

Heat Stress in Dairy Cows

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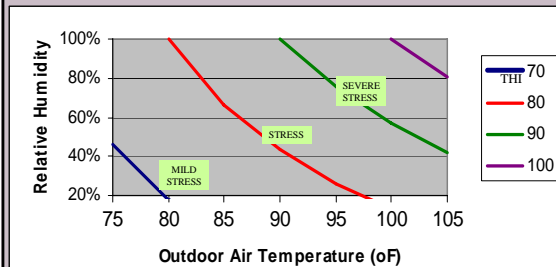


Topics

- Physiology of heat stress
- How Cows Deal with Heat Stress
- Impact of Heat Stress on cows and dairies
- Heat Audit Project
- Recommendations for cooling cows in the eastern US
- Recommendations for barn design



What constitutes heat stress?



Heat Stress consequences:

- Lower Production
- Poor Reproduction
- Rumen Acidosis
- Milk Fat Depression
- Laminitis/Lameness
- Lowered Immune System
- Mastitis
- Transition Disorders (RP, DA, etc.)
- Low Body Condition Score



Dairy cow heat production

- Cows produce 4,500-6,000 Btu's/hr.
- Equivalent to a 1500 watt hair dryer



Production and Heat Output

- Increasing milk yield increases heat output of the dairy cow
- Since 1950 heat production per cow has increased an average of 30 MJ/cow/day
- High producing cows become more cold tolerant and less heat tolerant i.e. the Thermal Neutral Zone shifts down
- Failure to recognize this and change barn design results in stress on cattle

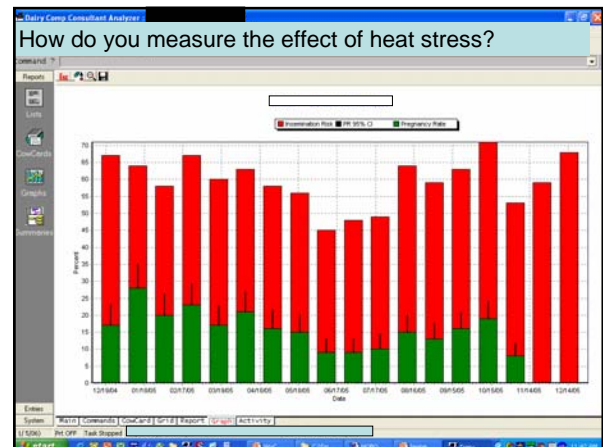
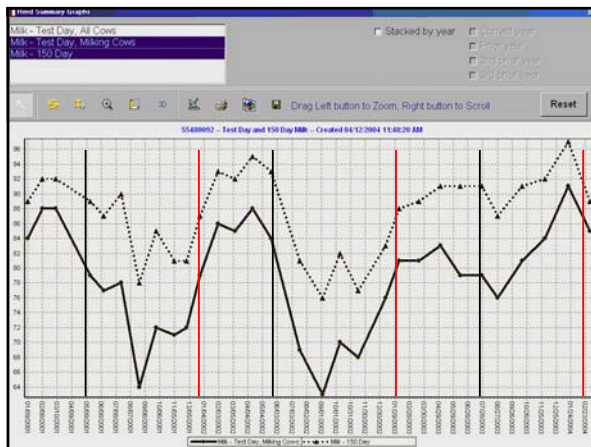


Physiological response to heat stress

- Hormones involved
 - Thyroxin
 - Prolactin
 - Cortisol, aldosterone
 - Somatotropin (bST)
 - increases animal's ability to dissipate heat



How do you measure the effects of heat stress in dairy herds?



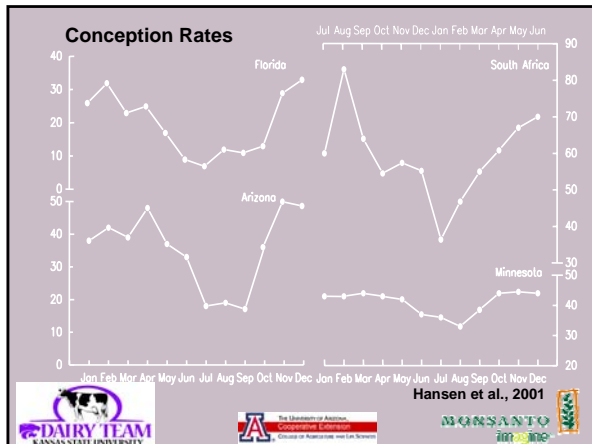
Heat stress can be devastating even in great herds

Date	Br E1a	Bred	Pct	Pa E1a	Preg	Pct	Aborts
10-27-04	930	684	73	935	260	28	41
11-17-04	853	561	66	851	225	26	21
12-08-04	868	635	73	866	237	27	31
12-29-04	975	884	90	970	224	23	23
1-19-05	1008	679	67	1006	210	21	19
2-09-05	1026	746	73	1025	240	23	21
3-02-05	1132	817	72	1129	266	24	30
3-23-05	1183	780	66	1177	257	22	32
4-13-05	1296	803	62	1294	265	20	37
5-04-05	1346	886	66	1342	275	20	9
5-25-05	1335	810	61	1329	187	14	4
6-15-05	1431	887	62	1422	207	15	6
7-06-05	1554	905	58	1542	197	13	3
7-27-05	1699	1075	63	1689	247	14	1
8-17-05	1864	1134	61	1854	345	19	2
9-07-05	1926	1089	57	1897	335	18	4
9-28-05	1897	1046	55	0	0	0	0
10-18-05	1603	846	53	0	0	0	0
Total	20434	3175	64	20328	3974	20	284

How about the impact on repro performance?

- Research indicates that negative impact begins at body temperature of approximately 102.5°
- Embryo is most sensitive in first 4-6 days after fertilization
- May only require 2-3 hours of exposure to increased body temp.





How does heat stress affect reproductive performance?

- Direct effect of hyperthermia on reproductive axis
- Indirect effect related to reduced DMI and nutrient intake

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Heat stress and reproductive patterns

(Rensis and Scaramuzzi, 2003. Theriogenology 60:1139-1151)

- reduces duration of estrus
- reduces intensity of estrus
- changes hormonal patterns
 - LH decreased
 - Estradiol reduced
 - Progesterone effects variable
 - Luteolysis delayed

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Heat stress and follicular development

(Rensis and Scaramuzzi, 2003. Theriogenology 60:1139-1151)

- Delays follicular selection
- Lengthens follicular wave

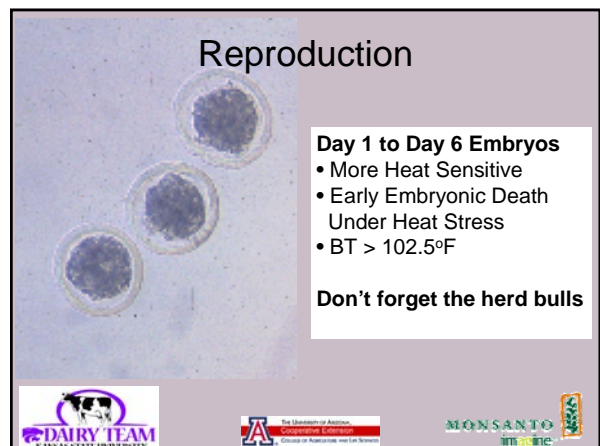
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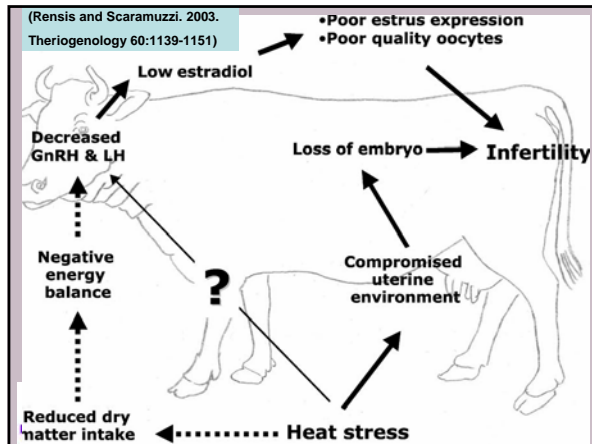
Heat stress affects gametes and embryos

(Rensis and Scaramuzzi, 2003. Theriogenology 60:1139-1151)

- Spermatogenesis inhibited
- Development of oocytes may be inhibited
- Decreased uterine blood flow
- Increased uterine temperature
 - Reduced embryo survival

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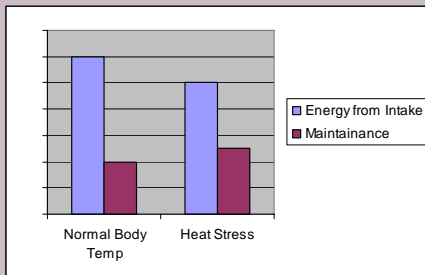
Heat stress and energy balance

(Rensis and Scaramuzzi, 2003. Theriogenology 60:1139-1151)

- DMI reduced
 - may prolong period of negative energy balance
 - reduced insulin, IGF-1 and glucose
 - reduces follicular development and oocyte quality
- Maintenance requirement increased



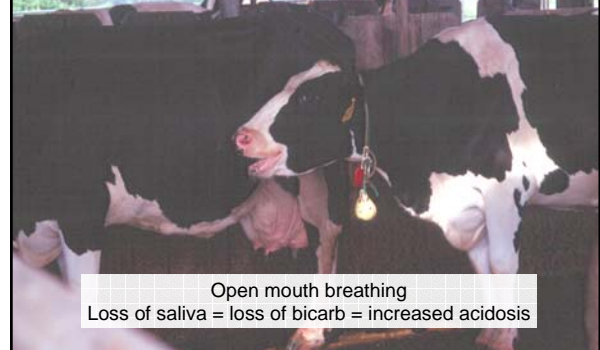
Impact of Heat Stress



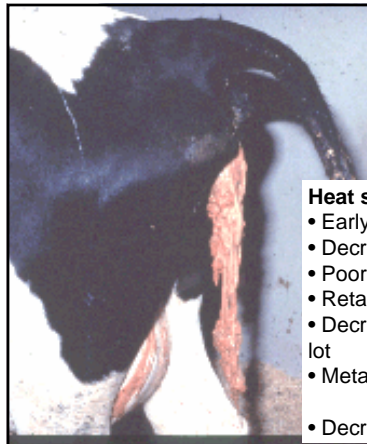
Lower DMI and Higher Maintenance = Less Energy for Milk and Repro



It's tough for this cow to eat much!!



Cow health



Heat stress:

- Early calves (10 to 14 days)
- Decreased birth weight
- Poor doing calves
- Retained placentas
- Decrease time in close-up lot
- Metabolic problems
Ketosis, DA's
- Decreased milk production

Heat Stress and Somatotropin

- bST is one of the cow's stress-fighting hormones
- Somatotropin's role in homeorhesis extends to acclimation to heat stress in lactating cattle



Heat Stress and Somatotropin

- 12 cows under both Field and Lab conditions
- Environmental THI > 72 16 hours per day
- Milk yield increase was 6.1 kg/day in Field Study and 8.1 kg/day in Environmental Lab
- bST treated cows increased heat production by 19 and 25% under Field and Environmental Lab
- bST treated cows increased heat loss via skin and respiratory vaporization by 36% and 24% under Field and Laboratory conditions

Manalu et al. J. Nutr. 1990 and Pollard et al. J. Dairy Sci. 2005



Somatotropin and Stress Resistance

- Increased capability to dissipate heat
 - Skin Surface
 - Respiratory Tract
- Increased resistance to cold stress
- Increased immune function
- Reduced adrenal corticoid secretion
- Increased feed intake



Effect of bST and Environment on Milk Yield in Holstein Cows under Farm and Environmental Laboratory Conditions

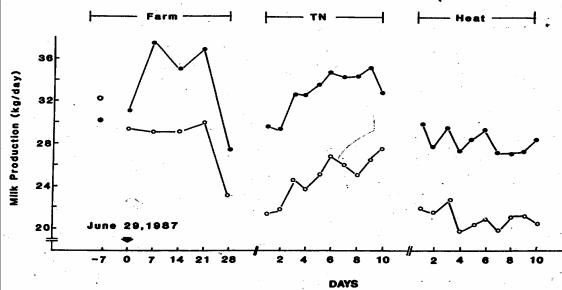


Figure 4. Average daily milk yields for control (O) and bST-treated (●) cows prior to experiment and during summer farm, laboratory thermoneutral (TN), and laboratory heat conditions. Initiation of bST injection (June 29, 1987) is indicated by arrow.

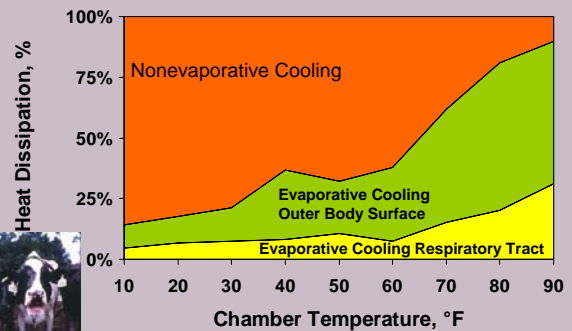
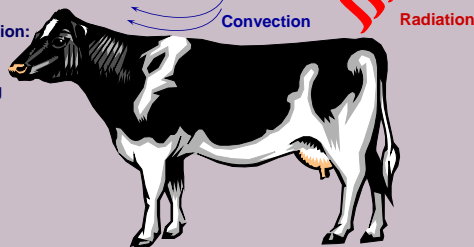
Journal of Dairy Science Vol. 74, No. 4, 1991

How does a cow deal with heat stress?

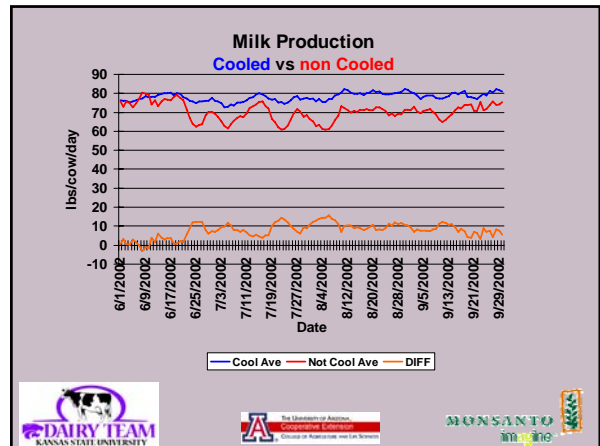


How do cows exchange heat with the environment?

Evaporation:
Panting
Sweating



Can we overcome the effects of heat stress?



Heat Audit project

University of Arizona
Kansas State University
Monsanto Dairy Tech Service



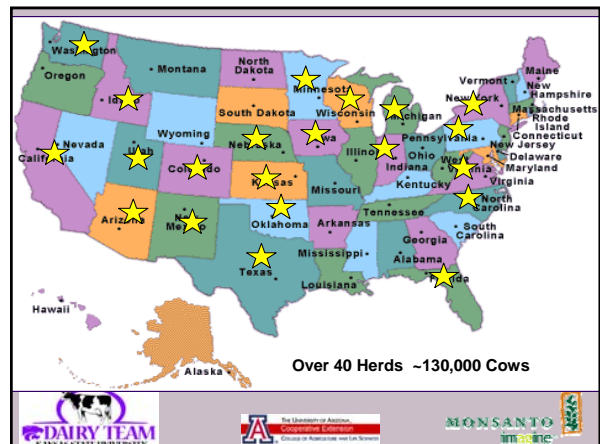
Collaborators

- Dr. John Smith Kansas State University
- Dr. Matt Vanbaale University of AZ
- Monsanto Technical Service Specialist
- Dairies involved in the project



Heat Audit Project




- Scope of the Project
- Technology
- Data








Objectives

- Evaluate a sample of cows in a variety of housing and environments
- Answer the questions
 - Do the cows get hot? $CBT > 102.5$
 - When do the cows get hot?
 - Is the current cooling system effectively cooling cows?

Data

- 8 Cows per pen
 - Selected by production, dim, parity or DCC (Dry Cows)
- HOBOs recorded temperatures for 72hrs
- Temperature recorded every 5 minutes
 - The 12 readings/hour were averaged
 - Each hourly reading was averaged over the 3 day period
 - $8 \times 12 \times 3 = 288$ data points within each hour
- Ambient Temperature and Relative Humidity was recorded with data loggers or through a weather service using GPS coordinates
- Data were downloaded from the data loggers and imported into Microsoft Excel
- This project was not designed as a comparative study

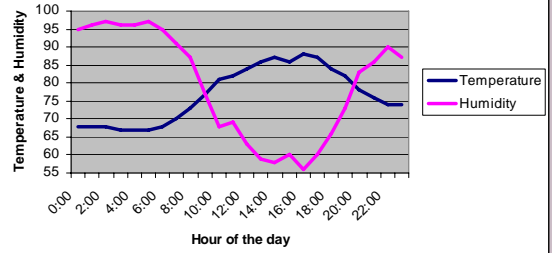




Dairy #1

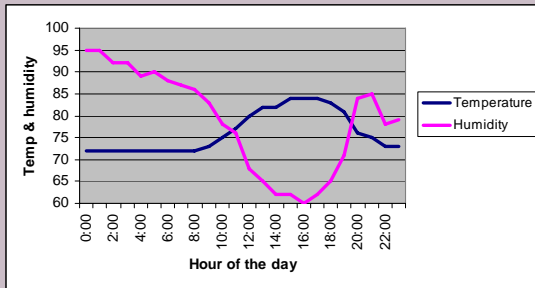
High-producing, well-managed dairy
Western NY



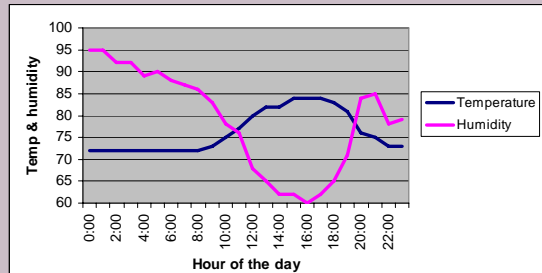
Saturday, June 11th



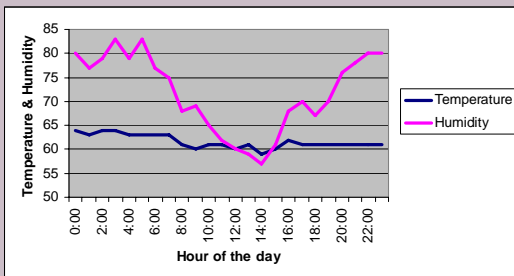
Tuesday, June 14th



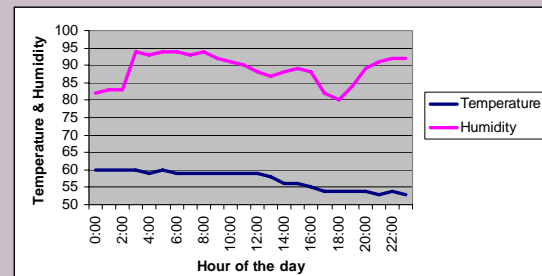
Tuesday, June 14th

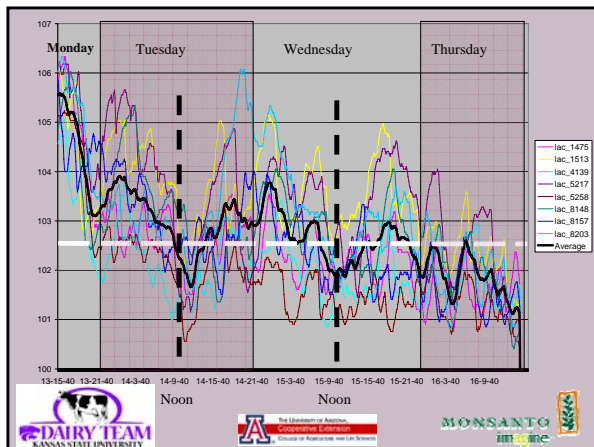
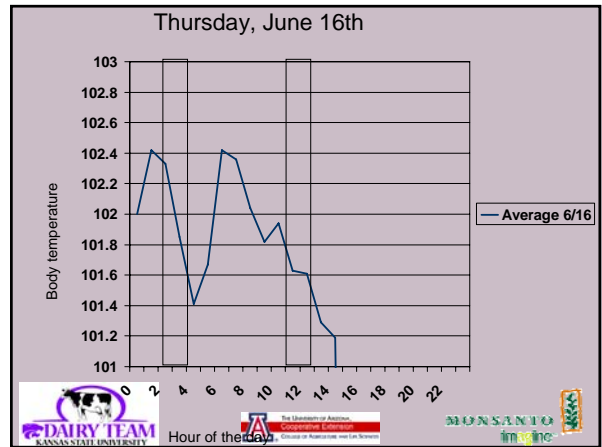
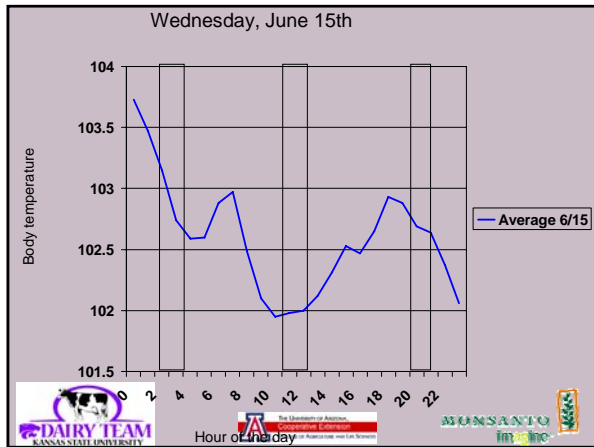
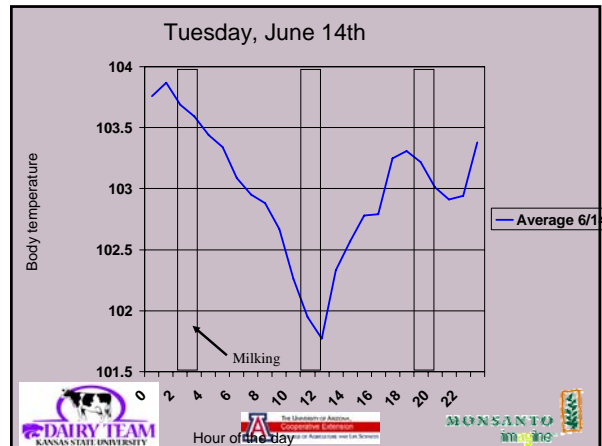
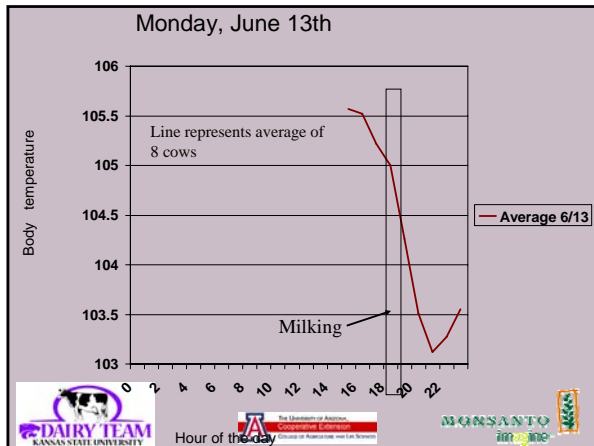


Wednesday, June 15th



Thursday, June 16th

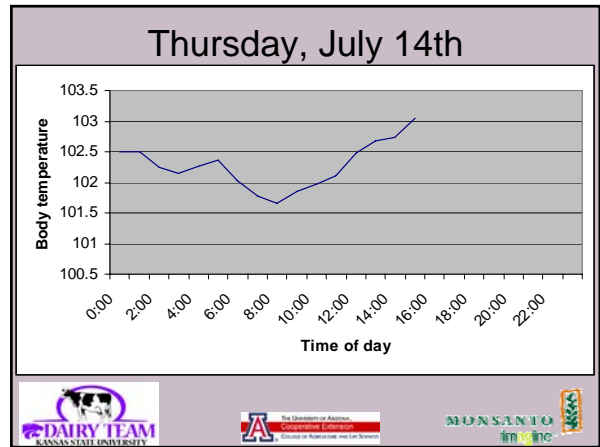
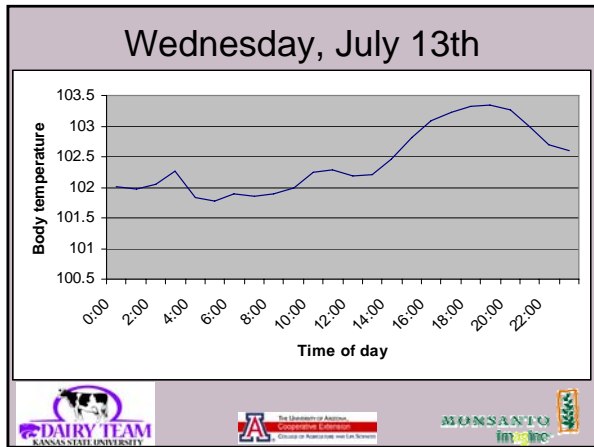
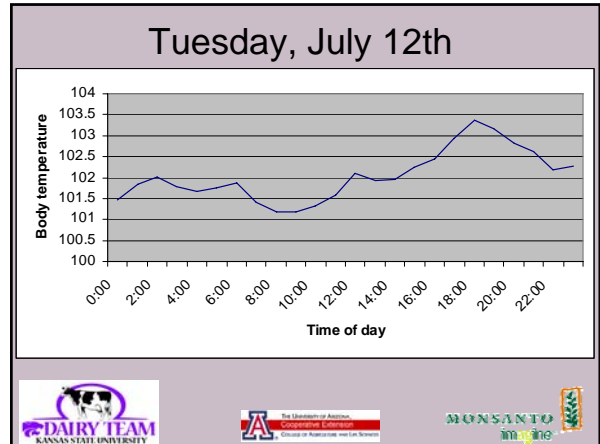
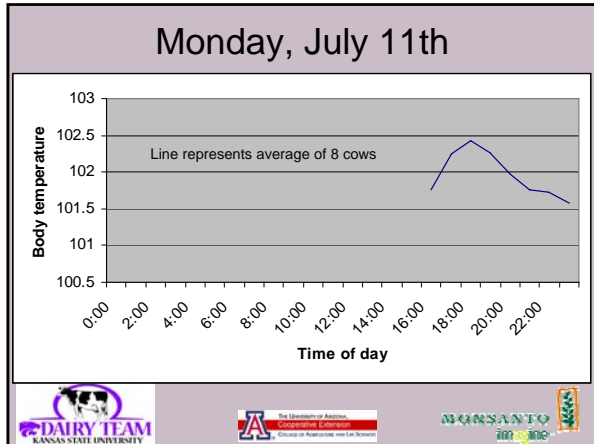




Dairy #2

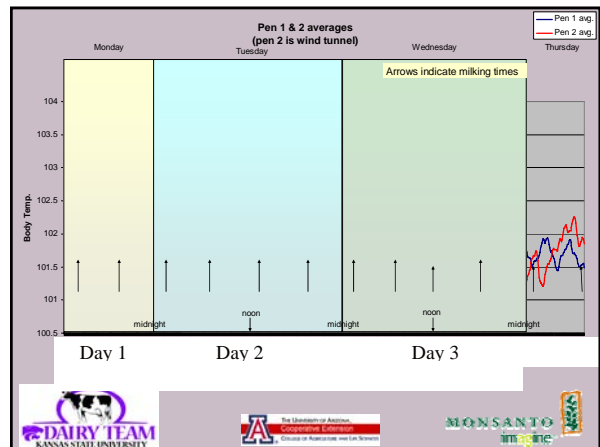
- Conventional free stall barns oriented north/south
- Little cow cooling
- Milk average around 75 lbs.
- Weather not as severe as in herd#1

Logos: DAIRY TEAM, The University of Arkansas, Cooperative Extension, MONTANTO, im:one



Dairy #3

- Combination of wind tunnel and conventional barns
- Some “mistrs” and fans
- Milk average around 75 lbs.
- Weather was moderately hot



How should we cool cows in the eastern U.S.?



Two Ways to Cool Cows

Cool the Cow

»Repeatedly soak the cow and blow air across her to *evaporate* the water

Cool the Air

»Evaporate water in the air to reduce air temp.
 »Doesn't work well in humid environments

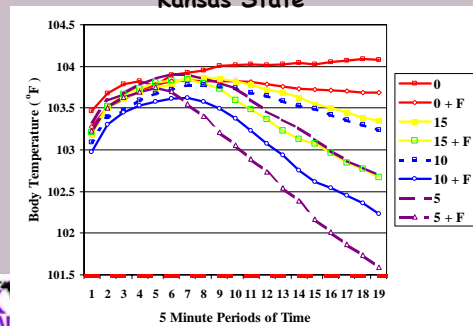


Cool the cow
(or the kid)

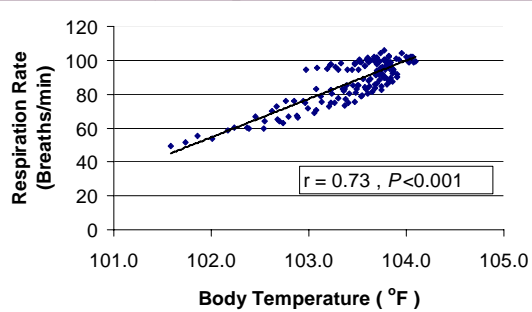


Effects of Cooling Treatments on Body Temperature over 95 Minutes

Kansas State



Relationship of Respiration Rate and Body Temperature of Cattle



Summary

- Air Alone did not reduce respiration rates
- Increasing soaking frequency reduced respiration rate and body temperature
- Adding fans on top of the water reduces respiration rate and body temperature
- Soak the Cow and Dry the Cow
- **Water is the Magic!!**



Your best bet in our climate

- Low pressure (20 psi) system
- Large droplets (not mist)
 - Must be able to wet the cow completely in less than 1 minute
- Edstrom controller to vary frequency
- Fans, fans, fans

- Build barns east-west
- 4-row probably better than 6-row

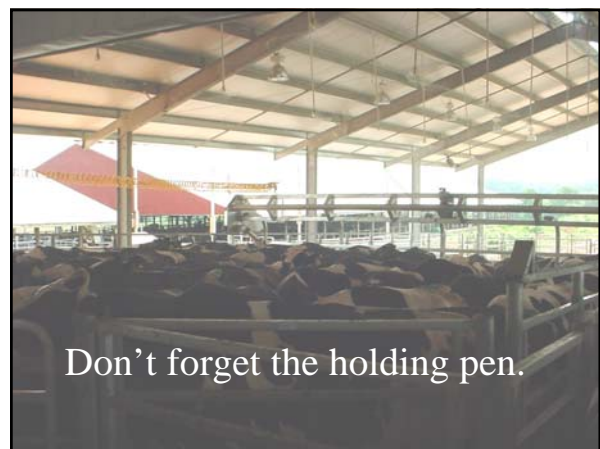


Priorities for heat abatement

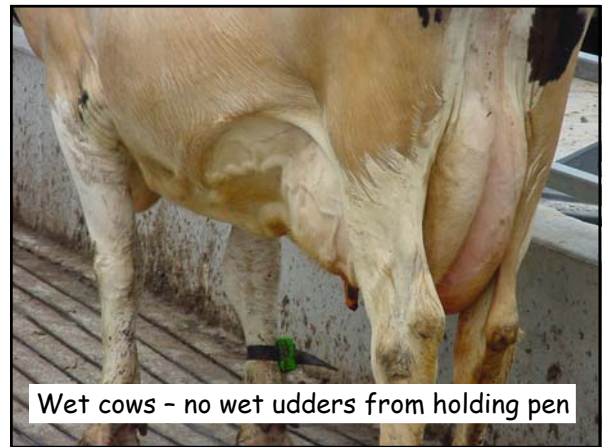
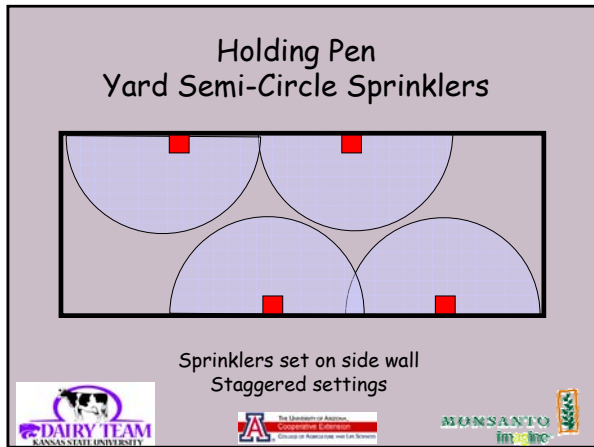
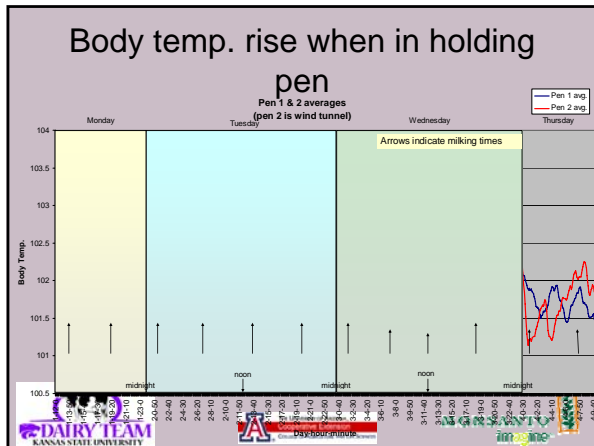
- Holding pen/parlor
- Maternity facilities
- Early lactation cows
- Close-up cows
- Mid- to late-lactation cows



Schedule 40 PVC using Fittings and Angle Iron Support



Don't forget the holding pen.



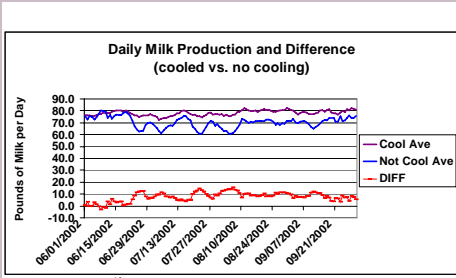
Are there \$ in cooling cows?

DAIRY TEAM KANSAS STATE UNIVERSITY

The Boardman Co. America
Cooperated Enterprise
Member of American West Life Services

MONSANTO imagine

6000 Cooled and 6000 with Fans Only



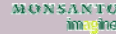
10# average difference for 4 months

Monsanto Dairy
POSILAC®



Economics of Cow Cooling

- Lost milk production during heat stress – \$1-1.50 per cow per day
- Reproduction?
- Future milk production?
- Health?
- Pay back is one year in most cases



What about barn orientation and barn design?

Average Morning and Afternoon Respiration Rates of Cows Housed in 4 and 6-Row Freestall Barns Located in NW Iowa.

Barn Type	Morning	Afternoon	Average
----- Breaths/min -----			
4-Row	60.5 ^a	73.8 ^a	67.2 ^a
6-Row	65.8 ^b	78.4 ^b	72.1 ^b

^{a,b}Means within the same column differ P<.05.

KSU CCC 2000



Average Morning and Afternoon Respiration Rates of Cows Housed in N/S versus E/W 4-Row Freestall Barns Located in California.

Barn Type	Morning	Afternoon	Average
----- Breaths/min -----			
East/West	52.2 ^a	68.8 ^a	60.5 ^a
North/South	56.4 ^b	77.4 ^b	66.9 ^b

^{a,b}Means within the same column differ P<.05.

KSU CCC 2000






Keeping cows cool vs. cooling Hot Cows



West Central NE




- Freestall Barns
- 2100 milking
- Milking 3X Production in the High 70s
- Fans and soakers in the Holding Pen
- Fans in freestalls
 - were not on during the Heat Audit
- Tested Lactating and Dry Cows



Tunnel Ventilated Barns




What's your climate????

Kansas

Description




- Location
 - Southwest Kansas
- Cows evaluated
 - Close-up cows (Pen 54)
 - Lactating cows 40-100 DIM, 2+ lactations (Pen 62)
 - Recovery- lactating cows leaving the hosp. (Pen 51)
 - Lactating cows 40-100 DIM, 1st lactation (Pen 31)
- Cow numbers 8000

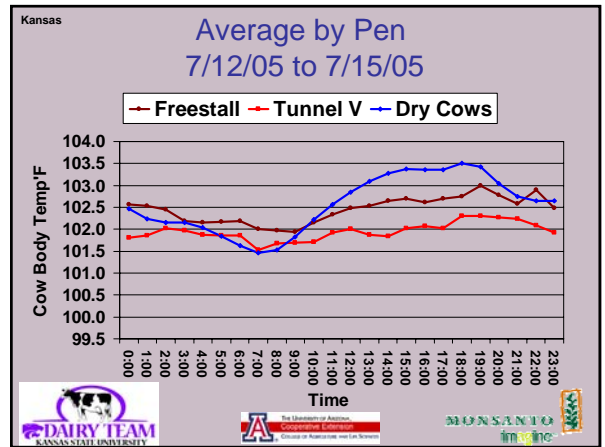
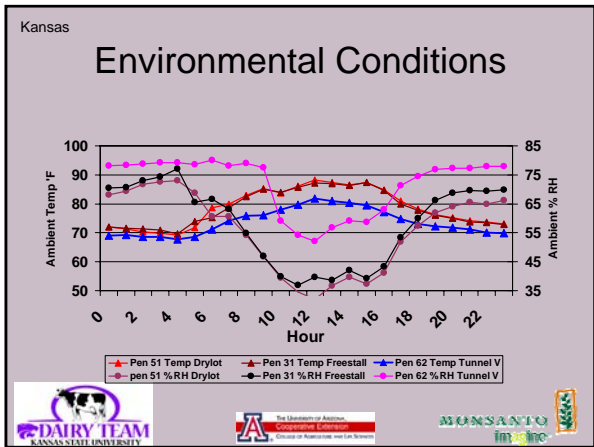




Kansas

Facilities

- Dry-lots with shade
 - Pens 51 and 54
- Tunnel ventilation with evaporative pads
 - Pen 62
- 4 row freestall barn naturally ventilated
 - Pen 31
- Cooling
 - Tunnel ventilation and evaporative pads in the milking center



Summary W KS

- Tunnel Barns maintained cow temperatures in the desired range
- Tunnel Barn %RH was consistently higher
- Considerations
 - Bedding
 - Air Quality
 - Economics

Logos: DAIRY TEAM KANSAS STATE UNIVERSITY, The University of Arizona Cooperative Extension, MONSANTO

Conclusions

- Data logger technology can be used to evaluate cooling systems on individual dairies
- Heat Abatement tools should be viewed as a system – Don't let cows get hot
- Current knowledge and technology is effective in cooling cows

Logos: DAIRY TEAM KANSAS STATE UNIVERSITY, The University of Arizona Cooperative Extension, MONSANTO

Thank You

