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Dairy Lines

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DAIRY RESEARCH & EXTENSION NEWS

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Upcoming Events

June 29, 1999—9:00am
Grady Co. Dairy Cattle Judging Clinic & Milking Shorthorn Field Day—
Grady Co. Fairgrounds, Chickasha, OK

July 1, 1999—9:00am
Brown Swiss/Jersey Field Day—
Evans Ag. Center, Perkins, OK

July 6, 1999—9:00am
Holstein Field Day, JSJRW Holsteins—
Lawton OK

July 8, 1999—9:00am
Ayrshire/Guernsey Field Day—
Mayes Co. Fairgrounds, Pryor, OK

July 29–31
Sooner State Dairy Show—
Payne Co. Fairgrounds, Stillwater, OK

Sprinkler Systems for Cooling Dairy Cows at a Feed line

Joseph Harner, Biological and Agricultural Engineering, John Smith, Animal Sciences and Industry, Mike Brouk, Animal Sciences and Industry, James Murphy, Biological and Agricultural Engineering

Cows experience heat stress when the temperature-humidity index (THI) is above 72. During heat stress, respiration rates increase, while milk production and reproduction decrease. One practice in heat stress control is to install sprinkler systems over the feed line and in the holding pen.

The objective of the sprinkler system is to wet the cow's back, but to avoid moisture accumulation on the udder or in freestalls. Evaporative cooling occurs when the moisture is evaporated by natural or mechanical ventilation.

System Components

System components include a timer, a thermostat, a solenoid valve, pressure reducer, piping, and sprinkler nozzles (See Figure 1). The casing of the equipment should be waterproof and dust proof to meet electrical codes.

The thermostat should be set to turn the sprinkler on when the air temperature exceeds 70 to 75° Fahrenheit. A thermostat will control a valve or solenoid located prior to the first nozzle. The solenoid valve controls the water flow through the pipe.

Sprinkler systems need a 15- to 30-minute on-off timer. A 15-minute cycle is common—the sprinkler is on for 3 minutes and off for the next 12 minutes. The timer should be controllable to the nearest 15 to 30 seconds. If flow quantity is a limiting factor, then sequencing the system is an option. If there are multiple sprinkler systems, a 60-minute timer may be needed to sequence the individual sprinkler systems.

The pressure reducer is needed to limit the sprinkler line pressure at the inlet to 20 to 40 pounds per square inch depending on the recommendation of the nozzle manufacturer. This primarily is needed when the water pressure in the distribution pipe exceeds 40 pounds per square inch. Pressure losses through the distribution pipe should not exceed 5 pounds per square inch. Water usage during a summer may vary from 500 to 1,500 gallons per cow depending on the weather conditions and sprinkler system used.

Water Application Rate

A simple design criteria of wetting rate is 0.03 gallons per square foot of wetted surface area per sprinkler on the cycle. The wetted surface area is the area wetted as the sprinkler nozzle oscillates back and forth. Normally, a distance of 6 to 8 feet is wetted behind the feed line. One guideline is to use 6 square feet per foot of feeding space. If the feed line is 100 feet long, then the wetted area per pen is 600 square feet (100 feet × 6 square feet). Therefore, 18 gallons (600 square feet × 0.03 gallons per square foot) of water is required to meet the design criteria of .03 gallons per square foot per cycle. The water pipes must be able to deliver 18 gallons of water during the selected sprinkler "on" cycle. If the sprinkler's cycle time is 3 minutes for the 18-gallon usage, the required flow rate is 6 gallons per minute (gpm).

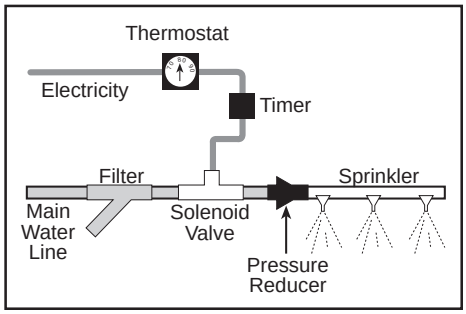


Figure 1. Cooling system components

continued on page 2

Heart of America Dairy Herd Improvement Summary (May)

	Quartiles				Your Herd
	1	2	3	4	
Ayrshire					
Rolling Herd Average	15,727	14,787	13,320	11,143	
Summit Milk Yield 1st	54.0	50.5	49.0	22.5	
Summit Milk Yield 2nd	66.0	60.0	56.0	23.5	
Summit Milk Yield 3rd	69.0	65.0	61.5	63.0	
Summit Milk Yield Avg.	63.0	60.0	56.0	60.5	
Income/Feed Cost	1,449	1,476	911	835	
SCC Average	296	324	254	263	
Days to 1st Service	70	80	70	61	
Days Open	144	123	147	184	
Projected Calving Interval	13.9	13.2	14.0	15.2	
Brown Swiss					
Rolling Herd Average	19,368	16,363	14,629	13,379	
Summit Milk Yield 1st	57.8	53.2	48.2	47.2	
Summit Milk Yield 2nd	62.1	65.0	59.0	57.7	
Summit Milk Yield 3rd	83.3	70.1	66.7	64.0	
Summit Milk Yield Avg.	73.8	63.4	58.5	58.1	
Income/Feed Cost	1,915	1,596	1,412	1,316	
SCC Average	346	395	253	309	
Days to 1st Service	76	87	72	88	
Days Open	175	164	149	192	
Projected Calving Interval	14.9	14.6	14.1	15.5	
Guernseys					
Rolling Herd Average	15,363	14,679	13,705	11,917	
Summit Milk Yield 1st	54.0	47.5	48.5	45.5	
Summit Milk Yield 2nd	63.0	68.5	66.5	53.0	
Summit Milk Yield 3rd	65.0	67.5	34.0	55.0	
Summit Milk Yield Avg.	60.0	61.0	61.0	51.5	
Income/Feed Cost	1,880	1,436	1,166	1,495	
SCC Average	188	206	544	241	
Days to 1st Service	78	105	95	81	
Days Open	183	179	250	175	
Projected Calving Interval	15.2	15.1	17.4	15.0	
Holstein					
Rolling Herd Average	22,585	19,674	17,548	14,425	
Summit Milk Yield 1st	71.5	64.3	58.3	50.2	
Summit Milk Yield 2nd	92.1	81.9	71.8	61.3	
Summit Milk Yield 3rd	97.7	87.5	77.8	67.0	
Summit Milk Yield Avg.	86.1	77.4	70.5	60.6	
Income/Feed Cost	2,195	1,867	1,593	1,269	
SCC Average	324	379	396	500	
Days to 1st Service	90	91	85	75	
Days Open	163	164	173	196	
Projected Calving Interval	14.5	14.6	14.9	15.6	
Jersey					
Rolling Herd Average	16,745	14,368	12,512	10,297	
Summit Milk Yield 1st	51.0	46.7	42.7	35.1	
Summit Milk Yield 2nd	62.6	56.5	44.1	37.8	
Summit Milk Yield 3rd	71.1	65.0	53.8	48.8	
Summit Milk Yield Avg.	63.0	56.8	49.1	43.2	
Income/Feed Cost	1,931	1,721	1,181	939	
SCC Average	330	312	311	448	
Days to 1st Service	66	80	66	68	
Days Open	147	129	147	141	
Projected Calving Interval	14.0	13.4	14.0	13.8	
Milking Shorthorn					
Rolling Herd Average	14,358	13,870	13,234	10,828	
Summit Milk Yield 1st	46.0	48.5	51.0	42.5	
Summit Milk Yield 2nd	51.0	57.0	63.0	46.0	
Summit Milk Yield 3rd	77.0	70.5	73.0	54.0	
Summit Milk Yield Avg.	63.0	59.0	64.0	47.5	
Income/Feed Cost	1,530	1,636	1,540	932	
SCC Average	149	312	173	315	
Days to 1st Service	0	79	0	99	
Days Open	201	143	316	134	
Projected Calving Interval	15.8	13.9	19.6	13.6	

Sizing of Water Pipe

The main distribution pipe is sized based on providing water to the number of sprinkler systems that are operating. If four pens are being cooled simultaneously, then the water usage per cycle rate is 72 gallons, using the above example of 18 gallons per cycle. Using 72 gallons in 3 minutes requires a water flow rate of 24 gallons per minute. Sequencing of the individual sprinkler systems requires a flow rate of only 6 gallons per minute.

Selecting the "on" time is also critical in sizing the water pipes. If the "on" cycle time of the above sample is 6 minutes, then the main pipe supply water to the individual sprinkler system must be able to handle 3 gallons per minute (18 gallons per 6 minutes). Increasing the "on" cycle time decreases the required water flow rate. The recommended flow rate in gallons per minute equals:

$$\frac{\text{wetted area (sq ft)} \times 0.03 \text{ gal/sq ft}}{\text{cycle on time (min)}}$$

Table 1 shows the maximum distance from a well or water meter connection to the sprinkler system controller based on flow rate, PVC pipe size, and limiting the pressure drop to 5 pounds per square inch. Assume a producer wants to determine if a 1½ inch PVC pipe will carry 27 gallons per minute for 400 feet. Table 1 shows that, with a 30 gallon per minute flow rate, a 1½ pipe should only be used if the distance is 200 feet or less. Therefore, a 2 inch PVC pipe would be selected since it can carry 30 gallons per minute up to 660 feet before exceeding the 5 pounds per square inch pressure drop. A new water line for sprinkling cows may have to be added in existing facilities if the current water lines were sized to handle peak demand of the waterers.

Table 2 shows the recommended minimum pipe size from the solenoid valve to the last sprinkler nozzle for the sprinkler distribution system. This table was developed based on applying 0.06 gallons per minute per foot length of feed line (note: (0.03 gal/sq ft × 6 ft/ft length) ÷ 3 min cycle = 0.06 gpm/ft length) and limiting the total pressure drop to 5 pounds per square inch or less. A 3-minute cycle was used in sizing the flow rate. If a feed line is 200 feet long and the solenoid valve is located at one end of the system, then the first 100 feet of pipe past the valve should be 1¼-inch PVC pipe and the next 100 feet should be 1-inch PVC pipe. Another option is to bring the main distribution line to the center of the feed line. This limits the distance from the solenoid to the last nozzle to 100 feet and then ¾-inch PVC pipe could be used.

The sprinkler nozzles and pipe must be supported between the building post if post spacing is greater than 4 feet (Figure 2). A steel cable can be placed along the feed line and stretched

Table 1: Recommended maximum distance from well or water meter connection for PVC pipe of varying diameters and flow rates and limiting pressure drop to 5 pounds per square inch (no allowances made for fittings or elbows).

Pipe Dia.	Flow Rate (gpm)					
(inch)	10	20	30	40	50	100
0.5						
0.75	60					
1.0	180	40				
1.25	700	200	100	60		
1.5	1,500	400	200	120	80	
2.0	5,000	1,400	660	400	240	80
2.5	12,000	3,300	1,600	900	600	160
3.0	43,000	12,000	5,600	3,300	2,200	600

Table 2: Recommended minimum PVC pipe size per 100-foot section based on the distance from the solenoid valve to last sprinkler nozzle and limiting total pressure drop to 5 pounds per square inch.

Total Length	Distance from solenoid valve to last sprinkler nozzle (ft)*				
(ft)	0–100	100–200	200–300	300–400	400–500
100	3/4 in**				
200	1 1/4 in	1 in			
300	1 1/2 in	1 1/4 in	1 in		
400	2 in	1 1/2 in	1 1/4 in	1 in	
500	2 in	2 in	1 1/2 in	1 1/4 in	1 in

** Minimum recommended PVC pipe size for this section

* Based on water application rate of 0.06 gallons per minute per foot length (0.03 gal/ sq ft, wetted distance 6 ft, 3 min sprinkler on-cycle)

tightly. The pipe can be fastened to the cable by using wire ties. Another option is to place a 2×4 along the post and use clamps to hold the pipe in place. Ideally, the nozzles should be located 12 to 18 inches behind the feed line (cow side of the feed line is considered the back side) (See Figure 3). The bottom of the nozzle should be 7 feet above the concrete floor (See Figure 2).

Sprinkler Nozzles

Sprinkler nozzles are rated to deliver a set number of gallons per minute (gpm) or gallons per hour (gph). An adequately sized nozzle should have a rating near 0.5 gallons per minute or 30 gallons per hour. The nozzle pattern or diameter should be 6 to 8 feet. Normally, there is an adjustment on the nozzle that adjusts the diameter. Nozzles can be purchased to spray water in a 180-degree or 360-degree pattern. The 180-degree nozzle works well at the feed line. If the 360-degree nozzle is used, then the sprinkler system needs to be suspended 5 feet behind the feed line and spray diameter limited to 8 feet.

Nozzle spacing is equal to the nozzle diameter or pattern. If the nozzle spray diameter is 8 feet, then the maximum spacing of the nozzles should be 8 feet on center. It is better to reduce maximum nozzle spacing 5 to 20 percent to ensure adequate coverage where the nozzles overlap and provide allowance for wind direction. The maximum spray diameter of a nozzle should be an 8 feet diameter to avoid wetting the free stall bedding.

Summary

When the temperature-humidity index (THI) is above 72, sprinkler systems can be installed to reduce heat stress to cows. Estimated daily cost for water is about 3 cents per 2 feet feeding space. A response of 100 pounds of milk per cow during the summer is needed to cover the fixed and variable cost of most sprinkler systems.

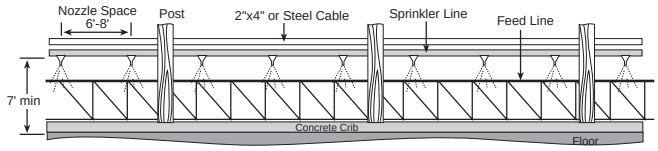


Figure 2. Typical sprinkler system located over feed line.

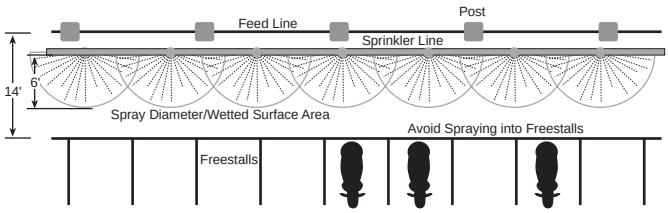


Figure 3. Top view of sprinkler system at feed line.

Hay Prices*—Kansas

	Location	Quality	Price ($/ton)
Alfalfa	Southwestern Kansas	Premium	65–85
Alfalfa	Southwestern Kansas	Good	n/a
Alfalfa	South Central Kansas	Premium	75–85
Alfalfa	South Central Kansas	Good	n/a
Alfalfa	Southeastern Kansas	Premium	80–90
Alfalfa	Southeastern Kansas	Good	n/a
Alfalfa	Northwestern Kansas	Premium	n/a
Alfalfa	Northwestern Kansas	Good	n/a
Alfalfa	North Central Kansas	Premium	n/a
Alfalfa	North Central Kansas	Good	n/a

Source: USDA Weekly Hay Report, *Week ending May 28, 1999*

*Premium Hay RFV = 170–200
Good Hay RFV = 150–170

Hay Prices—Oklahoma

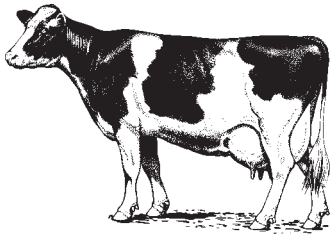
	Location	Quality	Price ($/ton)
Alfalfa	Central/Western, OK	Premium	85–110
Alfalfa	Central/Western, OK	Good	75–100
Alfalfa	Panhandle, OK	Premium	95–110
Alfalfa	Panhandle, OK	Good	80–95

Source: Oklahoma Department of Agriculture, *June 1, 1999*

Feed Stuffs Prices

	Location	Price ($/ton)
SBM 48%	Kansas City	131.70–136.70
Cotton Seed Meal	Kansas City	126–128
Whole Cottonseed	Memphis	152
Pork—Meat and Bone Meal	Texas Panhandle	137–143
Blood Meal	Central United States	280–294
Corn Hominy	Kansas City	65–70
Corn Gluten Feed	Kansas City	60–62
Corn Gluten Meal 60%	Kansas City	205–210
Distillers Dried Grain	Central Illinois	73–82
Wheat Middlings	Kansas City	30–36

Source: USDA Weekly Feed Stuffs Report, *Week ending May 26, 1999*



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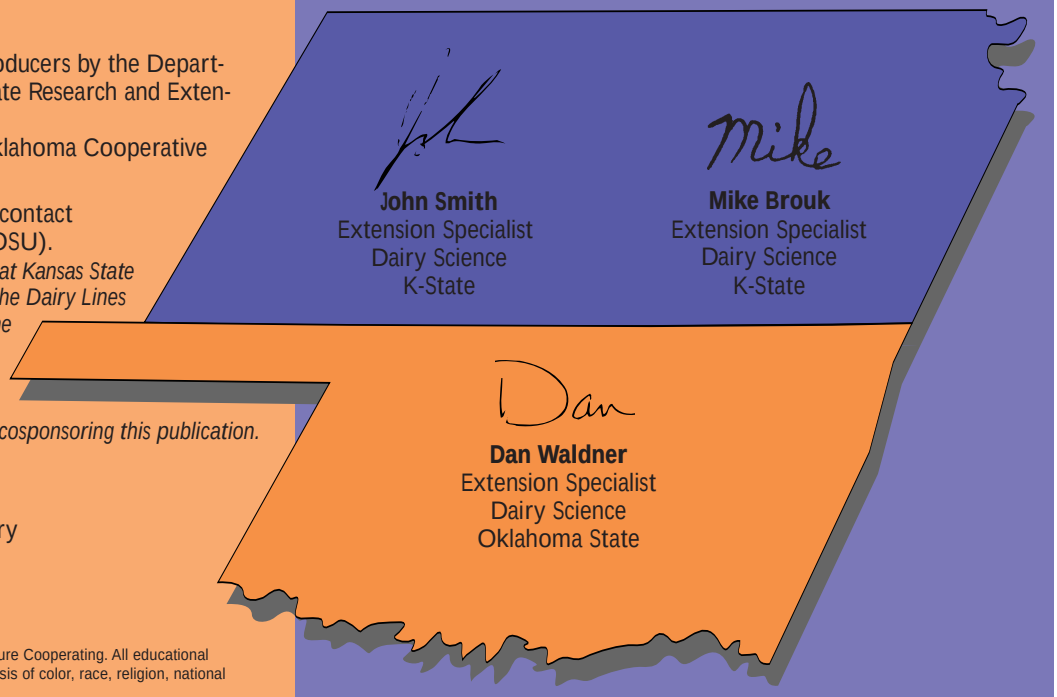

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