovered products.
- High capital cost, large dairy technology.

THANK YOU