NebGuide

Nebraska Extension

Research-Based Information That You Can Use

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Feedlot Heat Stress Information and Management Guide

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This NebGuide presents recommendations designed to help manage feedlot cattle during times of heat stress.

Cattle Do Not Handle Stress as Well as Humans

The thermocomfort zone varies greatly for beef cattle. Young cattle have a narrow comfort zone between 45 and 80°F. The comfort zone of feedlot cattle and mature cows will range from subzero temperatures in the winter to around 75°F in the summer, depending on body condition, hair coat length, and plane of nutrition. This wide comfort zone allows cattle to thrive under diverse climatic conditions with little or no need for shelter or protection. However, unlike humans, who can be reasonably comfortable on a warm spring day or when exposed to normal summer temperatures, feedlot cattle have difficulty coping with spring temperatures above 80°F and summer temperatures above 90°F. This is particularly true when humidity is high or wind speed is low.

Cattle's heat adaptive mechanisms only allow for approximately 1°F adaptation per day; therefore, in the spring, 30 days are required for cattle to adapt to average temperature changes from 50°F to 80°F. Hair coat color can add to the heat stress cattle endure. Black-hided cattle suffer heat stress more severely than do either red or white cattle. It is currently estimated that over 50 percent of all cattle in the United States have black hair coats, and the percentage of black cattle is steadily increasing.

Evaluate the Potential for a Heat Stress Emergency to Develop

Managing heat stress in cattle starts by evaluating the potential for a heat stress emergency at your operation and developing a heat stress management plan. To the extent possible, anticipate the crisis so you can get maximum benefit from your plan. Evaluate the previous history of heat stress events or the potential for a heat stress event to occur at your location.

The United States Department of Agriculture-Agriculture Research Service (USDA-ARS) Roman L. Hruska U.S. Meat Animal Research Center (USMARC) maintains a website to help cattle managers understand cattle heat stress, plan for heat mitigation, and anticipate or forecast upcoming cattle heat stress events (http:// www.ars.usda.gov/npa/marc/heatstress or http://www.ars.usda.gov/Main/docs.htm?docid=21306).

Managing Airflow, Water Most Critical Evaluations

Key elements to include in evaluating the potential of heat stress:

- The normal annual rainfall in your area. High rainfall areas are more susceptible to having high humidity. Historic weather data can be found at the National Weather Service (http://www.weather.gov/), National Climate Data Center (http://www.ncdc.noaa.gov/), or

Weather Underground (http://www.wunderground.com/).

- Precipitation above normal, particularly if wet weather continues into the summer months.
- Long-term weather forecast of hotter than normal conditions, which should signal early activation of a heat stress management plan. Forecasts can be found at the National Climate Data Center (http://www.ncdc.noaa.gov/) or at the USMARC website.
- Obstruction to airflow in cattle pens. Windbreaks and other airflow obstructions will create calm airflow up to 10 feet downwind for every foot in height. A windbreak 10 feet high will obstruct airflow 100 feet downwind. A Kestrel® meter (http://Kestrelmeters.com) can be used to assess the airflow (wind) movement on your facility. The base model also provides temperature and dew-point readings.
- Availability of water for watering cattle and wetting down the cattle or pen. Cattle can easily consume 1 to 2 gallons of water per hour under normal environmental conditions. Watering space and water flow to watering troughs should be evaluated to ensure cattle are protected from dehydration. For every 1,000 lb of weight, cattle can require at least 20 gallons of water per day when the ambient temperature is above 80°F. On hot days, they need to be able to get half of the required water during a two-hour period in the afternoon.

Developing a Heat Stress Management Plan

The following are procedures you should consider for your heat stress management plan. The first ones are more easily accomplished and may significantly improve the cattle's ability to withstand heat stress and to help maintain their performance during times of heat stress. They should always be done when the possibility exists for the ambient temperature and relative humidity to reach the heat stress critical limits of cattle.

Have Ample Water Available

At temperatures above 80 degrees, cattle need more water than normal to prevent dehydration and allow heat to be dissipated through evaporative cooling (sweating) and urination. Consuming water is the quickest and most efficient method to reduce body temperature.

Measure the water delivery flow rate into every waterer in your feedyard. The rate needs to be measured when the system is under consumption pressure such as mid-morning or during the afternoon on a warm day. To measure the rate, slide a soft rubber tube over the water outlet to divert the water into a 5 gallon bucket and measure the gallons per minute into the bucket when the float is lowered. If the waterer is supplying a pen of 100 head of 1,000 lb cattle, the flow rate should provide approximately 500 gallons of water per hour during a heat stress event.

Additionally, cattle need to have access to the waterer so the linear space around the waterer is also important. There is not a good rule of thumb, but an accepted estimate is 2 to 4 inches per 1,000 lb; therefore, a pen of 100 head of 1,000 lb cattle would need at least 200 inches or 16.7 linear feet of watering space. That may sound like a lot, but, actually, the upper end of this estimate may be required in a critical heat stress event in which cattle could potentially die. It can be the factor that prevents cattle deaths.

Put out extra watering tanks, if needed. This should be done in advance of anticipated need so animals become accustomed to multiple water sources. Providing up to 3 inches of linear space per animal can be lifesaving in feedyards and ensures that all cattle can get water when needed. Having ample space for cattle to drink and stay cool can also be important in maintaining cattle gain and feed efficiency.

Add additional water tank space, so that each animal has access to at least 5 gallons per hour. Keeping waterers clean should encourage water consumption. Weekly scheduled waterer cleaning also improves the likelihood of finding any malfunctioning waterers.

Use Low Stress Handling Techniques

Train everyone working around cattle to use low stress handling techniques. A series of classes taught by Tom Noffsinger is available online at the KSU Beef Cattle Institute website (http://beefcattleinstitute.org).

Processing cattle elevates body temperature 1 to 4°F, depending on environmental heat conditions and processing time. During heat stress periods, if cattle must be handled, work them in the early morning and absolutely not after 10 a.m. Your handling facility must have good airflow to the cattle and be shaded, if possible.

If there is any question about sufficient airflow, hang a 4- to 5-foot fan over the working facility and aim it at the cattle. While it may seem to make sense to work cattle after sundown, wait until the cattle have had at least six hours of night cooling before working them, i.e., wait until after midnight to start working cattle. Dissipation of body heat

is needed at night and allows cattle to deal with heat stress more effectively during the day.

Work with the packers to schedule shipping cattle at night or at least early morning. Try to start loading early enough so that all cattle can arrive before 7 a.m. Most packers have sprinklers and can keep the cattle comfortable. If cattle arrive with body temperatures elevated above what would normally be expected, carcass defects such as dark cutters may be more common.

Cattle that must be handled during hot days should spend no more than 30 minutes in the handling facility (processing or hospital area). Avoiding cattle bunching is equally important. Most cattle working facilities have very poor wind movement, causing cattle to gain body heat while they are in these areas. A 30-minute time limit minimizes the heat gain and allows the body core temperature to return to normal more quickly so the feedlot animal can deal successfully with heat stress.

Arrange to have shade and sprinklers in those areas. Tubing (½ to ¾ inch) equipped with spray nozzles (one nozzle per five animals) placed overhead will improve the cooling in handling and holding areas. Select a larger droplet size for the nozzle when implemented in these areas.

Change Feeding Patterns, Reevaluate Feed Additives

Shifting the feeding schedule toward evening deliveries may help hold cattle on feed and even out the consumption patterns. Delivering 70 percent or more of the daily scheduled feed two to four hours after the peak ambient temperature of the day may decrease the roller coaster intake patterns often observed. Moving to a late-day feeding schedule may also minimize the subclinical acidosis that is thought to contribute to the problems seen in times of heat stress.

Epidemiologic research in 2000 by Laura Hungerford while at the University of Nebraska–Lincoln indicated that cattle on an "all natural" feeding program have a higher death loss during a severe heat stress event than cattle fed conventional rations containing an ionophore, a medication to help control liver abscesses, and in heifer rations containing a progesterone to control estrus. On the other hand, research by Guy Loneragan at West Texas A&M indicated beta agonist included in rations at the end of the feeding period increased the death loss in pens during the mid- to late summer months.

Lowering the energy level has been controversial, but some research indicates that lowering the energy content of the diet or using a storm ration may lower the heat load on the cattle. Visit with a qualified beef cattle nutritionist about how to manage changes in ration energy being fed to finishing cattle.

Additional Strategic Heat Stress Management Planning

The following procedures may be more difficult to accomplish, because they require more intense planning, labor, and materials to implement. The key is to know your potential problem areas and focus your efforts on critical areas first.

Assess water supply and delivery capacity

Under heat stress conditions, the water delivery system needs to provide a minimum of 1.1 percent of body weight per hour; for a 1,000 lb feeder, this means 11 lb/hour, or about 1 ⅓ gal/hour. Ideally, a water system should be capable of delivering the amount of water required for an entire day's needs within a four-hour period.

This can be calculated from line diameter and line pressure. For example, a ½-inch water line will provide 8 gallons of water a minute at 40 lb pressure and a ¾-inch water line will provide 23 gallons of water a minute. In other words, increasing the size of the water line by half will more than double the output.

Another important rule of thumb is that the water pressure drops by 25 percent for each elbow. Thus, a 90 degree turn on a water line that has 40 lb water pressure will drop the pressure to 30 lb, which means a 25 percent decrease in water flow rate. Additionally, there is a loss of water flow over the length of the pipe in which it travels (*Figure 1*).

Water reserve capacity is the amount of water stored and ready for cattle consumption. This can be at the water tank or in underground storage in large supply lines ready to deliver to the cattle's watering tanks. An 8-foot round water tank that is 2 feet tall will hold approximately 700 gallons of water, enough for 7 gallons per head in a 100-head pen. Equally important, a tank of that size provides an additional 226 inches of linear watering space, giving more cattle an opportunity to have lifesaving access to water. Saving the life of one 1,400 lb feeder will pay for five water tanks of this size, which cost about $325 each.

Water reserve capacity and water flow rate calculations should always be performed before installing new watering systems. It is critical to know the existing water flow rate at each water tank. Water flow rates on automatic water tanks can be evaluated as noted previously. If deficiencies are identified in total supply or delivery at peak demand periods, additional supply and/or waterers must be added

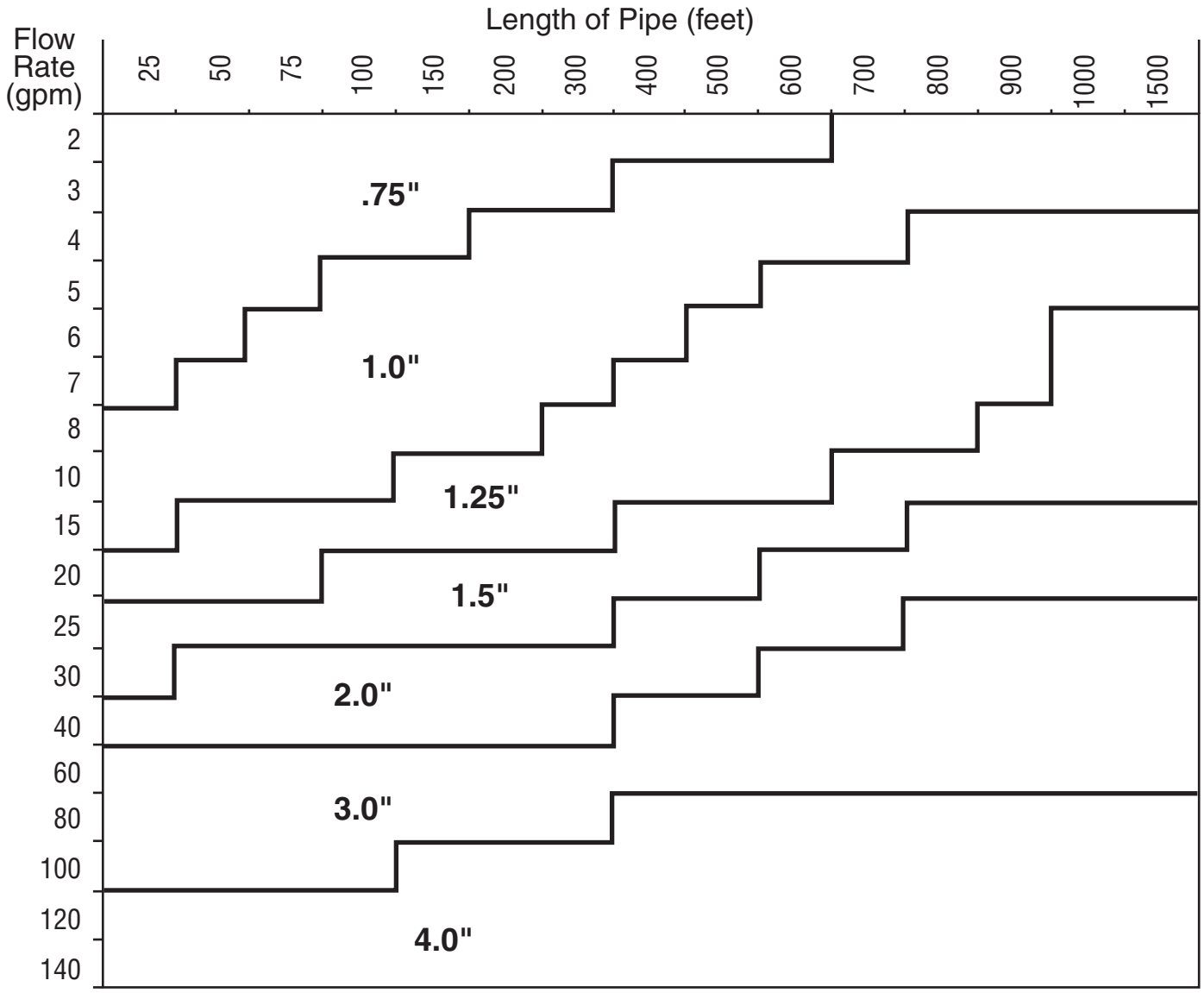

Figure 1. Frictional loss of water flow caused by friction between the flowing water and the internal pipe surface.

when temperatures are in the critical range. Alternatively, the cattle can be spread out to more pens so that the existing water supply can better serve critical needs.

Make Arrangements for Emergency Water

Contact your local fire department or producer cooperative to access equipment that can deliver emergency water. Make sure livestock drinking water is safe and palatable. Large volume sprinklers can be installed if water supply is adequate. Sprinklers can effectively keep cattle below their upper critical temperature by increasing evaporative cooling and lowering ground temperature. Coverage of 10 to 15 square feet per head should be adequate. Remember, water requirements can easily double when wetting pens and sprinkling cattle. Plan accordingly.

Move Cattle Away from Windbreaks

Windbreaks may be beneficial in the winter, but are a serious detriment in times of heat stress. Identify feedlot areas having limited air movement. Consider abandoning pens that have airflow impeded by windbreaks, trees, buildings, and grain bins during critical heat stress, or at the least, avoid stocking these pens with cattle that have black hair coats or cattle that are projected to finish in summer through early fall.

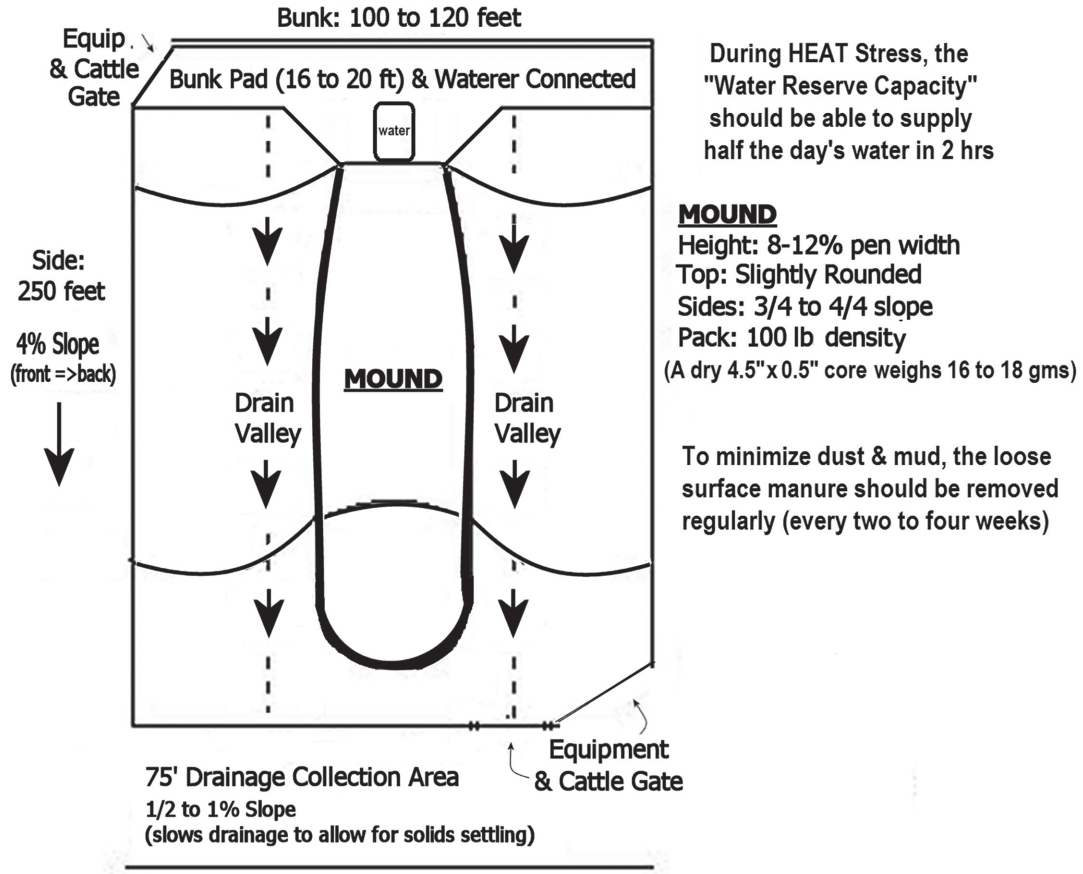

Figure 2. Tall mounds in feedlot pens can help prevent cattle from bunching.

Improve Airflow in Pens

Identify heavy, finished cattle, cattle new to the feedlot with a high risk for disease, and cattle with black hair coats, making sure to give these pens special attention to airflow. Tall vegetation, including growing crops, will obstruct airflow and provide a loafing area for the stable fly; remove tall vegetation 150 feet back from the perimeter of the pens. Consider building tall mounds in feedlot pens (see *Figure 2*). Mounds help prevent cattle from bunching and will usually enhance their exposure to air movement.

Provide Shade

Shade reduces exposure to solar radiation, thereby reducing solar heat load on the animal, but does not affect air temperature. Major design considerations for shade structures are orientation, space, height, and roof construction:

- A north-south orientation will minimize mud buildup under the shade since the projected shade will move across the lot from west to east (assuming the shade structure is sufficiently tall).
- The shade structure should provide approximately 20 to 40 square feet of floor space per feeder, recognizing that few production benefits will be realized if animals are overcrowded. To reduce mortality risks during emergency situations, a 15–25 ft^2/head can be beneficial.
- Shade height should be in the range of 7 to 14 feet, keeping in mind that the higher the shade, the greater the air movement under the shade. To enhance natural ventilation in shade structures, the selected site should have minimal trees, other buildings, or obstructions within at least 50 feet of all sides.
- Various types of roofing materials can be used for shade structures. The most effective in reducing heat load is a reflective roof such as white-painted galvanized or aluminum metal. However, high winds can increase the maintenance of solid roof shades. Slats, plastic, or other shade materials with less than total shading capabilities may appear to be less effective, but USMARC research indicates not much is gained beyond 60 percent shade cover. Shade structures need to be designed to handle high winds and winter snow

loads with minimal maintenance. Partial cover shades typically handle wind and snow loads better than solid cover shades.

Solely on the basis of performance, the economic benefit of shade may be difficult to calculate. However, research documents protection to feed intake decreases and maintenance of performance during heat events (Mader et al.). Research also documents the value of shade for decreasing the heat load on feeder cattle during heat stress events.

The USMARC has designed a unique stacked shade. Current research has not documented the value of this design to cattle performance. The design, when installed with a north-south orientation, will provide two shaded areas in the afternoon, one from each shade in the stack. The shades at the USMARC feedlot are installed on the fence line separating two pens.

To minimize interference with pen surface cleaning, the first shade is 15 feet high, well above the height of loaders used for pen cleaning. The second shade is 10 feet above the first shade. This louvered or stacked design casts a double shadow on the ground during the afternoon. The shade material is heavy duty plastic snow fence that has a ¼ inch cable along the edges and in the middle to add stability and strength to the plastic fencing. Thus far, the USMARC shades have withstood 60 MPH winds, 12-inch snow falls, and heavy ice.

For more information about the USMARC shade design contact Roger Eigenberg (Roger.Eigenberg@ARS.USDA.Gov); Tami Brown-Brandl (Tami.Brown-Brandl@ARS.USDA.Gov); or John Holman (John.Holman@ARS.USDA.Gov).

Control Biting Flies

Stable flies cost cattle feeders a lot of money. Research by Jack Campbell at the UNL West Central Research and Extension Center found that just a few feeding females can decrease average daily gain (ADG) by as much as 5 percent. These flies torment cattle, making them bunch and disrupting animal cooling. When not feeding, stable flies loaf in tall grass, weeds, brush, trees, and under building eaves. Removing weeds and brush within 150 feet of pens and spraying the shaded areas of buildings with a residual insecticide will help control stable flies. Minimizing shallow pools of water or muddy areas around the feedlot will help eliminate breeding areas for flies.

Look for Clues to Impending Heat Stress Crisis

First Clue

Predicted hot weather following precipitation. **It is the combined temperature, humidity, wind speed, and solar radiation (cloud cover) that determines the severity of heat stress**. Days in the high 80s or 90s (°F) following a precipitation event can be extremely stressful, especially if the wind speed is below 5 miles per hour for extended periods of the day.

Second Clue

Monitor the upper critical temperature-humidity limits of cattle. Consider this limit reached when the Temperature-Humidity Index (THI) reaches 80 or the Heat Index (HI) reaches 100 (see *Tables I* and *II*).

Third Clue

Evening weather forecast for overnight temperatures to remain above 73°F. A potential heat stress crisis exists for cattle when there is little or no night cooling. Watch for days following nights in which the ambient temperatures do not drop below 70°F. Feedlot losses have been commonly report-

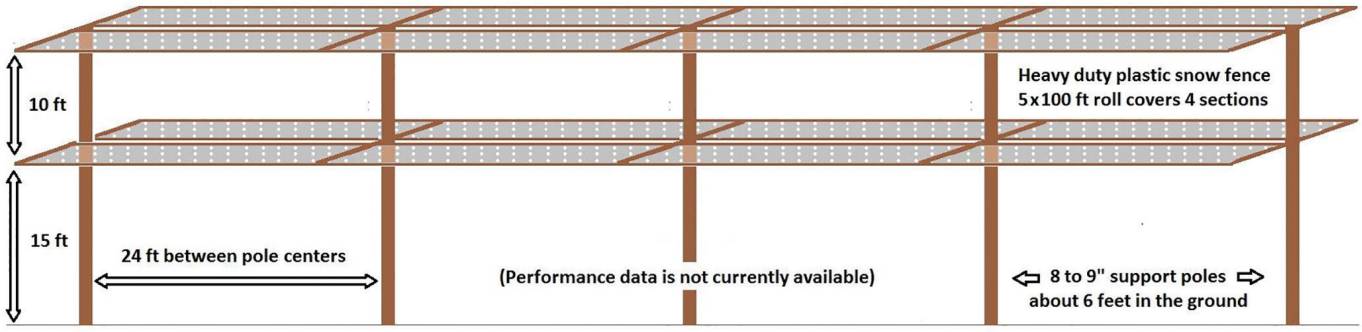

Figure 3. The USMARC high-rise shade design.

ed when two or more consecutive days with THI values above 80 (or HI values above 100) have been tied together with nights in which the temperature stayed above 70°F.

Fourth Clue

Observing cattle will tell you when they are becoming uncomfortable from heat. The cattle will start to walk around the pen looking for an area of the pen that is more comfortable. They will start to salivate, and their respiratory rate will increase to 75 breaths per minute or above. They will begin to elevate their head to make it easier to breathe. As the condition progresses they will drop their heads and pull their ears back. They will position their body to minimize their exposure to the sun, generally facing the sun. See the cattle heat stress stage identification photos at the USMARC Heat Stress website (http://www.ars.usda.gov/Main/docs.htm?docid=15625).

Activate Emergency Plans When Temperatures Combined with Humidity Are Forecast to Be in the Critical Range for Livestock (Temperature Humidity Index, Thi >80 or the Heat Index, Hi >100).

During a heat wave, the first day when the wind is calm can be lethal to cattle. If your resources are limited, focus on managing heat stress for those cattle that may be most susceptible to heat stress. These include cattle with dark hides, cattle close to being finished, newly arrived high stress cattle, and cattle suffering from or recovering from illness.

Keep Employees Safe

Maintaining feedlot employee health during a heat crisis is critical. Employee safety always comes first. If they are suffering, they can't do their best to care for the cattle, and managing heat stress can't be accomplished. These recommendations are for personnel doing reasonably strenuous outdoor work when temperatures are in the critical range:

- Minimize strenuous work during hotter times of the day or at least alternate between hard and light work. If employees must do hard work, they should spend 10–20 minutes of each hour doing less strenuous work, preferably in the shade.
- Employees must stay hydrated. They should drink 1 to 2 quarts of water per hour.
- A buddy system should be used to make sure water intake is adequate; the workload alternates between strenuous work with periods of light work; and early signs of heat exhaustion are detected. Signs of heat exhaustion include mood changes, emotional responses, and confusion.
- If an employee gets overheated, he or she should not return to strenuous work that day. Inside work or taking the rest of the day off is advised. Failure to do this may result in the employee developing heat stroke.

Heat Stress Management Review

- Post the Temperature Humidity Index (THI) and/or Heat Index (HI) table; in hot weather, evaluate the weather forecast against the THI and/or HI table every evening and morning.
- Start emergency measures when a sequence of hot days occurs with little or no night cooling (temperatures stay above 70°F).
- Schedule cattle handling between midnight and 8 a.m. Never handle after 10 a.m.
- Ensure cattle have adequate water and watering space in a heat stress emergency.
- Evaluate water flow rate and place extra waterers in each pen, if needed.
- Improve airflow by reducing or eliminating tall vegetation in and around the feedlot. Abandon pens with wind "dead air spots."
- Place shade and/or sprinklers in problem pens and consider installing in all pens.
- Shift daily feed delivery schedule toward evening feeding.
- Reformulate rations to lower the energy content by 5 to 7 percent, or lower total feed intake to minimize overall metabolic heat load.
- Two epidemiologic studies suggest a need to provide extra heat stress protection for cattle being fed on an "all-natural" program and for cattle being fed a beta-agonist during mid- to late summer.

A **critical heat stress emergency** exists when the combined temperature and humidity levels fall in the dark gray areas of either the THI or HI table. Wind (airflow) can have a tremendous positive moderating impact on the adverse

TABLES I AND II. Heat stress warning tables for Temperature Humidity Index and Heat Index

THI	Temp		Temperature Humidity Index, THI > 84 = Emergency																
RH	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
90	81	82	83	84	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98
85	80	81	82	83	84	85	86	86	87	88	89	90	91	92	93	94	95	96	97
80	79	80	81	82	83	84	85	86	86	87	88	89	90	91	92	93	94	94	95
75	79	80	80	81	82	83	84	85	86	86	87	88	89	90	91	92	93	93	94
70	78	79	80	81	81	82	83	84	85	86	86	87	88	89	90	91	91	92	93
65	77	78	79	80	81	81	82	83	84	85	85	86	87	88	89	89	90	91	92
60	77	78	78	79	80	81	81	82	83	84	85	85	86	87	88	88	89	90	91
55	76	77	78	78	79	80	81	81	82	83	84	84	85	86	87	87	88	89	90
50	75	76	77	78	78	79	80	80	81	82	83	83	84	85	86	86	87	88	88
45	75	75	76	77	78	78	79	80	80	81	82	82	83	84	85	85	86	87	87
40	74	75	75	76	77	77	78	79	79	80	81	81	82	83	83	84	85	85	86
35	73	74	75	75	76	77	77	78	79	79	80	80	81	82	82	83	84	84	85
30	73	73	74	75	75	76	76	77	78	78	79	80	80	81	81	82	83	83	84

HI	Temp		Heat Index, HI > 100 = Emergency																
RH	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
90	91	95	98	102	105	109	113	117	122	126	131	136	141	147	152	158	164	170	176
85	90	93	96	99	102	106	110	113	117	122	126	130	135	140	145	150	155	161	167
80	89	91	94	97	100	103	106	110	113	117	121	125	129	134	138	143	148	153	158
75	88	90	92	95	97	100	103	106	109	113	116	120	124	128	132	136	141	145	150
70	86	88	90	93	95	98	100	103	106	109	112	116	119	123	126	130	134	138	143
65	85	87	89	91	93	95	98	100	103	105	108	111	114	118	121	125	128	132	136
60	84	86	88	89	91	93	95	97	100	102	105	107	110	113	116	119	123	126	129
55	84	85	86	88	89	91	93	95	97	99	101	104	106	109	112	114	117	120	124
50	83	84	85	86	88	89	91	93	95	97	99	101	103	105	108	110	113	115	118
45	82	83	84	85	87	88	89	91	92	94	96	98	100	102	104	106	109	111	114
40	81	82	83	84	85	87	88	89	91	92	94	95	97	99	101	103	105	107	109
35	81	82	83	84	85	86	87	88	89	90	92	93	95	96	98	100	102	104	106
30	80	81	82	83	84	85	86	87	88	89	90	92	93	94	96	97	99	101	102

effects of high temperatures and humidities. Wind between 5 and 10 MPH can low the THI or HI by one unit per MPH wind speed. If there is little or no wind, expect cattle mortalities if there are more than three consecutive days in the GRAY area and night temperatures stay above 75°F.

Disclaimer

Reference to commercial products or trade names is made with the understanding that no discrimination is intended of those not mentioned and no endorsement by University of Nebraska–Lincoln Extension is implied for those mentioned.

Resources

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