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John F. Smith

Joseph P. Harner

S.E. DeFrain

See next page for additional authors

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Authors
John F. Smith, Joseph P. Harner, S.E. DeFrain, and Michael J. Brouk

EFFECT OF FAN PLACEMENT ON MILK PRODUCTION AND DRY MATTER INTAKE OF LACTATING DAIRY COWS HOUSED IN A 4-ROW FREESTALL BARN

M. J. Brouk, J. F. Smith,
J. P. Harner[1] and S. E. DeFrain

Summary

Heat stress reduces milk production, feed intake, and reproductive efficiency each summer in Kansas. Without heat abatement procedures, milk production may decline 20-30% during the summer months. Research has shown that supplemental fan cooling in combination with low pressure feedline sprinklers can reduce the effects of heat stress on milk production and feed intake. One critical issue in heat stress abatement is the location of fans in a 4-row freestall barn. Research conducted during the summer of 2000 on a northeast Kansas dairy found that locating fans over both the feedline and head-to-head freestalls increased milk production 5.8 lb/cow/d and reduced respiration rates in the morning and at night compared to mounting fans only over the feedline. Pen feed intakes also tended to be greater when fans were located in both areas. Economic analysis showed that after accounting for cost associated with ownership, operation, and increased feed intake, net farm income was estimated to be increased by $3,600-6,600 for a pen of 84 cows. A 100-cow Kansas dairy could increase farm profits by $8,000 if these heat abatement techniques were utilized. Location of fans over both the feedline and freestalls in combination with a low pressure feedline sprinkling system is an effective heat stress abatement strategy in 4-row freestall barns.

(Key Words: Heat Stress, Cow Comfort, Cow Cooling.)

Introduction

Heat stress abatement in freestall barns should be a major concern for dairy producers and dairy industry advisors. Under modern management systems, lactating dairy cows may spend over 90% of the day in the freestall barn. Without effective freestall cooling systems, significant production and reproduction losses will occur. In terms of cow comfort, the effective temperature is a function of air temperature, humidity, air flow, and solar radiation. Heat dissipation from the dairy cow at temperatures above 60°F is largely due to evaporative losses from the skin with a much smaller portion lost via lung cooling. Thus, the goal of heat stress abatement in freestall barns should be to provide protection from solar radiation and maximize evaporative losses from the skin. Heat dissipation from the skin is increased by increasing air exchange, air flow and the evaporation of supplemental water applied to the skin.

Freestall barns that are correctly designed will provide maximum natural ventilation. However, additional cooling equipment is necessary to maintain milk production and reduce its decrease during summer. In addition to maintaining production, heat abatement measures must be cost effective and return a net profit to the dairy producer. A study was conducted during the summer of 2000 to evaluate two different cooling systems in 4-row freestall barns located in northeast Kansas.

[1]Department of Biological and Agricultural Engineering.

Procedures

During the summer of 2000 a study was conducted to determine if fans were only needed over the feedline. One hundred mid-lactation Holstein cows were blocked by milk production and day in milk and assigned randomly to each of four pens of a 4-row freestall barn. Two replicates, north and south halves of the barn, contained 2 pens each. Cows in each treatment group averaged 173 days in milk and produced an average of 97.6 lb/cow/day at the start of the study. Pens contained 85-90 cows. In each pen, 25 were study animals. Fan treatments were either a single row of 36-inch fans mounted every 24 ft on the feedline (8, 36-inch diameter circulation fans with 0.5 horsepower motors) (feedline fans; F) or a single row of fans (8, 36-inch diameter circulation fans with 0.5 horsepower motors) mounted every 24 ft over the head-to-head freestalls plus another row of fans (8, 36-inch diameter circulation fans with 0.5 horsepower motors) mounted every 24 ft over the cow feedline (feedline and stall fans; F+S). Each fan was estimated to provide 10,000 cubic feet/min of airflow when operating.

Each pen was equipped with similar sprinkler systems consisting of 2.5 gallon/hr nozzles spaced every 78 inches on-center at a height of 8 ft above the headlocks. Sprinklers were on a 15-min cycle with 3-min on and 12-min off. Sprinklers were activated when the temperature was above 75°F. The designed application rate was 0.04 inches/ft^2 of surface area which consisted of 12 ft^2/headlock or a 24-inch feeding space. Total application rate was 50 gallons/cycle. Fans of all treatments were activated when the temperature was above 70°F both day and night. A description of fan and sprinkling systems is in Table 1.

Cows were milked 2× and milk production was measured every 2 wk throughout the 10-wk trial. All pens received the same diet. Amounts of feeds offered and refused were measured and recorded daily. Dry matter content of the diet and refusal of each was determined twice weekly. Cow respiration rates were measured on three separate days during heat stress. Fifteen cows were selected randomly from the 25 study cows in each pen and respiration rates were measured in the morning (0700-0800 hr), afternoon (1500-1600 hr) and at night (2200-2300 hr) on each of the 3 days.

Ambient and pen temperature and relative humidity were recorded every 15 min in two locations throughout the study with HOBO® Pro data loggers. Data from each day was averaged by 3-hr blocks of time beginning at midnight each day.

A switch back design with five 2-wk periods was utilized to evaluate fan placement. Cows and treatments were switched at the start of each period within each replicate. Milk and intake data were averaged by treatment within replicate and week prior to statistical analysis. Respiration rates were averaged by treatment within day, period and replicate prior to statistical analysis.

Results

Milk production (Figure 1) was greater (P<0.01) for cows exposed to F+S the treatment than for those exposed to the F treatment. Dry matter intake (Figure 2) tended (P=0.11) to follow a similar pattern as milk production with pen feed intakes (54.0 vs 52.7 lb/cow/d) greater when F+S was utilized rather than F. Milk production (Figure 3) was more consistent during the study for the F+S treatment compared to the F treatment. Milk production in periods 3 and 4 dropped 7 and 10 lb, respectively, for the F treatment, whereas milk in the F+S treatment did not drop greatly until period 4. Average ambient temperature (Figure 4) increased about 4.5°F during period 4 compared to period 3. If milk production by period is compared to period ambient temperature, it appears that the F+S maintained milk production over a longer period of the summer than did F. However, when ambient temperatures were the greatest, even F+S cattle experienced a significant drop in milk production, but not to the extent of cattle cooled with F. Based on the average pen temperature (Figure 5), no differences were observed between the treatments. It was possible that the F+S treatment allowed cattle to exchange greater amounts of heat while lying in the

freestalls due to the increased airflow. Increased airflow likely would have increased evaporation rates of sweat and supplemental water from the skin surface.

Respiration rates (Figure 6) showed that the cattle exposed to F+S had reduced (P<0.06) respiration rates in the morning (71.7 vs 79.3 breaths/cow/min), at night (76.0 vs 80.1), and daily (79.4 vs 83.2) compared to those under F. Afternoon respiration rates were unaffected by treatment. Respiration data indicate that the cattle treated with F+S were more comfortable than those cooled with F.

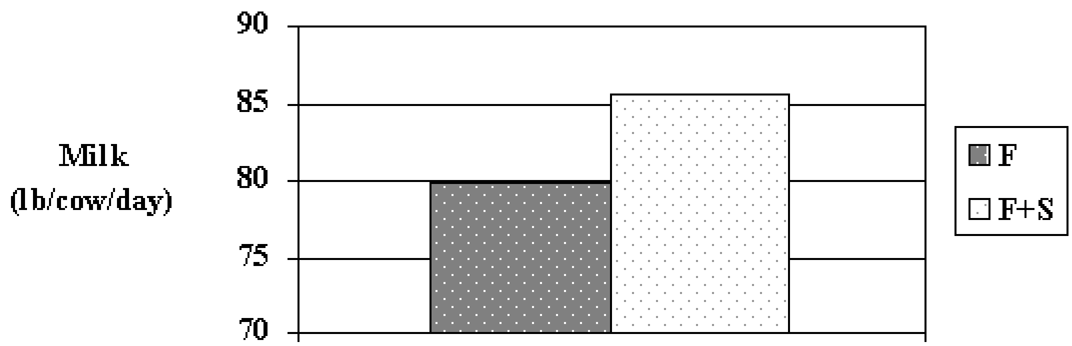
An economic analysis (Table 2) suggested that production losses due to heat stress were reduced from an estimated 20% with no heat abatement system (no fans or sprinklers) to 12% (F) and 5.6% (F+S). The cooling response of F was 7.3 lb of milk and that of F+S was 13.1 lb of milk relative to no heat stress abatement practice. Total cost to install cooling equipment was $3,536 (F) or $7,072 (F+S) per pen of 84 cows. Estimated increased milk income for and 85-day cooling season was $6,730 (F) or $12,114 (F+S) per pen. Estimated net income after accounting for ownership, operation, and additional feed expenses was either $3,656 (F) or $6,693 (F+S) for a pen of 84 cows. On a cow per day basis, net returns were either $0.51 (F) or $0.94 (F+S) for the 85-day cooling season. A 100-cow Kansas dairy could expect to receive an additional $4,335 (F) or $7,990 (F+S) by utilizing these heat abatement techniques. Additional net income would pay for the complete system in a single year.

This study clearly demonstrated that cows in a 4-row freestall barn produced more milk and had lower respiration rates by locating fans on both the feedline and over the freestalls. Based on lower respiration rates in the morning and at night, the duration of heat stress was reduced by the F+S treatment. Appropriate fan location in combination with feedline sprinklers reduced heat stress in lactating dairy cattle housed in a 4-row freestall building. In addition, heat abatement measures can be effective and profit generating.

Table 1. Description of Building and Cooling Treatments on Utilized to Determine the

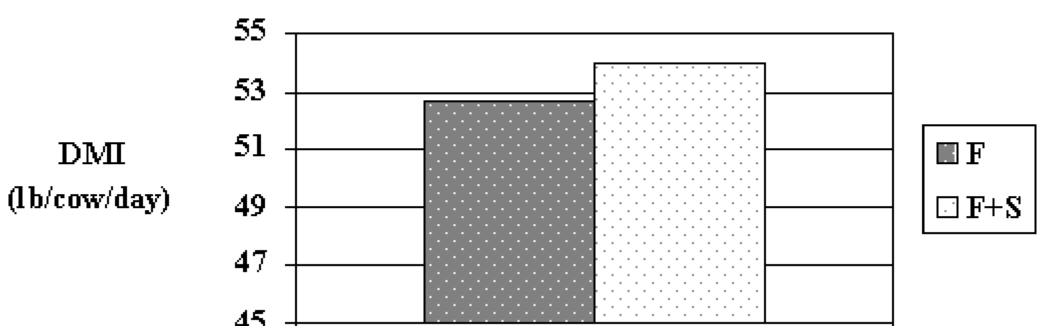
	Fan Treatment[1]	
Cooling System	F	F + S
Sprinklers		
Sprinklers location	feedline	feedline
Nozzle rating, gallons/hr	25	25
Nozzle type	18	18
Sprinkler cycle	on - 3 min	on - 3 min
	off - 12 min	off - 12 min
Sprinkler height, ft	8	8
Fans		
Rows over freestalls	0	1
Rows over feedline	1	1
Number of fans per row	8	8
Total number of fans	8	16
Fan spacing, ft	24	24
Fan diameter (hp)	36 in (1/2 hp)	36 in (1/2 hp)
Fan airflow/stall, cfm/stall	0	950
Fan airflow/headlock, cfm/head	800	800

[1]Building description: Building type: 4 row; Orientation: East-West (2% slope to west); Dimensions: width-100 ft, length-420 ft, sidewall height-14 ft, roof slope-4/12; Configuration: 4 pens with 84 stalls per pen and 100 headlocks per pen. [2]F=one row of fans over feedline and F + S=one row of fans over the feedline and one row of fans over the head-to-head freestalls.



F	79.8
F+S	85.6

Figure 1. Average Milk Production of Lactating Holstein Cows Exposed to Either Fans over the Feedline (F) or Fans over Both the Feedline and Freestalls (F+S).



	DMI
F	52.7
F+S	54.0

Figure 2. Average Pen Dry Matter Intakes of Lactating Holstein Cows Exposed to Either Fans over the Feedline (F) or Fans over Both the Feedline and Freestalls (F+S).

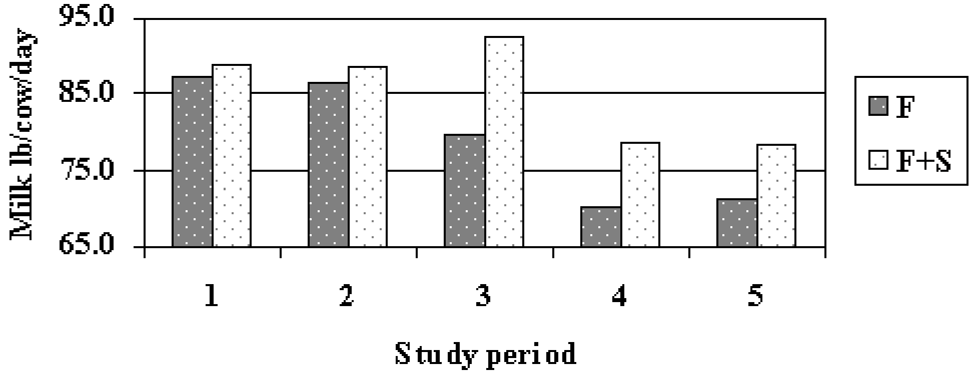


Figure 3. Average Milk Production by Period of Study of Lactating Holstein Cows Exposed to Either Fans over the Feedline (F) or Fans over Both the Feedline and Freestalls (F+S).

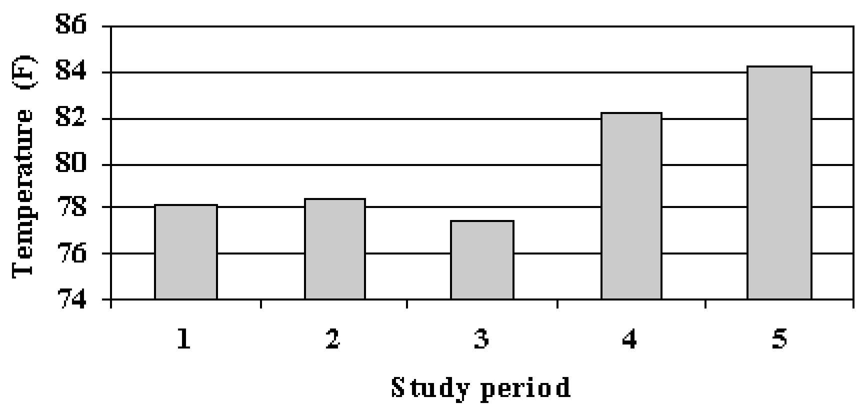


Figure 4. Average Daily Ambient Temperature During Study.

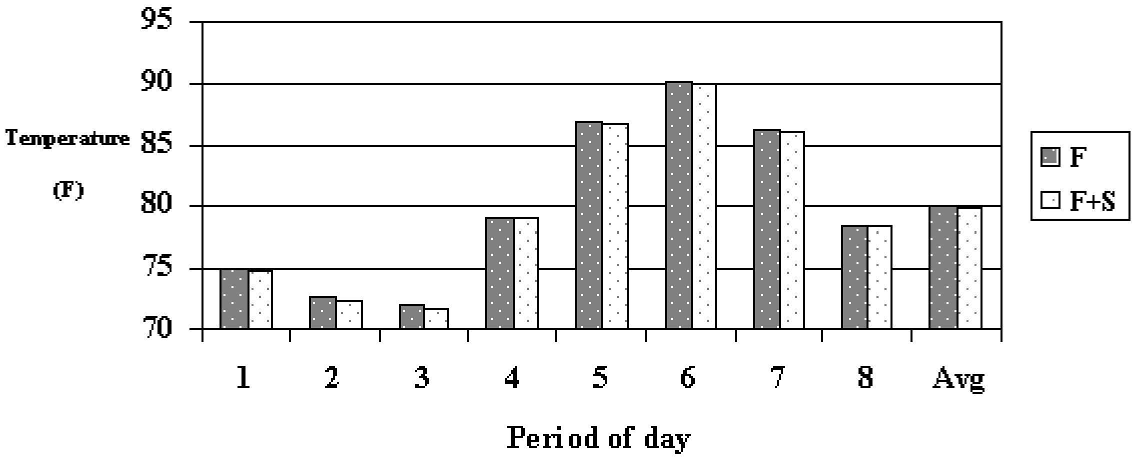
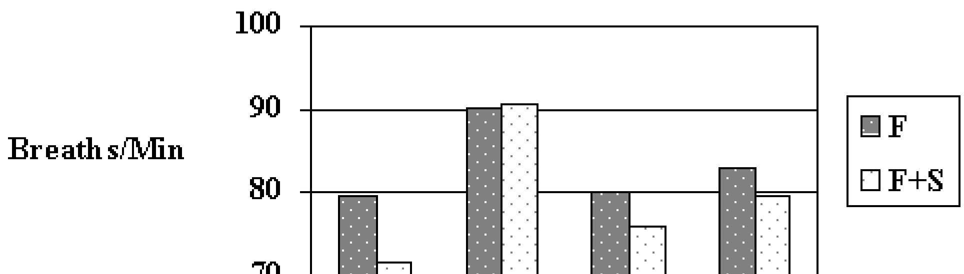


Figure 5. Average Temperature of Pens Cooled with Either Fans over the Feedline (F) or Fans over Both the Feedline and Freestalls (F+S) at Different 3-Hour Periods of the Day.



	Morn	After	Nite	Avg
F	79.3	90.1	80.1	83.2
F+S	71.7	90.6	76	79.4

Figure 6. Average Respiration Rates of Cows Exposed to Either Fans over the Feedline (F) or Fans over Both the Feedline and Freestalls (F+S).

Table 2. Economic Analysis of Using Either Fans over the Feedline (F) or Fans over Both the Feedline and Freestalls (F+S)[1]

	Treatment[2]	
Item	F	F + S
Beginning milk production, lb/cow/d	97.6	97.6
Milk production w/o cooling, lb/cow/d	72.5	72.5
Average milk production w/ cooling, lb/cow/d	79.8	85.6
Production loss due to heat stress w/ cooling, %	12.0	5.6
Cooling response, lb/cow/d	7.3	13.1
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Total extra income due to cooling, pen	6,730	12,114
Fixed and installation cost of fans, pen	3,536	7,072
Total fixed cost of cooling systems, pen	4,036	7,572
Annual fixed fan cost, pen/yr	505	1,010
Annual fixed sprinkler cost, pen/yr	100	100
Total sprinkler water usage, gal/pen/yr	189,567	186,428
Cost of water for sprinklers, pen/yr	303	298
Total cost of electricity for fans, pen/yr	445	890
Total Variable cooling cost, pen/yr	748	1189
Additional feed cost per cow, cow/d	0.20	0.35
Additional feed cost per pen, pen/yr	1,398	2,516
Gross income due to cooling system, pen/yr	6,730	12,114
Operating cost due to cooling system, pen/yr	3,074	5,420
Extra income due to cooling system, pen/yr	3,656	6,693

[1]Assumptions of Economic Model

- 84 cows per pen
- 85 days of heat stress
- $13/cwt milk price
- $1.60/1,000 gal of water
- 20% reduction in milk production without cooling system

[2]F=one row of fans over feedline and F + S=one row of fans over the feedline and one row of fans over the head-to-head freestalls.