Dairy Facilities and Cow Comfort for the Next Decade

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Factors that Determine Decisions Concerning Dairy Facilities

• The two big factors
  – Economics
    • Dairy industry trends
    • Investment per cow
    • Milk production per cow
  – Cattle performance
    • Milk production
    • Reproduction
    • Health
Summary of U.S. Dairy Industry

- Fewer dairies
- Larger dairies
- Cow numbers are flat
- More milk
- Higher milk production per cow
- Industry is moving west
- Consolidation
- Structural change
Investment Per Cow

Cow Comfort
## Sensitivity of Return on Assets to Production and Investment

<table>
<thead>
<tr>
<th>Production level (lbs/cow)</th>
<th>Investment per cow*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$3,000</td>
</tr>
<tr>
<td>22,000</td>
<td>9.2%</td>
</tr>
<tr>
<td>23,000</td>
<td>11.3%</td>
</tr>
<tr>
<td>24,000</td>
<td>13.5%</td>
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<tr>
<td>25,000</td>
<td>15.6%</td>
</tr>
<tr>
<td>26,000</td>
<td>17.7%</td>
</tr>
</tbody>
</table>

*Investment per cow in herd equals investment per lactating cow divided by 1.18.

**Costs vary by production level due to varying feed and hauling and promotion costs.

1 Based on K-State Dairy Budget MF-2442
Return on Assets vs. Production Level
Source: 2005 KSU Dairy Budgets

Milk Production, lbs/cow/yr

ROA for Freestall and Drylot production levels.
Cow Comfort & Behavior

• Under U.S. conditions we improve cow comfort or take advantage of behavior when it improves performance
  – Milk production
  – Reproduction
  – Health
Cow Comfort & Behavior

- Grouping Strategies
- Freestall Design & Bedding
- Cow Handling Facilities
- Management Strategies
- Walking Distance
- Stocking Density
- Cold Stress
- Travel Lanes
- Flooring Surfaces
- Walking Distance
- Stocking Density
- Cold Stress
- Freestall Design & Bedding
- Cow Handling Facilities
- Management Strategies
- Walking Distance
- Stocking Density
- Cold Stress
- Travel Lanes
- Flooring Surfaces
- Grouping Strategies
Improving Cow Comfort

• How you intervene is crucial
  – Order of steps to improve cow comfort
    • Rubber vs. managing heat stress
Cow Comfort & Behavior

- Time budgets
- Core body temperature
- Number of group changes
## Time Budgets for Dairy Cows Milked 3X<sup>C</sup> with Different Travel Times

<table>
<thead>
<tr>
<th></th>
<th>Recommended&lt;sup&gt;A&lt;/sup&gt;</th>
<th>20 min.&lt;sup&gt;B&lt;/sup&gt;</th>
<th>30 min.&lt;sup&gt;B&lt;/sup&gt;</th>
<th>40 min.&lt;sup&gt;B&lt;/sup&gt;</th>
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</thead>
<tbody>
<tr>
<td>Milking Parlor</td>
<td>1.2 - 3.2</td>
<td>3.0</td>
<td>3.5</td>
<td>4.0</td>
</tr>
<tr>
<td>Feeding</td>
<td>5.3</td>
<td>5.3</td>
<td>5.3</td>
<td>5.3</td>
</tr>
<tr>
<td>Water</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>Socialization &amp; Standing</td>
<td>3.0</td>
<td>3.0</td>
<td>3.0</td>
<td>3.0</td>
</tr>
<tr>
<td>Resting</td>
<td>12 – 14</td>
<td>12.2</td>
<td>11.7</td>
<td>11.2</td>
</tr>
</tbody>
</table>

<sup>A</sup>Rick Grant, Miner Institute

<sup>B</sup>Travel time to and from the parlor

<sup>C</sup>Time required to milk a group of cows is 40 minutes
Factors Influencing Time Budgets

• Grouping strategies
  – Group size

• Travel time to and from the parlor
  – Travel lane width
  – Distance from the parlor

• Stocking density
  – May not be enough time for individual cows to meet feeding and resting requirement
Number of Group Changes

Group changes in the transition period appear to be detrimental

– Move cows to maternity at the time of calving
Core Body Temperature (CBT)

• Heat stress
  – Is a problem all year

• Heat stress audits
  – Cows experience big swings in CBT
    • Occurs on many dairies that believe they are managing heat stress
    • May be why we do not obtain the health and reproductive performance we desire
Effects of Heat Stress
Short Term

- Respiration Rate (Up)
- Rectal Temperature (Up)
- Water Intake (Up)
- Sweating (Up)

- Rate of Feed Passage (Down)
- Dry Matter Intake (Down)
- Blood Flow to Internal Organs (Down)
- Milk Production (Down)
Effects of Heat Stress
Long Term

• Future milk production?
  – Lower peaks

• Poor reproductive performance

• Health
  – Udder health
  – Lameness
Total dry matter intake\(^1\) and pounds of dry matter required for maintenance with increasing environmental temperature (dew point = 30)

Peak Milk Production by Lactation and Month of Calving, 1997

Test Dates

Lbs of Milk Per Cow

Peak Milk L1  Peak Milk L2  Peak L3+
In a commercial dairy we never want to let a cow get hot!

• Cows start to get hot at 70° F
• We need to cool cows before they get hot!
Three Ways to Cool Cows

• Cool the cow
  – Primary method in naturally ventilated barns

• Cool the air

• Cool the cow and the air
  – Combination systems
Cooling the Cow

- Soak the cow and dry the cow
- Maximize the number of wet/dry cycles
- Combinations of soakers and fans
- Soak the cow until the skin is wet
- Evaporate the water off the skin
- Primary method in naturally ventilated facilities
- Water usage?
Locations

- Holding pens
- Exit lanes
- Feedlines
Cooling the Air

- Provide a cooler environment for the cow
Systems that Cool the Air

- Korral Kool
- Fans and high pressure misters
- Tunnel ventilation with evaporative pads
- High pressure misters on feedlines
Cooling the Air

• High Humidity Limits Our Ability to Take Advantage of Using Evaporative Cooling to Cool the Air
Potential Temperature Change at 90° F Due to Water Evaporation in a Low Relative Humidity Environment
Potential Temperature Change at 90° F Due to Water Evaporation in a High Relative Humidity Environment
Tunnel or Cross Ventilation with Evaporative Pads

- 100% Tunnel or cross ventilation
  - 24 hrs a day, 7 days a week, 365 days a year
Fully Tunnel Ventilated Freestall Barn, Western Kansas
Average Temperature of Evaporative Cooled and Tunnel Ventilated Four Row Freestalls Located in Western Kansas July and August of 2003
Average Relative Humidity of Evaporative Cooled and Tunnel Ventilated Four Row Freestalls Located in Western Kansas July and August of 2003
Average THI of Evaporative Cooled and Tunnel Ventilated Four Row Freestalls Located in Western Kansas July and August of 2003
Effect of Cow Cooling on Respiration Rate

Breaths/min

Morning  Afternoon  Night  Average

Evap + Tunnel  Dry Lot
Fully Tunnel Ventilated with Evaporative Pads
Located in Northern Indiana
Average Temperature of Evaporative Cooled and Tunnel Ventilated Four Row Freestalls Located in Indiana July and August of 2003
Average Relative Humidity of Evaporative Cooled and Tunnel Ventilated Four Row Freestalls Located in Indiana July and August of 2003
Average THI of Evaporative Cooled and Tunnel Ventilated Tunnel Ventilated Four Row Freestalls Located in Indiana July and August of 2003

![Graph showing THI over time with lines for Barn and Ambient conditions.]
Eight Row Cross Ventilated Low Profile Freestall Facilities

John F. Smith and Joe Harner
Kansas State University
Barn Specifics

- Located in SE North Dakota
- 210 ft wide and 420 ft long
- Sand bedding
- Crossbred cows
- Tail to tail stalls
- Crossovers
  - 20 feet
  - 2 waterers
- 5 ft perimeter walkway
Barn Specifics, Cont.

• Eave height
  – 11 ft 6 in

• Roof slope
  – .5 in 12

• Baffles
  – Located on front of stalls next to the feedlines
  – Metal
  – Parallel to the feedlines
  – 8 ft above alley
  – 6 ft 6 in above beds
Barn Specifics, Cont.

- **Evaporative pads**
  - Two 5 ft pads
  - Six inches thick
- **Fans**
  - Fifty one inch fans every 6 feet
  - Thirty inch minimum ventilation fans
- **R-12 Insulation**
  - Ceiling and sidewalls
- **Florescent lighting**
  - Two rows per pen
  - White baffles
Source: Joe Harner, K-State
Basic Layout of Cross Ventilated Low Profile Free Stall Building

- 398' Evaporative Pad
- 84 - 51" fans located along west side
- Baffle
- 184 Freestalls per Pen (46" stall width)
- 20' Cross Alley (2 8' Water Troughs)
- 210' Entrance Doors
- 34'-7" To Milk Parlor
- 42'-11"
- 200 Cows
- 46'-8"
- 217 Cows
- 53'-8"
- Entrance Doors 215 Cows
- 197 Headlocks
- 179 Cows
- 20' Cross Alley (2 8' Water Troughs)
- 32'-2"
- 184 Freestalls per Pen (46" stall width)
- Bottom of Baffle 8' above alley floor (6'4" opening)

Source: Joe Harner, K-State
3,000 COWS FREE STALL BUILDING
LOW PROFILE - CROSS VENTILATED
12 GROUPS @ 250 COWS/GROUP
Advantages of Cross Ventilation with Evaporative Pads

- Reduces the distance you have to pull air (as compared to tunnel)
  - Increase number of air exchanges per minute
    - Fresher air
    - More consistent temperatures
- Air can be baffled to the cow level
- May be able to put the dairy under one roof
  - Permitting
    - 25 year storm event
    - Controlling runoff
    - Emissions
- Consistent Environment
  - Summer and winter
- Cost less to construct than naturally ventilated barns
- Water usage of evaporative pads may be less as compared to soakers?
Advantages of Cross Ventilation with Evaporative Pads

- Reduces runoff to the lagoon
- Flexibility to cool the cow, air or both
- Lower electrical cost (as compared to fans and soakers)
- Fans are easy to service
- Site selection
  - Smaller foot print
  - Orientation is not an issue
  - Earth moving cost may be reduced
- Fly control
- Starling control
- Walking distance to parlor
  - Reduces time away from feed and water
- Ability to control lighting
- Air quality can be improved
Disadvantages of Cross Ventilation with Evaporative Pads

• Cost as compared to dry-lots
• Tied to mechanical ventilation
  – 24 hrs/day, 7 days/week, 365 days/year
• Airborne diseases?
• Need for generators is increased
Dairy Facilities of the Future

- Must provide an environment that cows can maintain normal CBT
- Time budgets will be essential
  - Cows must have adequate time to rest, eat, etc.
Ammonia Emission Rate in an Eight Row Cross Ventilated Barn

NH₃ ppm

Low, 21 Fans
Medium, 40 Fans
High, 78 Fans

Ventilation Rate

a, b, c P<.0001

Source: Ron Sheffield, Univ. of ID
Summary

• Dairy facilities in the future will need to provide a consistent environment
  – Maintain normal CBT

• Time budgets are essential

• Cross ventilated low profile freestall facilities allow us to manage CBT and time budgets
Thank You!
## Comparison of Fan Electrical Cost for Naturally Ventilated and Cross Ventilated Freestall Barns

<table>
<thead>
<tr>
<th></th>
<th># of Fans</th>
<th>H P (in)</th>
<th>Fan Size (in)</th>
<th># of Cows</th>
<th>Annual Electrical Costs</th>
<th>Annual Electrical Cost/Cow</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural Ventilation (4-Row)(^1)</td>
<td>140</td>
<td>.75</td>
<td>36</td>
<td>756</td>
<td>$19,845</td>
<td>$26.25</td>
</tr>
<tr>
<td>Cross Ventilation (8-row)(^2)</td>
<td>70</td>
<td>1</td>
<td>51</td>
<td>756</td>
<td>$16,097</td>
<td>$21.26</td>
</tr>
<tr>
<td>Cross Ventilation (16-row)(^2)</td>
<td>70</td>
<td>1</td>
<td>51</td>
<td>1512</td>
<td>$16,097</td>
<td>$10.65</td>
</tr>
</tbody>
</table>

\(^1\) 2 Rows of fans/ pen, Fan usage of 150 days/ 24 hrs/ day

\(^2\) Average 50% of fans running

\(^3\) $0.07 KW and .75 KW per HP per hour