Livestock Methane Emissions, Biogas Systems, Carbon Sequestration and Dairy Farm Viability

for the Northeast Climate Hub Partners Meeting
March 14, 2018

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Outline

1. Scope of livestock methane emissions
2. Digesters, mitigation, and adaptation
3. Carbon sequestration
4. How to talk about it and whom to engage

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Farming in Vermont: Land use and dairy

- 80% forested
- Dairy majority of agriculture
  - ~75% of open land is dairy
  - 70% of ag sales, $1.3 billion annually are dairy
- Steady trend: fewer dairy farms, slightly fewer cows (=consolidation).
- New trend: many more processors (cheese, yogurt, etc.).

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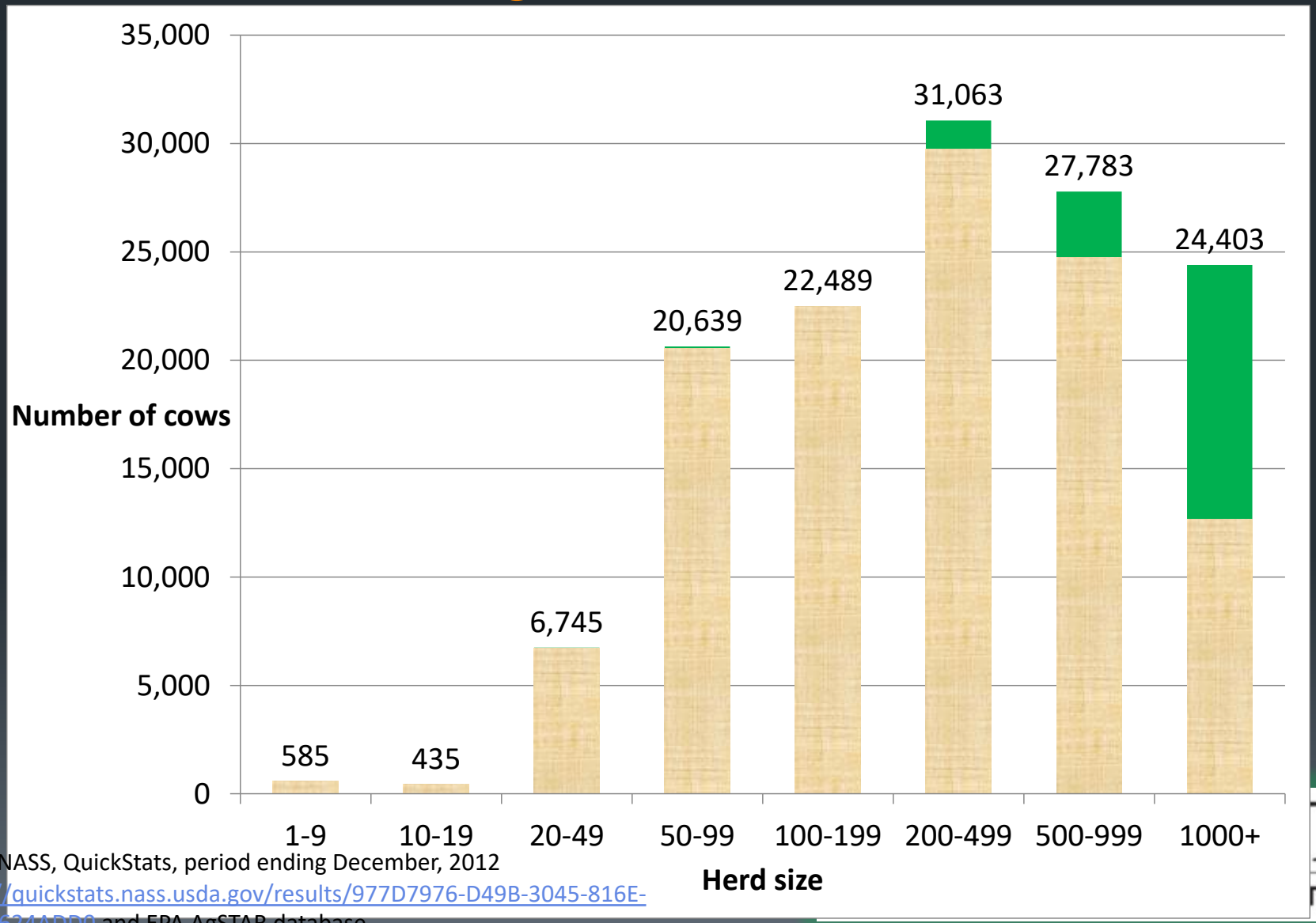
Vermont: dairy herd size (134,000) and digested manure



USDA NASS, QuickStats, period ending December, 2012 https://quickstats.nass.usda.gov/results/977D7976-D49B-3045-816E-332B8624ADD0 and EPA AgSTAR database

Agricultural GHG

- VT:
  - Ruminants! 6% of VT GHG is enteric (eructation and flatus! I.e. front and rear)
  - 2% soils (N2O)
  - 2% manure
- How to mitigate?

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Dairy farm viability

- Sustainable intensification, or…
- Lower inputs and outputs and adequate net revenue.
  - Raw milk, organic, sometimes value-added (cheese, yogurt) and sometimes diversification (agritourism, farmstand).
- America's cheap food system
  - Earl Butz in "King Corn": we won.

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Enteric mitigation and adaptation trade-offs

- Tweak diet to emit less CH4… and…
  - Higher production per GHG, ergo less grass-based agriculture? More acres in corn = less resilient land usage?
  - Differences in milk?
  - Less enteric = more volatile solids in manure?

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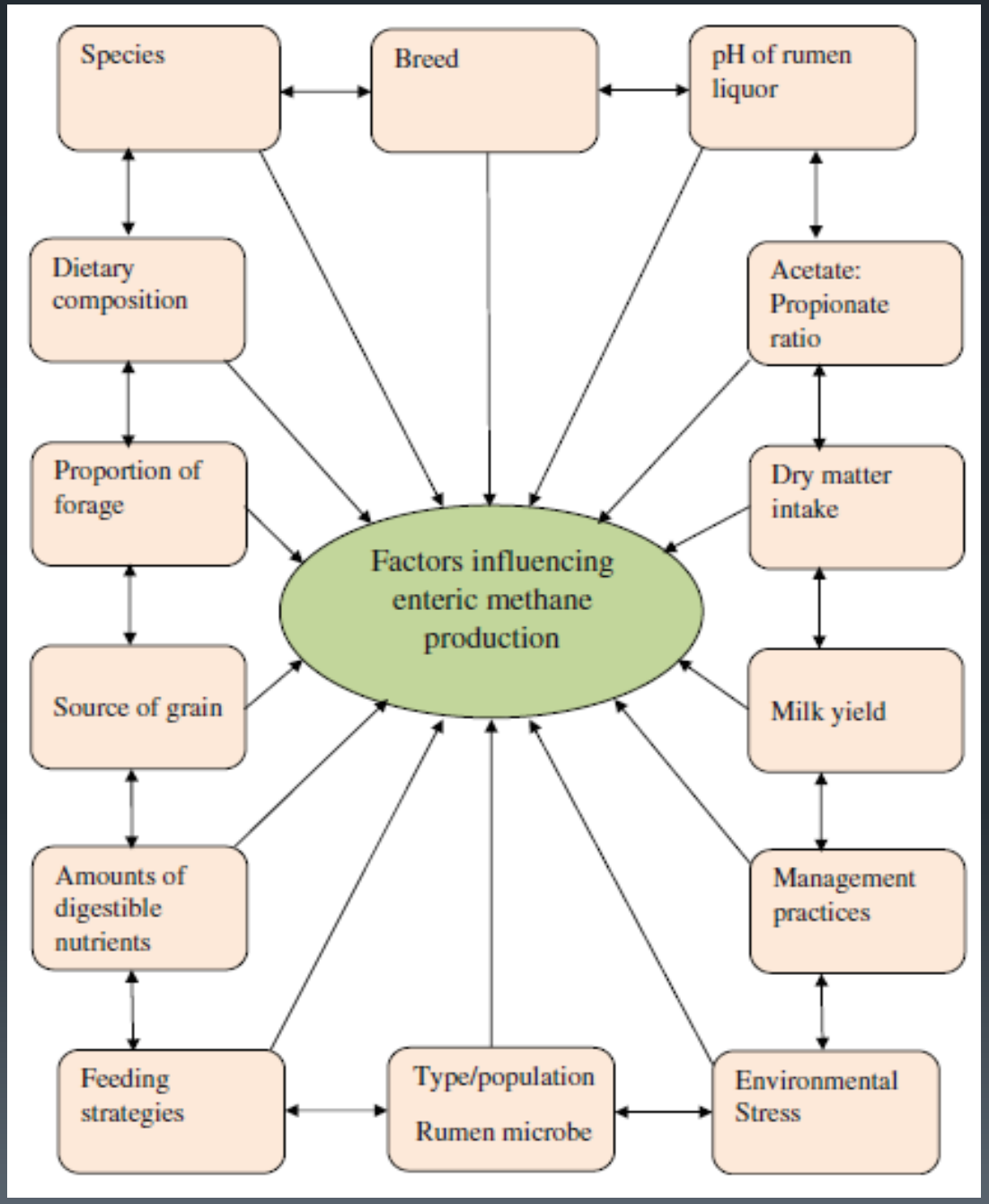

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Digesters

- Converting methane ("biogas") to CO2 by combustion acheives the mitigation. "Bonus" mitigation if you make electricity and/or use the heat.

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USDA United States Department of Agriculture

EPA United States Environmental Protection Agency

American biogas Council

Organic material is delivered to the digester system

This may include animal manure, food scraps, agricultural residues, or wastewater solids.

Co-products may be returned for livestock, agricultural and gardening uses.

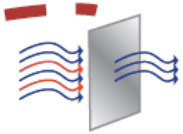
Some biogas can be used to heat the digester.

BIOGAS

DIGESTED MATERIAL

Organic material is broken down in a digester

The digester uses a natural biological process under controlled conditions to break down organic material into products for beneficial use or disposal.



Raw biogas is processed

Typically, water, carbon dioxide and other trace compounds are removed, depending on the end use, leaving mostly methane.

Processed biogas is distributed and used

The gas may be used to produce heat, electricity, vehicle fuel or injected into natural gas pipelines.

SOLIDS

LIQUIDS

Liquids and solids may be separated.

Digested material is processed and distributed

Solids and liquids from the digester may be used to produce marketable products, like fertilizer, compost, soil amendments or animal bedding.

organic material

Organic materials are the "input" or "feedstock" for a biogas system. Organic materials will digest more readily than some others. Restaurant fats, oils and grease; animal manures; wastewater solids; food scraps; and by-products from food and beverage production are some of the most commonly-digested materials. A single anaerobic digester may be built for a single material or a combination of them.

the digester

An anaerobic digester is one or more airtight tanks that can be equipped for mixing and warming organic material. Naturally occurring microorganisms thrive in the zero-oxygen environment and break down (digest) organic matter into usable products such as biogas and digested materials. The system will continuously produce biogas and digested material as long as the supply of organic material is continuous, and the microorganisms inside the system remain alive.

biogas processing

Biogas is mostly methane, the primary component of natural gas, and carbon dioxide, plus water vapor, and other trace compounds (e.g. siloxanes and hydrogen sulfide). Biogas can replace natural gas in almost any application, but first it must be processed to remove non-methane compounds. The level of processing varies depending on the final application.

biogas distribution

Processed biogas, often called "biomethane" or "renewable natural gas," can be used the same way you use fossil natural gas: to produce heat, electricity, or vehicle fuel, or to inject into natural gas pipelines. The decision to choose one use over another is largely driven by local markets.

digested material

In addition to biogas, digesters produce solid and liquid digested material, containing valuable nutrients (nitrogen, phosphorus and potassium) and organic carbon. Typically, raw digested material, or "digestate," is processed into a wide variety of products like fertilizer, compost, soil amendments, or animal bedding, depending on the initial feedstock and local markets. These "co-products" can be sold to agricultural, commercial and residential customers.

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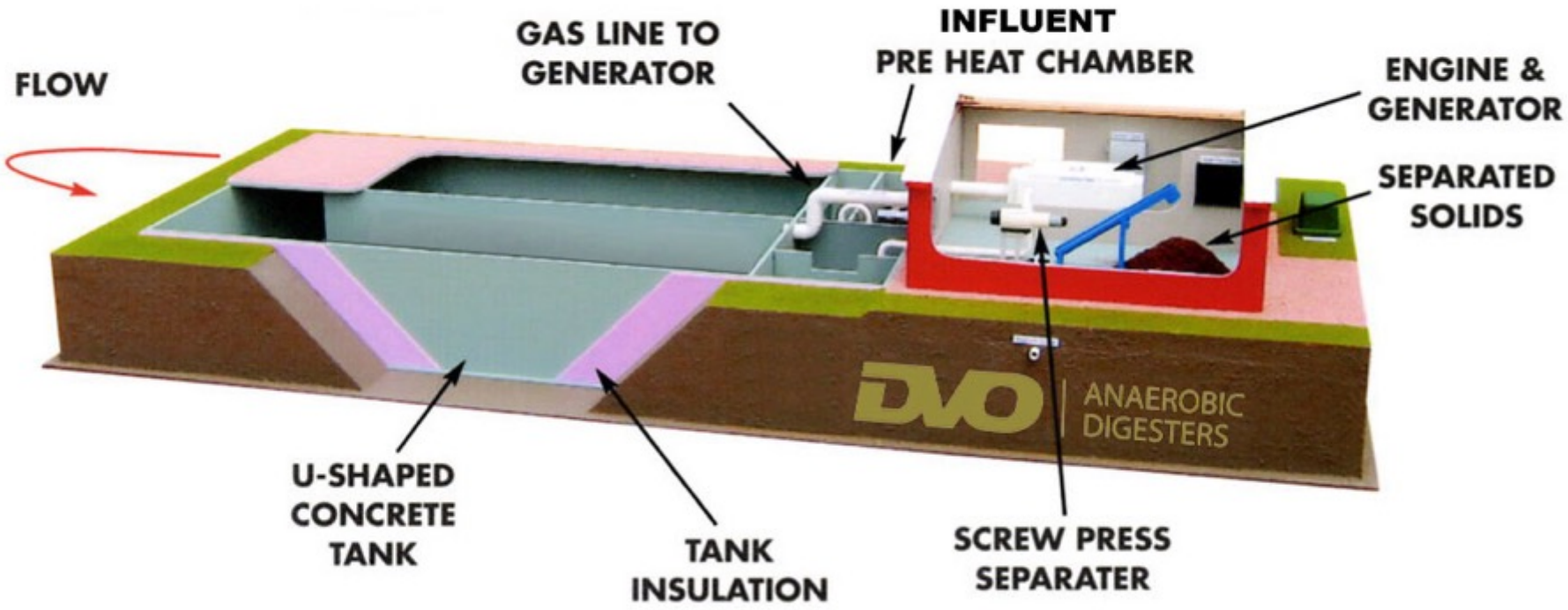

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VTC digester
Complete-mix with hydrolysis pre-treatment tank

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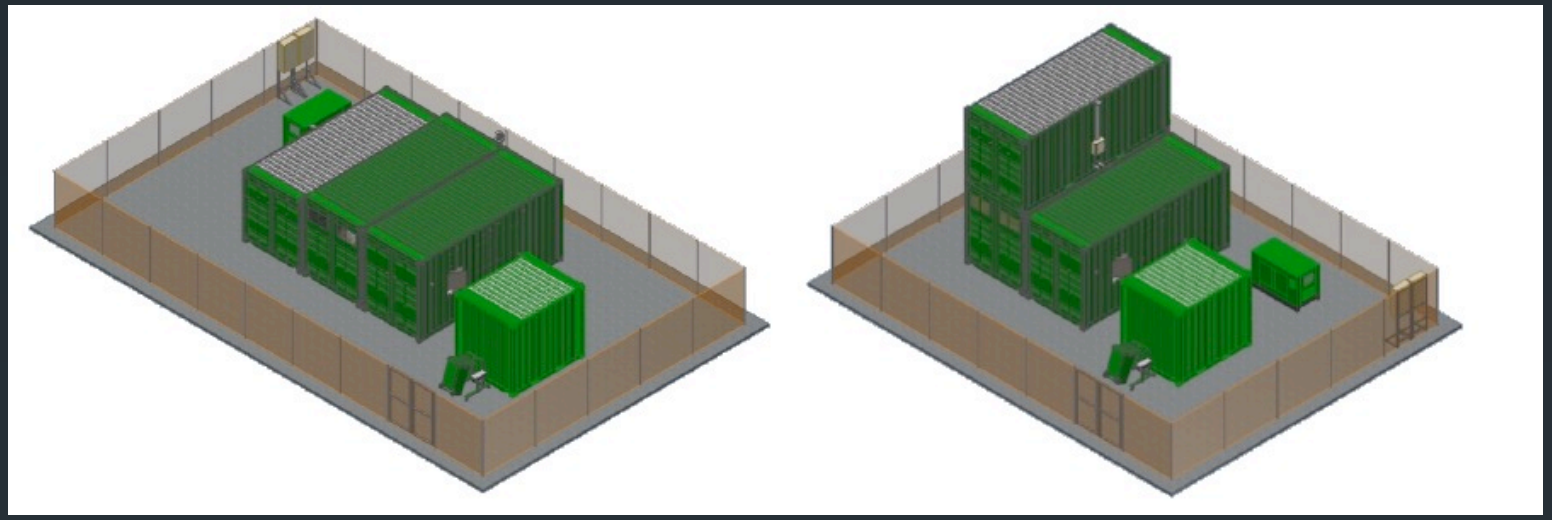
Emerging technology: small digesters



1,000 lbs/day, 8 kW

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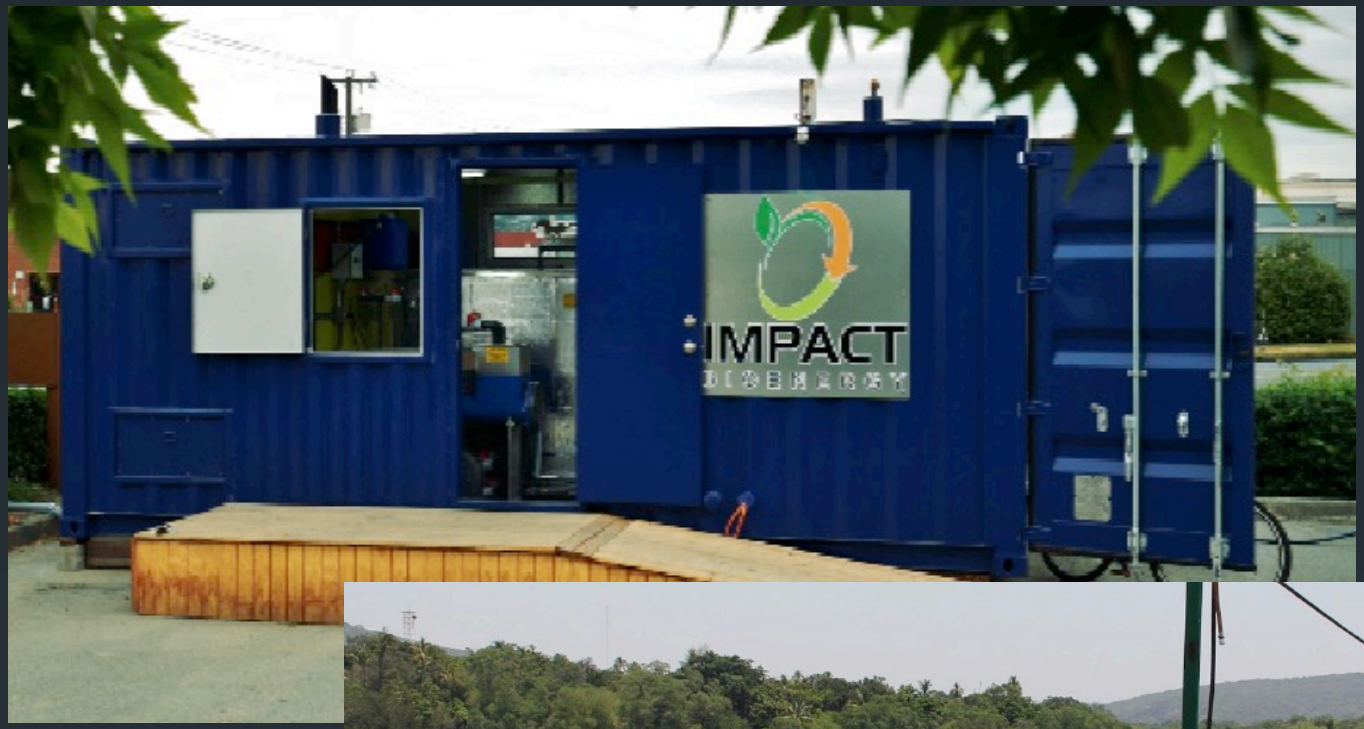
IMPACT
BIOENERGY



50-150 cows?

Digesters, mitigation, and adaptation

- Digesters tend to enable practices that improve water quality.
  - All VT projects have solids separators and use the solids for bedding. Some phosphorus stays with the solids.
  - Remaining slurry 1-2% solids instead of 8-10%
  - Draglining and/or injection and better timing
  - Less phosphorus means more N can be applied without overapplying P.

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Carbon sequestration in soils

- International, US, and Vermont discussion
- Biochar
- International
  - Paris UNFCC “Four per thousand” initiative
  - Increasing recognition of soil dynamics and potential for sequestration

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Sequestration, US

- EPA inventory starting to account for sequestration.
- Popular understanding
  - Paul Hawken's "Drawdown", ranking strategies

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Sequestration, VT

- Vermont Climate Change Action Commission
  - Executive order of Governor Scott
  - Aiming for legislation-ready recommendations on climate change
  - Many tracks (EVs, carbon taxes, grid modernization, etc.)
  - One track: ag and forestry sequestration

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Agricultural (soil) sequestration -- Issues

- Yes, sequestration, ***and***
  - No increase in soil GHG emissions from N2O (300 x CO2!)
  - Permanent
  - Enhances profitability
  - Presented in acceptable terms (how do we talk about this??)

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Agricultural (soil) sequestration -- Solutions

- N20: soil science
- Permanence
  - Admit that it's an issue!
  - Borrow and adapt tools/rules from forestry
  - E.g. annuitize, penalize, hold in trust
- Profitability and talking about it
  - Soil health, soil retention
  - Getting credits? Not yet… or?
    - Sufficient to make it worthwhile?

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Biochar

- Between charcoal an activated carbon
  - Solves permanence issue
  - Fits into 4 per 1000
  - Powerful drawdown, especially if heat byproduct is used.
  - Problem: solves too many problems. Too many usages and claims!! No standards, little data.
- Needed: field trials with and without manure.
  - Cost versus benefit
  - Effect on P and N behavior
  - Water retention

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How to talk about carbon sequestration and how it happens

- Soil health
- Farm viability
- Diffusion of Innovation (hybrid corn!)
- Climate-smart agriculture

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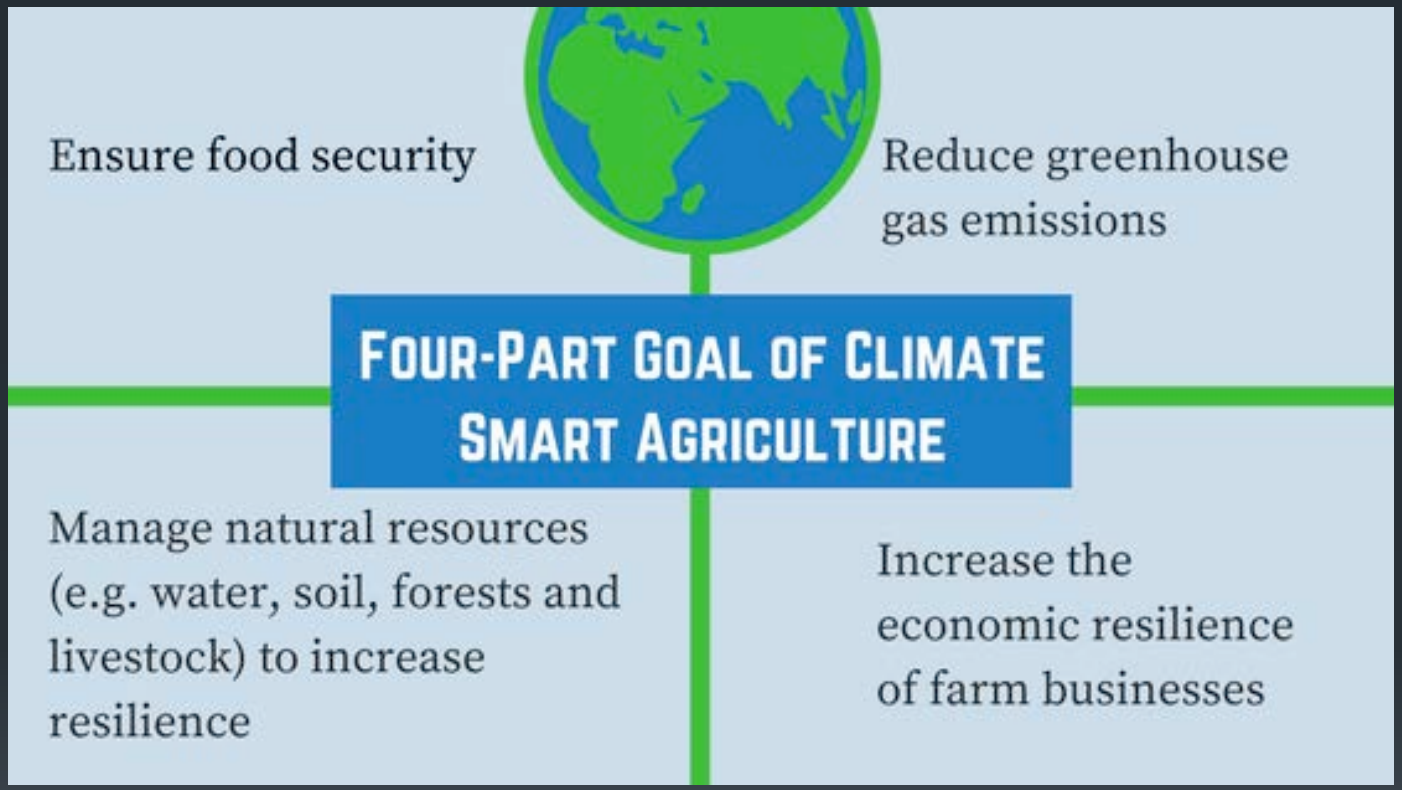

Dot exercise, for quadrants:
Five for what matters to you.
Five for how you talk about it.

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