From Flush (back to) to Scrape
Some Practical Considerations

Presentation to:

Subgroup #1,

Dairy and Livestock Working Group

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Today's Topics

- Flush short course
- Main non-flush manure collection methods
- Prevalence and use of methods
- Fate of manure
  - Conveyance, processing, storage, use
- Effect of seasonal weather on scrape and stack
- Effect on farm nutrient management
- Nutrient content and agronomic implications
- Equipment availability
- Environmental implications

This Presentation

- Reconnaissance effort
- Relies on information collected from several very knowledgeable people who have lived on or worked with dairies in California for much of their lives
- There are others who have not yet been spoken to but are expected to be able to make valuable contributions (e.g., Dr. Deanne Meyer, UC Davis)
- Quantitative statements are not based on ‘hard’ data, but are believed to be in the ballpark based on cumulative input

Sources of Information

4Creeks, Inc.....David De Groot

Hartman Engineering.....Craig Hartman

Milk Producers Council.....Kevin Abernathy

Provost and Pritchard.....Steven Bommelje

John Schaap

Jason Toste

Western United Dairymen.....Melissa Lema

Jake Oosterman

Paul Sousa

Freestall
Manure deposition on flush lanes

Solids Separation
Recovery of fiber for bedding

Liquid Manure Lagoons
Temporary Storage

Field Application
Fertilization of Crops

Milk Parlor
Wash Water

Flushing (top of lane)

- Recycles water from lagoon, typically uses make-up water from milking parlor

Flushing (down the lane)

Flushing (drop inlet)

- Flushing is fully automated and can occur any time of the day
- Can occur with cows in the barn
- Zero labor
- Extremely reliable and low maintenance
- Effective cleaning
- Safest for cows and employees

Methods:
Non-flush Manure Collection from Concrete Lanes

Tractor (push only)

Floor mounted arm

Autonomous robotic devices

Vacuum truck

Tractor
(front loader with standard bucket)

- Cows need to be out of the area (necessitates coordination with milking schedule, etc.)
- Labor

Tractor
(front loader with special attachment)

- Better cleaning than steel bucket due to squeegee effect (?)
- Leaves thin, slippery manure film
- Possibly less wear of the concrete surface

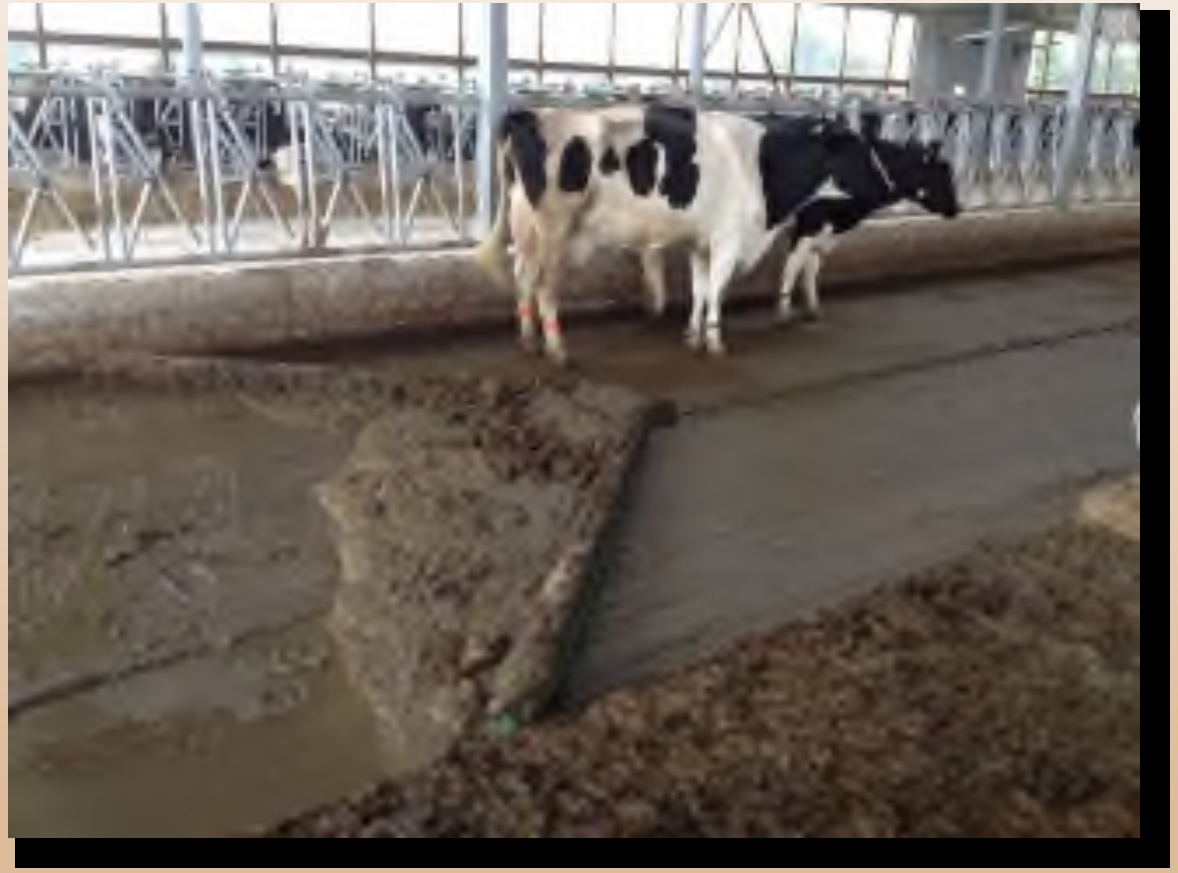
Tractor
(squeegee attachment)

Slurry (drop inlet)

Floor Mounted Arm

- Moved via chain, cable, or hydraulics
- Slow movement, 24/7 operation, cows step over it
- Many passes per day due to low carrying capacity

Floor Mounted Arm



- V-shaped scraper can move manure to underground channel

Under-floor Channel
(with paddle)

Autonomous Robotic Devices

- Different makes and models
- Programmable, slow movement, 24/7 operation, cows don't mind, self-charging, self-emptying, large/small quarters

Vacuum Truck

- Takes care of manure collection and conveyance
- Possibly too heavy for some thinly poured lanes

Use and Prevalence of Methods –Tractor

Central Valley

- Rarely used as primary method (<5%)
- More commonly used:
  - in South Valley (drier climate)(~10-20%)
  - for heifers (less and drier manure)
  - in the summer (drier)
  - flush can supplement scrape
- Used on dairies with ineffective flush (~10-20% of older dairies)
  - Tractor helps push islands during flushing

Use and Prevalence of Methods –Tractor

North Coast (Pasture Dairies)

- Commonly used as primary method (90-95%) but very small percentage of the state's cow population
- In combination with hand-scrape on very small dairies
- Summer: cows on pasture = less scrape
- Winter: cows in freestall barns = more scrape

Use and Prevalence of Methods –Floor Mounted Arm

2-4 dairies (chain and cable scrapers)

- One installed in conjunction with a digester
  - Chain scraper unused since digester became non-functional
- One installed in combination with flush (as back-up)
  - Chain scraper unused due to high maintenance cost
- Some recent interest in newer versions

Use and Prevalence of Methods –Autonomous Robotic Devices

No knowledge of current use in California

Use and Prevalence of Methods –Vacuum Truck

It appears that there are very few dairies using vacuum trucks (10-20?). Not sure if this is their primary manure collection method.

Fate of Slurry

Conveyance
Storage
Processing
Use

Slurry Conveyance

- Gravity alone is not sufficient to move slurry to storage location

Slurry Conveyance

- Gravity alone is not sufficient to move slurry to storage location

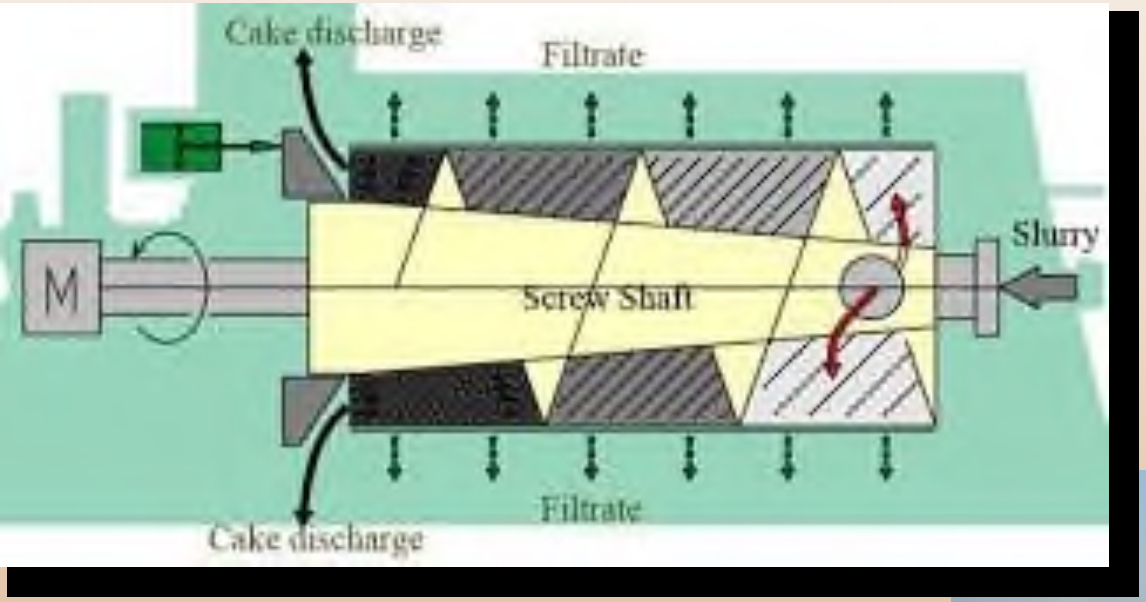
Slurry Pit or Lagoon

- Wet and anaerobic, no solids/liquid separation
- Likely land application
- Common on North Coast dairies

Pit with Weeping Wall

- Wet and anaerobic
- Some separation of liquids but retained solids non-stackable
- Likely land application or composting of retained solids

Dewatering (Screw Press)



Turns slurry into a stackable product by exerting pressure and squeezing liquid through screen

Very rare in California, including the North Coast

Composting and Drying

- Composting or drying in windrows is done on a fair number of dairies where this practice was grandfathered-in
- Slurry can be added to (drier) corral solids
- Slurry can be spread in corrals for drying

Slurry Application

Solids Application

Effects of Seasonal Weather on Scraping

Central Valley

- Slurry drying and composting only effective in the summer months
- Slurry incorporation in corral solids only possible in the summer

North Coast

- Seasonal housing differences affect frequency of scrape
- Winter: may haul slurry to lagoon
- Summer: may dewater & stack or directly land apply

Effect on Farm Nutrient Management

Liquid Manure	Is applied in irrigation water throughout the growing seasons in summer and winter, export very limited
Slurry	Could potentially be injected into irrigation stream
Solid Manure	Application via broadcast only preplant

Effect on Farm Nutrient Balance

Liquid Manure	Very limited exportability; loss of nutrients in liquid form will increase need for synthetic fertilizer
Slurry	Limited exportability
Solid Manure	Commonly exported now

Nutrient Content

- Pre-lagoon separation of coarse, fibrous, carbon-rich, nutrient-poor solids from the liquid stream
- Practical purpose: Recovery of excellent bedding material, keep solids from filling lagoon
- Stackable

Nutrient Content

Did not review literature for this presentation. However, nutrient content is expected to be much higher than in the fiber separated from liquid flush stream because:

- Majority of fine particles remain in dewatered product (that's where most of the organic N is)
- Remaining moisture is from fecal liquid and urine, not from (less concentrated) flush water

Equipment Availability

Many makes and models available off-the-shelf but need to further explore…

- Network of in-state dealerships and support services (e.g., maintenance, repair)
- Equipment reliability

Flush vs. Scrape Emissions Implications

Recent and ongoing CA work (all UC Davis)*

- Heguy, Karle, Miller, Meyer, Price, and Robinson
- Mitloehner
- Zhang, Kaffka, and Campbell

However, comprehensive (whole farm, all processes) and quantitative comparison difficult and currently lacking

*Subgroup #1 presentations at Meetings 2 and 3

Emissions from Different Places, Processes, Equipment

- Liquid manure lagoons
- Settling basins
- Slurry pits
- Compost piles, windrows, drying pads
- Flush lanes
- Flush pumps vs. scrape equipment
- Equipment to haul and process solids
- Equipment to land apply manure solids
- Field land surface
- Other

Other Environmental Considerations

- Odor and vector issues associated with scrape
- Increase of slurry wagons on county roads, damage to roads, tracking on earthen materials onto roads, traffic

Key Findings

- The flush dairy model has many practical advantages over the scrape model including the ability to spoon-feed manure nutrients to crops during the growing season
- Most flush dairies also generate and manage solid manure

Key Findings *(cont'd)*

Diverting more Nitrogen to solid storage

- Can help dairies with limited land base improve their whole-farm N balance by exporting
- May cause many significant undesirable side effects
- May reduce methane emissions from wet storage but increase other emissions on and off a dairy

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Thank You

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