Practical Heat-Stress Management

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In many parts of the United States there are times in the year when environmental conditions pose many challenges to the dairyman. In my practice territory, from May through October, temperatures above 90°F and relative humidity above 80% are prevalent. During these periods of heat-stress, the dairyman must adapt his facilities and management practices to provide an environment for the cow that is conducive to profitable milk production. Environment directly and indirectly affects the survival and productivity of the dairy cow.[1] Temperature, wind velocity, and solar radiation directly affect the cow, while environmental influences on feed quality and intake affect cows indirectly.

As the environmental temperature approaches body temperature, there is a drop in roughage intake and rumination, which in turn causes a drop in volatile fatty-acid production and a decrease in rumen PH.[1] Chronic heat stress also causes a reduction in the basal metabolic rate, which then lowers the cow's level of thyroxine, growth hormone, and glucocorticoid in the serum.[1]

Heat stress causes weight loss due to decreased feed intake which in turn increases days to first service, reduces conception rate, and increases cases of postpartum metritis and retained fetal membranes. Heat-stress decreases uterine blood flow which has a direct effect on conception rate, fetal growth and development, and the incidence of postpartum metritis.[8]

Factors Affecting Heat-Stress Management

The dairyman can improve production levels during adverse environmental conditions by improving building design, quality and quantity of water used, improved air flow, providing adequate shade, using a sound nutritional program and modifying the reproductive program.

Building Design

The facilities used to milk and house dairy cattle should be ventilated properly to allow for maximum heat dissipation and free air flow. Holding pens and feeding areas should be covered with a solid roof with an open center line in the roof to allow heat escape from the cow congregation area. Solid roofs are preferred since they reduce solar radiation exposure to zero.

Properly sloped roofs allow for heat to rise and dissipate through the open center line and as the heat rises it creates a natural draft which provides a cooler environment for the cow. Free-stall barns are becoming very popular on Southeastern dairies, but to be effective they must be properly designed to give maximum environmental comfort to offset the cost invested in the structure.

In existing facilities, exhaust fans and ventilators can be installed on the roof to help improve heat dissipation. Installing or enlarging windows in the milking parlor can also improve air flow and heat escape. Farms with totally enclosed holding pens and parlors are often the most severely affected by heat-stress.

To avoid overcrowding in congregation areas such as holding pens and feeding areas, dividing the herd into production groups makes for smaller groups. When production groups are smaller, there is improved milk production due to less time the animals are crowded, less congregation at the feed bunk, and more streamlined cow flow through the parlor.

Water Supply

When water is available in unlimited quantities and is not a regulated resource, it can be a major tool in combatting the effects of heat-stress on milk production. Water should always be offered to cattle free choice and be located near feeding areas and in the shade. Water should be fresh, cool, and free from organic matter.[8] Ponds are often too contaminated to offer potable water unless they are free flowing and do not retain too much organic matter or algae growth. Some dairymen have designed and installed water troughs in the parlor and offer water to cattle while they are being milked. Water is the most crucial element in maintaining adequate control in heat-stress management programs.

Water is also used as an external coolant in relieving heat-stress during periods of peak environmental temperatues. Water is delivered to the cow as a coolant either through pre-milking sprinkler systems mounted in the holding pen floor or through overhead sprinklers either before or after milking.

As ambient temperatures exceed 78°F evaporation becomes the primary means by which a cow disperses body heat to stay cool.[2] Evaporation is a natural process that occurs through sweating and breathing. Non-lactating cows can use both of these mechanisms to lower body temperatures; but lactating cows can only lower half of the excess body heat from production through sweating and breathing, so artificial systems must be implemented to aid them.[2]

Evaporative cooling systems are based on the addition of water to the air to help cool the cattle, this works best in arid regions not in areas where the relative humidity is often over 50%.

Sprinkling the upper bodies of the cow, followed by forced ventilation in the washing and holding pens, is a new concept in controlling the effects of heat-stress. Water is applied in enough force and quantity for 30 to 60 seconds to penetrate the hair coat and reach the skin. The sprinkler cycle is followed by 4 to 5 minutes of forced ventilation by regularly spaced box fans that are placed overhead and tilted on a 20° to 30° angle toward the cows. Then, the entire process is done repeatedly while the cows are waiting to be milked.[3]

Failure to adequately penetrate the hair coat with water can result in a blanket of moisture that further insulates the animals and raises instead of lowers the body temperature. Also if adequate air flow is not provided by the fans, then evaporation is reduced which also inhibits the heat-stress control program. One must not allow too much water to be applied to the animal, because it can wash dirt and manure from the upper body onto the udder. Trial-and-error methods must be implemented to determine the proper water droplet size, spray pattern, and spray duration to prevent over-wetting the animals.[3]

Sprinklers are placed upside down about 4 to 5 feet above the level of the animals backs. The spray pattern and number of sprinklers should cover the entire holding area. Sprinkler installation is simple and requires polyvinyl chloride pipe and sprinkler nozzles that can be purchased from an irrigation supply company.[3] The total amount of water to be applied during the spraying phase of the evaporative cooling cycle should be approximately 0.01 to 0.025 inch in 30 to 45 seconds from each sprinkler head. With 12 sprinkling cycles (every 5 minutes), the amount produced is about 0.12 to 0.30 inch of water per hour from each sprinkler head. For a 20 x 100 foot holding pen, about 8600 gallons of water are used daily if the systems operate continuously. This is estimated to be about half the amount of water used in the holding area daily to prewash the udders. The final objective is to have the cows dripped dry before they enter the parlor for milking. To ensure an effective and continuous spray system, a separate water source with strong pressure may be needed to operate the system.[3]

Forced ventilation is the second phase of the evaporative cooling process. Electric box fans with diameters 36 inches or larger and minimum 1/2-horsepower motors should be used to generate at least 11,000 cubic feet per minute of free air flow.[3] Fans need to be located above the sprinkler heads and pointed down toward the cows at a 20° to 30° angle, but pointed away from the milking parlor. They should provide free air flow through the entire length of the holding pen. When using 36-inch-diameter fans, 2 fans (5 feet in from the roof edge) should be placed every 30 feet over the entire length of the holding area.[3] (A fan generally has an effective throw of about 10 times its diameter.) Air velocity above the cows should be 9 to 10 feet per second (540 to 600 feet per minute) and at least 5 feet per second at the height of the main portion of the cows' bodies; 6½ feet per second provides optimum evaporation. Electric or electronic timers are used to regulate the sprinkler-and-fan sequence and duration.[3]

Cooling ponds or wading pools are becoming popular in Southern Florida. Pools are dug in pastures which allow the cows to submerge and cool their entire bodies.[8] Ponds must be free flowing to prevent stagnation and contamination; they are dug 4-6 feet deep and have a sloped bottom for organic material to settle. Cooling ponds often are more effective when used near shade structures since the cows stay in the water for 20 to 30 minutes, then exit the water for the shade for 45 to 60 minutes and then return to the pond to repeat the cycle.

Despite the potential for contamination, mastitis levels have not increased when ponds are available, possibly because the water is constantly moving in and out. The dairymen must test soil percolation and water availability before constructing cooling ponds in his geographic location. Also local and regional environmental regulations must be observed when using environmental water as a cooling source for dairy cattle.

Shade

Whether natural or man-made, shade is an important tool in controlling heat-stress in dairy cattle. Natural shade is the optimum for pasture cooling the cows. The criteria for using natural shade is that it must be close to milking and feeding areas, large enough to accommodate the entire herd, and on soil that is high and dry and not prone to allowing water to accumulate and form large muddy areas.

When cows congregate under inadequate shade size, the potential for environmental pathogens to cause mastitis increases and there is also a danger of lightening striking a larger percentage of the herd. Natural shade is a precious commodity and should be preserved at all costs.

Man-made shade has become very popular in the southeastern United States. This nylon mesh which is permeable to water and air is stretched over a metal pipe frame which has skids to allow it movability. Also it can be placed over feed bunks, holding pens and calf hutches. The shade cloth has about 80% effectiveness in blocking out solar radiation and has been shown to lower the ambient temperature around the cow by 10° to 12°C.[4] Adequate amount of shade must be provided or overcrowding will occur and further impede air flow which may exaggerate heat-stress on the cattle.[7] Shade should be placed close to feed, water, and the milking parlor to reduce walking time to and from the shaded areas.

In a study project conducted in Florida,[2] cows were kept in either a totally air-conditioned or partially air-conditioned environment during different portions of each day; this allowed for a 9.4% increase in 4% fat corrected milk. Cows cooled either during daylight hours or throughout a 24 hour period produced more milk and had a higher fertility rate.[2] The owner felt the increase in fertility and production were insufficient to offset the cost of air-conditioning the unit.

Nutrition

Nutrition and feed bunk management are also important in alleviating heat-stress in lactating dairy cows. During the summer months, roughage intake should be reduced, with a subsequent increase in concentration of protein and energy.[5] By increasing the nutrient density, the level of roughage drops because total dry-matter intake is lowered by the cow during periods of heat-stress.

When formulating a nutrient dense ration, great care must be taken to insure that the proper levels of nutrients are consumed by the cows to maintain efficient production levels. Increasing potassium in the ration is helpful since potassium is lost from the animal via sweating and most natural feed substances are low in potassium.[5]

Feed bunk space must be at least 2 to 2½ feet of linear space per cow to prevent over crowding and to insure adequate air flow. Multiple feedings per day and feeding at least 60% of the total ration at night has been used to improve feed consump-tion. Also haylage or silage-based rations are more prone to spoilage during periods of hot weather; therefore smaller quantities of feed, fed multiple times a day, can alleviate this spoilage problem.

Reproductive Management Programs

Modified calving and breeding programs can help control heat-stress on lactating dairy cattle.[6] Most southeastern United States dairies try to avoid breeding many cows during the hottest months. Where this is impractical, synchronization programs have proved useful.[7] Fertilization rates are normal in heat-stressed cattle, but the exposure of a cow and an early developing embryo to thermal stress induces embronic death while the embryo is still in the oviduct or after it arrives in the uterus, but before the time of pregnancy recognition in the cow (Day 15 to day 17).[2] Hence there is no noticeable effect on the length of the estrous cycle. Heat detection is considerably impaired by heat-stress and often prostaglandins have been used to improve heat-detection with mixed results.[8] Even the most diligent breeding programs used during the hottest months, yield poor results and the dairyman is often forced to delay breeding these cows till the fall of the year.

Conclusion

In conclusion, it is important for dairymen to understand fully the effects of heat-stress on their cattle as well as the resultant costs. For overall herd health programs to be effective, veterinarians must realize their roles in overcoming the environmental stresses on cattle.

By designing facilities to meet climatic conditions, feeding cows in areas that are comfortable, and feeding nutrient-dense rations according to a program of multiple feeds per day, dairymen can begin to realize the potential production that is possible during the warm months of the year. Veterinarians should be instrumental in establishing heat-stress management controls and should monitor the effectiveness of any program established. Whenever possible, veterinarians should consult with extension personnel and environmental and agricultural engineers to learn what new technology is available for achieving cow comfort and to obtain updates on environmental controls that will help alleviate heat-stress from the dairy operation.

Acknowledgements

The author extends special thanks to Dr. D. K. Beede and staff of the Dairy Science Department, University of Florida, for use of the technical data and research concerning the evaporative program installed at North Florida Holsteins Dairy owned by Don Bennink of Bell, Florida.

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