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Performance of lactating dairy cattle housed in two-row freestall barns equipped with three different cooling systems

Abstract

One hundred fifty-nine Holstein cows (66 primiparous and 93 multiparous) were assigned to each of three different cooling systems installed in two-row freestall barns on a northeast Kansas dairy. One barn was equipped with a row of five 48-inch fans mounted every 40 ft over the freestalls and a row of 10 36-inch fans mounted every 20 ft over the cow feed line. Another barn was equipped with five 48-inch fans mounted over the freestalls. Both of these barns were also equipped with identical sprinkler systems mounted over the feed line. The third barn was equipped with a row of five 48-inch fans mounted over the freestalls. In addition to the sprinklers over the feed line, additional sprinklers were mounted on the back alley of the third barn. Data were collected for an 85- day period to evaluate the three systems under heat stress during the summer of 1999. Cows cooled with these three systems produced similar amounts of milk and consumed nearly equal amounts of feed. Summer heat stress generally reduces milk production 20%, if cooling systems are not installed. Based on this estimated loss, these systems returned over $10,000/pen/year above ownership and operational cost. These results indicated that effective cooling in a two-row freestall barn includes a sprinkler system on the feed line and properly sized and spaced fans over the freestalls.; Dairy Day, 1999, Kansas State University, Manhattan, KS, 1999;

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PERFORMANCE OF LACTATING DAIRY CATTLE HOUSED IN TWO-ROW FREESTALL BARNS EQUIPPED WITH THREE DIFFERENT COOLING SYSTEMS

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Summary

One hundred fifty-nine Holstein cows (66 primiparous and 93 multiparous) were assigned to each of three different cooling systems installed in two-row freestall barns on a northeast Kansas dairy. One barn was equipped with a row of five 48-inch fans mounted every 40 ft over the freestalls and a row of 10 36-inch fans mounted every 20 ft over the cow feed line. Another barn was equipped with five 48-inch fans mounted over the freestalls. Both of these barns were also equipped with identical sprinkler systems mounted over the feed line. The third barn was equipped with a row of five 48-inch fans mounted over the freestalls. In addition to the sprinklers over the feed line, additional sprinklers were mounted on the back alley of the third barn. Data were collected for an 85-day period to evaluate the three systems under heat stress during the summer of 1999. Cows cooled with these three systems produced similar amounts of milk and consumed nearly equal amounts of feed. Summer heat stress generally reduces milk production 20%, if cooling systems are not installed. Based on this estimated loss, these systems returned over $10,000/pen/year above ownership and operational cost. These results indicated that effective cooling in a two-row freestall barn includes a sprinkler system on the feed line and properly sized and spaced fans over the freestalls.

(Key Words: Environmental Stress, Heat Stress, Milk Production.)

Introduction

Properly designed, two-row, freestall barns can provide maximum natural ventilation because of the reduced building width compared to four- and six-row barns. Increased natural air flow can help keep cows cooler during the summer. However, cows will still experience heat stress, so other measures generally are applied in these facilities. The purpose of this study was to evaluate the use of fans and additional sprinkler area upon the performance of dairy cattle.

Procedures

One hundred fifty-nine Holstein cows were blocked by lactation number, milk production, and days in milk (DIM) and assigned to each of three cooling treatments. A commercial dairy in northeast Kansas constructed three identical two-row freestall barns. The barns were similar in dimensions (Table 1) and equipment. Each barn contained a single pen with 100 freestalls and 108 cows. One barn (F+S) was equipped with a row of fans (five 48-inch-diameter circulations fans with 1 horsepower motors) over the freestalls and another row of fans (10 36-inch-diameter circulation fans with 0.5 horsepower motors) over the cow feed line. Fans were angled down at 30°. Fans over the stalls produced an estimated air flow of 1,000 cfm/stall, and those mounted over the cow feed line produced an estimated air flow of 900 cfm/headlock. Barns two (S) and three (S+) were equipped with a row of fans (five 48-inch-diameter circulations fans

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with 1 horsepower motors) over the freestalls that were angled as above. Treatments F+S and S both had a similar sprinkler system installed on the feed line. The sprinkling system consisted of 2.5 gal/hr nozzles spaced every 78 inches on center mounted at a height of 8 ft on the feed line. Sprinklers were on a 15-minute cycle, with 3 minutes on and 12 minutes off. They were activated when the temperature was above 75EF. The designed application rate was 0.04 inches/sq ft of surface area, which consisted of 12-sq ft/headlock or 24-inch feeding space. Total application rate was 25 gal/cycle. Treatment S+ had a similar sprinkler system to that of F+S and S, except that an additional line was installed on the rear alley of the barn. Sprinkler nozzles were spaced 156 inches on center and the total application rate was 35 gal/cycle. The system was activated as described above.

Fans for all treatments were activated both day and night when the temperature was above 70EF. When wind speed was greater than 15 mph, fans in all barns were switched off manually.

Amounts fed and refused for each pen were recorded daily for each pen. Cows were fed twice daily for 105% of ad libitum intake. Intake data were collected on a pen basis and included the treatment cows plus an additional 55 cows that were not part of the study. Cows were milked 2×, and daily milk production was measured for a 24- hr period every 2 weeks. Animals eligible for rbST were injected on 14-day intervals throughout the study. Respiration rates were measured four times during the study in periods of heat stress. Rates were estimated in the morning and again in the afternoon from 50 cows/pen.

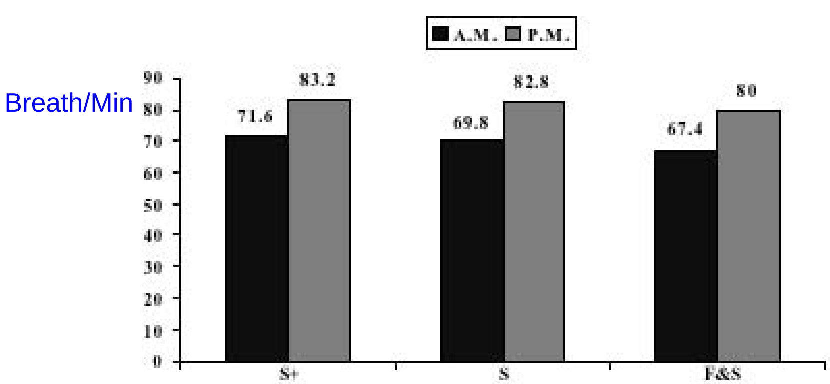
Results and Discussion

Milk production and days in milk did not differ among treatments at the beginning of the study (Table 2). Average milk production was similar during the trial as well as intake. First-lactation cows (Table 3) had lower milk production at the start and during the trial than older cows. However, neither heifers nor cows differed in treatment response. Respiration rates (Figure 1) were similar and increased 16 to 18% from morning to afternoon.

The economic analysis (Table 4) demonstrates that cooling systems are both economical and effective. Based on the assumptions presented, net income after expenses was $10,000 to $12,000/pen/year. This could amount to $100 to $120 per cow/year. These cooling systems are important to the profitability of Kansas dairies.

Conclusions

These results indicated that an effective cooling system for a two-row freestall barn would include fans over the freestalls and a sprinkler line over the feed line. Installing additional fans or sprinkler area did not increase milk production in this study.



F&S = one row of fans over cow feed lane and one row of fans over freestalls,
S = one row of fans over freestalls,
S+ = one row of fans over freestalls and additional sprinkler lines.

Figure 1. Average Respiration Rates of Cows Cooled with Three Different Spray and Fan Systems in Two-Row Freestall Barns.

Table 1. Descriptions of Two-Row Freestall Barns and Cooling Systems[1]

	Cooling System[2]		
Item	F+S	S	S+
Sprinklers			
Location	feed line	feed line	feed line & north alley
Nozzle rating, gal/hr	25	25	25
Nozzle type	180°	180°	180°
Cycle, gal/15 min	25	25	35
Height, ft	8	8	8
Fans			
Rows over freestalls	1	1	1
Rows over feed line	1	0	0
Number/ row stalls	5	5	5
Number/feed line	10		
Total number	15	5	5
Spacing:			
freestalls, ft	40	40	40
feed line, ft	20	—	—
Diameter:			
freestalls, inches	48 (1 hp)	48 (1 hp)	48 (1 hp)
feed line, inches	36 (½ hp)	—	—
Airflow, cfm/stall	1,000	1,000	1,000
Airflow/headlock, cfm/head	900	0	0

[1]Building description: building type, 2-row; orientation, east-west (2% slope to west); dimensions, width (40 ft), length (220 ft), sidewall height (12 ft), and roof slope (2/12); and configuration, 1 pen with 100 stalls per pen and 110 headlocks per pen.

[2]F+S = one row of fans over the feed line and one row of fans over the freestalls; S = one row of fans over the freestalls; and S+ = one row of fans over freestalls and additional sprinkler lines.

Table 2. Milk Yield, Body Condition Change, and Feed Intake of Dairy Cows Housed in Two-Row Freestall Barns Equipped with Three Different Cooling Systems

	Cooling System[1]			
Item	F+S	S	S+	SEM
Initial milk, lb	86.9	87.2	88.2	3.5
Initial days in milk	115	114	114	7
Average milk, lb	80.8	80.3	79.5	1.7
Dry matter intake, lb	49.9	49.8	49.6	-
Change in body condition	+.26	+.31	+.28	.04

[1]F+S = one row of fans over feed line and one row of fans over freestalls; S = one row of fans over freestalls; S+ = one row of fans over freestalls and additional sprinkler lines. SEM = standard error of mean.

Table 3. Milk Yield and Changes in Body Condition Score of Multiparous and Primiparous Dairy Cows Housed in Two-Row Freestall Barns Equipped with Three Different Cooling Systems

	Cooling System[1]							
	Multiparous				Primiparous			
Item	F+S	S	S+	SEM	F+S	S	S+	SEM
Initial milk, lb	93.1	92.3	93.9	3.0	86.9	87.2	88.2	3.5
Initial days in milk	117	118	118	9	112	111	110	11
Average milk, lb	81.5	81.6	80.5	2.6	80.0	79.0	79.4	2.7
Change in body condition	+.44	+.41	+.27	.06	+.11	+.22	+.25	.07

[1]F+S = one row of fans over feed line and one row of fans over freestalls; S = one row of fans over freestalls; S+ = one row of fans over freestalls and additional sprinkler lines. SEM = standard error of mean.

Table 4. Economic Analysis of Three Cooling Systems Installed in Two-Row Freestall Barns

Item	Cooling System[1]		
	F+S	S	S+
Beginning (6/12/99) milk production (lb/cow/day)	86.9	87.2	88.2
Estimated milk production w/o cooling (lb/cow/day)	64.6	64.8	65.6
Average milk production w/ cooling (lb/cow/day)	80.8	80.3	79.5
Cooling response (lb/cow/day)	16.2	15.5	13.9
Total extra income due to cooling ($/pen)	17,906	17,107	15,401
Fixed and installation cost of fans ($/pen)	6630	2210	2210
Fixed and installation cost of sprinkler ($/pen)	500	500	750
Total fixed cost of cooling systems ($/pen)	7130	2710	2960
Annual fixed fan cost ($/pen/yr)	947	316	316
Annual fixed sprinkler cost ($/pen/yr)	100	100	125
Total cost of electricity for fans ($/pen/yr)	1118	556	556
Total electricity cost per stall ($/stall/yr)	11.18	5.56	5.56
Total sprinkler water usage (gal/pen/yr)	136,573	132,428	210,419
Cost of water for sprinklers ($/pen/yr)	218.5	211.9	336.7
Water cost per stall ($/stall/yr)	2.19	2.12	3.37
Variable cooling cost for water and electricity ($/pen/yr)	1337	768	893
Additional feed cost per cow ($/cow/day)	0.44	0.42	0.38
Additional feed cost per pen ($/pen/year)	3719	3553	3199
Interest rate if money was invested (%)	8.00	8.00	8.00
Return on money if invested ($/yr)	570.40	216.80	236.80
Gross income due to cooling system ($/pen/yr)	$17,906	$17,107	$15,401
Total operating and feed cost ($/pen/yr)	$6,673	$4,954	$4,794
Net income due to cooling system ($/yr/pen)	$11,232	$12,153	$10,607
Net income per stall due to cooling ($/stall/yr)	$112	$122	$106
Additional income per day due to heat abatement (per stall)	1.12	1.22	1.06

[1]F+S = one row of fans over feed line and one row of fans over freestalls; S = one row of fans over freestalls; S+ = one row of fans over freestalls and additional sprinkler lines.

Assumptions:

- 100 cows or stalls per pen
- Calculations over a 85 days of heat stress
- Milk price = $13/cwt
- Rural water cost = $1.60/1000 gal
- 20% reduction in milk production with no cooling
- 5% loss in milk production per month due to increasing days in milk
- Feed cost = $135/ton of dry matter
- Estimated life of fan is 7 years, and that for sprinkler system is 5 years