Maintaining or Improving Performance of Cattle During Hot Weather

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Maintaining adequate intake and performance during hot weather can be a constant challenge in some areas. Problems are more likely to be incurred with confinement than with pasture cattle because higher levels of performance (i.e. daily gain) are expected and because of other constraints. Therefore, most of the discussion herein will be directed toward feedlot or confinement cattle although some pertinent items would also apply to cattle in pasture environments.

Problems with reduced performance become especially critical when cattle are heat stressed. Health disorders with bloat and acidosis in feedlot cattle can increase as well during hot weather because of drastic changes in eating pattern. In some locations, such as the High Plains, even though temperatures may be rather high during certain months, cattle may still do quite well especially where the humidity is low, and there is considerable wind. Higher elevations usually facilitate a better environment. However, not all cattle feeding areas in the U.S. or in the world are blessed with good conditions during hot months. Even locations with a generally favorable environment may at times incur miserable conditions, compromising performance.

Physiological Responses to Heat Stress

Warm blooded animals (Homeotherms) have developed a variety of physiological responses to attempt to maintain body temperature during periods of temperature rise (or in cold weather). With a rise in ambient temperature, animals must dissipate as much heat as they produce and take on from the environment (Minton, 1987), or body temperature will rise. Some of the physiological responses noted with heat stress are:

- Altered behavior, such as shade and/or wind seeking; surface wetting (e.g. standing in ponds or seeking misting/fogging); decreased activity; change in eating pattern.
- Vaso relaxation, permitting greater blood flow to the peripheral areas to increase heat loss.
- Increase in respiration rate and panting.
- Sweating, in those animals with an ability to sweat.
- Increase in maintenance requirement.
- Increase in surface temperature, to increase heat loss, and ultimately in internal body temperature if heat loss isn't sufficiently great.
- Decrease in feed/food intake, to reduce heat production. Food intake drops sharply when body temperature rises. If body temperature becomes high enough, food intake ceases completely.
- Shift in eating or grazing schedule toward cooler times of the day.

TABLE 1. Influence of effective temperature on maintenance requirements (McDowell et al., 1976).

Effective temperature[a]	(% of maint. req. at 68°F)
68°F	100
77	104
86	111
95	120
104	132

[a] Values for 77°F and higher are for days with at least 6 hours exceeding the denoted temperature class but not more than 12.

The degree to which intake is altered by heat stress is influenced by the level of feed intake, previous nutrition (e.g. thin, fat) and the magnitude of heat stress. According to NRC (1981) intakes are generally depressed 3 to 10% for effective ambient temperatures between 25 to 35°C (77-95°F) and from 5 to 35% at effective temperatures above 35°C (95°F). Effective ambient temperature basically means dry bulb temperature heating or cooling power of the environment as influenced by the combination of temperature and other environmental variables (wind speed, humidity, etc.) affecting heat gain and dissipation.

An increase in maintenance requirements with heat stress has been cited by McDowell et al. (1976) (Table 1). An increase in maintenance requirements increases heat production. Likewise, studies by Loew (1974) show fever causes an enormous rise in maintenance energy demand, and thus, heat production.

Whenever the total heat load, metabolic and environmental, exceeds the ability of the body to dissipate heat, temperature will rise (Teeter and Smith, 1986). Therefore, heat dissipation needs to increase and/or heat production decrease. Enhanced peripheral blood flow increases heat loss. Respiration rate regulates evaporative losses of water from the lungs. Each gram of water evaporated from the lungs results in .54 Kcal of heat loss (Jukes, 1971). Increased respiration rate or panting increases water loss and thereby increases evaporative cooling. Blood CO_2 levels can decrease, increasing blood pH. Respiratory alkalosis can result.

A variety of items will be discussed herein which may assist performance during periods of hot weather or potential heat stress. Not all may be practical in some locations or for some operations. No particular order of priority is intended. Since data with feedlot cattle is especially limited, some information and/or ideas presented have been extended from that found to have value in other animals or species. Moreover, a few ideas herein were generated from personal experience and practical observations of successful cattle operations over a number of years. Some other potentially useful strategies have not been included herein, and some may have been overlooked. Some of these concepts and practices can be extended to stocker or cow-calf operations.

Environmental—Management Considerations

Provide an environment which is as comfortable as possible.

A comfortable environment may include many items—perhaps a windy location, good air movement, shade, opportunities for surface wetting (i.e. foggers, ponds, etc.) and the like. Many of these items would apply equally well to confinement or pasture environments. In some cases, however, one may not be able to do much about the environment. Moreover, a location with a comfortable environment during very hot months (e.g. a breezy, windy terrain) may be an equally uncomfortable environment during winter months, unless temporary or permanent modifications (e.g. wind breaks, mounds, etc.) can be accommodated. Thus, changes may be needed with season.

TABLE 2.. The effect of wind speed and relative humidity on feed intake (adapted from Young, 1987).

	Relative intake[a]						
Ambient temp. °C	**6-10**	**10-15**	**15-20**	**20-25**	**25-30**	**30-35**	**35-40**
Lact. cows, wind <.2 m/s[b]			1.00	-	.88	-	.56
Lact. cows, wind 3.5-f m/s[b]			.97	-	.98	-	.76
Dry cows, wind <.2 m/s[b]			1.00	-	.92	-	.79
Dry cows, wind 3.5-4 m/s[b]			.97	-	.96	-	.83
Lact. cows, RH <50%[c]			1.00	-	.88	.87	.74
Lact. cows, RH >50%[c]			1.00	.97	.87	.79	

[a] Ratio of food intake to intake at thermoneutrality.
[b] Brody et al., 1954.
[c] Johnson et al., 1963.

Not surprisingly, greater wind speed and/or low relative humidities have important effects on maintaining intake as temperature rises (Table 2). These data give some clue as to why many of the Southern Plains or High Plains states have a relatively favorable feeding climate compared to many other areas during most, but not all, warmer months of the year. Even though temperatures can be high, it is generally windy with a low humidity. Moreover, since the elevation is high, the nights can be quite cool during most months. Nevertheless, even these areas can experience unfavorable conditions.

TABLE 3. Cooling or sprinkling for alleviation of heat stress (Morrison et al., 1973).

	Treatment		
Item	**No cooling**	**Cooled barn**	**Sprinkled**
Daily feed, kg	6.19[a]	6.90[b]	7.27[b]
Daily gain, kg	1.09[a]	1.33[b]	1.39[b]
Feed:gain	5.68	5.19	5.23

[a,b] Means with different superscripts differ, $P<.01$.

Locations with very hot days and/or nights, little wind, higher humidity, little or no shade and/or some combination of these variables will experience increasing difficulty with heat stress and lowered performance in cattle operations. Many times one may not be able to improve the environment, but in some locations, one might. It depends on the operation. Moreover, some alternatives may not be practical because of expense and/or other factors.

Shades have proven useful for improving intake in dairy herds (Schneider et al, 1984) and may be helpful in cattle feeding operations where there is intense sun, little wind and higher humidity. Shades are more common and may have better value in some areas than others. Cost, durability, location, portability and potential sanitation problems under the shades must be considered.

A cooled barn or sprinkling has been demonstrated to alleviate heat stress and to improve intake and performance during hot months (Table 3). In a study by Nichols et al. (1982), sprinkling improved gain and feed conversion (Table 4) and may have altered intake pattern (Minton, 1987).

In addition to shade, installing foggers over or near the feed bunks or providing ponds for cattle to stand in to provide surface wetting and to increase evaporative cooling has proven effective in dairy operations in some hot areas of the country like Florida for increasing intake, frequency of feeding and performance (Huber and Higgenbotham, 1986). Some of these methods, especially ponds, may not be practical or economical in many locations for feedlot cattle. In addition to the use of fans and/or cooled areas, surface wetting via various means is commonly used by many people who feed show cattle (beef) to improve performance during hot months. Of course, these practices may also be employed for other reasons, i.e. growing hair.

Emphasize adequate fly control.

Fly control can be especially important in many confinement operations and even in open feedlots or in pasture programs. A variety of control measures may work. If cattle are unduly irritated or frustrated by battling excessive flies, they will be much less calm, have a greater heat load because of increased activity and quicker to display adverse effects from high temperatures.

TABLE 4. Performance of sprinkled cattle (Nichols et al., 1982).

Treatment	Daily Feed (kg)	Gain (kg)	Feed/gain
Sprinkled	5.68	1.28[a]	4.43[a]
Nonsprinkled	5.71	1.11[b]	5.20[b]

[a,b] Means with different superscripts differ P<.05.

Avoid shaggy haircoats.

Cattle with shaggy haircoats or those which don't shed off when they should will be less heat tolerant. Shaggy haircoats are often associated with cattle which have been grazing on endophyte infested fescue pastures. Such cattle often are very slow to shed off when the weather turns warm and will carry shaggy haircoats for a long time, even during very hot weather. They often maintain higher body temperatures and are much quicker to suffer heat stress. Performance suffers accordingly. In cows, rebreeding performance will suffer because conception rates are reduced. Cattle which are heavily parasitized will usually have shaggier haircoats as well. In purebred beef cow herds, cows with shaggy haircoats might be clipped or shaved (i.e. hair cut short with an electric hair clipper) to reduce heat stress and improve breeding performance. For other cattle, the added cost of clipping probably wouldn't be justified.

Provide adequate access to clean, fresh, cool water.

When water intake declines, feed intake does too. Interesting studies with poultry (Teeter and Smith, 1987) show water losses via the lungs increase greatly as temperature rises. So does water consumption. Water intake appears to serve a most important role as a heat receptor, diluting a potential rise in body temperature or decreasing body temperature during heat stress. If birds received water warmed to body temperature, no reduction in elevated body temperature was noted, but if **cool** water (55° F) was provided, a 2.0° F reduction in body temperature was noted during heat stress. From a practical standpoint, the importance of adequate water, **preferably cool water,** cannot be overlooked. Hence, ready access to cool water supplied via automatic waters, with the water being no higher than essentially ground temperature, would be much preferred to water supplied via stock tanks or ponds and heated by the sun. In some hot feeding locations (e.g. Southern California), methods for providing cooled water are commonly used to increase feed intake and animal performance.

Consider kind of cattle for the environment.

Zebu (*Bos indicus* or Brahman) or Zebu crossed cattle are more heat, but less cold tolerant than most European or British breeds (Table 5). Basically, this is why such cattle are more prevalent in Southern states or in tropical or hot, arid areas of the world. In addition to being more insect and parasite resistant, *Bos indicus* based cattle have more body surface area relative to body weight and have the ability to sweat, increasing heat loss and heat tolerance. Moreover, such cattle have a thinner hide and shorter hair, increasing heat loss, and perhaps a lower maintenance requirement, decreasing heat production. Factors which increase heat tolerance, on the other hand, also decrease cold tolerance (e.g. inability to grow long hair during the winter). Documentation for higher intakes by *Bos indicus* cattle during hot conditions is shown in Table 5. Intakes are reduced during heat stress in *Bos indicus* cattle, but not as much as in *Bos taurus* cattle. The farther South, the more numerous and evident Zebu type cattle become. For much the same reason, we often see substantial seasonal or regional shifts in the feeding of such cattle in the U.S. Many such cattle are fed and perhaps often preferred by feeders during the hot summer months in more Southern parts of the U.S. (e.g. Imperial Valley of California, Arizona, southern Texas, Georgia, Florida, etc.). They can simply tolerate higher temperatures without reduced performance. The reverse is also true in the winter. In the High Plains, many Brahman crossed cattle are commonly seen in commercial feedlots in the summer months with many fewer in winter months. Having learned from past mistakes and disasters, many feeders in some states now shift the type of cattle fed depending upon season. In some locations, this may not be important.

TABLE 5. The effect of type of cattle and type of diet on relative feed intake with increasing temperatures (adapted from Young, 1987).

	Relative intake[a]						
Ambient temp. °C	6-10	10-15	15-20	20-25	25-30	30-35	35-40
Growing, 1 to 12 mo.[b]			1.00		.92		
B. taurus, 5 to 7 mo.[c]			1.00		.86		
B. indicus, 5 to 7 mo.[c]			1.00		.89		
B. taurus, conc diet[d]	1.30		1.00			.83	
B. taurus, rough diet[d]	1.10			1.00			.60
B. indicus, conc diet[d]	1.38		1.00			.88	
B. indicus, rough diet[d]	1.07		1.00			.87	

[a] Ratio of food intake to intake at thermoneutrality.
[b] Johnson et al., 1960.
[c] Colditz and Kellaway, 1972.
[d] Olbrich et al., 1973.

Dietary—Feeding Considerations

A number of dietary-feeding management alterations or strategies may have value in maintaining or improving performance during very hot weather. Some of these include the following:

Recognize a change in feeding patterns.

Usually the most obvious change with hot weather is a change in eating behavior. More is eaten during the cooler times of the day and less when it is hot. The shift becomes more noticeable with increasing heat. When temperatures become quite elevated cattle may not eat at all for many hours during the heat of the day. This sets the stage for hungry cattle "tanking up" on feed, creating more potential acidosis and bloat. Rations and feeding schedules may need to be modified to reduce such risks.

Allow adaptation and acclimatization to the extent possible.

Adaptation to increasing heat is important in heat tolerance. Cattle have the ability to show considerable acclimation to sustained changes in temperature (NRC, 1981; Young, 1987). A recent study with broilers (May et al., 1987) showed that birds allowed to acclimate to high diurnal temperatures maintained approximately 2°F lower body temperatures and suffered lower mortalities when subjected to heat stress than did non-acclimated birds. Acclimatization is of special concern when cattle are shipped from a cold to a hot region (or vice versa).

Consider feeding a lower level of roughage unless minimum levels are already being fed.

With most commercial feedlot diets, minimum levels of roughage must be honored to maintain proper rumen function and to minimize acidosis. When cattle may not eat for long periods during the heat of the day in hot months, risk of acidosis and bloat increase. This argues for minimum levels of 7-10% roughage in most commercial diets. Whole corn diets may be some exception. Type of roughage, type and form of grain, inclusion of ionophores, perhaps buffers, the feeding schedule and other variables can influence the minimum acceptable roughage level in a given operation. Experience usually dictates what the sale minimum might be in a given operation.

Feeding excess roughage, however, increases heat production (Tyrrell et al., 1979) because of greater heat increment, contributing to a greater total heat load and heat stress. Body heat production and rectal temperatues are higher during hot weather on high forage than on high concentrate diets (Huber and Higgenbotham, 1986). Moreover, less heat production occurs with higher quality roughages, than lower quality.

Consider the addition of some fat, if not already being fed.

Fat provides less heat production or heat increment during utilization than either carbohydrates or protein, reducing heat load. Dietary heat increment is reduced by shifting calories away from carbohydrates via fat inclusion (Dale and Fuller, 1980). Practical experience in bull test stations also suggests that eating pattern may be altered some by fat inclusion during hot weather—i.e. perhaps eating less per feeding, but eating more frequently, reducing problems with cyclical intakes, rumen distress and bloat. Dustiness and particle separation are also reduced by fat in dry rations. What is a reasonable fat level? Perhaps 1-2-3%, but not more than 4 or 5%. Higher levels depress rumen function, fiber utilization and intake.

Feed adequate protein, but don't overfeed. Moreover, emphasizing protein supplements with lower solubilities or degradabilities may offer some advantage over highly degradable protein sources.

Metabolism and elimination of excess protein and urea are exothermic and increase heat production. Lowering protein content by increasing protein quality has been shown to lower heat production and increase performance in nonruminants (Waldroup et al., 1976) at a given level of metabolizable energy intake. Similar results have been noted with swine and poultry.

In recent summertime studies with dairy cows in Arizona, cows receiving high protein diets with a high protein degradability had lower intakes and production and suffered more heat stress than cows receiving high protein diets with a low degradability or lower protein diets with intermediate degradability (Huber and Higginbotham, 1986). In Missouri studies (Zook, 1982), diets with lower protein solubility resulted in higher intakes and yields when cows were subjected to heat stress. Similar studies need to be done with finishing cattle subjected to hot environments. Perhaps more conservative urea levels would, likewise, have merit in hot weather.

Consider feeding higher levels of minerals to improve acid-base balance, resulting from potential respiratory alkalosis, and to increase water intake.

Little in this area has been done with finishing beef cattle, however work with other species and with dairy cattle subjected to heat stress looks very promising.

Increased water loss and evaporative cooling via the lungs during heat stress can decrease blood CO_2 levels and increase blood pH, causing respiratory alkalosis. Studies with heat stressed broilers show that carbonated water (Bottje, 1985) or the addition of NH_4Cl and HCl to the water (Teeter and Smith, 1986) substantially increased weight gain. In another study supplemental dietary KCl increased weight gains and decreased mortality notably during heat stress. Moreover, when NH_4Cl, KCl, NaCl or K_2SO_4 were added individually on an isomolar basis, water consumption and growth rate increased similarly. Adding acids or salts increased water intake substantially. The primary underlying mechanism of adding ions appears to be increased water intake which acts as a heat receptor to lower body temperature (Teeter and Smith, 1987). As noted, to be an effective heat receptor, water temperature needs to be below that of body temperature.

Recent Florida studies with the addition of KCl and even MgO (0.5%) and $NaHCO_3$ (1.25%) appeared beneficial in improving feed intake and performance in dairy cows during heat stress (Schneider et al., 1984; O'Conner and Beede, 1986). In a recent feedlot study in Kansas, supplemental K resulted in a trend (but not statistically signficant) for improved performance (Doran et al., 1986). However, the summer was regarded as considerably milder than usual. Moreover, this location in the country may offer less heat stress than many others because of a higher altitude, relatively low humidity and higher average wind speed. Nevertheless, based upon promising work with other animals, feeding higher levels of certain minerals appears to have potential merit for partially alleviating heat stress and deserves further study with finishing cattle.

Emphasize fresh, palatable, high quality feeds.

Keeping feeds fresh, appealing and appetizing helps to maintain better intakes during difficult times. While most realize the importance of this, it is easy to overlook. Some alteration in feeding schedules may be helpful. When it is hot, experience has shown that cattle usually prefer moist or wet feeds (e.g. some silage) to dry, dusty ones. Yet, wet rations which contain silages (or whatever) can dry out and become stale and unappetizing quickly during hot weather. If cattle are overfed or are not fed frequently enough or are fed at the wrong times of the day, wet feeds can set in the bunk too long and become stale.

Earlier marketing may be needed for some cattle.

Cattle which are quite fat will often be the most prone to suffering during hot weather. Intakes and performance can decline noticeable. Marketing some cattle with less finish and at lighter weights may be worthy of consideration during unfavorable weather.

Temperature and Photoperiod Effects

Increasing photoperiod of day length (hours of daylight) generally causes a rise in feed intake, although there is a lag phase of about 8 to 16 weeks in most domesticated animals (Young, 1987). Hot temperatures, on the other hand, generally result in decreased feed intake, while colder temperatures result in increases. Therefore, conflicting stimuli to animals for photoperiod and temperature effects can and do occur. In some locations, photoperiod may be the overriding stimulus, while in others it may be temperature. In commercial feedlots in southern states, higher mean intakes are usually noted during seasons of longest day light (winter being lowest) as long as the feeding conditions aren't too hot or uncomfortable. This implies that photoperiod is the overriding factor in these locations. In northern states, however, the reverse is generally true in that mean intakes usually average 5 to 8% higher during cold (winter) months. In this case, temperature is probably the major determinant in regulating intake.

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