Characterize Physical and Chemical Properties of Manure in California Dairy Systems to Improve Greenhouse Gas (GHG) Emission Estimates

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to our cooperating dairy operators, their employees, and their families.

Request that images not be used without producer consent

Known at the beginning…

- **Every dairy was built and is operated independently.**

- **The amount of excreted volatile solids (VS) stored in anaerobic conditions can range from 12.5% to nearly 100%.**

- **Need to know amount or % VS excreted stored in anaerobic conditions to identify which management practices (if any) are useful.**

Known at the beginning…

- **Nutrient management has driven much of treatment technology or alternative management practices researched in CA. Focus on N, P and K and not fate and form of C.**

- **Any changes in manure management practices must be consistent with Regional Water Board requirements and Air District permits.**

Known at the beginning…

- Dairies and their manure management system do not run the same way every day.

- Seasonal differences will have an effect on TS collected and methane production.

Plan A

Plan B

Plan C

Plan D

Help !

Known at the beginning…

- **There are large knowledge gaps. The Research sub-group (#3) is working to identify these.**

- **Large uncertainties exist around baseline quantification which makes documentation of improvements (also with large uncertainties) sub-optimal.**

- **Current working knowledge of California dairy manure management essential to design and apply research results.**

Dairy Locations and Herd Size
Central Valley California

Driving questions responsible for this work

1. How much manure (tons as excreted or percent of animals) is handled

- aerobically (likely a solid)
- anaerobically (likely a liquid)
- other

Driving questions responsible for this work

2. What chemical or physical conditions make all manure not equal to all manure?

- aerobically
- "anaerobically"
  - pH, temp, redox, total solids loading rate, salt?, $[NH_4^+]$
- other

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UC Team approach

Task 1. *Evaluate existing information on dairy practices and air emissions calculations in California*

Use of SJVAPCD data to identify

- **animal populations by housing type,**

- **manure collection systems (solid, liquid, slurry).**

Use of Regional Water Quality Control Data when appropriate

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Nothing is perfect

- **Animal numbers are maximum capacity and may not actually exist**
- **Unable to differentiate between settling basins, pits, ponds**
- **Unable to identify if all milking cows are in freestalls at freestall dairies**
- **Unable to identify if heifers are in freestalls at dairies with freestalls**

In general

- **Identify lactating cow housing type: freestall, non-freestall, or mix**

- **Identify cow and herd distribution by facility size**

- **Inform types of facilities to study in project**

Desire for Task 2 dairies

- 3 freestall and 2 non-freestall facilities
- 1 to 2 dairies under 1,500 cows
- 3 to 4 dairies between 1,500 and 3,000 cows

UC Team approach
Task 2. Data collection

➢ **Monthly feed and diet information analysis to estimate excretion**

➢ **Monthly animal management observations (where is manure deposited--must include bedding)**

➢ **Quarterly analysis of**
  - **waste streams (how much manure is going where)**
  - **lagoons (at least 3) for pH, redox, temperature**

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Site visits to select dairies (max n=5) with high probability of successful data collection for required information:

➢ Estimate TS, VS, TKN and "ammonium N" excreted
  ❑ Feed management and delivery
  ❑ Milk production
➢ pH, redox, temperature (liquid/slurry manure)
➢ Determine VS delivery to anaerobic system

UC Team approach

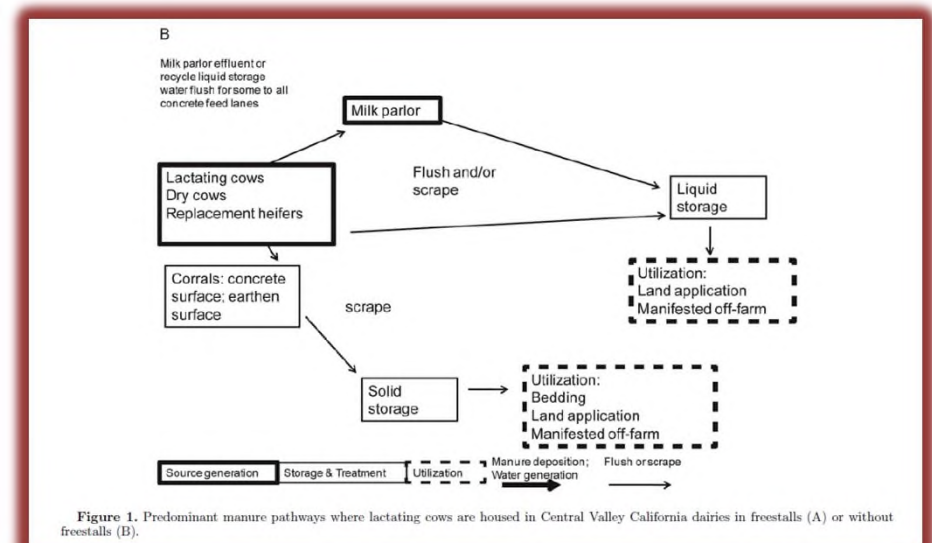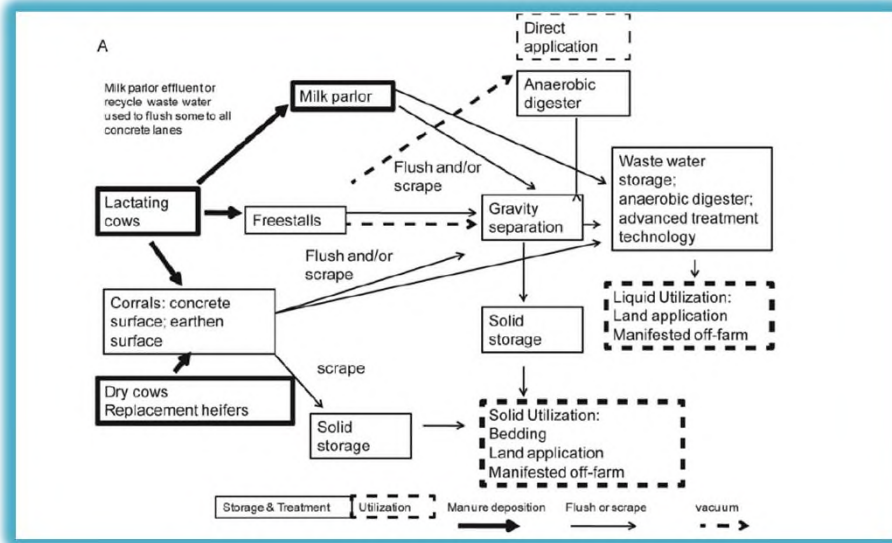**Leverage strengths in reading dairy facilities to facilitate** *a comprehensive survey and analysis of TS, VS and N flows from excretion through storage*

Figure 1. Predominant manure pathways where lactating cows are housed in Central Valley California dairies in freestalls (A) or without freestalls (B).

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What goes in, will come out

Need to know

- **How much VS in liquid system.**
  - Straight forward approach
  - [VS] of liquid x volume of liquid = VS
  - Need representative samples
  - Need estimate of liquid volume
    - Liquid = water + manure + bedding + ???

- **12 months of sampling**

Each dairy is operated independently

- bedding
  - type
  - frequency
  - amount
  - composition (organic vs inert)
  - particle size
  - nutrient content

Each dairy is operated independently

- **water use**
  - **Animal consumption**
    - **leaky faucets**
  - **Animal cooling**
  - **Animal hygiene**
  - **Milk cooling**
  - **Milk equipment and parlor sanitation**
  - **other**

Each dairy is operated independently

- Reuse water from lagoon to flush

- Flush water contains VS, volume can be estimated with uncertainty

Each dairy is operated independently

- **separation system**
  - mechanical or gravity
  - retention time
  - frequency of clean out
  - method of clean out
  - removal of fines
  - how separated solids are handled
- **other treatment technologies**
- **anaerobic lagoon management**
  - see separation system plus introduction of fresh water

Management considerations

- **Hot weather abatement**
  - Keep cows inside
  - Use animal cooling
- **Wet weather abatement**
  - Keep cows inside
  - May collect more rain water
- **Impacts of bedding needs and potential bedding alternatives**
- **Impacts of animal housing/management**
- **Manure collection methods**

Work in progress

- **Reviewed aerial photos of 177 randomly selected dairies (SJV)**
- **Eighteen facilities met physical criteria.**
- **Boots on the ground identified viable potential facilities.**

Work in progress

- Site visits were conducted to determine if sufficient infrastructure would be present.

- Two freestall c. 2,150 and 2,250 cows facilities. We continue to look for another freestall facility.

- Two non-freestall c. 1,000 and 1,800 cows

Making camp

Going forward

- Continue field work.

- Use data collected to understand how management preferences impact options for manure treatment technologies.

- Fill data gaps.
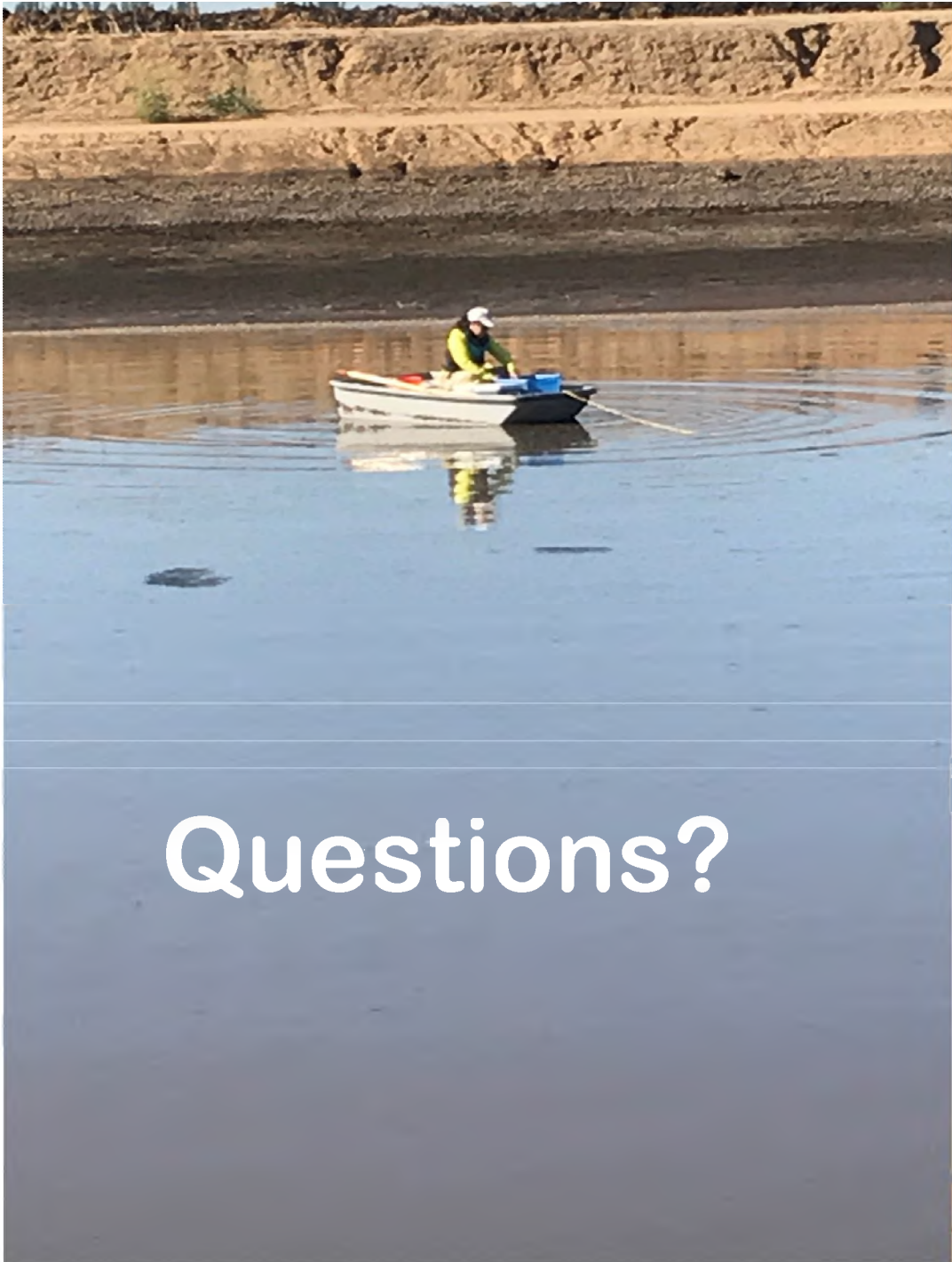
Questions?

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