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# Integrating Vacuumed Manure into Nutrient Management: Analysis, Considerations, and Seasonal Changes

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# Dairy Manure Management

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- How manure is collected, stored, treated, transported and used
- Non-flush dairies need to manage dry/slurry waste streams
- Scrape systems or vacuum scraper
  - Allows nutrient export and reduces lagoon loading
- Composting or solar drying of collected manure
  - Manure solids applied to crops or exported

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# Manure as a Fertilizer Source

- Challenges to using manure as a fertilizer source – handling, storage and application method

| Handling/Storage or Application Method (solids) | Nitrogen Loss, % |
|---|---|
| Daily Scrape & Haul | 13 – 35 |
| Manure Pack | 20 – 40 |
| Open Lot | 40 – 60 |
| Broadcast w/out Incorporation | 15 – 30 |
| Broadcast w/ Incorporation | 1 – 5 |

**Source: Sutton et al., 1983**

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# Manure as a Fertilizer Source

- Challenge to using manure as a fertilizer source – not all N present is immediately available to the crop

| Manure Type | Year 1, Nmin % | Year 2, Nmin % |
|---|---|---|
| Dairy Lagoon Water | 40 – 50 | 15 |
| Dairy Lagoon Sludge/Slurry; Corral | 20 – 30 | 15 |
| Dairy Mechanical Screen Solids | 10 – 20 | 5 |

**Source: Pettygrove, Heinrich, and Crohn, 2009**

- Year 2 N mineralization can result in a manure "credit" to be used in future N budget

# California Dairy Research Foundation Project

- Goal is to better characterize physical and chemical composition of vacuumed dairy manure

- Vacuumed manure sampled from four dairies
  - Sampled once in the summer (warm season) and once in the winter (cold season)
  - 4 to 14 samples collected in one day
  - Characterize physical and chemical composition
  - Determine fertilizer nutrient value

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# Manure Deposition and Vacuum Collection

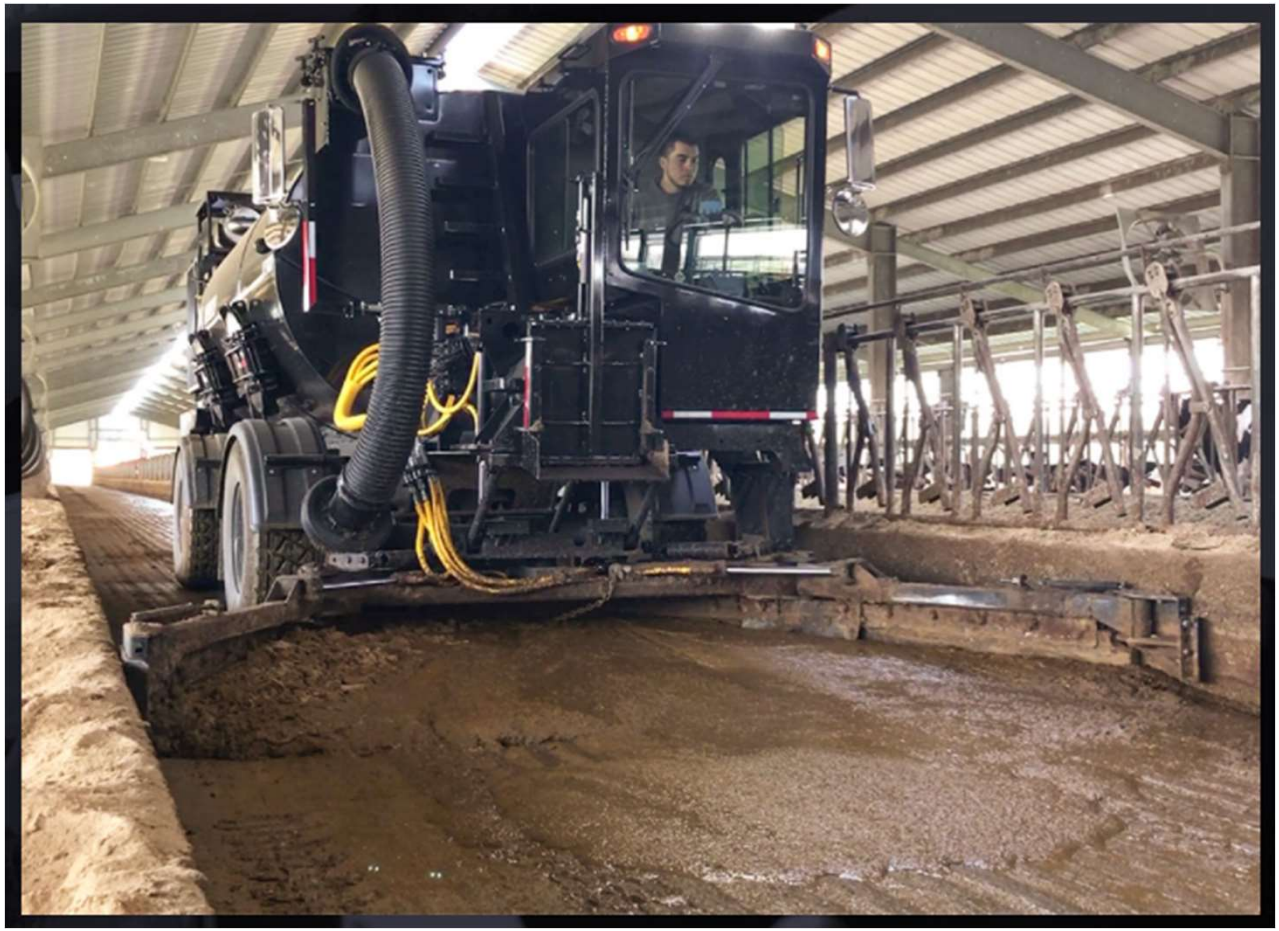
- Manure deposited on concrete lanes during feeding
- High moisture content and collected as a slurry
- Vacuum collects manure along with sand and soil on concrete lanes

Concrete Lane – “Feed Apron”

# Manure Vacuum Scraper

- Vacuum tank capacity
  - 2,000 to 4,000 gallons
- Weight
  - 22,000 to 25,000 lbs (empty)
  - 41,500 to 65,000 lbs (loaded)
- Adjustable front-end scraper
  - Controllable down pressure
  - 8.5 to 14 ft. wingspan

# Manure Collection



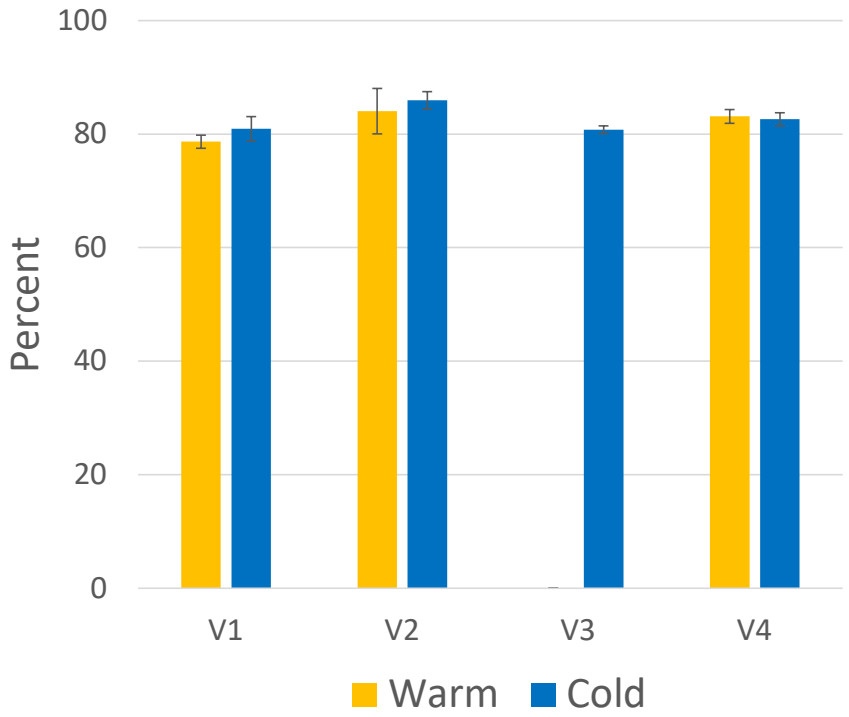
Composting


Dry and Scrape

# Application of Vacuumed Manure Solids

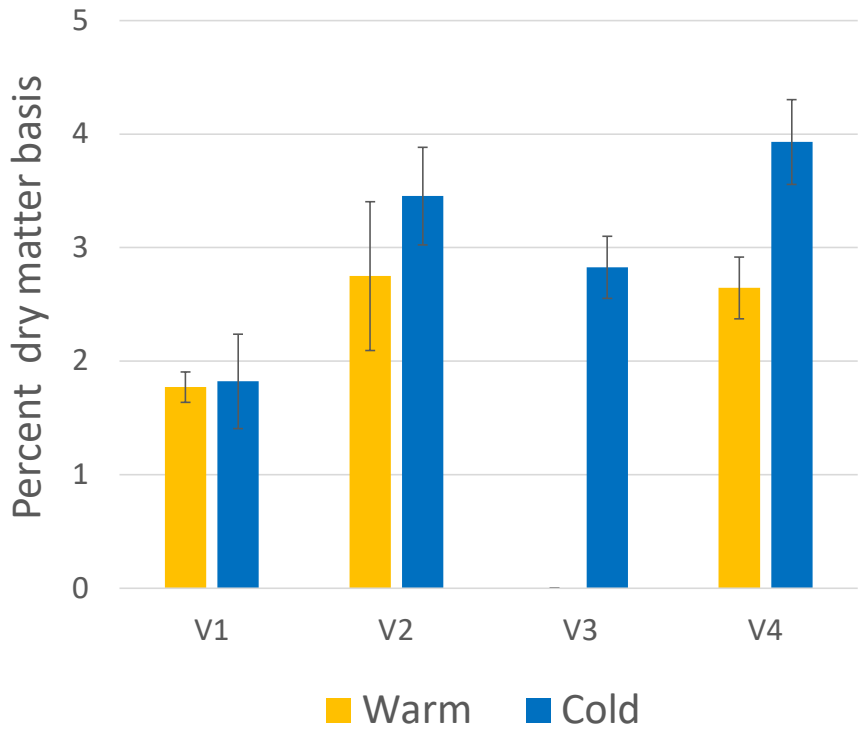
# Vacuumed Manure – Moisture

- Slurry with high moisture content!
- 79% (Warm) to 86% (Cold)
- For composting want between 40 to 60% moisture
- Drying required before composting



# Vacuumed Manure – Total Nitrogen

- Greater nitrogen in winter compared to summer
- 1.8% (Warm) to 3.9% (Cold)
- Sample-to-sample variability was similar between seasons



# Vacuumed Manure - Fertilizer Value & Carbon

| Dairy/Manure | Season | N (lbs/ton dry) | $P_2O_5$ (lbs/ton dry) | $K_2O$ (lbs/ton dry) | Carbon (lbs/ton dry) |
|---|---|---|---|---|---|
| V1 | Warm | 35 | 23 | 29 | 506 |
| | Cold | 36 | 25 | 29 | 481 |
| V2 | Warm | 55 | 24 | 43 | 688 |
| | Cold | 69 | 34 | 64 | 740 |
| V3 | Warm | - | - | - | - |
| | Cold | 57 | 22 | 72 | 840 |
| V4 | Warm | 53 | 29 | 59 | 668 |
| | Cold | 79 | 31 | 68 | 756 |
| Corral Solids* | - | 42 | 28 | 47 | - |

*Data: Miller et al., 2019. Waste Mgmt.

# Vacuumed Manure - Fertilizer Value

**40 T/ac corn silage takes up 132 lbs $P_2O_5$, 304 lbs N, 304 lbs $K_2O$**

- N-based manure application
  - 7 tons/acre
  - 210 lbs $P_2O_5$, 304 lbs N, and 464 lbs $K_2O$
- P-based manure application
  - 4 tons/acre
  - 132 lbs $P_2O_5$, 191 lbs N, and 292 lbs $K_2O$
- N-based application, too much P and K
- P-based application, too little N and K

| Dairy Manure | N:P | N:K | C:N |
|---|---|---|---|
| Vacuumed Slurry | 2.0 | 1.1 | 12.5 |
| Corral Solids* | 1.5 | 1.6 | - |

*Data: Miller et al., 2019. Waste Mgmt.

# Summary

- Vacuumed manure had a high moisture content regardless of season
  - Drying needed before composting
- Total N was consistently greater in winter compared to summer
- N-based or P-based application would lead to losses (excess or deficiency)
- Drying or composting would lower nutrient content compared to slurry

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