

California Dairy 101: Overview of dairy farming and manure methane reduction opportunities

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SUB-GROUP #1, DAIRY AND LIVESTOCK WORKING GROUP

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Key understandings desired:

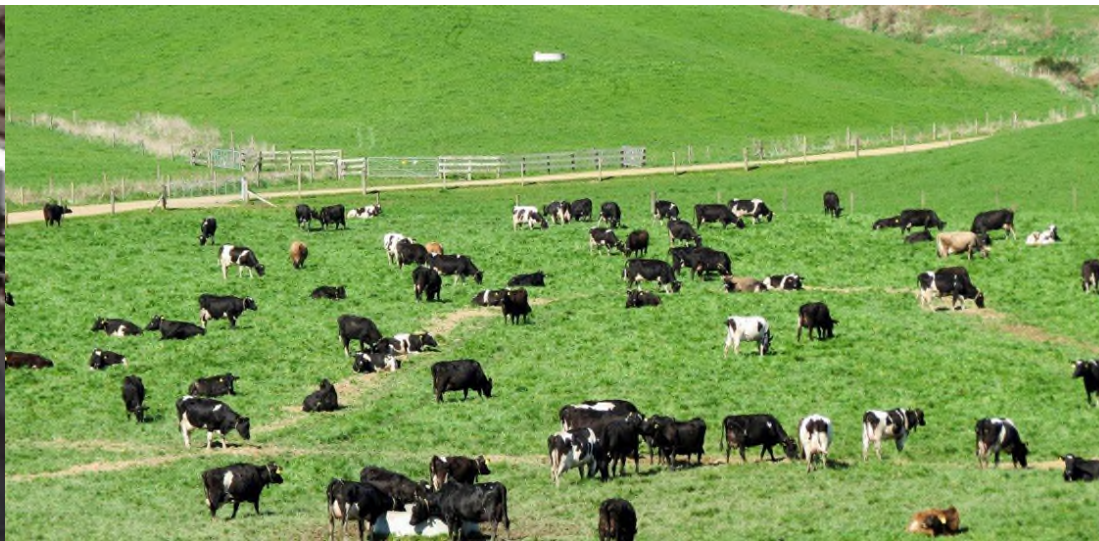
- Distribution of cows/dairies in the state
- Regulating agencies
- Disadvantaged communities overlay
- Definitions of key terms
- Understanding of basics of manure management
- How manure is used
- Components of dairies that produce more/less methane
- Key areas where more information is needed



California dairy industry snapshot

- 20 percent of U.S. milk
- \$6.29 billion in farm gate value for milk
- \$21 billion in economic activity and 190,000 jobs
- 1.7 million milking cows plus support stock (heifers, calves)
- 1,392 dairies (herd statewide average is 1,249 milking cows plus support stock)
- Mostly Holsteins and Jerseys and cross-breeds
- 20 counties with significant dairy herds (more than 1,000 animals in county)

Large variation in styles of dairies



California's main dairy regions

- Vary by overall population, dairying style, climate, and environmental conditions
- Approximately 91 percent of state's dairy cows and more than 80 percent of dairies are in the Central Valley (primarily freestall barns with flush systems or drylots)
- ~3 percent of state's dairy cows are in North Coast region, such as Humboldt, Marin and Del Norte counties, primarily on pasture
- ~5.6 percent of dairy cows are in Southern California, including Riverside, Imperial, and San Diego counties, primarily on drylots

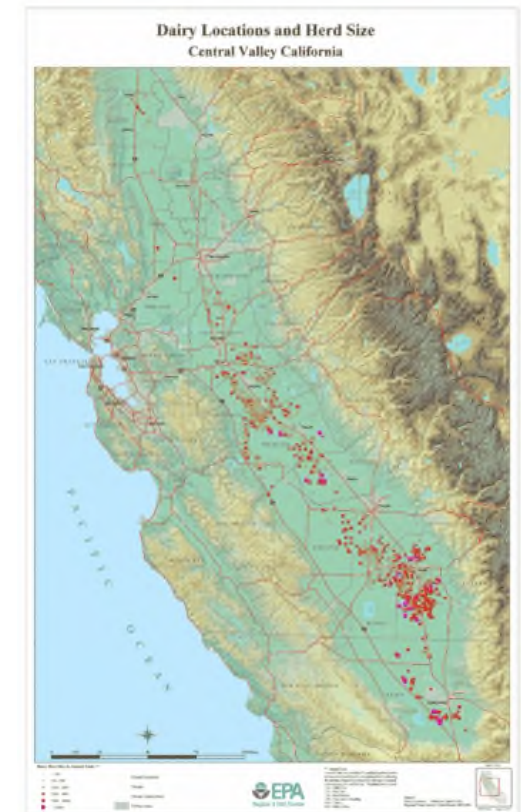
Key regulating agencies

- California Department of Food and Agriculture
- Regional Water Quality Control Boards
- State Water Resources Control Board
- California Air Resources Board
- Regional air districts (especially San Joaquin Valley APCD and South Coast APCD)
- County governments (land use, permitting, CEQA)



Disadvantaged communities

- Many identified disadvantaged communities, especially in the Central Valley, overlay with agriculture generally, including dairies

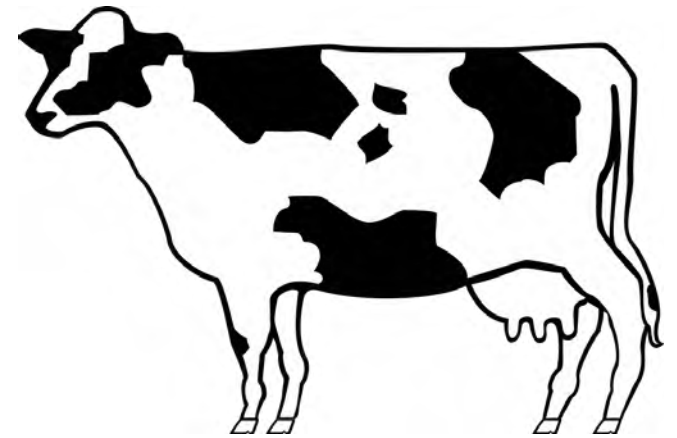


Coming to terms

- There are many terms used to describe dairies and manure management that are not familiar to the general public, or are used inconsistently within the industry and stakeholder groups
- In the next few slides we go through some of these toward creating a common understanding when using these terms
- This list is not exhaustive but a working understanding of these basic dairy features is essential to addressing our mission and topics in coming months

Manure

- Includes both urine and feces excreted by the cow



Manure management

- The process of collecting, transferring (this is technically transfer processing), storing, treating, transporting and utilizing manure



Freestall

- A freestall is an individual stall (space) in a barn for one animal; it has enough space for the cow to lie down comfortably and is separated from other stalls. Cows are allowed to freely enter and exit the stall (to eat or walk around in the exercise area, or to be milked). Stalls are located within feet of a feeding station where the cow can eat and drink water whenever she wants to.



Freestall barn

- A freestall barn (especially in California and mild climates) is a roofed barn, generally without walls to increase ventilation, with individual freestalls, where cattle are housed and fed.
- A feature of a freestall barn is a **feed lane**, a clean area separated from cattle by stanchions, where rations are deposited for cows to eat.
- Another feature is a **feed apron**, where most of the manure excreted in the barn is deposited. These concrete lanes are designed to be easily cleaned on a regular basis.



Dry or open lots/corrals

- Another method of housing cattle, in an enclosed area with an unvegetated (dirt) surface. Most freestall barns have adjacent open lots or exercise pens. Dairies without freestalls often includes shade structures and have an associated feed lane. The concrete feed apron (where cows stand to eat) may get cleaned by flushing, scraping , or vacuuming.
- A single dairy may house cattle in both freestall barns and dry open lots



Pasture

- Land covered with grass or low plants, as the primary or only forage source for cattle. Pasture also serves as a housing area during good weather
- During grazing, manure is deposited in the same area where cows live/eat, left to dry and decompose, to return to soil
- Pastures may be naturally rain fed, irrigated, or both
- May involve housing animals in a barn during poor weather; requires manure collection, storage, and management during this period
- May involve supplemental feeding (e.g. hay, grain and silage not coming from grazing) during poor weather
- Organic milk standards require a minimum number of days grazing annually

“Flush” dairies

- Dairies where **most** of the manure excreted by milking cows is deposited on concrete surfaces (in or outside of barns) and collected and moved to storage with water
- Requires water (including recycled water) for flushing
- Requires an area to store what is flushed (lagoon, pond) and may or may not include solid separation prior to the lagoon (settling basins, pits, ponds, or separators)
- Liquid manure collected is stored and/or treated until it can be applied to crops

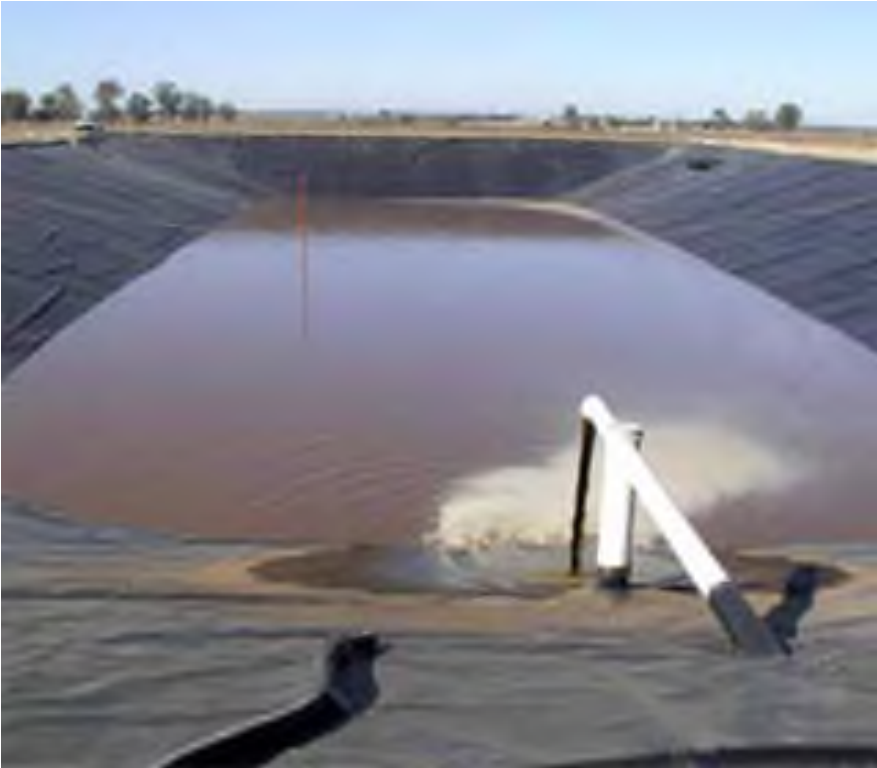


Drylot dairies

- Dairies where most of the manure excreted by milking cows is deposited in corrals and managed as corral solids



Lagoon



- A large retention pond intended to collect water and manure as it is flushed. The supernatant (water from the upper layers of the pond) may be recycled to use as flush water in housing areas but not milking barns.
- Water from lagoons, which contains plant nutrients from manure, is blended with irrigation water and applied to crops in a process known as **fertigation**.

Settling basins

- Smaller retention ponds often used before the lagoon to capture and “settle out” larger and more dense solids from the flushed manure. Slows sludge buildup in the main lagoon.
- Liquid (and some solids) flow from the settling basin to the lagoon
- When full, the solids are removed and applied to cropland (usually preplant)



Mechanical separators

- Many types, but prevalent in California are sloped or scraped screens (above grade) that remove larger manure particles from flushed manure and allow liquid and smaller particles to pass through
- Same basic goal as settling basins; to prevent unnecessary solids from entering lagoon
- Most are designed to remove larger particles (25 percent or less solids by mass)
- These separated solids are managed to dry out quickly compared to settling basins, pits or ponds because they are not constantly rewetted
- Separated solids are high in carbon but low in nitrogen

Separated solids

- A fraction of whole manure after it has been (a) flushed and (b) processed through a settling basin or mechanical separator
- Physically different than “whole” manure – salts and nitrogen are removed, large high-carbon fragments remain



Corral (manure) solids

- Manure deposited on the unvegetated soils of the corral and therefore not flushed (typically at drylot dairies or for the fraction of time/herd that is housed in corrals at a freestall dairy)
- Typically dries quickly, surface regularly harrowed for fly control, excess manure scraped to side of corral to stockpile and dry for further use
- Used for bedding or applied to crops

Bedding

- A soft and absorbent material used to create a “mattress” in freestalls for cows to rest or sleep. Must be maintained, cleaned (raked) and replaced regularly for cow comfort and health
- Dried or composted whole manure or separated solids is a common source of bedding, as are materials like almond shells and clean sand



Scrape

- A non-flush method for collecting manure from concrete-floored barns and/or housing areas
- Can use tractors or vacuum trucks
- Can use automated systems such as chain scrapers
- Rarely used in California at this time
- Leads to changes in both storage of the collected manure and how it can be used



Slurry

- Thicker (but still liquid) manure resulting from collecting freshly excreted manure from concrete surfaces
- Higher solids content (8 to 10 percent) compared to flushed manure
- Typical storage and utilization outside of California is **daily spread**, which typically involves applying slurry directly to crops or pasture very shortly after collection
- In California, this may go to a settling pit for dewatering or be land applied

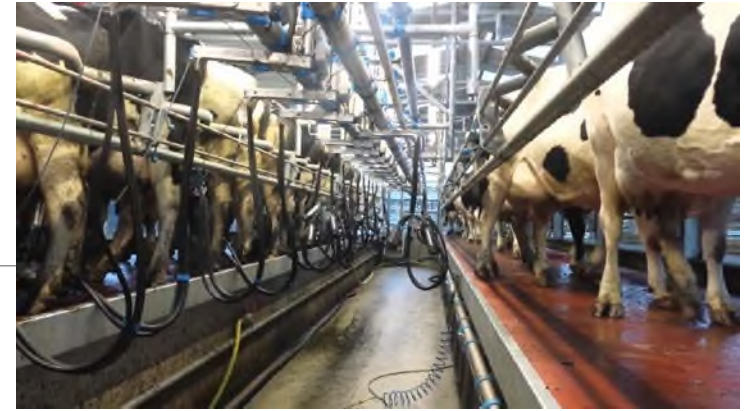


Compost

- Decayed/cured organic material (including manure) used as a fertilizer and soil amendment, can also be used as bedding
- Accomplished typically through windrows/turning and aerobic decomposition
- Increases value/quality of manure by improving quality for use as either bedding or soil amendment (kills weed seeds)
- Composting on California dairies typically (currently) uses manure from corrals, solids separators, or settling basins



Milking barns



- All dairies (drylot, flush or pasture) use milking parlors
- These are not housing units; individual cows are only in the milking parlor for 8 to 10 minutes per milking, two to three times a day
- However, the milking parlor will be occupied much of the day
- A minor portion of the overall manure excreted daily occurs in the milking parlor
- Parlors are always cleaned/flushed with (clean non-recycled) water, thereby creating at least some liquid waste, regardless of how the other housing areas on the dairy are managed
- Equipment used to harvest and store milk is cleaned and sanitized daily and contributes to the liquid waste stream

Process pits



- A small, usually concrete-lined structure used to regulate flow of flushed manure prior use of a mechanical separator
- May also be used as a source of recycled water for the flush

How is manure currently used?

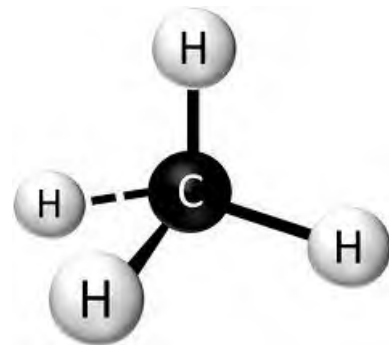
- Liquid manure (from lagoons) is added to irrigation water and used to grow feed crops; it can be added to growing crops
- Liquid manure can be exported to neighboring farms with a written agreement but infrastructure to pump needed
- Solid manure can be applied to crops but generally only preplant
- Solid manure can be sold and transported economically for short distances; crop uses for non-composted manure are limited
- No good numbers on how much manure is exported from dairies

Untangling concepts

Housing	Manure collection	Manure treatment	Manure storage
Barn (including freestall)	Flush	Solids separation	Lagoons (liquid)
Open lot/corral	Scrape/vacuum	Composting or solar drying	Settling basins (also treatment)
Pasture	None		Slurry pits
			Solids piles

Where's the methane?

- For now, we are not talking about enteric (directly from the cow) emissions, which are about 45 percent (state average, highly variable dairy to dairy) of dairy methane emissions in the current CARB inventory
- Methane from manure storage is expected to be coming from portions of dairy where manure (especially volatile solids or non-mineral fraction of manure) are stored anaerobically (absence of oxygen)



Current assumptions

- Higher sources of manure methane: Lagoons, settling basins and process pits
- Lower sources of manure methane: Manure deposited on corral surface, pastures (both directly deposited by cows and daily spread on crops or pasture after collection from barns), stockpiles of corral solids, stockpiles of (dried or drying) separated solids

What are current assumptions based on?

EPA/CARB values

Management method	Methane conversion factor	California MM analog	H/L	Compared to SS baseline
Anaerobic lagoon	0.748	Lagoon Settling basin?	H	50x
Slurry	0.17	Settling basin?	H	11x
Pasture	0.006	Pasture	L	40%
Solid storage	0.015	Corral solids, mechanically separated solids?	L	Baseline
Daily spread	0.005	?	L	33%
Deep pit	0.33	Settling basin?	H	22x

How accurate are these for California?

- Dairy Cares/Environmental Defense Fund measurement research on two CA dairies suggests settling basins, lagoons and process pits are dominant sources
- Additional already funded research through CDFA is intended to measure emissions on more dairies and provide additional data for validation or modification of our assumptions



Key takeaways for discussion:

What we know (?) or need to know

- Do we agree there is reasonably strong evidence that most manure methane is coming from lagoons, settling basins and related components?
- As such, should our main focus be on advancing markets and economic incentives for practices or technologies that address these specific areas of the dairies?
- What can we learn about the percentage of dairies that use these higher-methane components?

Key takeaways for discussion (continued)

- In general what do we know (or what can we learn) about the percentage of volatile solids on dairies that end up in higher-methane-producing management components versus lower-methane components?
- What other knowledge do we need to further determine where to focus our efforts (on which types of dairies and/or parts of dairies do we need to focus)?
- What other knowledge do you need to be able to effectively assess different practices within this subgroup?

Thank you

