Reducing Heat Stress for Dairy Cattle

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The ideal external temperature for a dairy cow is between 41 and 77o F. At temperatures above 77o cows have to use energy to cool themselves through heat loss via surface skin and the respiratory tract. As temperature increases, it becomes more difficult for a cow to cool herself adequately. High producing cows are the most sensitive animals to heat stress because of their high feed intake requirement. Dry matter intake starts to drop and milk production losses of 20-30% occur, which may exceed 10-25 lb./day, when temperatures exceed 90 F. Cows that had been cooled were found to peak at 9 lb. more milk per day than non-cooled cows. Each 1 lb. peak daily yield equals 225-240 lb. per lactation. A 9 lb. difference is equivalent to more than 2,000 lb.

Heat stress can result in sick cows that require prolonged care, difficult births, heat exhaustion, fatty liver in fresh cows, and mastitis, as well as adverse reactions to vaccinations such as abortions and death. Heat stress contributes to lameness, perhaps due to acidosis or increased output of bicarbonate. Lameness with sole ulcers and white line disease may not show for a few weeks to few months. Heat stressed cattle eat less frequently, feeding during cooler times of the day, but eat more at each feeding (Shearer, 1999). Reduced feed intake, followed by slug feeding when the temperature cools down, causes acidosis which is considered a major cause of laminitis. As temperatures increases, a cow's respiratory rate increases with panting progressing to open-mouth breathing. A consequence is respiratory alkalosis resulting from a rapid loss of carbon dioxide. The cow compensates by increasing urinary output of bicarbonate and rumen buffering is affected by decreased salivary bicarbonate pool. Conception was reduced due to less activity during estrus, unviable follicles, and early embryonic death. Dry cows whose last 3 mos. of gestation occurred during hot weather had smaller weight calves and more metabolic problems. Also, they produced 12% less milk in the next lactation.

The most common index of heat stress (temperature-humidity index or THI) is calculated from the temperature and relative humidity (RH). Dairy cows begin to suffer whenever the THI exceeds 72 such as 75o F and 80% RH, 80o F and 65% RH, and 85o F and 40% RH (Combs, 1996). Moderate stress occurs with temperatures ranging from 80o F and 100% RH to 90o F and 50% RH, causing rapid shallow breathing, profuse sweating and over 10% decline in milk yield. Severe stress, which occurs with temperatures of 90o F and 100% RH to 100o F and 60% RH, causes open mouth panting, elevated body temperature, and a 25% decrease in milk yield. Heat stressed cows will:

- Seek out shade,
- Increase water intake,
- Reduce feed intake,
- Stand rather than lie down,
- Increase respiration rate,
- Increase body temperature,
- Increase saliva production (Combs, 1996).

Cows need water during this time to dissipate heat through the lungs (respiration) and sweating. Water consumption will increase by as much as 50%. If water supplies are not adequate or heat stress becomes severe, cows divert water normally used in milk synthesis to the metabolic processes of heat dissipation. Water intake will rise by 5-6 gal on summer days due to temperature effects alone. Beede (1992) showed that cows consumed about 3 lb. water/lb. dry matter (DM) intake with temperatures between 0-41o F but reached 7 lb. water/lb. DM at high temperatures with high producing cows capable of consuming 50 gal. water/day. Practices which may encourage water consumption include:

- Put waterers in the shade
- Provide access to waterers right after milking.
- Ensure enough waterer space
  - Provide at least 2 waterer locations per group (at least 1 watering station per 20 cows)
  - At least 3-5 gal/minute (cows can consume 6 gal./hr.)
  - Minimum of 3" water depth
  - Minimum of 0.65 sq. ft. of surface area per cow at single- or double-position waterers.
- Keep tanks clean
  - North Florida Holsteins empties tanks each week and brushes them with a chlorine solution to disinfect surfaces and cut down on algae growth.
- Monitor temperature of water
  - Very limited research shows cows prefer water at 70-86 F.

The most practical methods to reduce heat stress can be grouped into three main areas; shade, ventilation, and cooling. Common areas that will benefit are feed barns, loafing areas and holding areas.

Shade

Although shade trees are the best method for relieving heat stress, most trees don't survive intensive use. When not enough natural shade is available, artificial shades can provide needed shelter from the effects of solar radiation. If cows are to be confined under a shade structure, it should be oriented east-west (Shearer et al., 1999). Each cow should be provided with 60 square feet of shade. The floor should be four-inch concrete grooved to provide firm footing. It should be sloped about 1.5 to 2% for proper operation of flush systems. Earthen floors under shades quickly can become mud holes and so are not generally recommended. A concrete slab needs to be larger than the area of the shade roof. The slab should extend 8 feet on the north side, and 20 feet on the east and west sides if the eave height is 12 feet. Higher eaves will require that the slab be extended further. The recommended eave height is 12 feet for structures up to 40 feet wide and 16 feet for structures wider than 40 feet. Gable roofs should have a 4:12 slope and a continuous open ridge to promote natural ventilation.

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Shade cloth is available in patterns providing 30 to 90% shade and fabricated from a variety of yarn materials. The most common material used for animal shades is woven polypropylene fabric, providing 80% shade. Shade cloth is considerably less expensive than solid roofing material but does not provide as much protection from solar radiation as a solid roof. It should last five years or longer if kept tight. To achieve the most benefit from the shade structure, feed and water must be available to the cows under the shade. A waste management system must be planned as an integral part of any shade structure.

Cooling

Cooling Pays. Cool the holding pen first. Congregating cows in a small area aggravates heat stress. Fans and sprinklers reduce temperature by 15o F and cooled cows produce more milk than non-cooled cows.

1) Evaporative cooling pad and fan system appears to be effective in areas of low or high humidity and cools the air while raising the relative humidity. Arizona studies were able to reduce the temperature by 20-24° F which resulted in 7-13 lb. more milk per cow. This system requires fans, evaporative cooling pads, and pumps to circulate water to the pads. A fine mist injection apparatus injects water under high pressure into a stream of air blown downward from above (Shearer et al., 1999). Coolers are positioned every 20' in the roof and air is pulled through the cooler at very high rates. There is a substantial initial investment and operating expense which is probably offset by increased milk yield, improved reproduction, and decreased culling.

2) Other evaporative cooling methods can be grouped into mist, fog, and sprinkling systems. A mist or fog system sprays small water droplets into the air and cools the air as the droplets evaporate. When an animal inhales the cooled air it can exchange heat with the air and remove heat from its body. The difference between a mist and a fog system is in droplet size. A mist droplet is larger than a fog droplet and will drop slowly to the floor, evaporating as it falls. A fog particle stays suspended in the air and evaporates before it touches the ground.

   a) High pressure foggers disperse a very fine water droplet which quickly evaporates and cools air while raising the RH. As fog droplets are emitted they are immediately dispersed into the fan's air stream where they soon evaporate. A ring of fog nozzles is attached to exhaust side of fan. Cooled air is blown over animal's body. They should operate during daylight hours only; humidity is too high at night but fans operate continuously. They use about 3-5 gals water /cow/day but require more maintenance because water filters must be checked daily and cleaned. They should not be used in low barns with side walls that restrict air flow and droplet evaporation and reduce cooling and make excessively wet conditions. Fog systems are very efficient methods of cooling air but also are more expensive than mist systems and require more maintenance.

   b) A mist droplet is larger than a fog droplet and animals are cooled primarily by inspiration of cooled air. Mist systems are difficult to use under windy conditions or in combination with fans. In warm humid environments, mist droplets are too large to fully evaporate before settling to the ground and bedding or feed becomes wet. If a misting system does not wet the hair coat to the skin, an insulating layer of air can be trapped between the skin and the layer of water. This impeded evaporative heat loss and can cause a harmful heat buildup. Cooling studies involving mist systems also have reported respiratory and pneumonia problems when cows were exposed to mist particles in enclosed areas. A mist system probably is not advisable.

   c) An alternative to mist and fog systems is the sprinkling system. This method does not attempt to cool the air, but instead uses a large droplet size to wet the hair coat to the skin of the cow, and then water evaporates and cools the hair and skin. Sprinkling is most effective when combined with air movement. Each fan should provide an airflow of about 11,000 cfm and should be tilted downward at 20-30° angles. At least one 36 inch fan for each forty animals is needed. A fan of this size will move air effectively for about 30 feet. Other fan sizes also can be used (every 40' for 48" fans). Nozzles (10 psi, 180° spray) are spaced above cows approximately every 8'. Sprinklers should be located immediately below the fans so that the water is thrown just under the bottom of the fans which run continuously. Cows are sprinkled for 1-2 minutes at 15 minute intervals. Concrete floors must be sloped to handle water runoff rates of 50-100 gal./cow/day. The sprinkling system can be used in holding areas, shade structures, feed barns, and free stall barns.

3) Cooling ponds effectively reduce body temperature with no apparent adverse effect on udder health (protothecal or coliform mastitis) or other diseases such as leptospirosis. Seven of 12 groups of lactating cows in a 1,400 Florida cow herd were located in lots with access to cooling ponds. All groups had permanent shade structures. The incidence of clinical mastitis for cows accessing ponds was half that of cows without ponds. These cows were cleaner and easier to milk, with lower somatic cell and bacteria counts; perhaps resistance was enhanced by lower heat stress. Man-made ponds are provided with constant inflow of water with overflow at one end. Ponds are drained and dredged every 1-2 years.

In the August 25, 1998 issue of Hoard's Dairyman, Dr. Jim Jarrett described how a 500 cow herd in deep South utilized a sprinkler system that sprayed water onto cows periodically but fans ran continually, heat detection was conducted during nighttime and early morning, highest quality forage was offered mostly at night in small meals and not allowed to stay long in bunk to heat, and dietary potassium level was increased. It was reported in the May 1998 issue of Dairy Herd Management that one herd installed sprinklers and fans to the holding area, shade cloth over the outside feeding areas, fans in the free-stall barns, and converted solid sidewalls to curtains. Over two summers in Alabama, milk production was greater when sprinklers were over feed alley and misters over free stalls versus either

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alone (misters were not recommended for free stalls bedded with sawdust or shavings). Water cooling increased milk production and reduced respiration rates versus fans only which reduced barn temperatures. And cleaning feed bunks is especially important.

Selected References:

Beede, D.K. 1992. Water for dairy cattle, Large Herd Management, H. H. Van Horn and C.J. Wilcox, eds. Management Services, American Dairy Science Assoc., Champaign, IL.

Bucklin, R. A., Bray, D. R., and Beede, D. K. 1992. Methods to relieve heat stress for Florida dairies. Circular 782, Florida Cooperative Extension Service.

Combs, D. 1996. Drinking water requirements for heat stressed dairy cattle, Univ. of Wisconsin Dairy Profit Report Vol. 8, No. 3 http://www.wisc.edu/dairy-profit/dpr/dpr83.pdf

Roenfeldt, Shirley. 1998. You can't afford to ignore heat stress. Dairy Herd Management, May issue p. 8.

Shearer, J.K. 1999. Foot health from a veterinarian's perspective. P. 33-43 in Proc. Feed and Nutritional Management Cow College, Virginia Tech.

Shearer, J.K., D.R. Bray, and R.A. Bucklin. 1999. The management of heat stress in dairy cattle: What we have learned in Florida. P. 60-71 in Proc. Feed and Nutritional Management Cow College, Virginia Tech.

Virginians Fare Well In Hoard's Judging Contest

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Several Virginians were recognized recently for an outstanding performance in the 69th Annual Hoard's Dairyman Cow Judging Contest. Results were printed in the May 10, 1999 issue of the magazine. Aaron Shiflett, a member of the Augusta County 4-H Dairy Club, placed second in the junior division and Powhatan 4-H'er Billy Matheny was the eighth high individual. Jennifer Bailey, also from Powhatan County, received an honorable mention. The Powhatan 4-H Dairy Club (Laura Graham, coach) and Amelia 4-H Dairy Club (Jimmy and Donna Kerr, coaches) both received an honorable mention in the 4-H club division.

The Virginia Tech Dairy Club placed fourth in the college division. Members of the team were Jorge Comas, Dee Guyton, Brad Haga, Daniel Horton, Sonja Houff, Katy Hurd, Matt Kimball, Brad Ramsey, Amanda Stiles, and Lynnette Wright.

Three agricultural education instructors received honorable mentions in the ag-ed instructor division. They were Ken Smith (James Wood FFA), Terry Lam (Turner Ashby FFA), and Mark Hawkins (Sherando FFA). The David Hardesty Family from Berryville also received an honorable mention in the family division.

Approximately 35,000 entries were received in this year's contest. Congratulations to each of these individuals and groups on a super job!

Wanted: Farmers with Pesticides... Notice Disposal Sites Below

The Virginia Department of Agriculture and Consumer Services and the Virginia Pesticide Control Board invite farmers, pesticide dealers, and pest control firms to participate in the 1999 pesticide disposal program, which removes unwanted, outdated, or banned pesticides from their storage sites and disposes of them in a safe manner. The agriculture department, through its Office of Pesticide Services, provides this service at no cost to participants. The program is funded through pesticide product registration fees.

The 1999 disposal program will collect and dispose of pesticides in over 30 localities state-wide including: the counties of Accomack, Charles City, Chesterfield, Dinwiddie, Goochland, Greensville, Hanover, Henrico, Isle of Wight, James City, New Kent, Northampton, Powhatan, Prince George, Southampton, Surry, Sussex, York, and the cities of Chesapeake, Colonial Heights, Emporia, Franklin, Hampton, Hopewell, Newport News, Norfolk, Petersburg, Poquoson, Portsmouth, Richmond, Suffolk, Virginia Beach and Williamsburg.

Tentative collection dates are scheduled during September and October of 1999. Commercial and private pesticide applicators interested in participating in the upcoming pesticide disposal project should contact their local Virginia Cooperative Extension Agent or the Office of Pesticide Services (804/371-0152).

Eight disposal programs completed on an annual basis since 1990 have successfully disposed of over 639,000 pounds of unused pesticides from over 1,577 participants in 106 localities. Since the program began in 1990 the most commonly removed pesticides include DDT, arsenic-containing pesticides, toxaphene, dieldrin, silvex, 2, 4, 5-T. The Office of Pesticide Services has developed plans to continue this advantageous program through 2002, with disposal opportunities in varying locations each year.

"Safe and proper disposal of pesticides is essential, but can be a costly task especially on an individual basis," says J. Carlton Courter III, Commissioner of the Virginia Department of Agriculture and Consumer Services. "The pesticide disposal program, offered at no cost to participants, encourages responsible handling of pesticides, ensures that Virginia remains free of unwanted, stored pesticides and promotes environmental stewardship from which we all benefit."

The Pesticide Disposal Project is a program of the Virginia Department of Agriculture and Consumer Services and the Virginia Pesticide Control Board with participation from Virginia Cooperative Extension, the Virginia Department of Environmental Quality, the Division of Consolidated Laboratory Services, and the U.S. Environmental Protection Agency. For more information, call 804/786-2373.

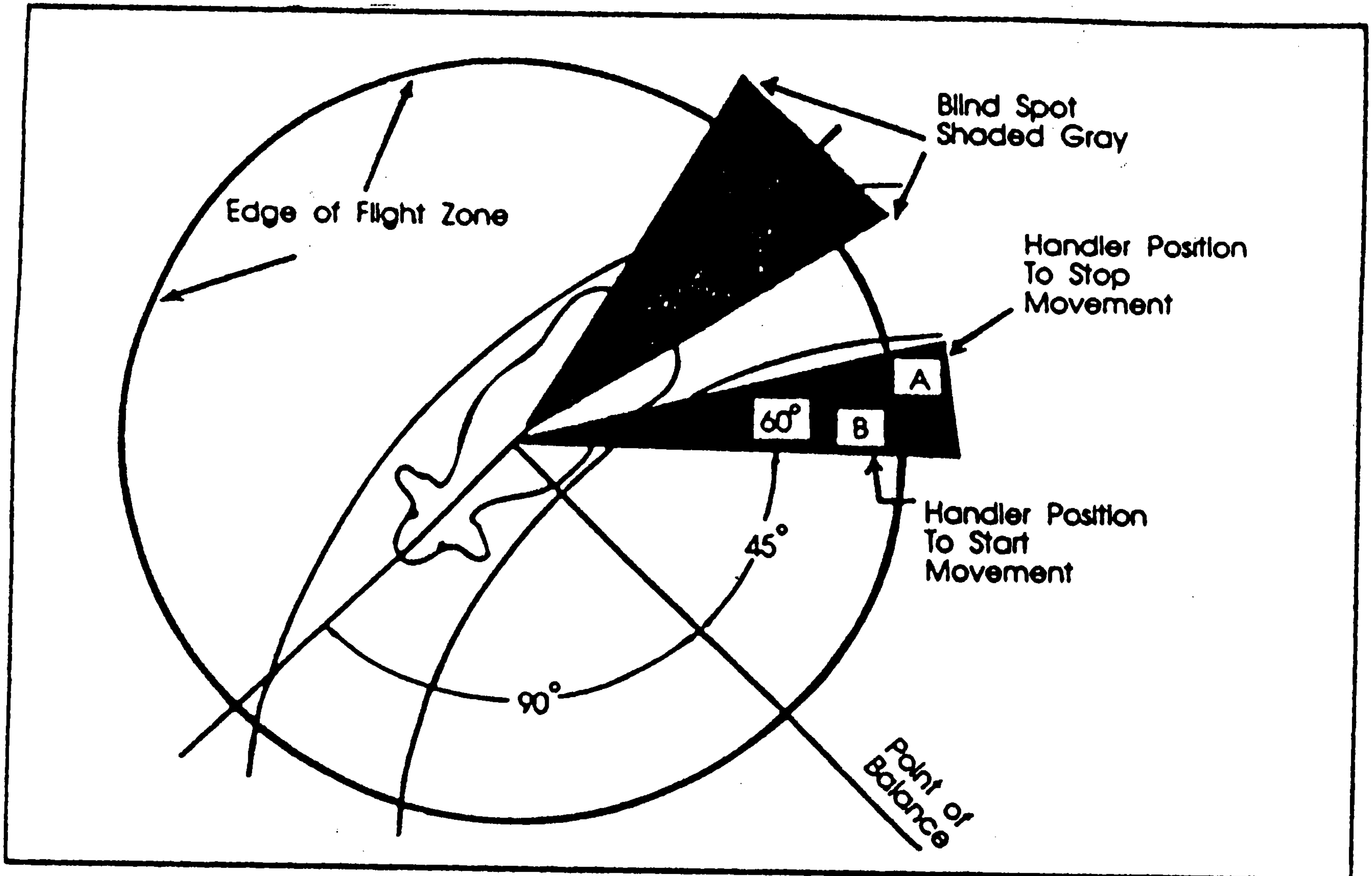

Figure 2—Diagram of an animal's flight zone (personal space). To move the animal forward, the handler must stand behind the point of balance at the shoulder and should work on the edge of the flight zone. Moving to position B causes the animal to move forward, whereas moving to position A usually causes the animal to stop.