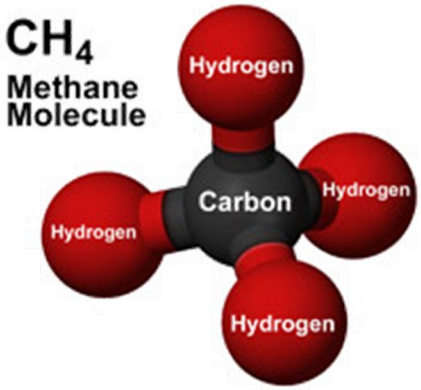
Agricultural emissions and possible intervention points



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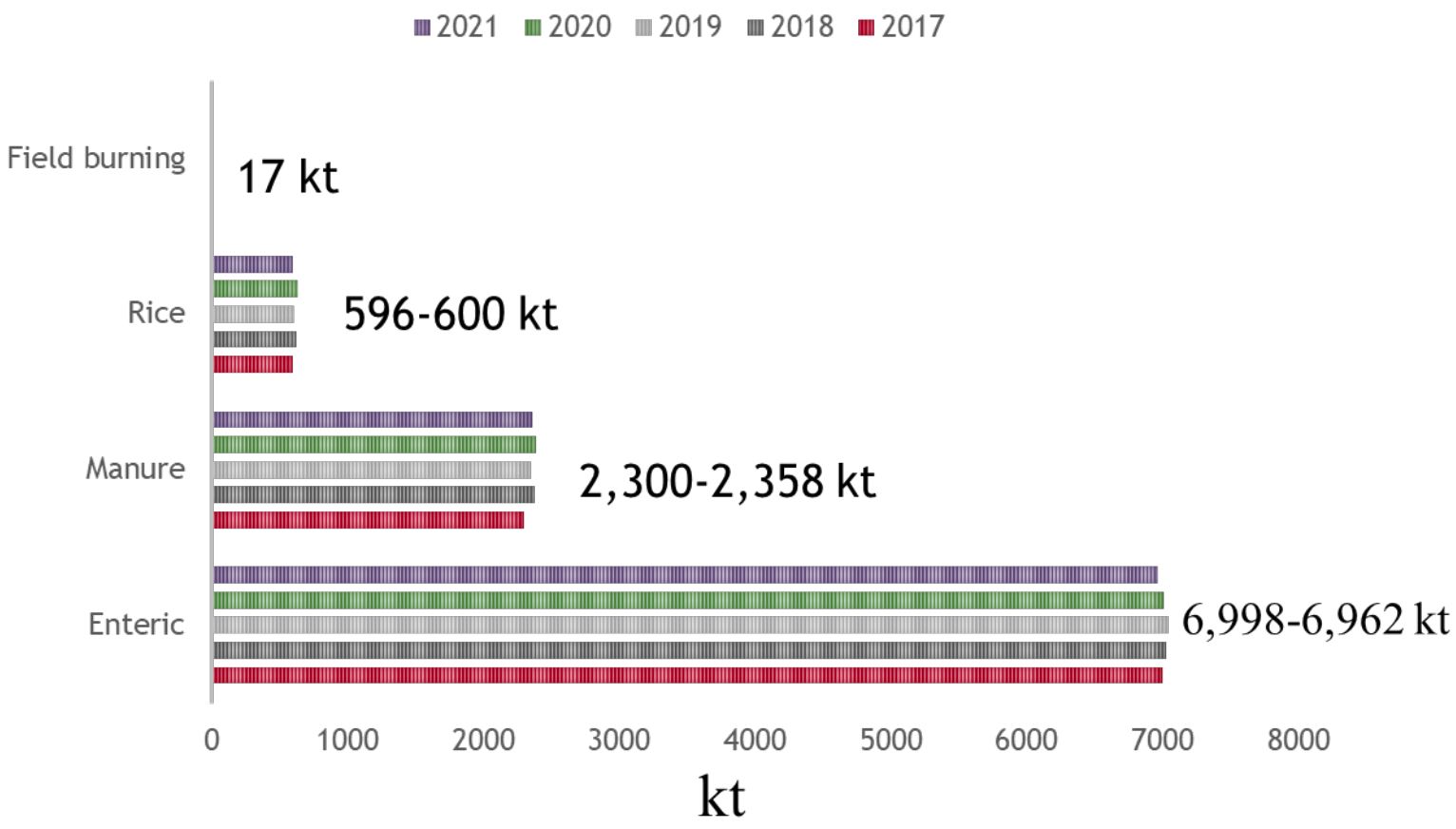


US EPA, Inventory of U.S. GHG Emissions and Sinks: 1990-2021

Field Residue Field Burning

A field burn north of Grangeville, ID. David Rauzi. 2019

Some regulation:
Local air quality boards

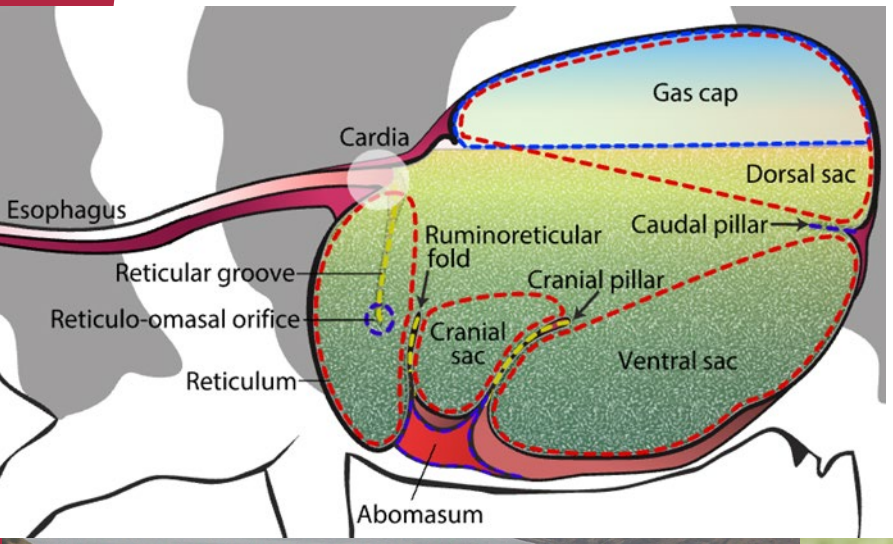
Challenge:
Diffuse sources

Rice cultivation

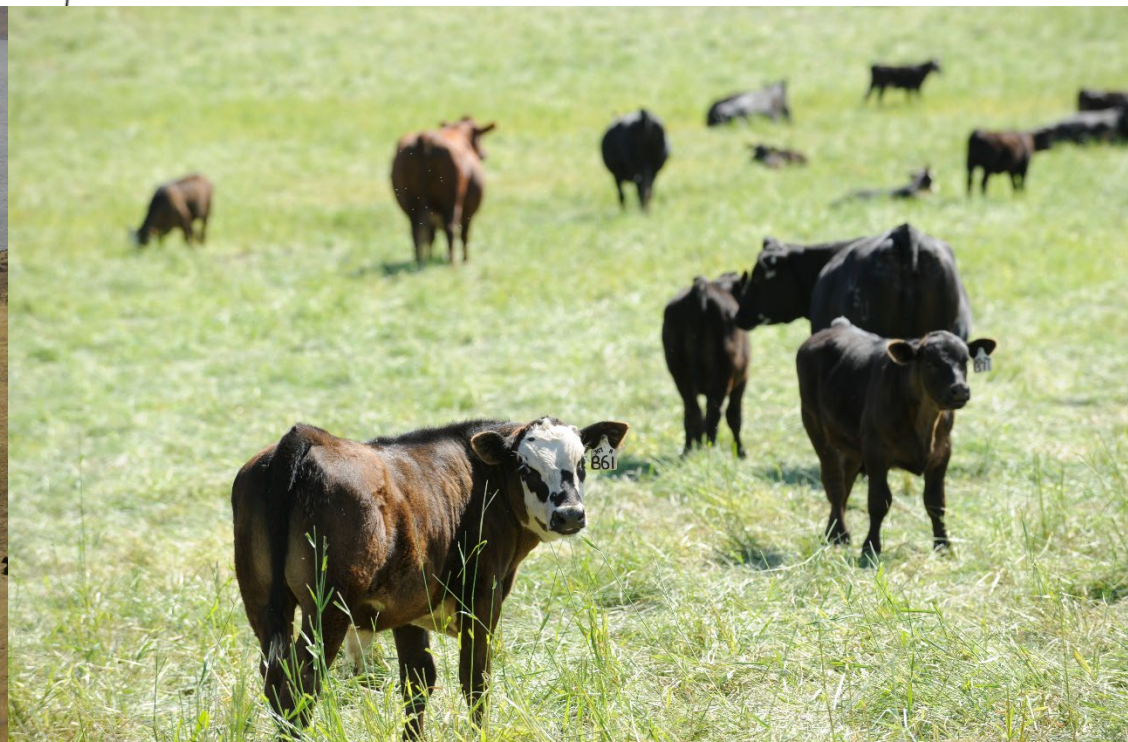
https://www.ers.usda.gov/publications/pub-details/?pubid=90925

Current work into management practices to reduce CH4 emissions

Enteric emissions ---point source and diffuse source



Needed: on-farm measurement capability (user friendly) to validate reductions



Why are Archea Good/Bad?

Chemical reactions

Prevent

- Excess H_2 accumulation
- Subsequent decrease ruminal pH

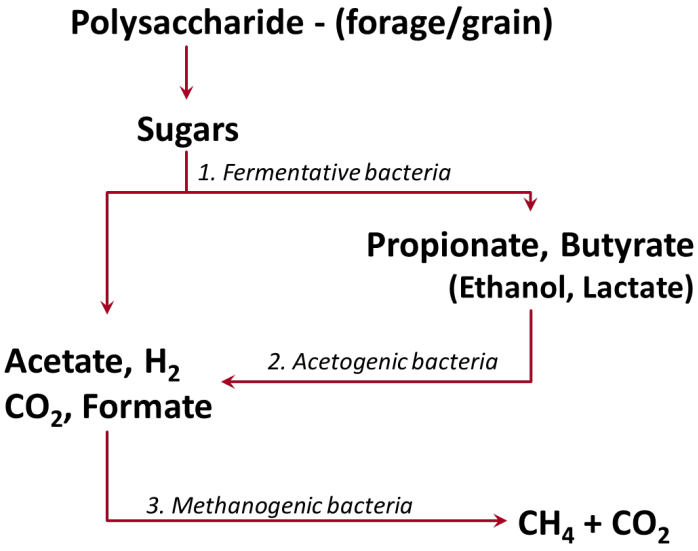
Reduction reactions can continue

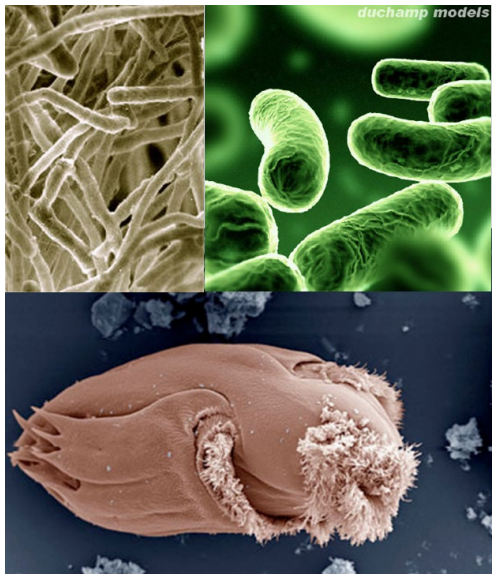
For the animal…

Carbon lost as CH_4 = loss of energy

Quest…

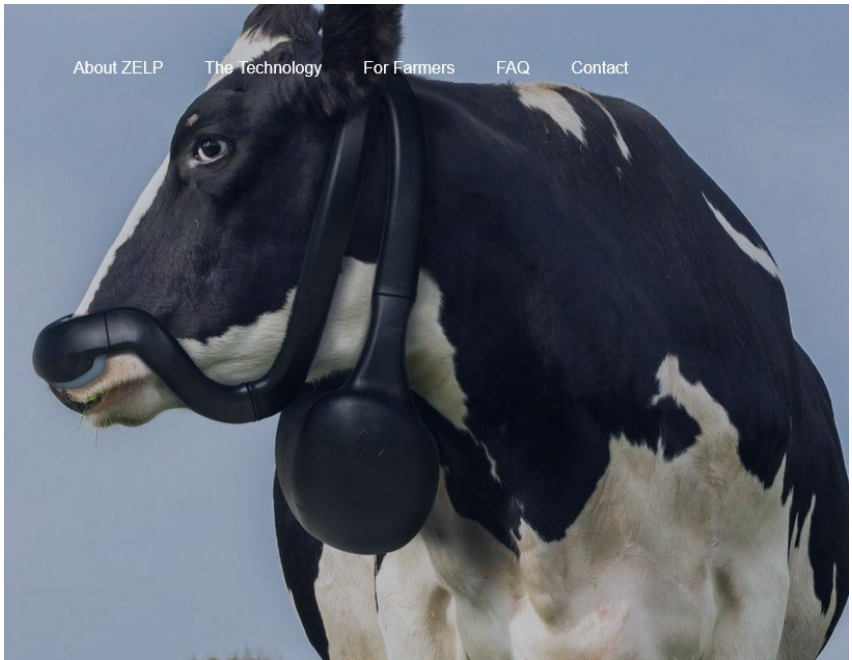
Find an alternative H_2 sink….





Zelp (Zero Emissions Livestock Project)

- Currently in development (web says available in 2023)
- Worn constantly--works for 4 yrs
- Oxidizes 50-60% of the CH_4 and releases CO_2 and H_2O
- Subscription-based device (data for C-trading)
- Includes solar cell and thermoelectric generator
- Adding other sensors to increase value for producers
- Funding partners include: Cargill, Gates Foundation



https://www.zelp.co/the-technology-2/

Mitigation Strategies

- High starch diets
- Resistant starches
- High quality forages
- Eliminate nutrient deficiencies
- Productivity enhancers
- Bromoform
- Lipid supplementation
- CRISPR-rumen microbes
- Pellet forages
- Ionophore use
- Ionophore persistence
- Protozoa inhibitors
- Shift site of digestion
- Slow-release nitrate
- Vaccination
- Genetic selection

Ventilated barns

https://agromatic.net/agro-air-dynamics/

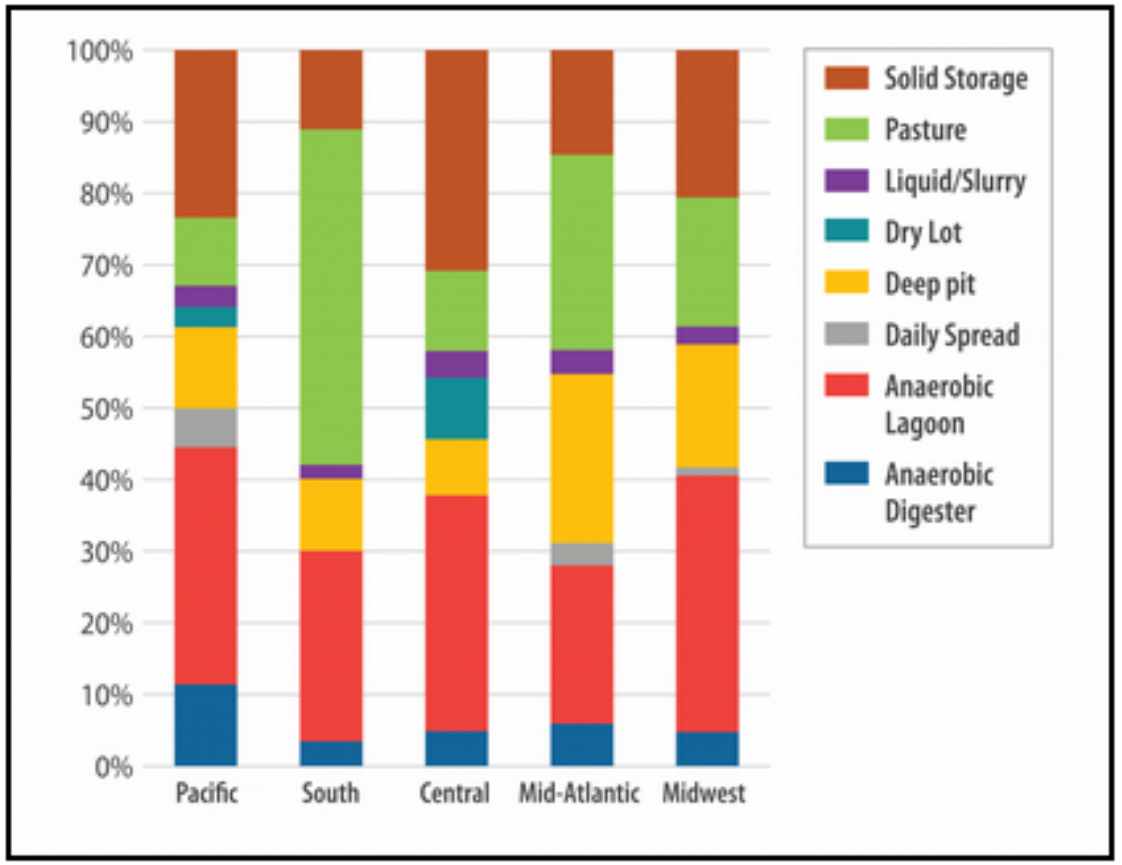
Figure 3: Cooling pads in cross ventilation compost barn

Potential:
Scrubbers/oxidizers on exhaust fans

https://www.munters.com/en/knowledgebank/articles-library/articles/cross-and-tunnel-ventilation/

Manure emissions

Figure 3. Manure Management Practices on Dairy Farms in the U.S., 2018



Source data: USDA Agricultural Resource Management Survey; U.S. EPA GHG Inventory of Greenhouse Gas Emissions and Sinks: 1990-2018

https://www.epa.gov/agstar/anaerobic-digestion-dairy-farms

Composting

- Piles or windrows
  - Volume reduction, heat
  - Can be applied to improve soil quality and fertility
  - Can be sold
  - Requires large areas for storage and operation – location must meet federal, state & local laws
  - Requires management - temperature & oxygen (turning)

Opportunity: Cover. Add pipe or flare or ventilated building. If clean enough, use a digester/bioreactor.
Problem: soil contamination

https://blog.midwestbiosystems.com/blog/bid/247395/Composting-Helps-Dairy-Farms-Cut-Costs-and-Increase-Efficiency

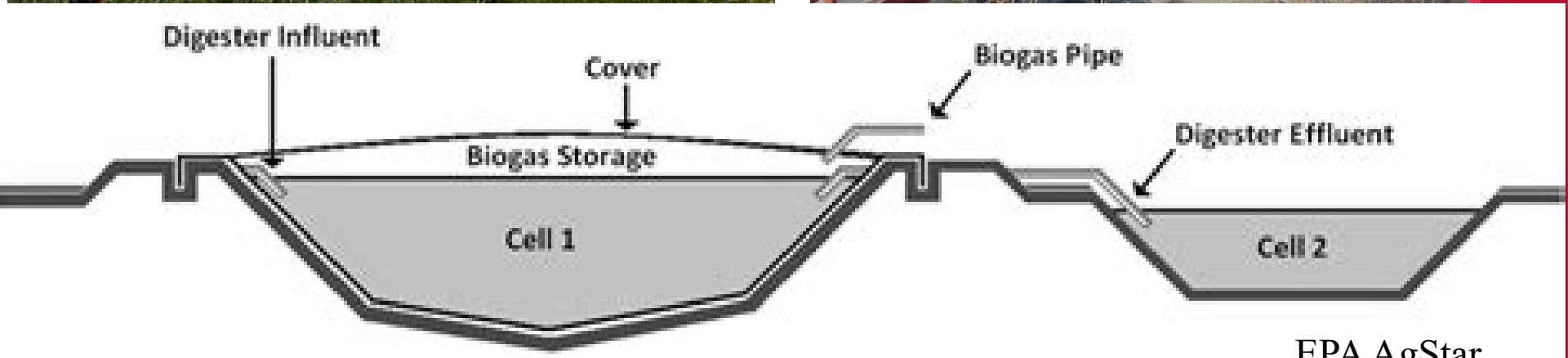
Stockpiling

- Temporary storage of < 180 days
- Formation of crust
- Inexpensive
- Requires less management
- Location must meet all federal, state, and local laws

Opportunity: Cover with pipe or flare or ventilated building or, if clean enough, use a digester/bioreactor.

Research need: bioreactor technologies

Lagoon Systems



EPA AgStar

Water treatment options

Vermiculture

Reduce CH_4 (aerobic)
BUT…..other issues may increase…

Challenges to reductions at these sources

Diffuse sources
- Animals
- Manure handling systems are farm specific

Focused sources
- Compost piles
- Stockpiles
- Covered lagoons
- Mechanically ventilated barns

Adoption
- Available technology
- Economics
- Monitoring instruments at farm scale

Final thoughts

1. Concern that reductions in emissions will not be achievable without impacting other pollutant species.
2. Safety concerns
3. Whole system approach should be applied to strategies.
4. Social sustainability

Thank you

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Potential of ZELP to Improve the Cargill Holistic Approach to Mitigate Enteric Methane Emissions

***Alexandre Budan*[1], *Yairy Roman Garcia*[2], *Paola Piantoni*[2], *David Humphries*[3], *Yan Sun*[2]** [1] Cargill Animal Nutrition West Europe, Yffiniac, France [2] Cargill Animal Nutrition and Health, Elk River, MN, USA [3] CEDAR, University of Reading Hall Farm, Church Lane, Arborfield Reading, United Kingdom

To support farmers to reduce methane emissions, Cargill implements a holistic approach including best farm management practices, feed nutrition and formulation, additives, and digital solutions. Prototypes of ZELP, a wearable digital device that can oxidize methane to carbon dioxide and water were evaluated in two preliminary trials to understand its effects on methane emissions, performance, and animal behavior. In Trial 1, four beef steers (462 kg of body weight) were adapted to respiration chambers, diet and ZELP. Chamber measurements of methane concentrations were obtained over four consecutive days on two separate weeks, where ZELP devices were fitted for two days or removed for two days each week in a crossover design. Methane production ranged from 24.3 to 30.4 g/kg dry matter intake without ZELP and from 13.0 to 22.5 g/kg dry matter intake with ZELP, showing a potential for ZELP to mitigate methane emissions from 25.8 to 53.3%. In Trial 2, 10 Holstein cows (37.4 ± 8.8 kg/d milk yield; 271 ± 53 days in milk) were used in a crossover design with 8-d periods. Cows were randomly assigned to treatments, which were absence or presence of ZELP. Data and samples were collected during the last 3 days of each experimental period. ZELP did not affect dry matter intake (26.1 kg/d), yields of milk (36.4 kg/d), fat (1.55 kg/d) and protein (1.27 kg/d), rumination time (569 min/d) and eating time (183 min/d; all $P >$ 0.25). It was concluded that ZELP is a promising technology that can reduce methane emissions from ruminants without impairing animal welfare.