BEEF CATTLE RESEARCH UPDATE

Britt Hicks, Ph.D.
Area Extension Livestock Specialist
Oklahoma Panhandle Research & Extension Center

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Effects of Cold Stress on Feedlot Cattle

The performance, health and well being of cattle are strongly affected by climate. Many environmental factors influence nutrient requirements and performance of feedlot cattle. Temperature, wind, snow, rain and mud all cause winter stress. Severe winter weather causes significant losses in the feedlot industry. Early snowstorms in 1992 and 1997 resulted in the loss of over 30,000 head of feedlot cattle each year in the Southern Great Plains.[1] The feedlot death loss due to the heavy snowstorms that recently hit the Southern Great Plains is not yet known but estimates of around 10,000 to 30,000 have been mentioned. Economic losses from reduced cattle performance may exceed those associated with cattle death by several-fold.[2]

Research reviews from 1981[3] and 1983[4] looking at the effects of cold stress on beef cattle production concluded that cold stress elevates resting heat production, energy requirements for maintenance and appetite drive, while decreasing feed digestibility. The appetite stimulation may partially counteract the increased energy requirements but it cannot fully alleviate the reduced efficiency of utilization of dietary energy. In general, it is thought that cattle have a comfort zone of about 59°to 77°F (Figure 1). At temperatures above this zone, intake generally decreases, whereas, at temperatures below this zone, intake begins to increase.[5] At temperatures immediately below optimum, but still within the thermoneutral zone, there is a cool zone where animals invoke mechanisms to conserve body heat. The effectiveness of various insulative and behavioral responses to cold stress are maximal at the lower boundary of the thermoneutral zone, a point referred to as the lower critical temperature (LCT). Below this point, the heat from "normal" tissue metabolism and fermentation is inadequate to maintain body temperature. As a result, animal metabolism must increase to provide adequate heat to maintain body temperature. It has been suggested that for feedlot cattle, maintenance energy requirements increase by 1 to 1.5% for each degree that effective ambient temperature is below the LCT.[6] Estimated LCTs for various classes of cattle are shown in Table 1.

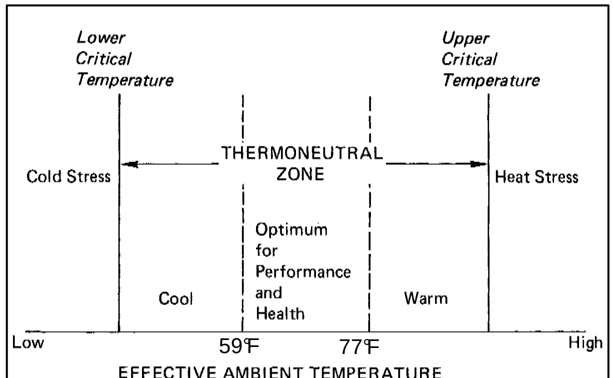

Figure 1. Schematic representation showing relationship of thermal zones and temperatures. Source: Ames, 1986.

Table 1. Estimated lower critical temperatures for various classes of cattle (Source: Ames, 1986)

Class of Cattle	Lower Critical Temperature (°F)
0.315 inch hair, fasting	64
0.315 inch hair, maintenance	45
0.315 inch hair, full feed	30
Summer coat or wet, maintenance	59
Fall coat, maintenance	45
Winter coat, maintenance	32
Heavy winter coat, maintenance	19

The 2000 Beef NRC[7] includes adjustment factors for estimating the effects of environment on dry matter intake of cattle (Table 2). Voluntary intake of beef cattle is increased by temperatures less than 59°F but decreased by exposure to wind storms, and mud or by temperatures greater than 77°F. It is suggested that mud may decrease intake s by as much as 15 to 30%. Adjustment for these effects is more accurate based on the average environmental state for a week or month than on daily fluctuations.[8] Dry matter intake records[9] that I collected from Hitch Feeders I at Hooker, OK for cattle marketed during 1983 through 1985 suggested that cold stress depresses feed intake more for lighter cattle (600 lb initial weight) than heaver cattle (800 lb initial weight) suggesting that cold is more stressful for lighter cattle.

Table 2. Effects of environment on feed intake of beef cattle[a]

Temperature (°F) or Lot Condition	Intake Change (%)
>95 with no night cooling	-35
>95 with night cooling	-10
77 to 95	-10
59 to 77	None
41 to 59	+3
23 to 41	+5
5 to 23	+7
< 5	+16[b]
Mild mud, 4 to 8 inches deep	-15
Severe mud, 12 to 24 inches deep	-30

[a]Modified from NRC (1981) and NRC (2000).
[b]Intakes during extreme cold (<-13°F) or during blizzards and storms may be temporarily depressed.

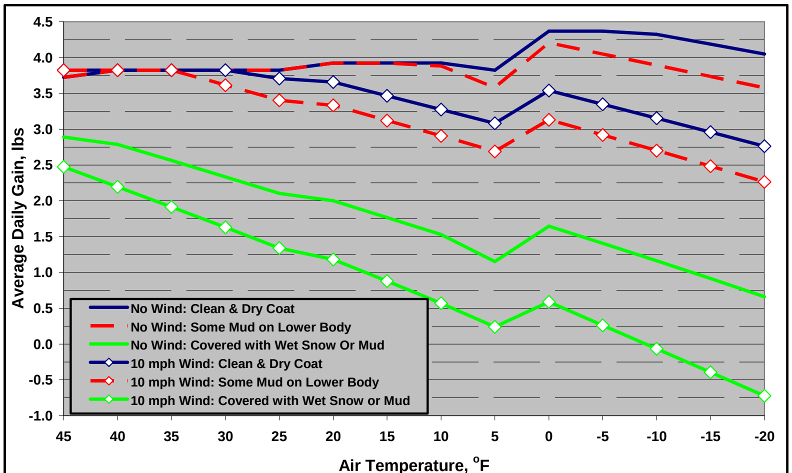

Figure 2. The effect of wind speed and coat condition on daily gains of 900 lb beef steers under various temperatures.

Using equations from the 2000 Beef NRC, projected average daily gains for a 900 lb beef steer fed a high energy diet (NEm of 98 Mcal/cwt and NEg of 63 MCal/cwt) are shown in Figure 2. Maintenance energy requirements can be adjusted for air temperature, wind speed, hair depth, hide thickness, and coat condition (dry and clean; some mud on lower body; wet and matted; or covered with wet snow or mud). The projections show that at 40°F, an animal with a wet coat with no impact of wind gains 27% less than the same animal with a dry coat. The reductions in gain become greater as temperature decreases. This data illustrates that cold stress alone reduces performance, but it is most detrimental when combined with mud. This occurs because cattle in mud may eat less frequently and the muddy hair coat reduces insulation. This figure also shows the affect of wind on projected gains (lowers animal's LCT due to wind chill effect). Increasing the wind speed to 10 mph at 20°F for a d ry, partially muddy, and wet hair coat reduces projected gain by 7, 15, and 70%, respectively. As wind speed increases, reductions in gain become much greater. For example, at 20°F with a 1 5 mph wind for the same steer with a wet hair coat, projected gain is reduced by 85%.

Management Considerations

A recent review[1] suggested that one of the most effective methods of minimizing cold stress is to provide insulation in the form of bedding. In this review, a summary of two winter feeding trials conducted in South Dakota and Colorado found that providing a little over 2 lb of wheat straw per animal daily as bedding improved gains approximately 7% and efficiency more than 6%. The benefits of bedding were not observed in the early part of these trials, but rather in the last 90 to 100 days of each trial, which corresponded to the late-winter and early-spring feeding period. During this time period, the cattle in these trials were heavier, and the adverse effects of wetter conditions and mud would likely be most prevalent and difficult for cattle to cope with. In these studies, the economic benefit of providing bedding averaged $11/animal after accounting for bedding cost.

A recent Nebraska study (two 2007 trials)[10] evaluated the effects of straw bedding (in sheltered and unsheltered facilities) and pen density (500 vs 250 ft^2/hd) in unsheltered facilities on feedlot cattle performance during the winter and spring (mid-December to late March). Bedding (about 2 lb/hd/day) was used when air temperature was below 14°F and/or precipitation of at least 0.1 inch rain or 1 inch snow was received. It was noted that bedding had no effect on overall performance in the sheltered facilities but gains and efficiency were improved by about 6% and 5%, respectively, from December through February in unsheltered facilities. Lowering pen density (increasing pen space per animal) tended to increase gains by about 9% in Trial 1 and improve efficiency (feed/gain) by about 8% in Trial 2 over the entire trials. Reducing pen densities also improved pen conditions by reducing the amount and severity of mud.

Nebraska research[1] has shown that providing windbreaks during the winter may improve cattle performance by reducing cold stress. However, wind protection may decrease performance during the summer by increasing heat stress.

Proper feedlot pen design and layout can also minimize the effects of adverse climates. Mounds will minimize mud problems during wet periods and enhance airflow during hot periods. The basic goal of using mounds is to remove water as quickly as possible from the pen with minimum erosion of soil and manure. Dr. Terry Mader from Nebraska offers the following considerations when designing mounds.[2]

- Reshape and add soil yearly.
- Shape side slopes steeply enough to drain water, but flat enough to allow cattle to rest on them comfortably out of the wind.
- Crown the top of the mound a slight amount for good drainage. The top should be fairly narrow, 5 to 10 feet wide to help maintain the crown.
- If possible, use clay to rebuild mounds, although a limited amount of packed manure can be used since it forms a better seal than soil alone, allowing faster runoff and less water retention.
- Design pens so mounds are tied to concrete pads around waters and feed bunks allowing the cattle to flow naturally from the mounds across the concrete pads to the feed bunk.

Determining what ration to feed during cold stress is a challenge. Nebraska research[11] evaluated the effect of diet energy level and/or energy level adjustments on feedlot steer performance in two trials over two winter seasons. In these trials, two levels of alfalfa hay (7.5%, Low and 15%, High) along with two diet switch feed regimens (7.5 to 15%, Low-High and 15 to 7.5% alfalfa hay, High-Low) were evaluated in two facilities (with and without wind protection). The ration switch occurred under cold stress conditions which were defined as the point at which ambient temperature was less than the animal's LCT. The common feedlot practice of switching from low to high roughage diets was not found to be beneficial. For cattle exposed to the greatest cold stress (no wind protection), the opposite was found in that switching from high to low roughage diets appeared to be most beneficial. The extra energy provided by grain appeared to be more beneficial than the extra heat increment (heat generated by rumen fermentation and tissue metabolism) derived from fiber. Apparently, the extra energy from grain is needed to offset the increase in maintenance requirements of feedlot cattle exposed to cold stress. However, feeding a higher fiber diet may simplify bunk management and help keep cattle on feed during adverse weather conditions that may disrupt normal feeding schedules and activity.

Feeding management and delivery schedules may also reduce the impact of cold conditions on feedlot cattle. Research from South Dakota[12] suggested that altering feeding time for limit-fed cattle in the winter can help to maintain body temperature. In this study, steers were limit-fed a high-moisture ear corn diet (NEg of 58 Mcal/cwt) at 9 am (AM), 3 pm (PM), or 50% at both times (SPLIT) to allow for gains of 2.5 lb/day. Maintenance energy requirements were 5.6 and 7.6% higher for AM and SPLIT cattle compared to PM cattle. Tympanic temperature (TT) suggested that the AM treatment group was unable to maintain TT during the coldest part of the day (9:30 pm to 7:30 am). In contrast, the PM treatment group was able to maintain TT during these hours possibly taking advantage of heat of fermentation.

Canadian research[13] has also suggested that feeding feedlot cattle in the evening during the winter months may be of benefit. In this study, cattle (682 lb initial weight) fed December through June (209 day trial) were fed either at 9 am or 9 pm. These researchers reported that evening feeding increased gain and efficiency during a 56 day backgrounding period, whereas, performance was not improved during the finishing period.

Summary

Temperature, wind, snow, rain and mud all cause winter stress. Cold stress increases maintenance energy requirements and free-choice intake, while decreasing feed digestibility. Increased intakes will only partially offset the increased energy requirements. Cold conditions combined with mud (due to rain or snow) can severely reduce cattle performance. Managing cattle during periods of cold stress is a challenge. Management strategies are aimed at alleviating rather than eliminating stress. Proper feedlot pen design and layout (providing mounds) will help to minimize the impact of adverse weather conditions. In addition, bunk management, type of ration and delivery schedules are all important management concerns when feeding cattle during winter stress conditions.

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