Dairy Facilities and Cow Comfort for the Next Decade

John F. Smith, Joe Harner,
Kevin Dhuyvetter & Mike Brouk

Kansas State University, Manhattan, KS

DAIRY TEAM
KANSAS STATE UNIVERSITY

Factors that Determine Decisions Concerning Dairy Facilities

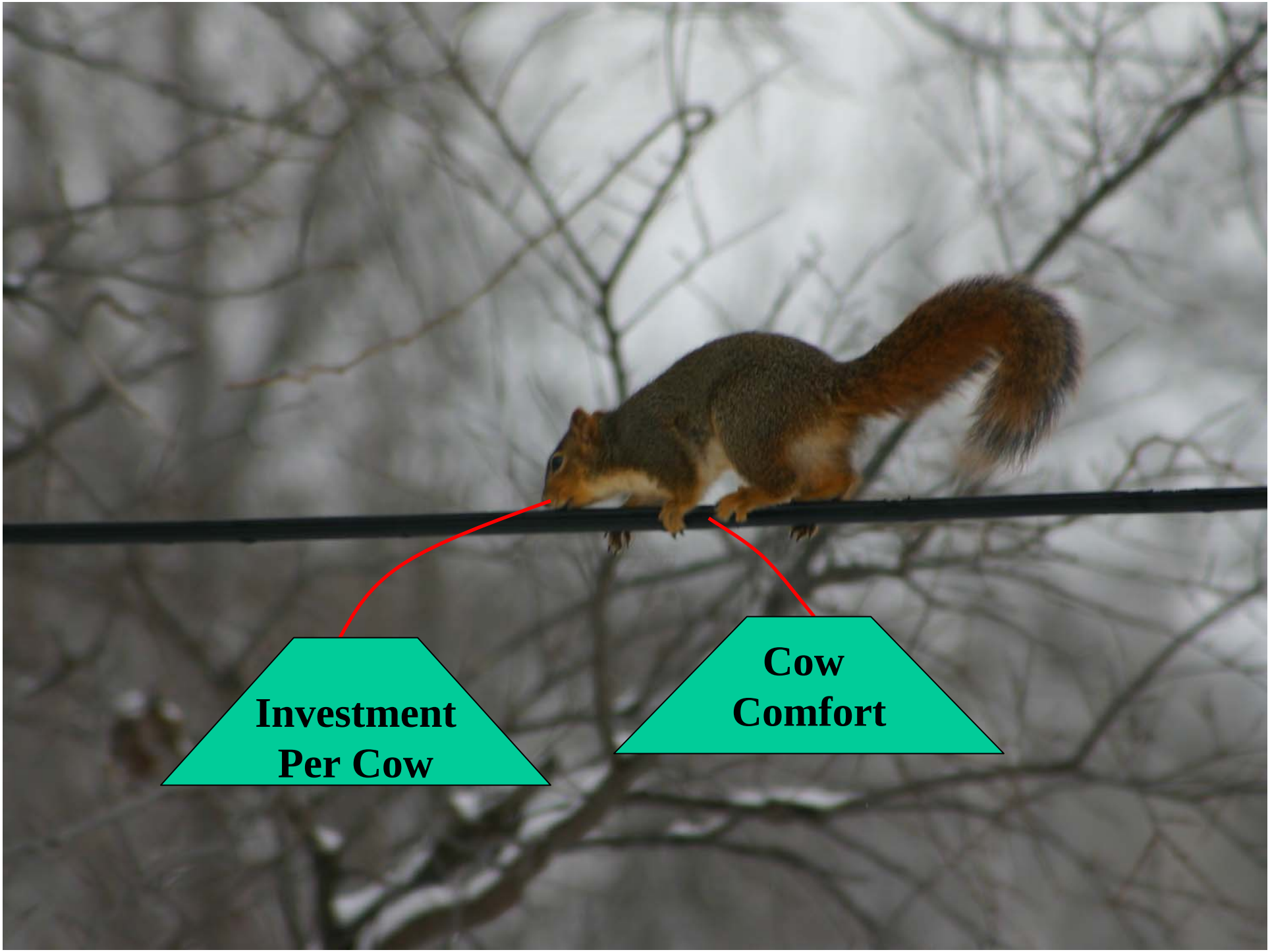
- **The two big factors**
  - **Economics**
    - **Dairy industry trends**
    - **Investment per cow**
    - **Milk production per cow**
  - **Cattle performance**
    - **Milk production**
    - **Reproduction**
    - **Health**

DAIRY TEAM
KANSAS STATE UNIVERSITY

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

DAIRY TEAM
KANSAS STATE UNIVERSITY


Investment
Per Cow
Cow
Comfort

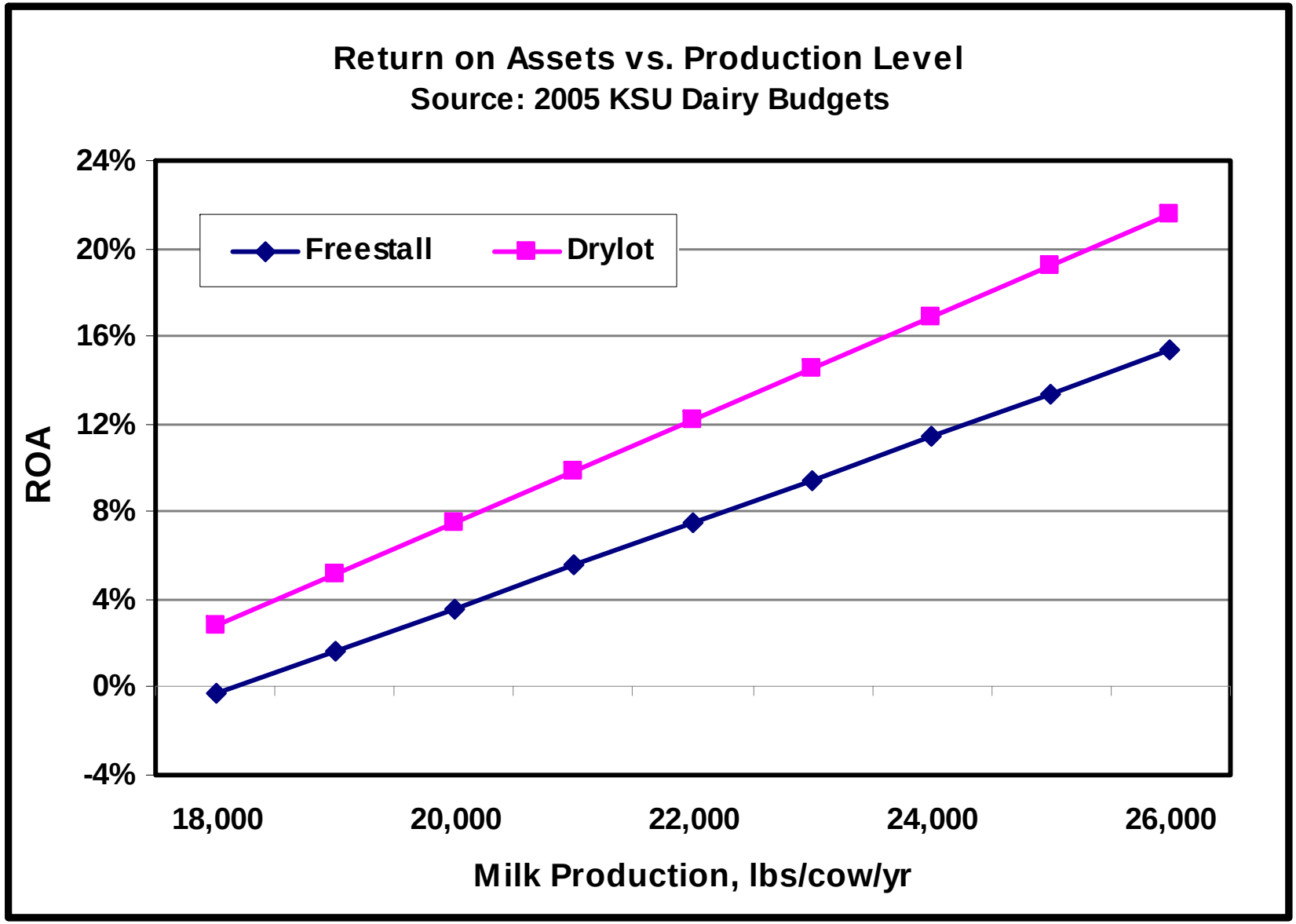
Dairy Enterprise – 2,400 Lactating Cows – Freestall[1]

Sensitivity of Return on Assets to Production and Investment					
Production	**Investment per cow***				
level (lbs/cow)	**$3,000**	**$3,500**	**$4,000**	**$4,500**	**$5,000**
22,000	**9.2%**	**7.5%**	**6.1%**	**4.9%**	**3.8%**
23,000	**11.3%**	**9.5%**	**7.9%**	**6.6%**	**5.4%**
24,000	**13.5%**	**11.4%**	**9.7%**	**8.2%**	**7.0%**
25,000	**15.6%**	**13.4%**	**11.5%**	**9.9%**	**8.5%**
26,000	**17.7%**	**15.3%**	**13.3%**	**11.6%**	**10.1%**

*** 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**

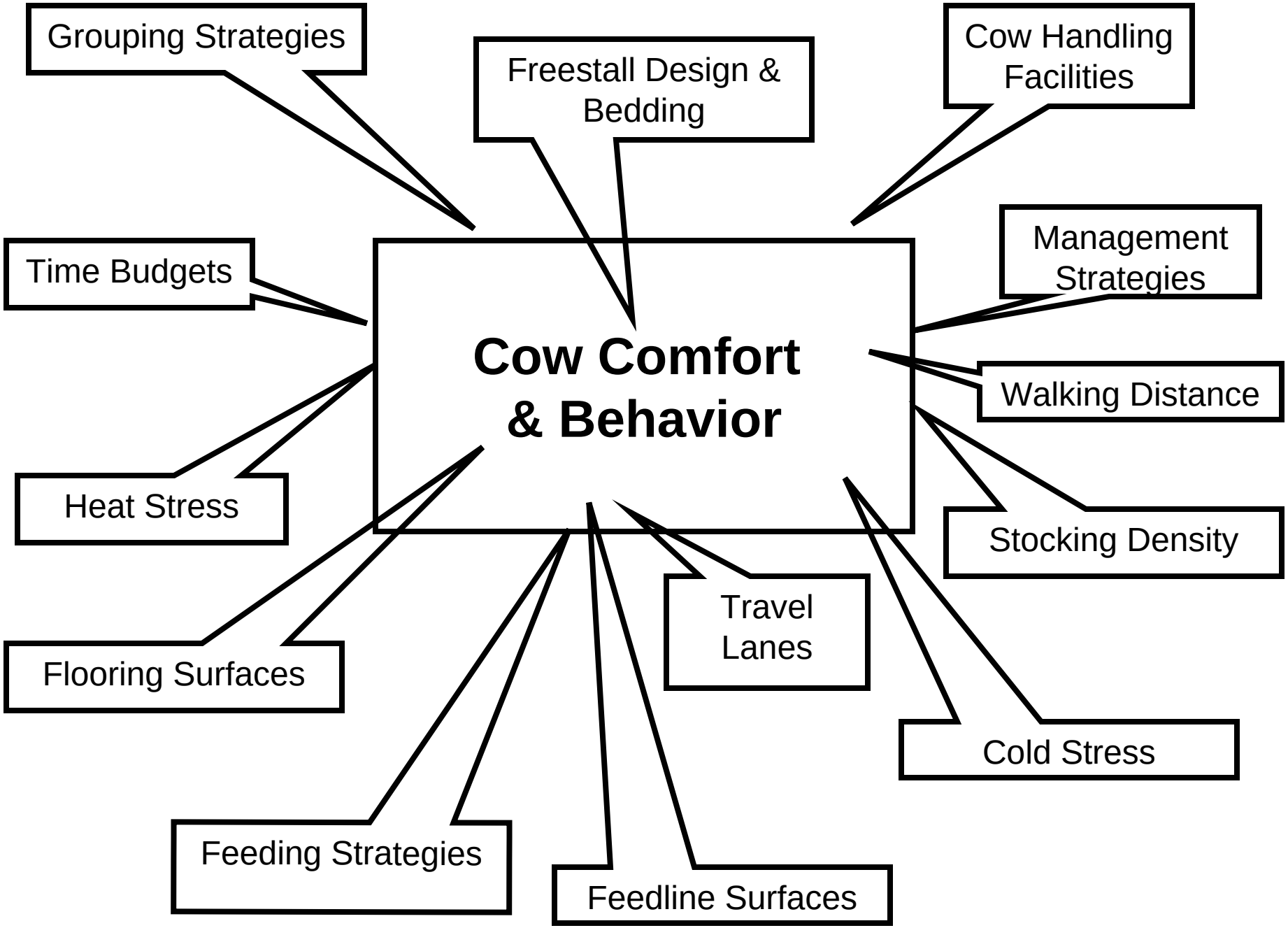
[1] Based on K-State Dairy Budget MF-2442


Return on Assets vs. Production Level
Source: 2005 KSU Dairy Budgets
24%
20%
16%
12%
8%
4%
0%
-4%
ROA
Freestall
Drylot
18,000
20,000
22,000
24,000
26,000
Milk Production, lbs/cow/yr

Cow Comfort & Behavior

- **Under U.S. conditions we improve cow comfort or take advantage of behavior when it improves performance**
  - **Milk production**
  - **Reproduction**
  - **Health**

DAIRY TEAM
KANSAS STATE UNIVERSITY


Grouping Strategies
Freestall Design & Bedding
Cow Handling Facilities
Time Budgets
Management Strategies
Cow Comfort & Behavior
Walking Distance
Heat Stress
Stocking Density
Travel Lanes
Flooring Surfaces
Cold Stress
Feeding Strategies
Feedline Surfaces

Improving Cow Comfort

- **How you intervene is crucial**
  - **Order of steps to improve cow comfort**
    - **Rubber vs. managing heat stress**

DAIRY TEAM
KANSAS STATE UNIVERSITY

Cow Comfort & Behavior

- **Time budgets**
- **Core body temperature**
- **Number of group changes**

DAIRY TEAM
KANSAS STATE UNIVERSITY

Time Budgets for Dairy Cows Milked 3X[C] with Different Travel Times

	Recommended[A]	20 min.[B]	30 min.[B]	40 min.[B]
Milking Parlor	1.2 - 3.2	3.0	3.5	4.0
Feeding	5.3	5.3	5.3	5.3
Water	0.5	0.5	0.5	0.5
Socialization & Standing	3.0	3.0	3.0	3.0
Resting	12 – 14	12.2	11.7	11.2

[A]Rick Grant, Miner Institute
[B]Travel time to and from the parlor
[C]Time required to milk a group of cows is 40 minutes

DAIRY TEAM
KANSAS STATE UNIVERSITY

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**

DAIRY TEAM
KANSAS STATE UNIVERSITY

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**

DAIRY TEAM
KANSAS STATE UNIVERSITY

Effects of Heat Stress
Short Term

- ↑ Respiration Rate
- ↑ Rectal Temperature
- ↑ Water Intake
- ↑ Sweating

- ↓ Rate of Feed Passage
- ↓ Dry Matter Intake
- ↓ Blood Flow to Internal Organs
- ↓ Milk Production

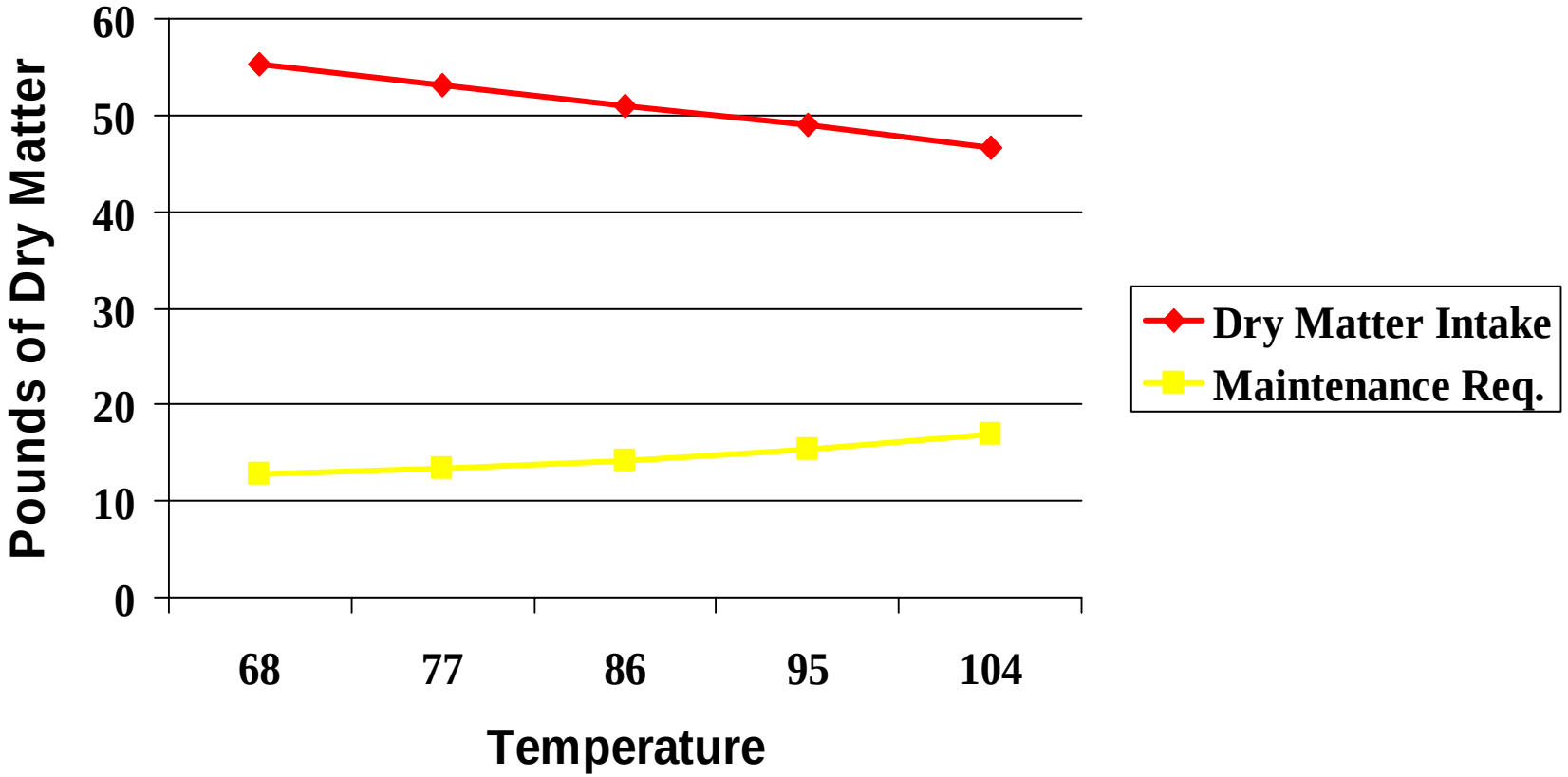
DAIRY TEAM
KANSAS STATE UNIVERSITY

Effects of Heat Stress
Long Term

- **Future milk production?**
  - **Lower peaks**
- **Poor reproductive performance**
- **Health**
  - **Udder health**
  - **Lameness**

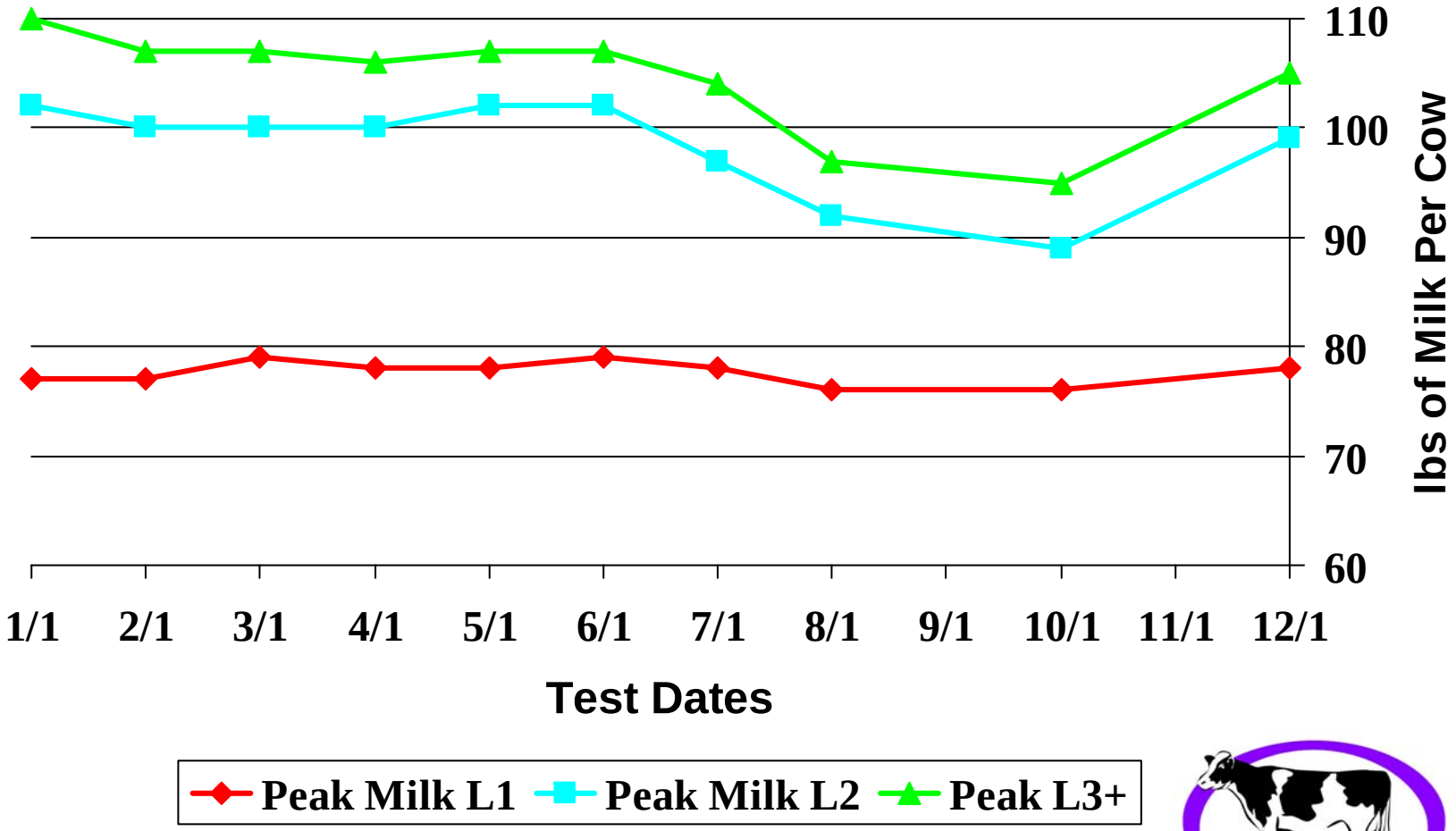
DAIRY TEAM
KANSAS STATE UNIVERSITY

Total dry matter intake[1] and pounds of dry matter required for maintenance with increasing environmental temperature (dew point = 30)



[1] Holter, West, and McGilliard. 1997. Journal of Dairy Science 80:2188.

Peak Milk Production by Lactation and Month of Calving, 1997



DAIRY TEAM
KANSAS STATE UNIVERSITY

In a commercial dairy we never want to let a cow get hot!

- **Cows start to get hot at 70º F**
- **We need to cool cows before they get hot!**

DAIRY TEAM
KANSAS STATE UNIVERSITY

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**

DAIRY TEAM
KANSAS STATE UNIVERSITY

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?**

DAIRY TEAM
KANSAS STATE UNIVERSITY

Locations

- **Holding pens**
- **Exit lanes**
- **Feedlines**

DAIRY TEAM
KANSAS STATE UNIVERSITY

Cooling the Air

- **Provide a cooler environment for the cow**

DAIRY TEAM
KANSAS STATE UNIVERSITY

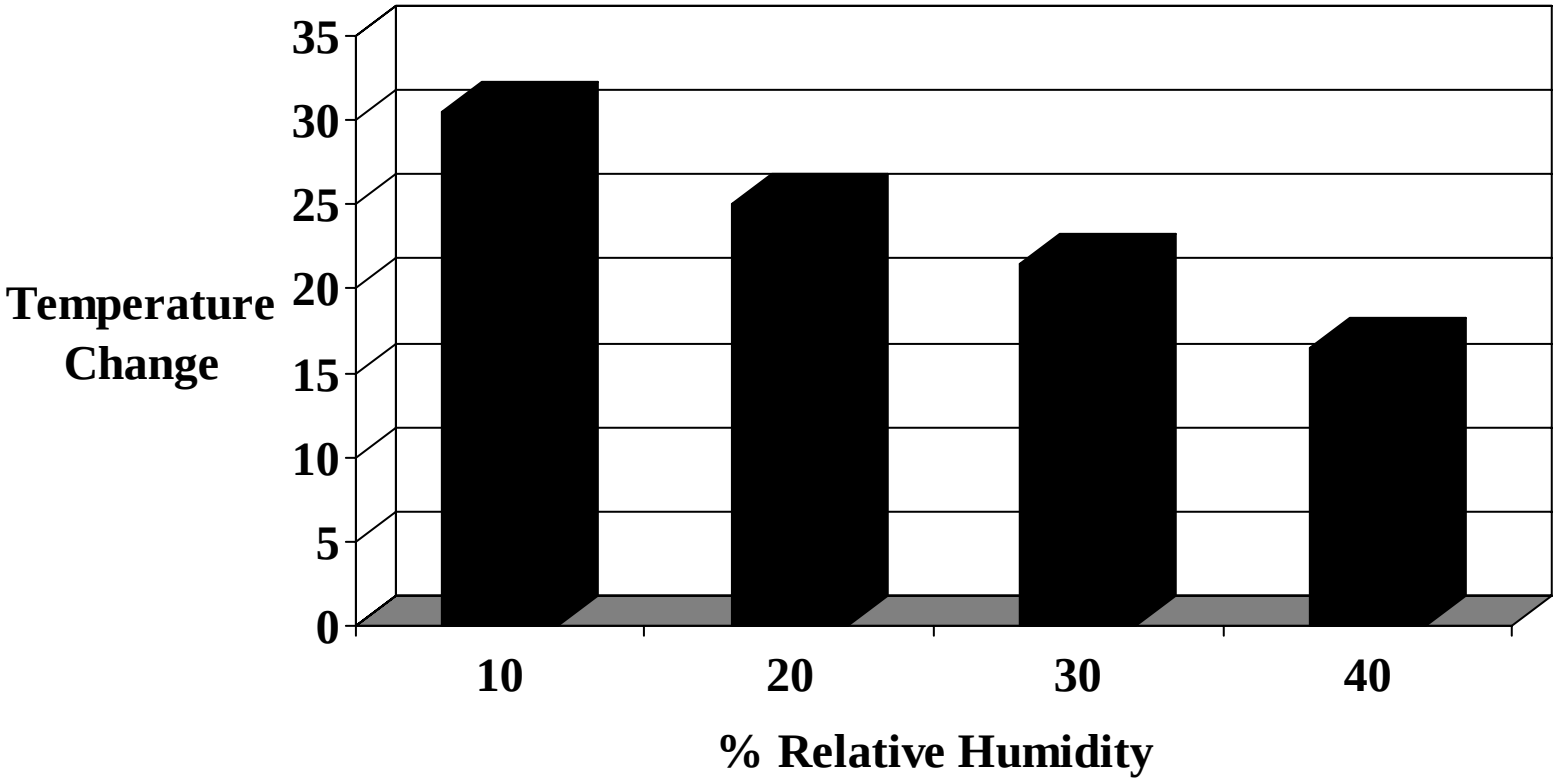
Systems that Cool the Air

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

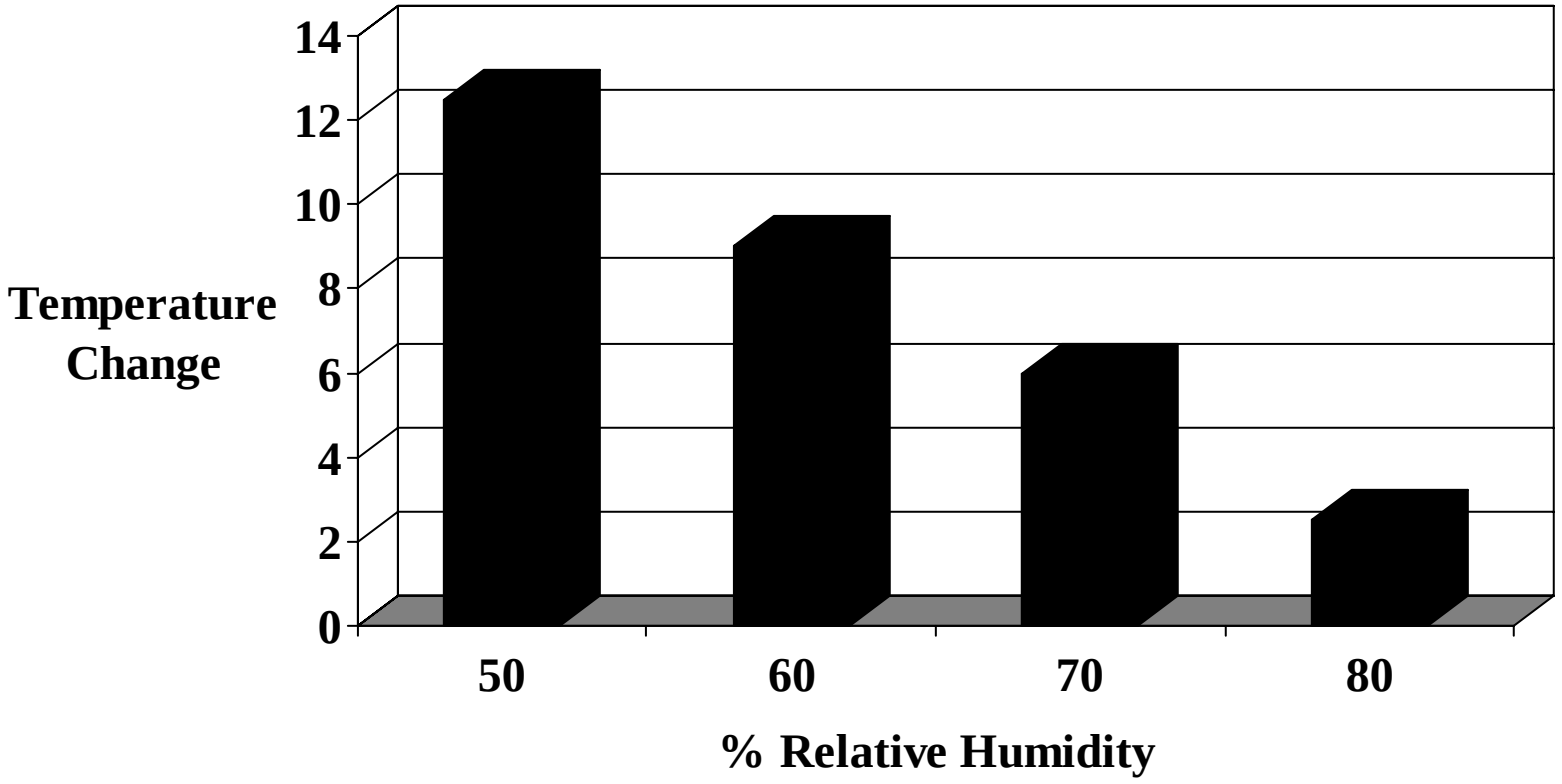
Cooling the Air

- **High Humidity Limits Our Ability to Take Advantage of Using Evaporative Cooling to Cool the Air**

Potential Temperature Change at 90º F Due to Water Evaporation in a Low Relative Humidity Environment



Potential Temperature Change at 90º F Due to Water Evaporation in a High Relative Humidity Environment

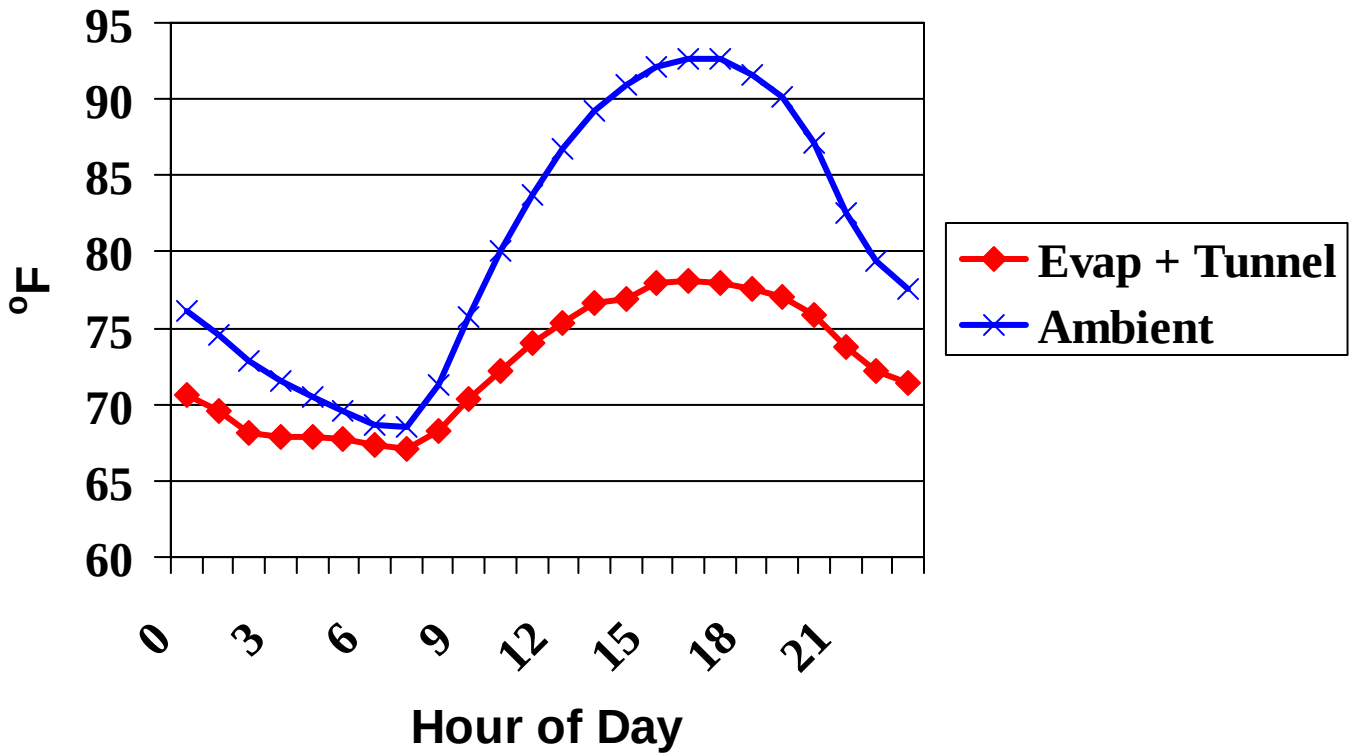


Tunnel or Cross Ventilation with Evaporative Pads

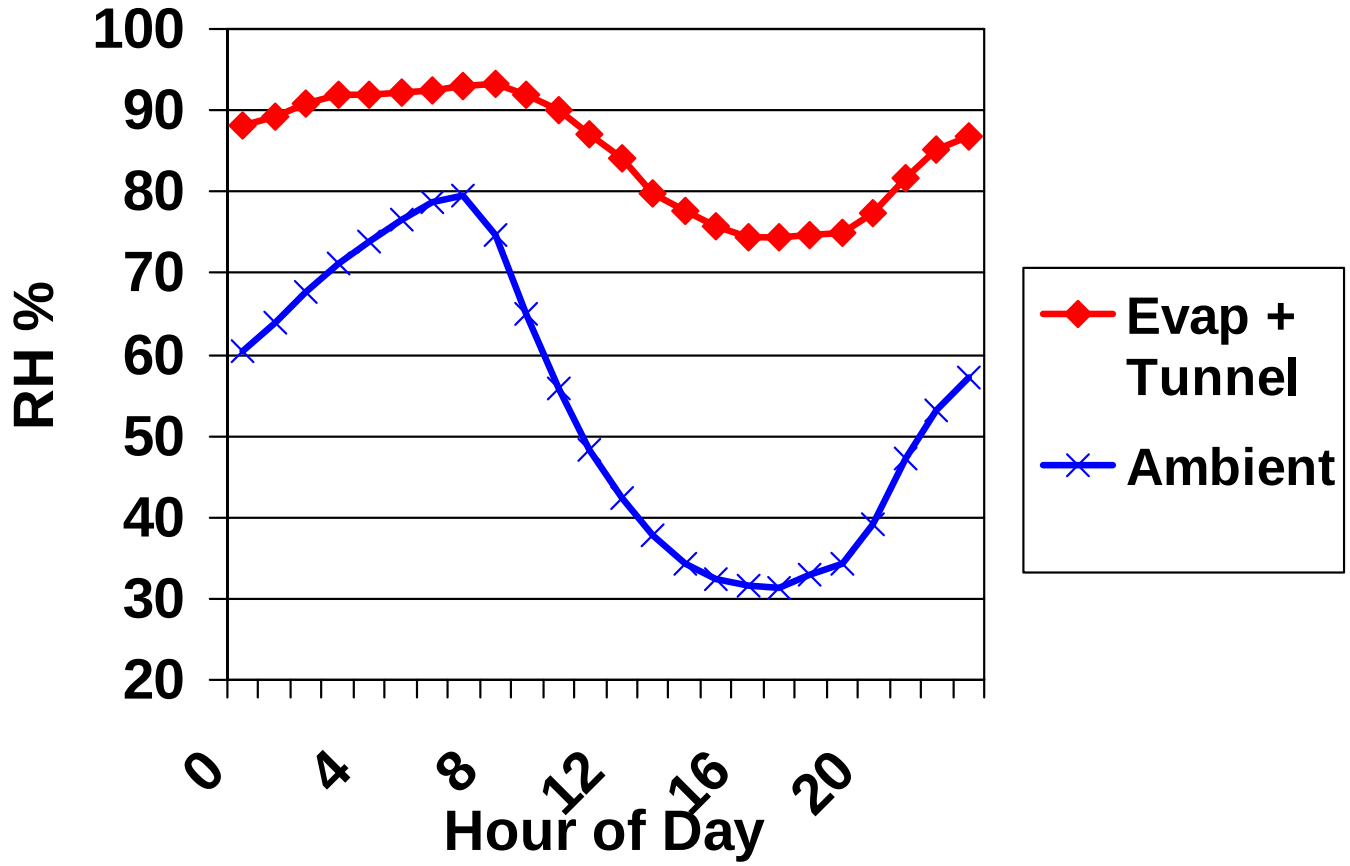
- **100% Tunnel or cross ventilation**
  - **24 hrs a day , 7 days a week, 365 days a year**

Fully Tunnel Ventilated Freestall Barn, Western Kansas

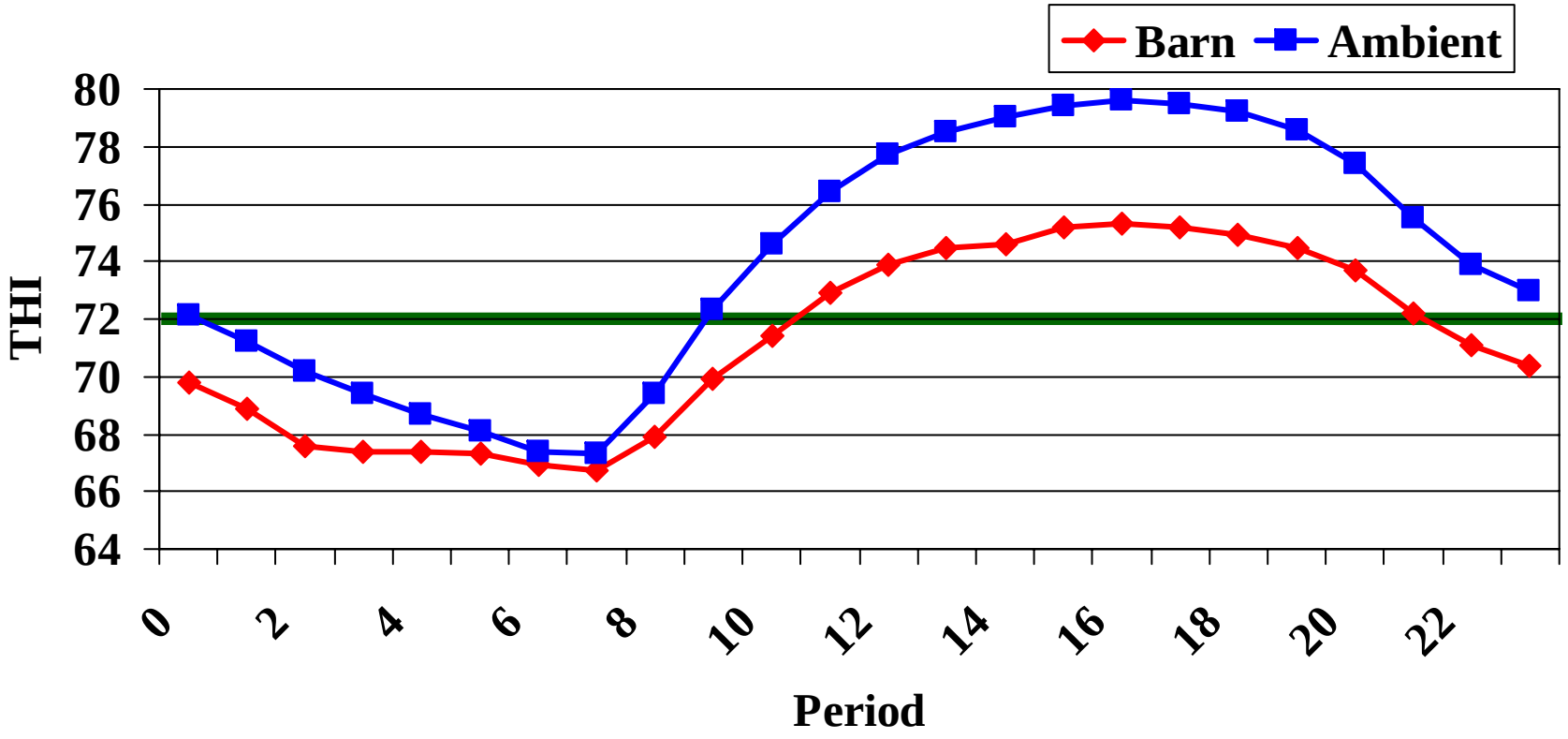
Average Temperature of Evaporative Cooled and Tunnel Ventilated Four Row Freestalls Located in Western Kansas July and August of 2003



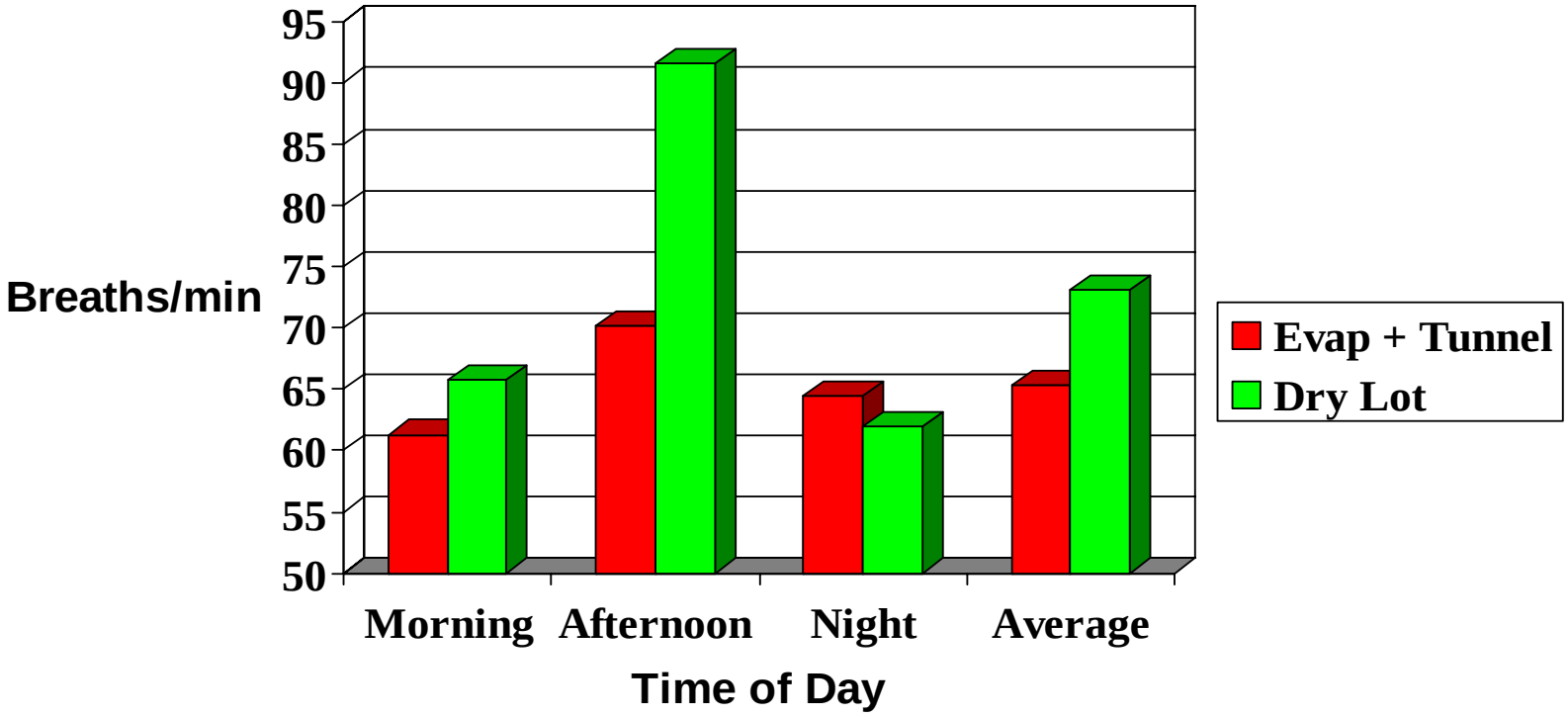
Average Relative Humidity of Evaporative Cooled and Tunnel Ventilated Four Row Freestalls Located in Western Kansas
July and August of 2003



Average THI of Evaporative Cooled and Tunnel Ventilated Four Row Freestalls Located in Western Kansas July and August of 2003

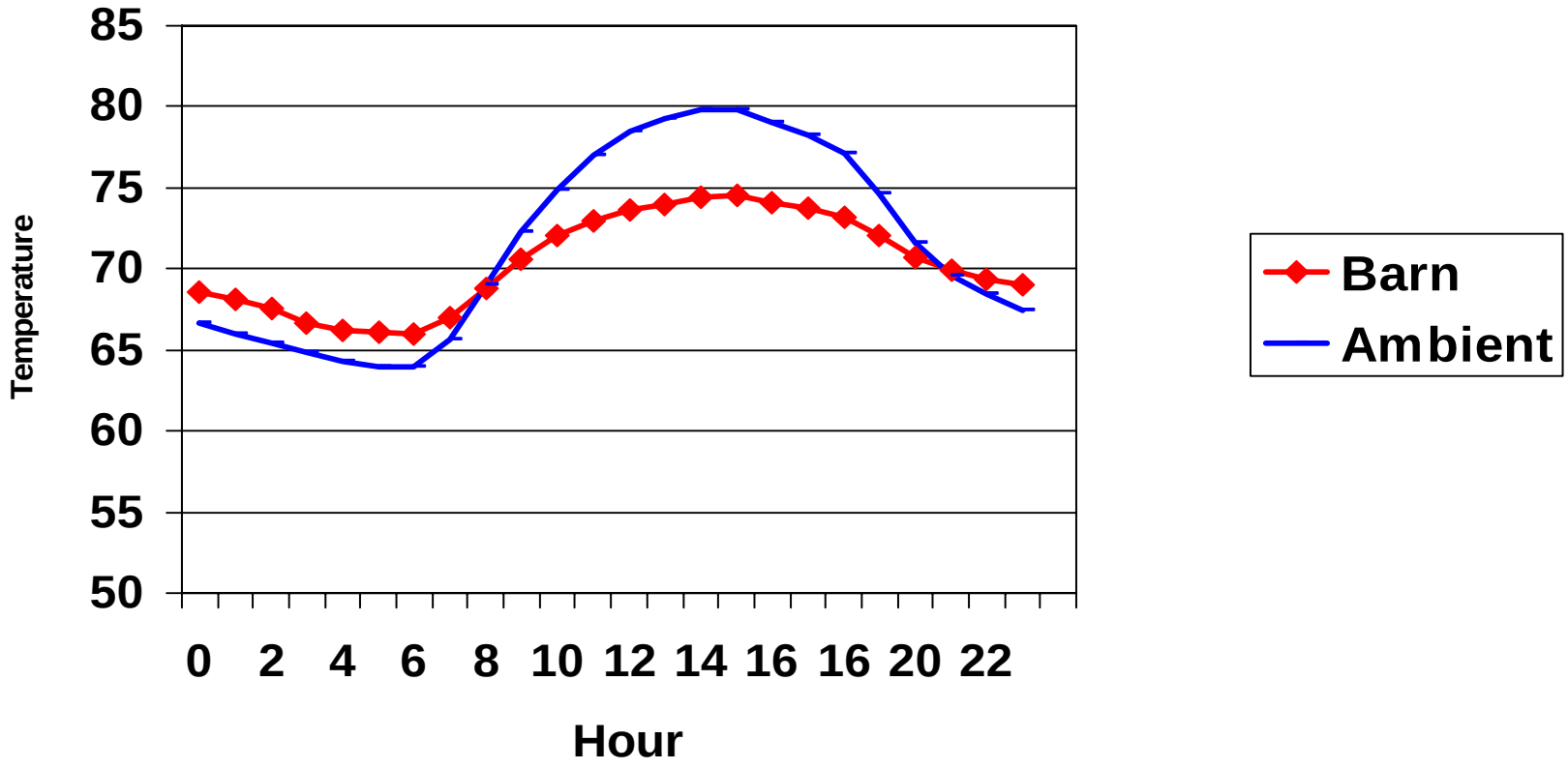


Effect of Cow Cooling on Respiration Rate

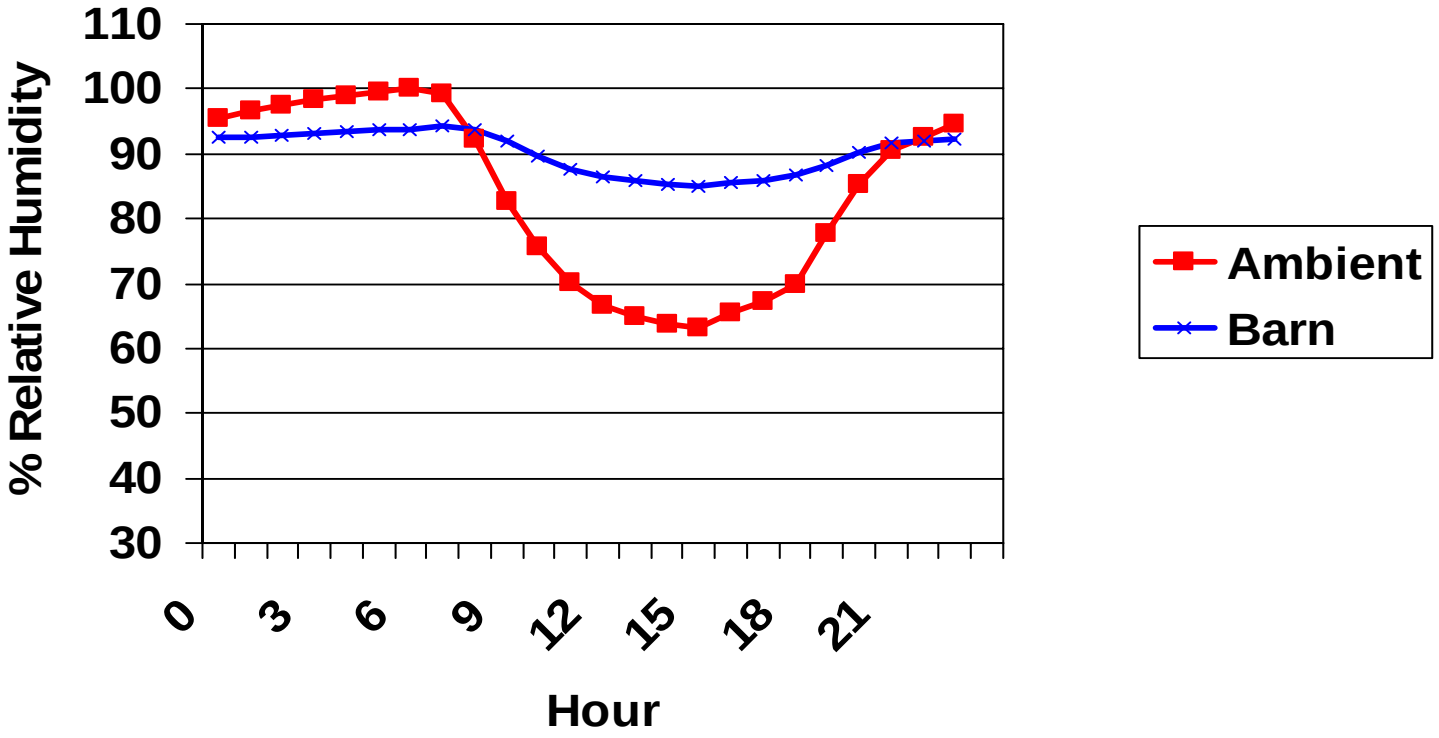


Fully Tunnel Ventilated with Evaporative Pads
Located in Northern Indiana

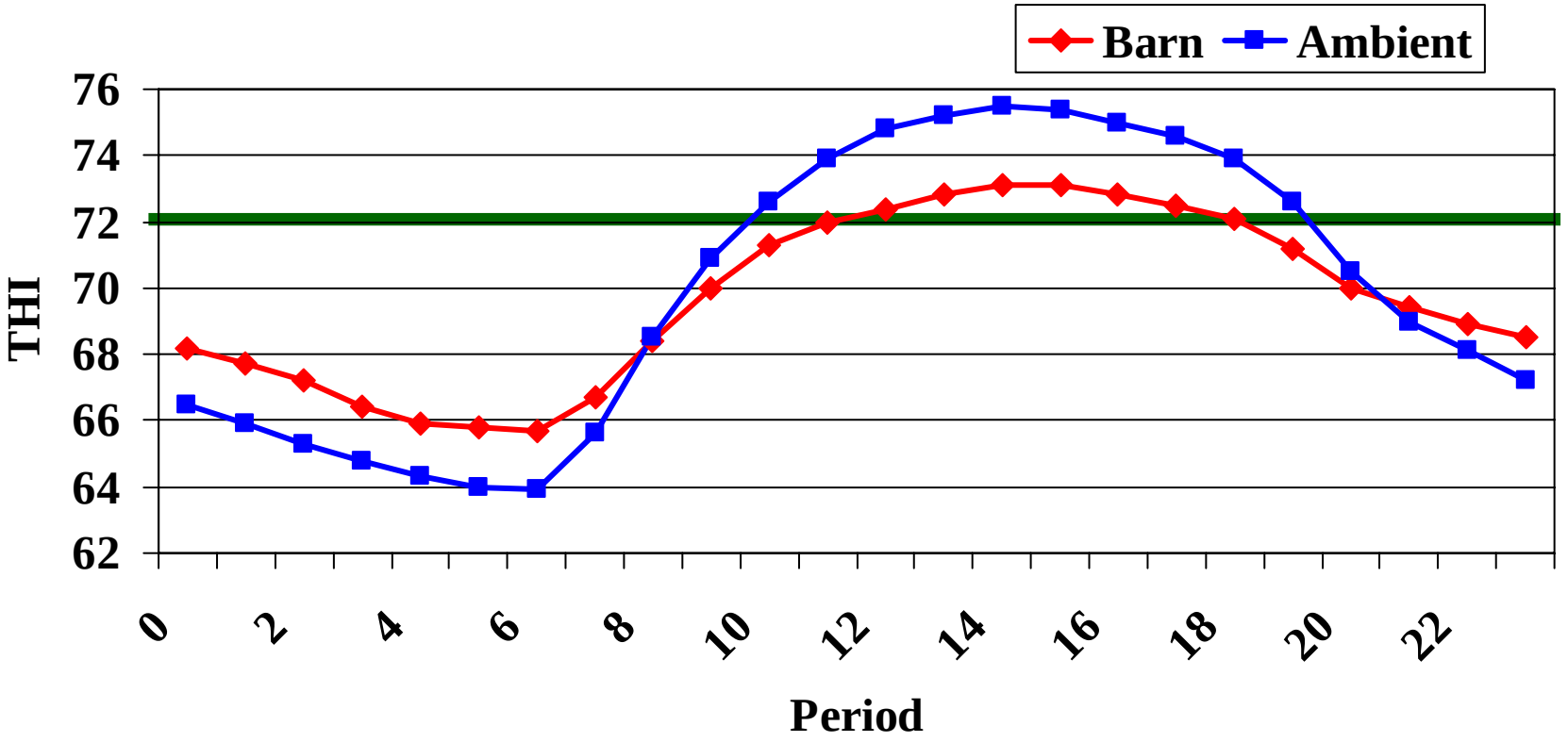
Average Temperature of Evaporative Cooled and Tunnel Ventilated Four Row Freestalls Located in Indiana July and August of 2003



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



Eight Row Cross Ventilated Low Profile Freestall Facilities

John F. Smith and Joe Harner

Kansas State University

DAIRY TEAM
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

DAIRY TEAM
KANSAS STATE UNIVERSITY

Barn Specifics, Cont.

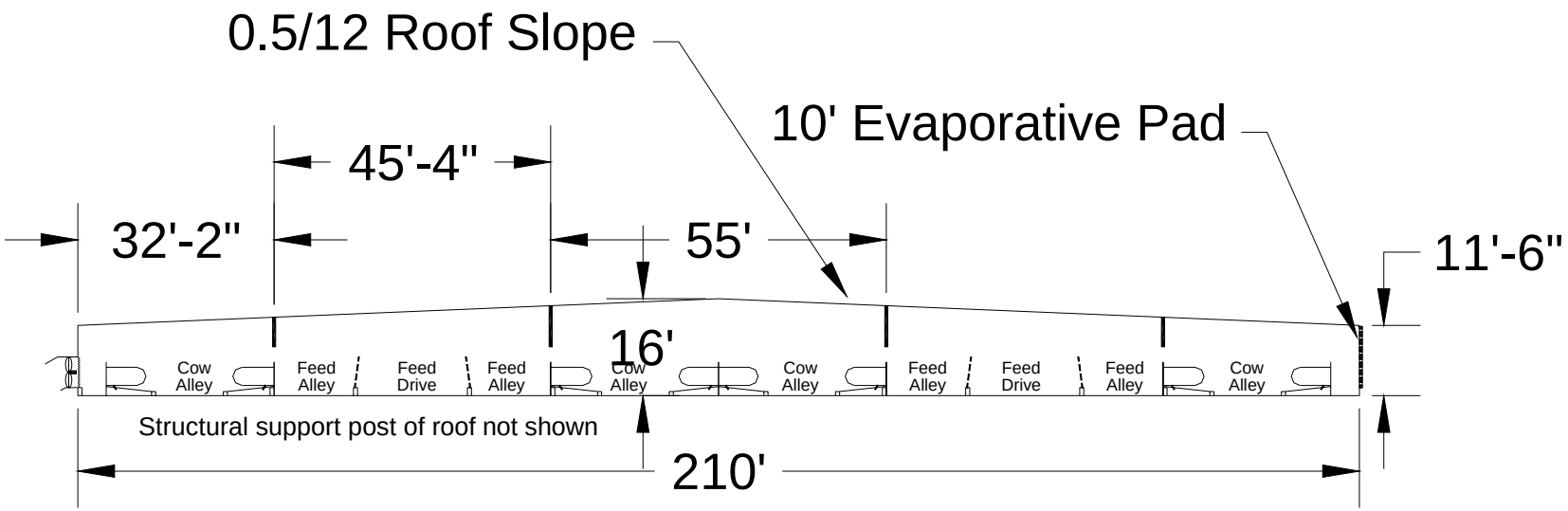
- **Eave height**
  - **11 ft 6 in**
- **Roof slope**
  - **.5 in 12**
- **Baffles**
  - **Located on front of stalls next to the feedlines**
  - **Metal**
  - **Parallel to the feedlines**
  - **8 ft above alley**
  - **6 ft 6 in above beds**

DAIRY TEAM
KANSAS STATE UNIVERSITY

Barn Specifics, Cont.

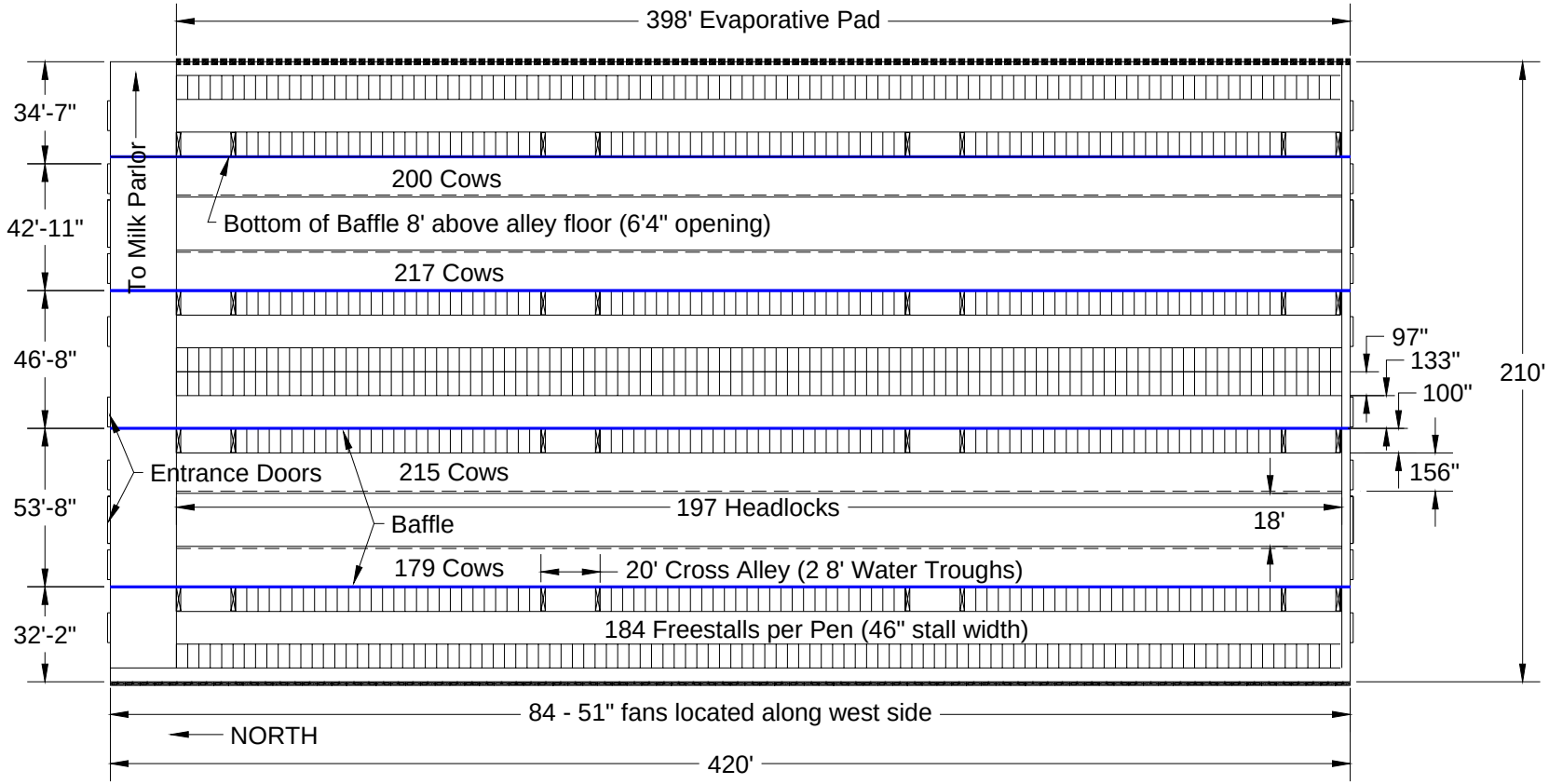
- **Evaporative pads**
  - **Two 5 ft pads**
  - **Six inches thick**
- **Fans**
  - **Fifty one inch fans every 6 feet**
  - **Thirty inch minimum ventilation fans**
- **R-12 Insulation**
  - **Ceiling and sidewalls**
- **Florescent lighting**
  - **Two rows per pen**
  - **White baffles**

DAIRY TEAM
KANSAS STATE UNIVERSITY



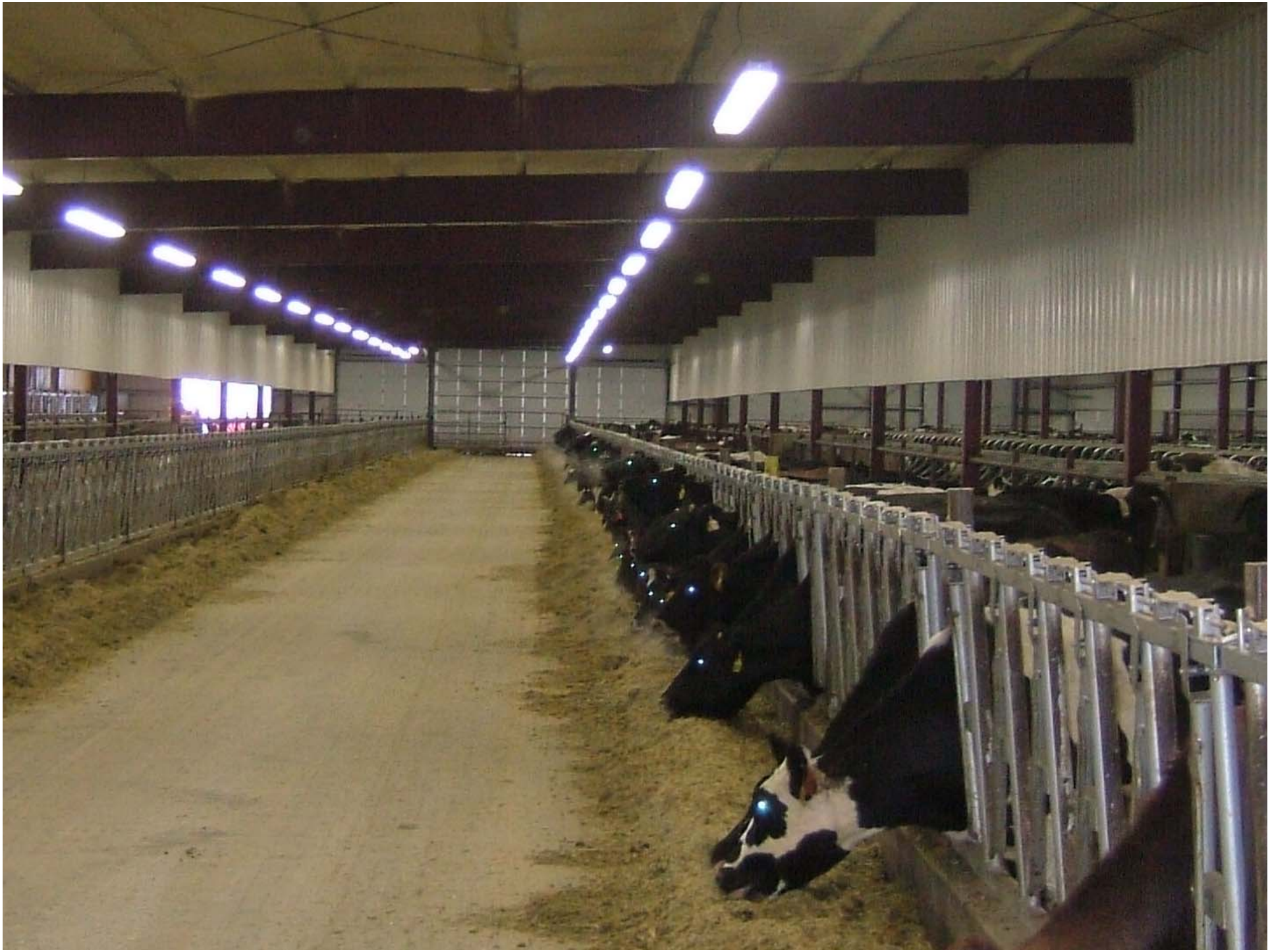
Source: Joe Harner, K-State

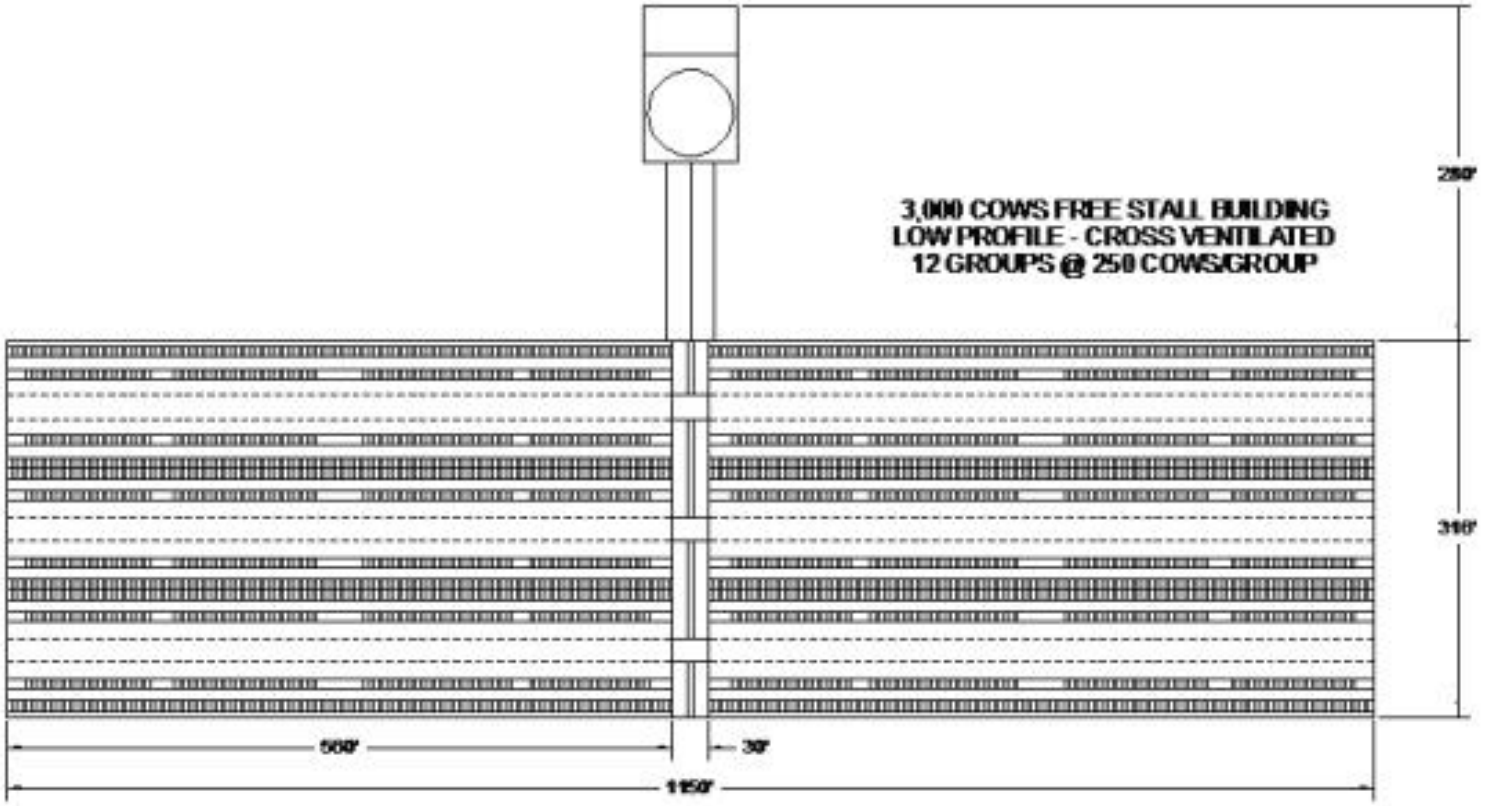
DAIRY TEAM
KANSAS STATE UNIVERSITY



Basic Layout of Cross Ventilated Low Profile Free Stall Building [redacted]

Source: Joe Harner, K-State




3,000 COWS FREE STALL BUILDING
LOW PROFILE - CROSS VENTILATED
12 GROUPS @ 250 COWS/GROUP
250'
310'
560'
30'
1150'

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 then 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

DAIRY TEAM
KANSAS STATE UNIVERSITY

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**

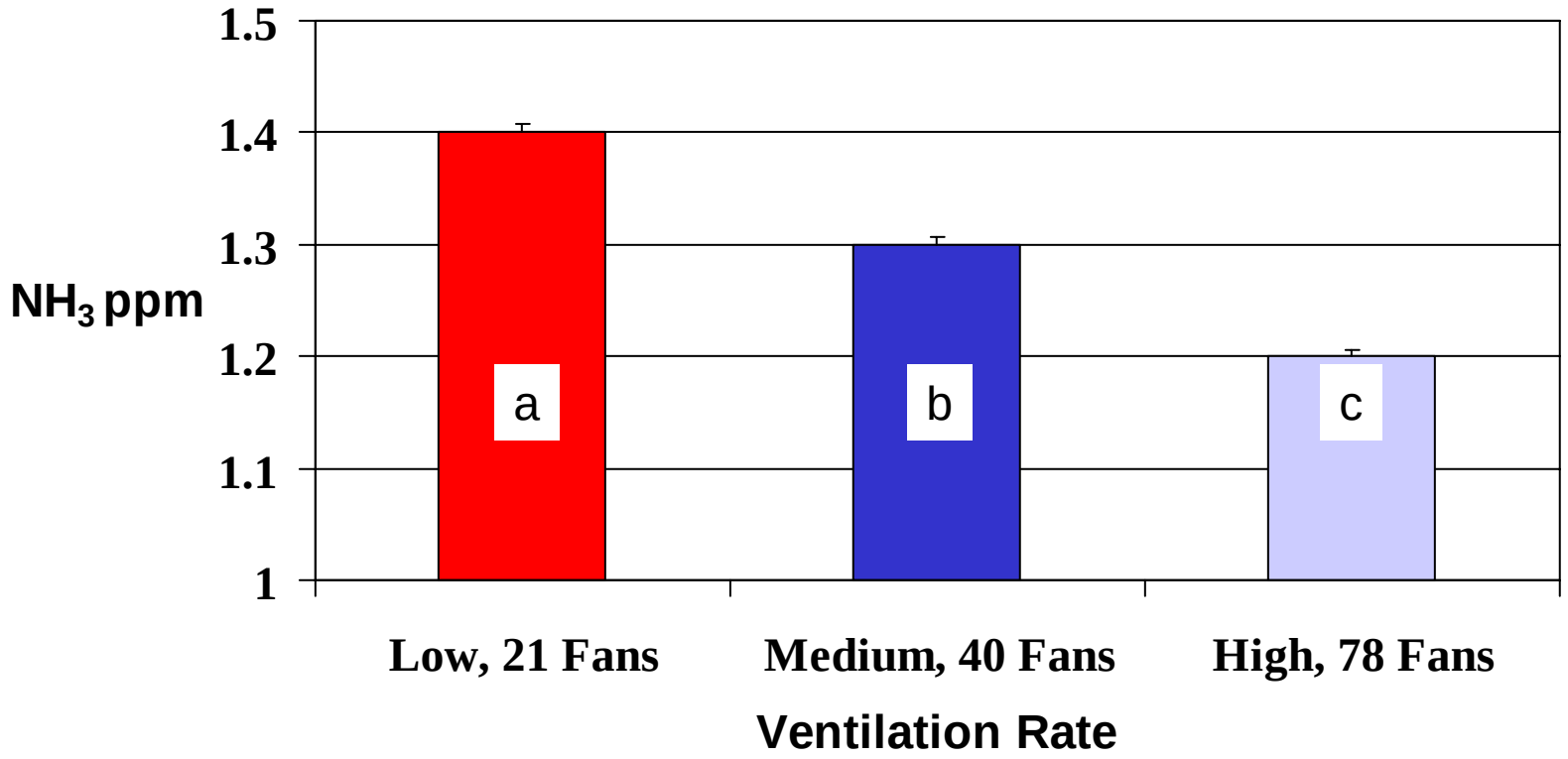
DAIRY TEAM
KANSAS STATE UNIVERSITY

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.**

DAIRY TEAM
KANSAS STATE UNIVERSITY

Ammonia Emission Rate in an Eight Row Cross Ventilated Barn



[a,b,c] P<.0001

Source: Ron Sheffield, Univ. of ID

DAIRY TEAM
KANSAS STATE UNIVERSITY

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**

DAIRY TEAM
KANSAS STATE UNIVERSITY

Thank You!

Comparison of Fan Electrical Cost for Naturally Ventilated and Cross Ventilated Freestall Barns

	# of Fans	H P	Fan Size (in)	# of Cows	Annual Electrical Costs[3]	Annual Electrical Cost/Cow[3]
Natural Ventilation (4-Row)[1]	140	.75	36	756	$19,845	$26.25
Cross Ventilation (8-row)[2]	70	1	51	756	$16,097	$21.26
Cross Ventilation (16-row)[2]	70	1	51	1512	$16,097	$10.65

[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

DAIRY TEAM
KANSAS STATE UNIVERSITY