

Total Dairy Nutrition

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Supplemental Cooling to Provide Heat Stress Relief For Northeast Dairy Cows -- You Can't Afford Not To Do It!

By Curt Gooch

Traditionally, when heat stress is mentioned, dairy producers think about southern dairy farms. In the south, producers combat heat stress with the primary objective of keeping cows alive and secondary to maintain some realistic level of production. Even though the northeast doesn't get as many total heat stress days as our southern neighbors, substantial periods of hot, humid, spells do occur and they can rival conditions found anywhere else in the country. The effects of heat stress on dairy cattle are enormous and cost the northeastern dairy industry significant lost revenues each year.

Some northeastern farms are very aware of the economical effects of cows suffering from heat stress. Oakwood Dairy in Auburn, New York has kept complete production records since 1988. They track lbs./cow per day sold on a daily basis. This data is graphed and displayed in the herdperson's office offering a visual impact to the effects of a number of production variables, including summer heat stress. Their data shows a production loss of 20 lbs./cow during one significant heat wave a few years ago. Using \$13 per cwt milk price that translates to a daily loss of \$1,300 for a herd of 500 cows!

Effects of Heat Stress

Decreased dry matter intake and subsequent loss of milk production are not the only adverse effects of heat stress. Daytime feed intake depression and subsequent

nighttime slug feeding can cause acidosis and possibly further lead to laminitis. Nutrient absorption of consumed feed is reduced, decreasing feed utilization efficiency.

Heat stress can cause reproductive systems to shut down, possibly for several months afterwards. Consequently, rates of conception are lower and those animals that do conceive subject their embryos and fetuses to conditions within the uterus that compromise growth causing lower birth weights of calves. Milk production in the subsequent lactation (occurring in cooler weather) has also been shown to be adversely effected by previously endured heat stress.

The economical effects of heat stress clearly cannot be based on lost production alone. Fortunately, there are methods available to relieve heat stress, which are economical and practical.

Symptoms of Heat Stress

Effective heat stress in dairy cattle is actually the result of two separate variables; temperature and relative humidity. These two variables, acting together on a cow, determine the effective degree of heat stress that the cow is subjected to at any given time. As the temperature increases, less humidity is required to create a stressful situation. On the contrary, as temperature decreases, more humidity is required to cause the same level of stress.

So, without taking temperature and relative humidity measurements and then referencing a chart that relates the two together how can you tell if your cows are suffering from heat stress and need relief? Researchers at the University of Florida suggest the following rules of thumb to determine if cows are stressed and need relief:

- If the respiration rate is over 80 respirations per minute for 7 or more out of 10 cows, you need it.
- If the rectal temperature is 102.5 degrees F. or above for 7 or more out of 10 cows, you need it.
- If dry matter feed intake drops 10 or more percent in hot weather, you need it.
- If milk production drops 10 or more percent in hot weather, you need it.

How A Cow Cools Herself

In looking for ways to effectively relieve heat stress from a dairy cow, we need to understand how a cow cools herself and subsequently design relief mechanisms that are targeted at enhancing her natural cooling system.

There are four basic pathways to remove metabolic heat produced within or heat transferred to a cow's body. Non-evaporative means include conduction, convection, and radiation. These first three ways require a thermal gradient (temperature difference) between the cow and her ambient environment for cooling to take place. When a high thermal gradient exists, heat is readily transferred from the cow to the surrounding

environment. However, as summer temperatures rise to 70 degrees and above, the gradient is too small to effectively cool cows by non-evaporative means. During these conditions, evaporative cooling, the fourth pathway, is most effective at keeping cows comfortable.

Evaporative cooling takes place at two primary sites on a cow's body; in the upper respiratory tract and on the outer body surface. As ambient temperatures rise, there is an increased potential to lose more heat from the outer body surface than via the respiratory tract. As a result, it makes sense to target heat stress relief efforts towards removing heat from a cow's outer body surface in order to receive the most benefit.

Fans First

Locating fans in strategic locations throughout your dairy facility is the first step in providing supplemental cooling to your cows (we are assuming that adequate ventilation is present and plenty of fresh water is available throughout the shelter). Research has shown that airflow over a cow with a velocity between 400 and 600 feet per minute will increase cow comfort at temperatures 75 ° F and above.

When locating fans at your facility, follow the following guideline in order of importance when incrementally installing fans:

1. Holding area
2. Milking area
3. Close up dry cows
4. Calving area
5. Fresh cows
6. High producers
7. Low producers

Holding Area:

Supplemental cooling fans should ideally be positioned in a holding area to direct air away from the parlor. When limited vertical space does not allow for placement of fans over the cows, locate fans along the sidewall to blow laterally across the pen in the direction of prevailing summer wind (figure 1). Do not blow air from the holding pen into the parlor since this can be unsanitary and moves hot humid air into the milking area.

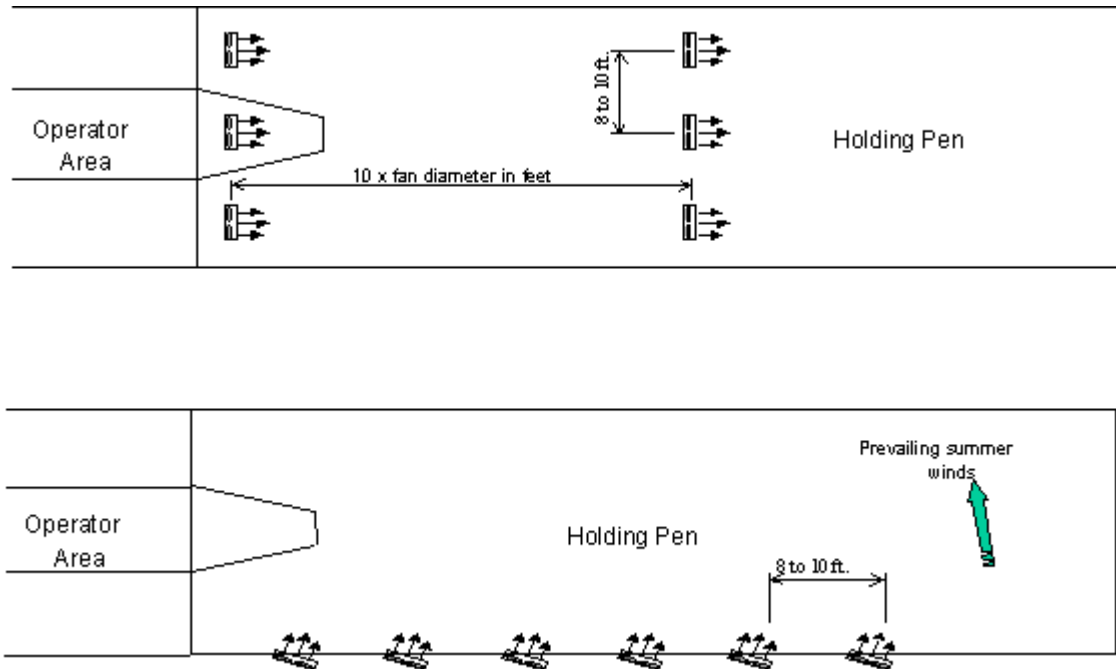


Figure 1. Placement of fans for cooling cows within a holding area. Preferred positioning is shown at the top with the compromised option located below.

Lactating Cow Shelters:

When fans need to be installed incrementally in your lactating cow shelter for economic reasons follow the following order:

1. Over the feed alley
2. Over the inner rows of stalls
3. Over the outer rows of stalls

If sufficient funds are available to outfit all rows of stalls but not the feed alley then provide fans over each row of stalls first.

Fans should be installed so that they are spaced longitudinally down the barn with a spacing of no more than 10 times their blade diameter (figure 2). Three-foot fans should be spaced no more than 30 feet apart while four-foot fans any more than 40 feet. Fans spaced more than 10 times their diameter lose their effective velocity and as a result all cows will not be adequately cooled.

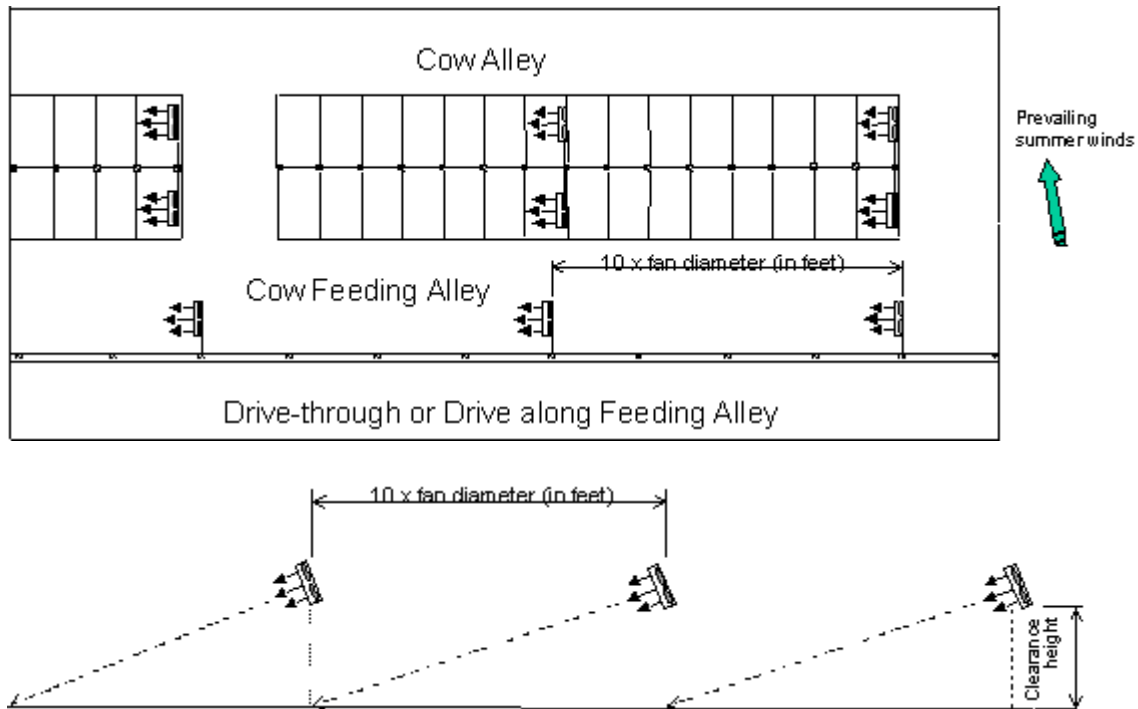


Figure 2. Placement of supplemental cooling fans in a freestall shelter. Top is a plan view and bottom is a side view.

Fans should be located vertically just high enough so they are out of each of cattle and don't interfere with alley scraping or bedding operations as shown in figure 3. Tilt fans approximately 15 to 20 degrees from the vertical so they are aimed at the bottom of the next fan down the line. If structural limitations require that fans be mounted directly above the feed barrier (cannot be cantilevered over the feeding cows) then consideration should be given to rotate these fans so they are blowing at an angle into the cow zone.

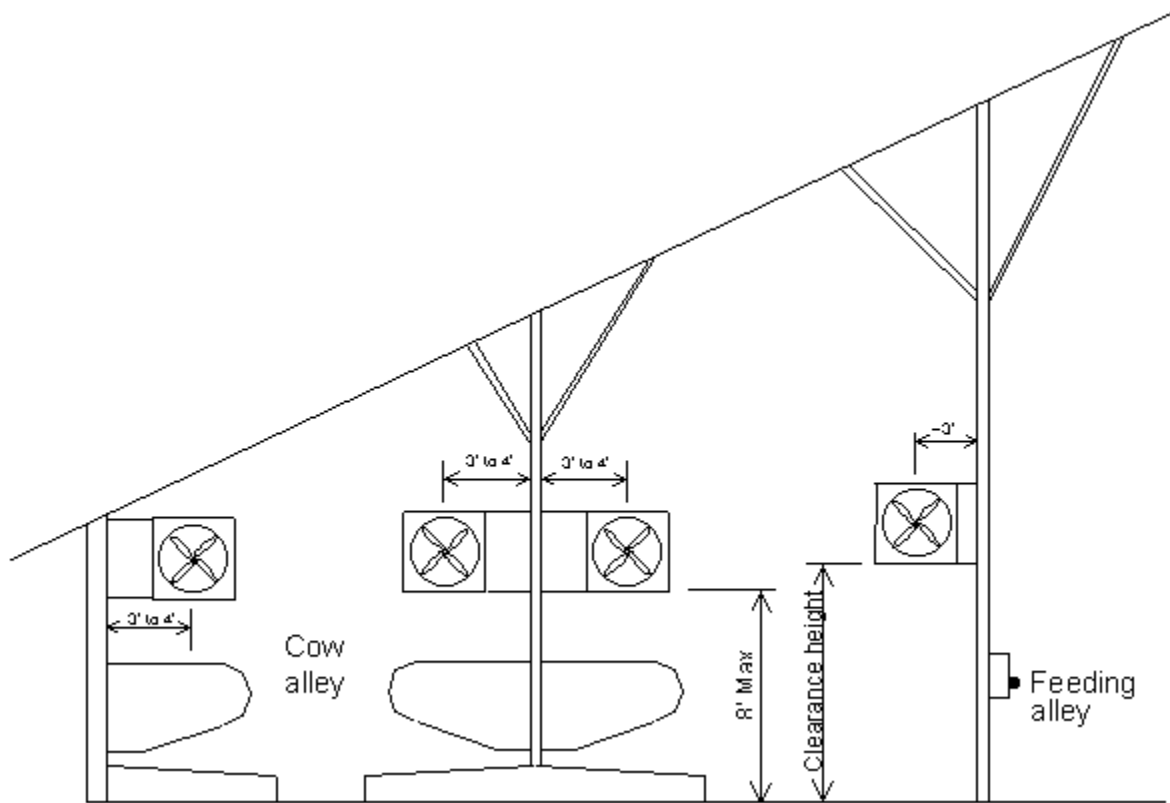


Figure 3. Placement of fans over feeding and resting cows in a freestall shelter.

Fan Controls:

Fans are best controlled by a thermostat. This eliminates the need for daily human attention. Mount the sensor for the thermostat so its reading represents the conditions in the cow zone. Set the thermostat so the fans start running at about 73 degrees or even a little lower if multiple hot days followed by hot nights are predicted.

Evaporative Cooling – The Process

Providing substantial air movement over a cow's body doesn't always offer complete relief to her. Additional mitigation can take place by evaporating water – evaporative cooling.

The process of evaporative cooling is nothing more than using heat to convert water from a liquid phase to a vapor phase. The heat consumed during this change in state results in a temperature reduction.

Evaporative cooling can be employed to cool a dairy cow in two distinctly different ways. With one method, the ambient air that surrounds the cow is cooled and in turn offers

cooling to the cow by removing heat predominately via convective heat transfer. Misters and foggers are examples of this method. Alternatively, the cow's outer body surface can be cooled directly by evaporative cooling. Sprinkler systems used in conjunction with fans are an example of direct cooling. Which method is ultimately used depends on several factors.

Ambient Air Conditions Effect Cooling

One of the major factors that determine which method of evaporative cooling to use is your specific geographic location. Location has an influence on the predominate condition or state of the ambient air conditions that are present during the summer months.

In the southwest, where summer conditions are hot and dry, cows are successfully cooled by evaporative cooling of the ambient air. Air temperature reductions of over 18 degrees or more have been reported with well-designed systems.

However, in the northeast, summer conditions are typically hot and humid. Humid conditions make it hard to cool the air by evaporative cooling because the air already has relatively high levels of moisture vapor. Primary for this reason, the use of sprinkler systems used in conjunction with fans to direct cool cows offers an advantage. Cooling by this method is little affected by ambient humidity as large volumes of air are passed over the animals.

Sprinkling and Fan Cooling

Using a sprinkler system to provide heat stress relief is effective but can only be used in shelters with proper ventilation. The extra moisture generated in the shelter must be removed by **air exchange** in order to provide a quality environment. Additionally, shelters must be appropriately outfitted with fans as described above for a sprinkling system to be effective. In hot, humid conditions sprinklers alone will not effectively cool cows.

Like lawn sprinkling systems, cow sprinkling systems are designed to operate at low water pressures, about 10 psi. Low water pressures result in large water droplets that will effectively soak a cow's hair coat to the skin. After the hair coat is soaked, the water is allowed to evaporate until such time application of water is again required. Fans located throughout the sprinkling area help in the evaporation process by quickly removing water just evaporated off of the cow's skin.

Caution should be used to ensure that the hair coat is soaked and not merely covered with a light mist. Application of a light mist will result in the outer portion of the hair coat only to be covered creating an insulating layer which will impede heat loss from the cow. Conversely, over application is a waste of water can possibly be counter effective if the udder becomes wet. Target rates of application are to apply 0.05 inches of water in 0.5

to 3-minute time intervals during a 15-minute cycle. The recommended schematic layout of a sprinkler system is shown in figure 4.

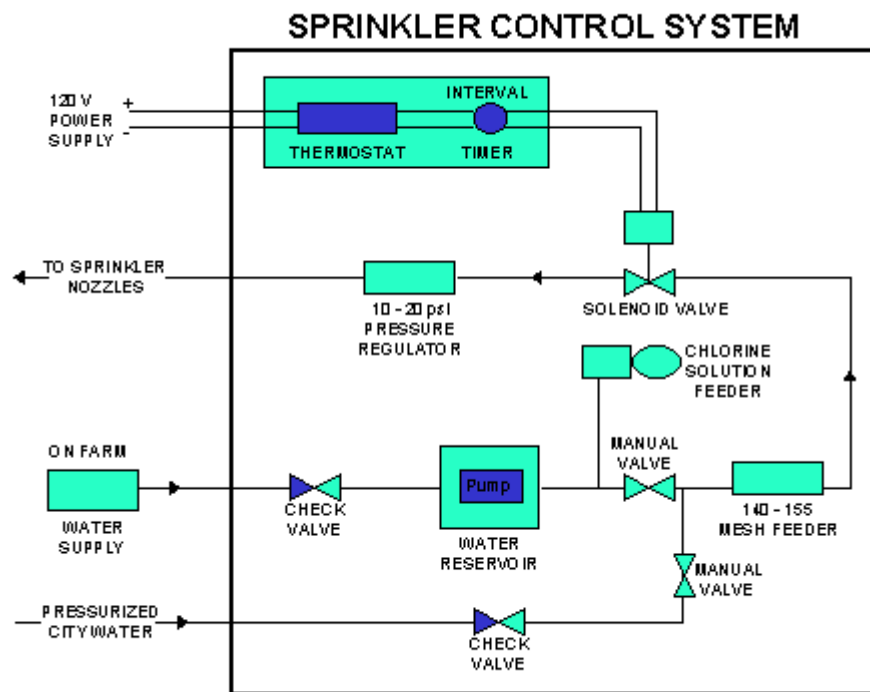


Figure 4. Schematic layout of the components of a sprinkler cooling system.

Sprinkler Nozzles:

The type sprinkler nozzles used depends on the specific application. Sprinklers that are mounted on the feed barrier for use over the feed alley should cover a 150 to 180 degree area. Sprinklers in a holding area or return alley can cover 360 degrees. Sprinklers should have at least a ½ inch base. High capacity sprinklers typically have a ¾ inch base.

Sprinkler nozzles should be spaced so that their coverage area overlaps. This ensures complete coverage. Exact spacing is determined by reviewing manufacturer's literature.

Pipe Size:

The size of the pipe delivering water to the barn must be sufficient to meet all of the peak water demand needs. Water usage for sprinklers, between 50 to 100 gallons per cow per day, must be accounted for in sizing the farm water supply pipe and overall water budget. The length of area to be sprinkled, and number and size of sprinkler nozzles employed govern the size of sprinkler manifold pipe.

Sprinkler Manifold Pipe Location:

This depends on the height of the barn, location of structural posts or other attachment points, width of area to be sprinkled, the type of sprinkler used, and vertical position of fans. For drive through or drive along feeding systems, the supply pipe can be installed either on or above the feed barrier or above the center of the feed alley.

Steps to Select Sprinklers

1. Define what area you want to sprinkle cool (feed alley, holding area, return alley).
2. Determine where you want to mount sprinklers (from a horizontal or vertical member).
3. Determine what specific sprinkler nozzle is to be used (150 to 180 degree nozzle for the feed alley if mounted immediately above the feed barrier (8 foot spray radius) or 360 degree nozzle if mounted in the middle of the alley (4 foot spray radius)).
4. Determine the water pressure that provides the proper radius.
5. Determine the proper nozzle size (specified in gallons per minute (gpm) of water delivery). Select nozzles with a rating of 0.5 to 2 gpm.
6. Determine trajectory of the nozzle.

Providing supplemental cooling is important to minimize milk production drops and maintaining herd health. Outfit your shelter first with cooling fans in all prioritized areas and then add sprinkler systems to add additional heat stress protection. Use thermostatic controls and timers to optimize system response and overall effectiveness.