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Feeding Strategies for Heat Stressed Dairy Cows During Hot Dry Weather

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Hot weather during the summer is a predictable factor that must be dealt with on most California dairy ranches. Long summer days with high temperatures between 90F and 115F under cloudless blue skies are not the best conditions for lactating dairy cows, although they are far from the worst. However the reductions in animal performance that are associated with heat stress can be minimized with appropriate dietary management.

The purpose of this article is to briefly outline current information relative to feeding dairy cows in ways that minimize negative effects of heat stress on performance. Strategies to prevent heat stress from occurring were discussed in a previous article.

Ration Formulation

If the cows are heat stressed, in spite of the use of management strategies designed to prevent it from occurring, then DMI will decline and the diet should be reformulated if the performance level of the cows is to be maintained. However, diet reformulation should only be used to manage the reduced DMI caused because the cows are heat stressed. Diet reformulation will not prevent heat stress from occurring. The best means to assess the extent of heat stress is to track the DMI of the cows directly. If this is not possible, then an alternative is to observe the respiration rate of the cows. Cows are heat stressed if their respiration rate rises above 75 breaths per minute.

Fermentation of feedstuffs in the rumen creates heat. In a cool or cold environment this heat is beneficial by helping dairy cows prevent a decline in body temperature below the range of thermoneutrality. However this heat of fermentation is not beneficial in a hot environment since it makes it more difficult for the cow to prevent its body temperature from rising above the range of thermoneutrality and becoming heat stressed. Reduced DMI associated with heat is almost certainly the body's mechanism of reducing heat of fermentation simply by reducing the amount of feed to be fermented in the rumen. While heat stress will depress DMI, it has little impact on the amount of nutrients required to support a particular level of milk production. Thus the nutrient density of the ration must be increased if milk production is to be maintained. This is demonstrated in the table.

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Clearly the nutrient densities required in rations to overcome depressions in DMI of 10% and more are probably not attainable without changes to the ration that are so substantial that they may introduce other problems. Thus feeding management has to be excellent and small day to day changes to the ration may be necessary in response to changes in environmental conditions and/or changes in string DMI. Some ration reformulation options to increase the nutrient density of the ration are discussed below.

Decreased Forage (Fiber) Level of the Ration

The heat of fermentation of individual feedstuffs rises with its total fiber (i.e., NDF) content as it is the fiber that is associated with the most active rumen fermentation and the most heat of fermentation. Thus as cows begin to feel the heat (i.e., the DMI starts to decline), the NDF level of the diet should be reduced. In practice this is generally accomplished by reducing the forage to concentrate ratio. This acts by reducing the heat of fermentation as well as increasing the energy density of the ration. In addition, forages with the highest possible fiber quality (i.e., the fastest fermenting) should be utilized as they have a lower heat of fermentation and higher energy value.

Effect of Heat Stress on the Required Nutrient Density of the Ration[1]

DMI (% depression) Respiration Rate (/min)	0 < 75	5 80	10 85	15 90	20 95
Dry Matter Intake (lb/d)	53.2	50.5	47.9	45.2	42.6
Energy (NEl)					
Mcal/d	38.4	38.9	39.4	39.5	40.4
Mcal/lb of DMI	0.72	0.77	0.82	0.87	0.95
Crude Protein					
Total (% DMI)	17.4	18.1	18.9	19.8	20.8
Soluble (% CP)	28.5	28.5	28.5	28.5	28.5
Digestible UIP (% CP)	39.9	42.7	45.7	48.7	51.7
Fiber (NDF) [2]					
Maximum (% DMI)	35.0	31.0	28.0	26.0	25.0
Fat (Rumen Protected) [3]					
Maximum (% DMI)	0.0	1.0	2.0	3.0	4.0
Minerals					
Ca (% DM)	0.66	0.70	0.73	0.78	0.82
P (% DM)	0.41	0.43	0.45	0.49	0.51
Mg (% DM)	0.25	0.27	0.28	0.30	0.31
K (% DM)	1.00	1.15	1.30	1.45	1.60
Na (DM)	0.18	0.23	0.28	0.33	0.38
S (% DM)	0.20	0.21	0.22	0.23	0.24

1 - 1450 lb high string cows losing 1.7 lb/d of BW and producing 100 lb/d of milk with 3.6% fat and 3.2% protein.
2 - NDF should not be lower than 25% of ration DM .
3 - Total fat should not exceed 8% of ration DM with rumen unprotected fat no higher than 4%.

Reducing the NDF level of the ration is the first management modification that should be utilized. As the extent of heat stress increases, and DMI falls further, the NDF level of the diet should be progressively reduced, but to a lesser extent for each pound of DMI that is lost. Obviously such declines in the NDF level of the diet will make the cows more prone to acidosis and so higher levels of an effective rumen buffer should be added to the diet in order to maintain rumen pH and minimize depressions in milk fat production. Sodium bicarbonate can be used for this purpose at the rate of 0.25% of DMI for each reduction of 5% in DMI to a maximum of 1% of DMI.

Addition of Fat to the Ration

Fats are commonly used as feed ingredients in rations of dairy cows. While they are very high in energy, they do not contribute other nutrients to the ration. In addition, animal and vegetable fats, oils and greases may reduce the palatability of the ration and/or interfere with microbial growth in the rumen. Obviously neither of these effects are desirable. Thus the use of fats should be used with extreme caution in rations for heat stressed cows. Nevertheless, if heat stress results in lower DMI it is necessary to increase the nutrient density of the ration if productivity is to be maintained. The best option, as declines in DMI rise above 10%, are fats that have been treated to allow them to escape the rumen intact, thereby not affecting rumen microbial growth, to be digested in the small intestine. There are several of these products that are available commercially in California. While some are more readily accepted by cows than others, most require adaptation by the cows to prevent a negative impact on DMI. Thus it is wise to utilize low levels of ruminally protected (RP) fats in rations formulated to deal with even small declines in DMI due to heat stress, so that if more nutrient dense rations are used later to deal with more severe declines in DMI, the cows will have been exposed to the RP fat product.

Ration Protein Formulation

The protein levels in the table demonstrate that as DMI is progressively depressed due to heat stress, it is necessary to increase the protein level of the ration. However the proportion of the dietary protein that must be provided as digestible undegraded intake protein (D-UIP) must be increased, since the net passage of microbial protein from the rumen declines with lower DMI. This makes ration protein formulation a real challenge, as oversupply of rumen degraded intake protein (DIP) will lead to its inefficient use in the rumen which in turn will require the animal to expend energy to convert this wasted protein (as nitrogen) to urea which will largely be excreted in the urine. At a time when the challenge is to provide sufficient energy in the diet to allow the cow to maintain productivity, such a loss of energy to productive purposes must be avoided. Thus in heat stressed cows it is particularly important to not only meet the cows' requirements for protein but to not exceed them.

Ration Mineral Formulation

In general the mineral densities in the rations should be increased relative to the decline in DMI, as is shown in the table. However there appear to be two exceptions. Because cows will be sweating more if they are heat stressed, the sodium (i.e., salt) level of the diet should be increased more rapidly than the decline in DMI. There is also some experimental data which supports a proportionally higher rate of increase in the potassium level of the ration as DMI declines due to heat stress. Reasons for this are not clear, but are probably related to maintaining the blood cation/anion balance.

Rumen Fermentation Modifiers

There are a number of products on the market that claim the ability to enhance microbial growth in the rumen by various mechanisms. Few of these have been examined as tools to prevent the declines in DMI that are associated with heat stress. However, such products may be beneficial by enhancing microbial growth in the rumen thereby increasing nutrient digestibility to deliver more nutrients to the body. Alternatively, such products may not be beneficial if, by enhancing fermentation of fiber in the rumen, the heat of fermentation is increased. Some dairy ranchers have reported a perception of improved performance in heat stressed cows supplemented with yeast culture products. This is an under-researched area that deserves attention.

These ration modifications may introduce other problems, such as acidosis and rumen upsets leading to increased incidences of cows going off-feed. They will also increase the immediate cost of the ration under most conditions, both per ton and per 100 lbs of milk produced. Thus the extent of the modifications that are actually utilized on any dairy ranch will be heavily dependent on the management and financial position of that dairy. However, regardless of the level of expertise of the management on the dairy, ration modifications to deal with heat stress induced depressions of DMI that exceed 10% may be unworkable on most ranches.

Ration Presentation

Cows housed in dry lots and open-sided freestalls with natural lighting prefer to eat in the hours immediately before and after dawn as well as the hours immediately before dusk. This pattern is strengthened when temperatures rise. Thus to maximize DMI, rations should be provided when the cows want to eat, not when it is convenient to feed them. In general, about 65% of the ration should be provided between about 6 and 7 pm (i.e., 3 to 4 hours before dusk) with the balance provided before 5 am (i.e., about dawn). In this way, DMI will be maximized and the bulk of the heat of fermentation will be produced during the relatively cooler overnight and early morning hours.

Summary

Hot summer temperatures are a fact of life for dairy ranchers in most areas of California. If extreme temperatures overwhelm the ability to prevent heat stress, then the ration can be reformulated to help the cows maintain performance in spite of reduced DMI. However, reformulation requirements to deal with depressions in DMI of 10% or more are extreme, and may introduce other problems unless overall dairy management is high.

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