OSU
OKLAHOMA COOPERATIVE EXTENSION SERVICE

# BEEF CATTLE RESEARCH UPDATE

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## Effect of Management Strategies on Reducing Heat Stress in Feedlot Cattle

The Livestock Weather Safety Index (LWSI) is commonly used as a benchmark to determine the susceptibility of cattle to heat stress, by assigning potentially heat stressed animals into normal, alert, danger and emergency categories (see Figure 1). The LWSI is based on the temperature – humidity index (THI) which quantifies environmental conditions using a combination of temperature and relative humidity. The LWSI classifications for heat stress are as follows: normal, THI ≤74; alert, 74< THI <79; danger, 79≤ THI <84; and emergency, THI ≥84. Nebraska data suggest that a THI between 70 and 74 is an indication to producers that they need to be aware that the potential for heat stress in livestock exist. For a reference point, average historical climatic data for Goodwell, OK for the years 2000-2005 are shown in Table 1. Over these years, the average number of days per year with high temperatures above 100°F is 14. There was an average of 80 days with highs above 90°F.

| Temperature Humidity Index (THI) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Relative Humidity, % | | | | | | | | | | | |
| Temperature, °F | 30 | 35 | 40 | 45 | 50 | 55 | 60 | 65 | 70 | 75 | 80 | 85 |
| 100 | 84 | 85 | 86 | 87 | 88 | 90 | 91 | 92 | 93 | 94 | 95 | 97 |
| 98 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 | 91 | 93 | 94 | 95 |
| 96 | 81 | 82 | 83 | 85 | 86 | 87 | 88 | 89 | 90 | 91 | 92 | 93 |
| 94 | 80 | 81 | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 | 91 |
| 92 | 79 | 80 | 81 | 82 | 83 | 84 | 85 | 85 | 86 | 87 | 88 | 89 |
| 90 | 78 | 79 | 79 | 80 | 81 | 82 | 83 | 84 | 85 | 86 | 86 | 87 |
| 88 | 76 | 77 | 78 | 79 | 80 | 81 | 81 | 82 | 83 | 84 | 85 | 86 |
| 86 | 75 | 76 | 77 | 78 | 78 | 79 | 80 | 81 | 81 | 82 | 83 | 84 |
| 84 | 74 | 75 | 75 | 76 | 77 | 78 | 78 | 79 | 80 | 80 | 81 | 82 |
| 82 | 73 | 73 | 74 | 75 | 75 | 76 | 77 | 77 | 78 | 79 | 79 | 80 |
| 80 | 72 | 72 | 73 | 73 | 74 | 75 | 75 | 76 | 76 | 77 | 78 | 78 |
| 78 | 70 | 71 | 71 | 72 | 73 | 73 | 74 | 74 | 75 | 75 | 76 | 76 |
| 76 | 69 | 70 | 70 | 71 | 71 | 72 | 72 | 73 | 73 | 74 | 74 | 75 |
| THI = Temp – (0.55 – (0.5 x (RH/100))) x (Temp – 58) | | | | | | | | | | | | |
| Normal ≤ 74 | | | Alert 75 - 78 | | | Danger 79 - 83 | | | Emergency ≥ 84 | | | |

Figure 1. Temperature Humidity Index

Recent Nebraska research[1] evaluated whether adjustment of the THI for wind speed and solar radiation could enhance its usefulness. This research concluded that within a day, adjustments to THI can be made by reducing the THI by approximately 1 unit for each 1 mile/hr increase in wind speed and for each 100 $W/m^2$ increase in solar radiation, THI should be increased by 0.68 units. Thus, adjustments to THI for wind speed and solar radiation would be useful for assessing current environmental stress levels.

Performance by feedlot cattle is reduced by heat stress during the finishing phase. Heat stress can substantially reduce an animal's appetite leading to decreased feed intake. Dry matter intake records[2] that I collected from Hitch Feeders I at Hooker, OK for cattle marketed during 1983 through 1985 suggested that heat stress depresses feed intake more for heaver cattle (800 lb initial weight) than lighter cattle (600 lb initial weight). Management strategies that may help alleviate heat stress include providing shade and sprinkling or misting of cattle.

Table 2. Historical Climatic Measures for Goodwell, OK (2000-2005).

| Month | Air temperature, °F | | | Relative Humidity, % | | | Wind Speed, mph | | |
|---|---|---|---|---|---|---|---|---|---|
| | Min[a] | Max[b] | Avg | Min[c] | Max[d] | Avg | Avg | Max[e] | THI[f] |
| January | 22.2 | 49.1 | 34.5 | 38.1 | 82.9 | 62.2 | 10.8 | 25.7 | 38.8 |
| February | 24.5 | 51.7 | 37.1 | 37.5 | 84.1 | 62.4 | 12.3 | 29.2 | 40.9 |
| March | 30.6 | 59.8 | 44.7 | 32.8 | 85.0 | 59.9 | 12.6 | 30.9 | 47.2 |
| April | 40.9 | 70.9 | 56.0 | 27.7 | 83.2 | 54.8 | 14.8 | 35.6 | 56.1 |
| May | 50.4 | 80.1 | 65.5 | 30.2 | 86.3 | 57.1 | 13.7 | 34.4 | 63.3 |
| June | 60.1 | 87.5 | 73.4 | 32.7 | 86.2 | 59.9 | 13.6 | 35.0 | 69.6 |
| July | 65.1 | 94.1 | 79.8 | 27.5 | 82.2 | 53.1 | 12.0 | 31.0 | 73.8 |
| August | 63.7 | 91.5 | 77.2 | 30.1 | 82.4 | 55.3 | 11.4 | 30.2 | 72.0 |
| September | 55.7 | 84.8 | 69.7 | 28.6 | 81.0 | 54.2 | 12.5 | 29.8 | 66.4 |
| October | 43.3 | 70.7 | 56.5 | 36.2 | 84.9 | 61.9 | 11.7 | 28.9 | 56.5 |
| November | 31.1 | 57.5 | 43.0 | 35.6 | 83.4 | 61.3 | 11.8 | 28.7 | 46.1 |
| December | 21.8 | 49.7 | 34.6 | 34.5 | 81.3 | 59.6 | 11.2 | 27.3 | 39.3 |

[a]Average minimum daily air temperature.
[b]Average maximum daily air temperature.
[c]Average minimum daily relative humidity.
[d]Average maximum daily relative humidity.
[e]Average maximum daily wind speed.
[f]Calculated using average daily air temperature and average daily relative humidity.

Shade can reduce the exposure to solar radiation by 30% or more by intercepting direct solar radiation, thus reducing heat load on the animal. However, shade does not affect air temperature. Texas Tech University research has looked at the effect of shade on the performance of feedlot cattle. In trials run during the summers of 1998 and 1999[3], providing shade to 739 lb heifers housed in concrete, slotted-floor pens (194 $ft^2$ pens) significantly improved dry matter intake, average daily gain, and feed efficiency by 7.5%, 13.5%, and 5.7%, respectively. In the summer of 2000[4], 781 lb heifers were fed in pens more similar to those found in commercial feedlots (soil-surfaced pens of 2002 $ft^2$). Providing shade (22.8 $ft^2$ per heifer) significantly increased dry matter intake and average daily gain by 2.9% and 6.1%, respectively. Providing shade also improved carcass quality and reduced respiration rate.

Providing shade may also reduce death loss in feedlot cattle. In Iowa during a heat wave (July, 1995), death loss among shaded cattle (24 $ft^2$ per head) was 0.2% (35 feedlots) as compared to 4.8% (46 feedlots) for non-shaded cattle[5]. Most feedlots (79%) without shade experienced some cattle loss while only 14% of shaded feedlots experienced death loss. The effect of shade on animal performance may be offset by lack of air movement. Overcrowding of cattle underneath shade structures or windbreaks in close proximity reduce air movement and benefits. In Nebraska research[6], feedlot cattle fed with overhead shelter enclosed on the north side had 7.4% lower daily gains and tended to have lower intakes and be less efficient. Presumably, this occurred because lower wind velocities led to less evaporative cooling and greater heat load. Additional Nebraska research[7] suggest that shade can temporarily improve performance when the animals have not become acclimated to hot conditions and (or) have greater body condition. However, once cattle are acclimated or hot conditions subside, compensation by unshaded cattle offsets much of the additional benefits of providing shade.

Research conducted 30 to 40 years ago in Arizona and California showed that sprinkling of heat-stressed feedlot cattle improved performance[8]. In addition, sprinkling is often used in commercial feedlots to alleviate dust. However, more recent research has failed to show consistent performance benefits with sprinkling. Texas Tech University research[3] showed that misting of feedlot heifers provided no measurable relief from summer heat stress when water misters (delivered 0.13 gal/min) were turned on when ambient temperature exceed 90°F and kept operating until temperatures dropped below this threshold. These researchers speculated that sprinkling might be more effective than misting since the fine water droplets from misting cling to the outer hair of the cattle's coat and hardly reach the skin. This might build up an insulation layer (air between skin and wet outer hair), which could act as evaporation barrier. However, more recent Texas Tech research[9] conducted during the summer of 2001 showed that sprinkling of feedlot heifers also did not affect feedlot performance. In this trial, sprinklers (flow rate of 5.84 gal/min) were turned on for 2-min periods every hour from 11 am to 5 pm daily when ambient temperature exceeded 86°F.

Recent Nebraska research[10] looked at the effect of applying water to feedlot mounds on hourly tympanic temperature of feedlot steers fed during the summer. In one experiment, three treatments were evaluated: 1) no water applied, 2) water applied to mounds continuously between 10 am and noon (AM), and 3) water applied between 2 pm and 4 pm (PM). Water was applied to mounds using impact sprinklers placed at ground level only when predicted maximum temperature-humidity index (THI) $\geq$ 77. The decision for water application was made at 10 am based on local weather reports and current climactic conditions. From 10 pm to 9 am and noon to 2 pm, steers assigned to morning sprinkling had lower tympanic temperatures than steers sprinkled in the afternoon. The control steers had temperatures intermediate to the AM and PM steers. In a second experiment, sprinkling vs non sprinkling was evaluated. Water was applied to mounds with impact sprinklers for 20 min every 1.5 hr from 10 am to 5:30 pm when THI at 9 am was $\geq$68. Steers in sprinkled pens tended to have lower temperatures at 2 pm and 4 pm than steers in dry pens and significantly lower temperatures between 5 pm and 7 pm. In these experiments, performance was also measured[11]. In the first experiment, feed efficiency of AM steers was superior to that of PM steers with control steers intermediate. In the second experiment, feed efficiency was improved with sprinkling.

South Dakota research[12] suggests that sprinkling is most beneficial in the evening hours; improves performance and lowers body temperature as compared to not sprinkling. Sprinkling during the day may cause problems in the water load in the feed yard since cattle spend a larger amount of time around water tanks during this time. South Dakota State University recommends mound sprinkling from 6 pm to 7 pm and from midnight to 1 am at a rate of 5 to 6 gal/hd/day.

Henry C. Hitch Feedlot at Guymon has been using a sprinkler system on a portion of the yard since 1992-93. The system was originally installed to help control dust but feedlot manager, Rod Schemm, reports that behavioral patterns of sprinkled cattle is altered and performance is improved. The yard generally begins using the sprinkler system when high temperatures begin to reach around 90°F. They use no set measure of heat index to activate the system but simply observe the cattle for signs of heat stress such as panting. The system runs nearly every day during the summer. During periods of rainfall or cooler temperatures (high temperatures from 70's to low 80's), use of the system may be reduced depending on the response of the cattle.

During periods of heat stress, the system runs from about 11 am to 9 pm daily. The system cycles five times during these hours. Each set of cattle is sprinkled for 3 min and then the system moves on to another pen of cattle. Each cycle last about 1 hr with about 1 ½ to 2 hrs between cycles. The system has five guns through which 500 gal/min of water are pumped at 90 to 95 PSI.

Schemm notes that behavioral patterns of sprinkled cattle are considerably different than that of non-sprinkled cattle. Cattle in sprinkled pens generally stand up when they are being sprinkled and after the sprinkling stops, they visit the feed bunk and water trough before lying down again on the wet ground. This same pattern is generally observed with every cycle of the sprinkler system. In contrast, non-sprinkled cattle generally lie down through out the day and do not begin eating until dusk. After eating, they then romp and play creating huge plumes of dust. Apparently since sprinkled cattle are more active during the day, they are less active in the evening.

The yard has never actually run controlled performance comparisons of sprinkled versus non-sprinkled cattle. High-risk cattle are generally fed in the sprinkled pens in an effort to reduce heat stress and thus, reduce health problems. However, Schemm has observed that performance of high-risk cattle in the sprinkled pens is comparable to that of good, native cattle. He feels that dry matter intake (DMI) is increased by 0.5 to 0.75 lb/day with sprinkling. Using net energy equations, projected gains of 900 lb feedlot cattle increase by about 0.06 lb/day with every 0.25 lb increase in DMI. In addition, the number of respiratory pulls appears to be reduced in the sprinkled pens.

**Implications of this Data**

The temperature-humidity index (THI) is a common bench mark used to determine the susceptibility of cattle to heat stress. This index quantifies environmental conditions using a combination of temperature and relative humidity. Adjusting THI for wind speed and solar radiation should allow producers to more accurately predict the potential for heat stress. Wind reduces the risk of heat stress, whereas, increased solar radiation increases the risk of heat stress.

Providing shade has the potential to improve feedlot performance and reduce death loss due to heat stress. However, the bunching of cattle underneath shade structures or windbreaks in close proximity reduces air movement and negates the benefits of shade. Nebraska data suggest that shade can temporarily improve performance when the animals have not become acclimated to hot conditions and (or) have greater body condition. However, once cattle are acclimated or hot conditions subside, compensation by unshaded cattle offsets much of the additional benefits of providing shade.

Research evaluating sprinkling of feedlot cattle has shown that sprinkling reduces heat stress but performance responses have been inconsistent. However, actual experience at the Henry C. Hitch Feedlot suggest that sprinkling dramatically alters behavioral patterns and increases DMI which should increase daily gains. In addition, sprinkling helps alleviate dust. Limiting heat stress along with less dust should reduce the risk of respiratory problems in the cattle.

A number of measures can be taken to help feedlot cattle deal with heat stress. These include:

- Insure that an adequate water supply is available. Water requirements during hot conditions more than double (Table 2). Consuming water is the quickest and most efficient method to reduce body temperature. Provide extra watering tanks, if needed. This should be done in advance of anticipated use so cattle become accustomed to multiple water sources.
- During hot weather, work or process cattle prior to 8 am and absolutely not after 10 am. Processing cattle can raise body temperatures by ½ to 3 ½°F, depending on cattle temperature and processing time.
- Change feeding schedule or ration. Shifting the feeding schedule toward evening deliveries (after peak daily ambient temperatures have occurred) may help hold cattle on feed and even out consumption patterns. Lowering the energy content of the diet may lower the metabolic heat load on the cattle.
- Keep extremely current on marketing finished cattle.

Table 2. Water requirements of beef cattle in different thermal environments (NRC, 1981).

| Thermal Environment | Water Requirement (lb/lb DM intake) |
|---|---|
| >95°F | 17.6 to 33.1 |
| 77 to 95°F | 8.8 to 22.0 |
| 25 to 59°F | 4.4 to 8.8 |

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