Fans: How Cool Are Your Cows?

COOPERATIVE EXTENSION SERVICE

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Heat stress negatively affects dairy cows[15,25]. Heat Stress decreases dry matter intake, production, and reproductive performance. Financial losses due to the effect of heat stress on cattle have been estimated to be $900 million/year for the U.S. dairy industry[8]. Emphasis on environmental temperature modification in the U.S. has focused on construction of freestall and loose housing with steep pitched roofs, which usually have an open ridge vent. However, cow performance in hot, humid weather necessitates improved cooling capability. The southeastern United States is characterized by extended periods of high ambient temperatures and relative humidity[24], making mechanical ventilation important to help cows dissipate heat.

Effects of heat stress

Heat stress occurs when the cow's heat gain is higher than its heat loss[23]. Warm temperatures decrease feed intake, production, and reproductive performance[11] and alter milk composition[10]. Milk production per cow has increased dramatically since the 1940's. Increased production increases metabolic heat produced by the cow[23]. Because of this, high milk yield cows are more susceptible to the detrimental effects of heat stress[1]. When cows are heat stressed, fewer cows have been detected in heat and have lower conception rates[7]. Moreover, heat stress increases lameness through increased standing times during hot weather. Cattle need to rest for 12 to 14 hours/day[14,17]. However, cows in warmer climates will decrease their lying time and increase their standing time[19,22]. Standing for longer periods of time may allow cows to maximize effective surface area for heat loss, reduce heat transfer from a warm lying area, or increase respiration efficiency[1].

The temperature humidity index (THI) is a measure of thermal stress. The THI is used to estimate cooling requirements needed by cattle to improve the efficiency of management practices to dissipate heat[9]. Cows start experiencing heat stress at a THI of 68, which is when cooling efforts should begin[9]. Physically modifying the environment by adding shades, sprinklers, and cooling fans can help minimize heat stress[4] since air movement, evaporation, and sun protection, minimize the negative effects of heat stress[24].

Mechanical ventilation

The most prevalent type of ventilation system in confinement dairy facilities is natural ventilation with fans placed over interior portions of the barn to supplement cow cooling[20]. Two types of fans exist, axial and high volume low speed fans[23]. Axial fans (figure 1, often box or round fans) are the high speed fans seen on many dairy farms[23]. High volume low speed fans (Figure 2, HVLS) are large diameter paddle fans, with 10 blades on each fan[16].

Figure 1. Axial fan example

Figure 2. High volume low speed fan example

Mississippi State researchers conducted a study over two summers where cows were in groups housed with or without fans and their estrous behavior was monitored. In the second summer, 71.4% of cows housed with fans displayed estrus whereas only 33% of cows housed without fans displayed estrus. The Mississippi state researchers also discovered that cows housed with fans had lower rectal temperatures. Average rectal temperatures in the afternoon for cows housed with fans and without fans for the first summer were 102.74 ± 0.04°F and 104.0 ± 0.06°F and for the second summer were102.38 ± 0.03°F and 102.92 ± .03°F, respectively[26].

Evaporative cooling

Sprinklers supplemented with fans is the most recommended cooling system to keep cows comfortable[18]. Convective cooling, which is the transfer of heat from one place to another by using increasing air speeds over cows, may help alleviate heat stress, but once heat stress is reached, convective cooling may not be enough and evaporative cooling should be employed. Evaporative cooling is divided into two sub sections, indirect or direct. Indirect evaporative cooling employs fogs or misters to lower the ambient air temperature, which is then circulated around the cows. Indirect evaporative cooling is an effective means of cow cooling, however, it may be compromised due to high relative humidity, which impedes evaporation[24]. Direct evaporative cooling employs intermittent sprinklers to wet the cow's skin and then uses fans running continuously to evaporate the water off the skin[2,23]. When wetting the cow to the skin, avoiding moisture buildup on her udder and in the cows lying area is important[13]. In a study where 41 barns were visited across California and Texas, fans (36 to 48 inches) spaced 20 to 40 feet apart with nozzles to spray water above the feed line were the most effective cooling system[3] and is also the best way to cool cows at the least cost[11]. However, it creates a large volume of wastewater that must be processed appropriately[24] and increases utility costs[21].

Recommendations

Strategic location of fans throughout the dairy is the first step for cooling cattle. When installing fans, they are needed in the holding pen first, followed by the milking area, close-up dry cow area, calving area, fresh cow area, high producing group area, and low producing group area[12]. The holding pen is the most stressful area for cows as they are often held there for long periods. Fans should be angled away from the holding area to improve the holding pen thermal environment as most holding pens lack proper ventilation and sprinklers should be placed over the cows[2].

Fan location within freestalls can affect where cows choose to spend their time. Fan installation in the barn should start over the feed alley, followed by the inner rows of stalls, and then the outer rows of stalls. Axial fans need to be spaced longitudinally down the barn at no more than 10 times their blade diameter width. For example, three-foot fans should not be placed more than 30 feet apart. High volume low speed fans spacing is best at 2 times their diameter. Vertically, axial fans should be located out of equipment and cow's way at 7 to 8 feet high. Axial fans should be angled at 15^0 to 20^0 so that the air velocity is aimed at the next fan down the line[5]. High volume low speed fans are usually placed 16 to 18 feet high (from the ground). Farmers typically use an overhead door of their barn as the reference point, placing the fans 1 foot higher than the door[16]. High volume low speed fans are advised to be turned off during high wind speeds because they can be blown up and hit the trusses[23]. A thermostat should control fans, which will eliminate labor for turning them on and off. Set the thermostat so that fans turn on when the ambient temperature at cow level is 73.0^{0}F. Fans should be targeted to move air speed over cows at 7.2 feet per second to aid in convection heat loss[23]. Fans also need to be kept clean to run properly[6].

With a sprinkler system, a wetting rate of 0.03 gallons per square foot of wetted surface per sprinkler, per cycle, is advised. A distance of 6 to 8 feet is usually considered wetted behind a feed line. Therefore, if the distance wetted is 6 feet and the feed line is 100 feet long, then the wetted surface is 600 square feet, meaning that the water lines must be able to deliver 18 gallons (600 × 0.03) of water per cycle[13].

In conclusion, heat stress negatively affects cows and mechanical ventilation can help alleviate the deleterious effects of heat. Heat stress lowers feed intake, production, and reproductive performance. Higher milk yield cows are more susceptible to the negative effects of heat stress. In order to keep cows cool, fans with sprinklers are the most recommended cooling system for cows and fans properly placed throughout the dairy can administer effective cooling.

REFERENCES

[1]Anderson, S. D., B. J. Bradford, J. P. Harner, C. B. Tucker, C. Y. Choi, J. D. Allen, L. W. Hall, S. Rungruang, R. J. Collier, and J. F. Smith. 2013. Effects of adjustable and stationary fans with misters on core body temperature and lying behavior of lactating dairy cows in a semiarid climate. J. Dairy Sci. 96(7):4738-4750.

[2]Armstrong, D. V. 1994. Heat Stress Interaction with Shade and Cooling. J. Dairy Sci. 77(7):2044-2050.

[3]Armstrong, D. V., P. E. Hillman, M. J. Meyer, J. F. Smith, and S. R. Stokes. 1999. Heat stress management in freestall barns in the western US. in Proc. Westeren Dairy Management Conference, Las Vegas, NV.

[4]Beede, D., K, and R. J. Collier. 1986. Potential nutritional strategies for intensively managed cattle during thermal stress. J. Anim. Sci. 62:543-554.

[5]Bottcher, R. W., J. R. Magura, J. S. Young, and G. R. Baughman. 1995. Effects of tilt angles on airflow for poultry house mixing fans. 11(5).

[6]Bucklin, R. A., D. R. Bray, J. G. Martin, L. Carlos, and V. Carvalho. 2009. Environmental temperatures in Florida dairy housing. 25(5).

[7]Cartmill, J. A., S. Z. El-Zarkouny, B. A. Hensley, T. G. Rozell, J. F. Smith, and J. S. Stevenson. 2001. An Alternative AI Breeding Protocol for Dairy Cows Exposed to Elevated Ambient Temperatures before or after Calving or Both1. J. Dairy Sci. 84(4):799-806.

[8]Collier, R. J., G. E. Dahl, and M. J. VanBaale. 2006. Major Advances Associated with Environmental Effects on Dairy Cattle. J. Dairy Sci. 89(4):1244-1253.

[9]Collier, R. J., R. B. Zimbelman, R.P. Rhoads, M.L. Rhoads, and a. L. H. Baumgard. 2011. A re-evaluation of the imapct of temperature humidity index and black globe humidity index on milk production in high producing dairy cows. in Proc. Western Dairy Management Conference, Reno, NV.

[10]Coppock, C. E., P. A. Grant, S. J. Portzer, D. A. Charles, and A. Escobosa. 1982. Lactating Dairy Cow Responses to Dietary Sodium, Chloride, and Bicarbonate During Hot Weather. J. Dairy Sci. 65(4):566-576.

[11]Flamenbaum, I., D. Wolfenson, M. Mamen, and A. Berman. 1986. Cooling Dairy Cattle by a Combination of Sprinkling and Forced Ventilation and Its Implementation in the Shelter System. J. Dairy Sci. 69(12):3140-3147.

[12]Gooch, C. A. Fan cooling dairy cows.

[13]Harner, J. P., J. F. Smith, M. Brook, and J. P. Murphy. 1999. Sprinkler Systems for Cooling Dairy Cow as a Feed Line.

[14]Jensen, M. B., L. J. Pedersen, and L. Munksgaard. 2005. The effect of reward duration on demand functions for rest in dairy heifers and lying requirements as measured by demand functions. Appl. Anim. Behav. Sci. 90(3–4):207-217.

[15]Kadzere, C. T., M. R. Murphy, N. Silanikove, and E. Maltz. 2002. Heat stress in lactating dairy cows: a review. Livestock Production Science 77(1):59-91.

[16]Kammel, D. W., M.E, Raabe, and J. J. Kappelman. 2003

Design of high volume low speed fan supplemental cooling system in dairy freestall barns. in Proc. Pp. 243-254 in Fifth International Dairy Housing Proceedings of the 29-31 January 2003 Conference (Fort Worth, Texas USA).

[17]Munksgaard, L. and H. B. Simonsen. 1996. Behavioral and pituitary adrenal-axis responses of dairy cows to social isolation and deprivation of lying down. J. Anim. Sci. 74(4):769-778.

[18]NAHMS. 2007. Facility characteristics an cow comfort on U.S. dairy operations. USDA:APHIS:VS, CEAH, National Animal Health Monitoring Systems, Fort Collins, CO.

[19]Schütz, K. E., A. R. Rogers, Y. A. Poulouin, N. R. Cox, and C. B. Tucker. 2010. The amount of shade influences the behavior and physiology of dairy cattle. J. Dairy Sci. 93(1):125-133.

[20]Stowell, R. R., C. A. Gooch, and S. Inglis. 2001
Performance of Tunnel Ventilation for Freestall Dairy Facilities as Compared to Natural Ventilation with Supplemental Cooling Fans. in Proc. Pp. 29-40 in Livestock Environment VI: Proceedings of the 6th International Symposium (21-23 May 2001, Louisville, Kentucky, USA) ed. Richard R. Stowell, Ray Bucklin, and Robert W. Bottcher.

[21]Strickland, J. T., R. A. Bucklin, R. A. Nordstedt, D. K. Beede, and D. R. Bray. 1989. Sprinkler and fan cooling system for dairy cows in hot, humid climates. 5(2).

[22]Tucker, C. B., A. R. Rogers, and K. E. Schütz. 2008. Effect of solar radiation on dairy cattle behaviour, use of shade and body temperature in a pasture-based system. Applied Animal Behaviour Science 109(2–4):141-154.

[23]Tyson, J. T. 2010. Dairy heat abatement system selection tool. in 2010 Pittsburgh, Pennsylvania, June 20 - June 23, 2010.

[24]West, J. W. 2003. Effects of heat-stress on production in dairy cattle. J. Dairy Sci. 86(6):2131-2144.

[25]West, J. W., B. G. Mullinix, and J. K. Bernard. 2003. Effects of hot, humid weather on milk temperature, dry matter intake, and milk yield of lactating dairy cows. J. Dairy Sci. 86(1):232-242.

[26]Younas, M., J. W. Fuquay, A. E. Smith, and A. B. Moore. 1993. Estrous and endocrine responses of lactating Holsteins to forced ventilation during summer1. J. Dairy Sci. 76(2):430-436.