ADSA Southern Section Symposium: Meeting the Nutrient Requirements of Dairy Cattle During Heat Stress

190 Heat stress in young dairy calves. C. C. Williams,* *Louisiana State University AgCenter, Baton Rouge.*

The initial 2 mo of a calf's life directly influence the quality and condition of its future growth and development. During this period, stress is detrimental to the proper growth of the calf. One common type of stress of particular concern to southern dairy producers is heat stress. Heat stress occurs when any combination of environmental factors causes the relative temperature of the environment to be greater than the calf's thermoneutral zone. In the southern United States, heat stress is particularly common due to uncontrollable environmental factors such as the temperature-humidity index (THI). As a result of an elevated THI, the calf's respiration, internal temperature, and water intake will increase, and dry matter intake, average daily gain, fecal score, and feed efficiency will decrease. These homeostatic alterations disrupt calf development and prohibit the achievement of full production potential. In addition, heat stress can cause a variety of problems on a molecular level. Heat stress causes the adrenal gland to produce the steroid cortisol; in high enough quantities, cortisol can render a calf incapable of absorbing important immunoglobulins through its cellular membranes. Heat stress can also lead to dehydration, which can cause blood urea nitrogen levels to rise. This is a direct result of poor renal function. Dehydration and poor renal function, left uncorrected, are associated with a high mortality rate among calves less than 2 mo old. Limited research has been conducted to determine the effect of heat stress in neonatal calf health and performance. However, studies that been conducted indicate that providing supplemental shade to calves housed in hutches can reduce the severity of heat stress.

Key Words: heat stress, dairy calves

191 Managing heat stress in dairy heifers. R. E. James* and S. Neal, *Department of Dairy Science, Virginia Tech, Blacksburg.*

Limited research indicates that heat stress affects dairy heifers through depressions in ration dry matter intake, nutrient utilization, reproductive function and colostrum production although not to the same degree as milking animals. Given this relationship, the recently weaned heifer, the breeding age heifer and close springing heifer will benefit most from reductions in heat stress. Weaned heifers are especially susceptible to reduced intake as they are adjusting to dry feed and group housing systems. Italian workers found that exposure of 10-mo-old heifers to a THI of > 84 resulted in depressed intake and increased water intake and rectal temperature. However, they also noted that heifers adjusted to longer term heat stress. Virginia Tech researchers found that the influence of temperature on intake was relatively minor as heifers delayed consumption of the diet until the cooler hours of the evening. The breeding age heifer expresses impaired growth and function of the dominant follicle when exposed to 33°C at 50% relative humidity as compared with 21°C at 60% relative humidity. Smaller follicles were associated with decreased serum estradiol concentrations, delayed luteolysis and impaired reproductive success. During the prepartum period, exposure of gravid heifers to a THI of 82 as compared with one of 65 resulted in lower concentrations of IgG, IgA, total protein, lactalbumin, fat and lactose in the colostrum. Management should focus on the critical ages noted. First priority should be given to provision of adequate supplies of water. Water intake is highly correlated with feed intake and is especially important during heat stress. Research is not available to estimate the economic return from use of cooling fans and sprinkler systems. Given the critical influence of reproductive function on timely calving and the production of IgG rich colostrum, facilities featuring use of fans, high and open side walls and open ridge vents will facilitate animal cooling for these animals. Finally, it is apparent that increasing nutrient density of the ration will maintain nutrient intake during heat stress.

Key Words: heifers, heat, stress

192 Impact of management on feeding dairy cows in heat stress. G. Bethard,* *Dairy Records Management Systems, Raleigh, NC.*

Most modern and productive dairy cows experience heat stress of some kind throughout the year. Heat stress degrades short-term financial performance, largely through the direct loss of milk production and milk components. Milk volume declines are obvious and noticeable; less noticeable and potentially more costly are milk component and quality premium losses. Other short-term losses include herd health issues and associated herd losses. Long-term costs are escalated by poor reproductive performance. Much of the economic cost is directly related to the decline in dry matter intake and change in feeding behavior. Lower dry matter intake can lead to lower milk production and body condition loss; altered feeding behavior can lead to slug feeding and perceived rumen health issues. Much is known about the physiological consequences of heat stress. Much less is known about nutritional approaches to alleviate these consequences. Nutritional strategies implemented in the field include altering mineral levels, cation-anion balance, buffering capacity, or fiber digestibility. None are widely accepted in the field, and implementation of strategies differs by region. Management at the dairy typically provides the best opportunity to prevent the decline in dry matter intake. Heat abatement strategies are obvious and recognized widely in the dairy industry. Cow comfort, over-crowding, and cow resting time also have an effect and heightened during periods of heat stress. Preserving and managing forages to extend bunk life and managing feedbunks is crucial to minimizing the declines in dry matter intake.

Key Words: heat stress, dairy, feeding

193 Lactating cows and changes in dry matter intake during heat stress. J. W. West,* *University of Georgia, Tifton.*

Exposure of high yielding dairy cows to elevated ambient temperature and relative humidity impairs the cow's ability to dissipate body heat, leading to increased internal heat load. The mechanisms to dissipate excess body heat (conduction, convection, radiation, and evaporation) are compromised by hot, humid conditions, leading to physiologic and metabolic responses that reduce DMI and milk yield. Declining DMI during thermal stress may be a protective mechanism to limit metabolic heat and is credited with a concomitant reduction in milk yield. Work indicates that reduced DM and nutrient intake is only partially responsible for declining milk yield and that hormonal shifts alter energy metabolism, further reducing yield. Slower rate of passage in the digestive tract occurs in hot weather and can limit intake, though nutrient digestibility may improve. Subclinical acidosis often limits DMI because of very high energy diets fed in an attempt to maintain energy intake at a time when blood buffering is reduced by hyperventilation. The reduced DMI that occurs during heat stress is a complex response to environmental stressors and the steps to ameliorate the impact are multifaceted. Most important is to reduce exposure to radiant energy by shading and to enhance body heat transfer to the environment via cooling. Greater air movement with fans and addition of water in the form of sprinklers or misters are keys to enhancing evaporative cooling for the cow. Once environmental modifications are in place, dietary adjustments to enhance DM or nutrient intake can be implemented. Dietary buffers and rumen modifiers including yeast culture and fungal additives stabilize the rumen environment and may reduce body temperature. Attention to forage quality and particle size is crucial during hot weather and caution should be used when dietary fiber is reduced in the pursuit of greater dietary nutrient density. Continued genetic selection for greater DMI and milk yield presents challenges for the manager who must balance the exceptional metabolic potential of the modern dairy cow with the need to eliminate excess metabolic heat produced in a challenging climatic environment.

Key Words: dairy, heat stress, DMI

194 Use of fat and other feed additives in heat-stressed cattle.

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Heat stress (HS) negatively affects parameters associated with profitable milk production. Implementing HS-abatement strategies (barn construction, fans, evaporative cooling, etc.) is crucial to minimize fiscal losses and quantitatively more important at maintaining milk production than potential nutritional changes. However, the effects of nutritional management are not trivial and are key components to efficient production and optimal cow-health during the summer months. Obviously the most vital nutrient to consider is water (water intake can more than double during HS) and ensuring adequate access to clean, fresh water is critical. HS reduces rumen pH and thus nutritional approaches aimed at maintaining rumen health are important. Potassium requirements increase during HS as ruminants utilize potassium to sweat, therefore a dietary potassium based rumen buffer may have dual benefits. A widely held dogma is that supplementing dietary fat is an effective tactic during HS stemming from theoretical calculations indicating that the heat increment of feeding is much lower for lipids (especially compared with roughages). HS markedly alters post-absorptive metabolism and this is, in part, characterized by increased systemic glucose utilization so dietary strategies aimed at safely increasing gluconeogenic precursors (i.e., monensin) are suggested. HS causes "leaky gut" in a variety of species and although not described in ruminants, we suspect it plays a key role in the etiology of HS-induced poor performance and mortality in dairy cows. Consequently, dietary strategies aimed at strengthening intestinal integrity (rehydration therapies, betaine, zinc, etc.) show promise and need to be thoroughly evaluated. It is unknown whether protein or energy requirements (and this is especially true for maintenance costs) increase or decrease during HS, but this is of practical and economic importance to the dairy industry. Surprisingly, our understanding of nutrient requirements during HS is woefully insufficient, and this makes formulating nutritional strategies to mitigate summer-induced low production difficult.

Key Words: heat stress, nutrition, dietary fat

195 Feeding dairy cattle in a grazing system during heat stress.

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Dairy cattle in a grazing system are negatively affected by heat stress resulting in decreased DMI and milk yield and elevated core body temperature. The physiological and metabolic responses to heat stress that contribute to reduced DMI and milk yield will be discussed by others in this symposium. For grazing dairy cattle, heat stress alters grazing behavior as cows seek shade during the day and tend to graze more at night and early morning, reducing nutrient intake. Forage quality also tends to decline in response to heat stress, resulting in higher NDF concentrations and lower digestibility further reducing energy intake. Concurrently, maintenance requirements increase during heat stress because of panting and greater time standing as cows attempt to reduce body temperature. Diets must be adjusted to compensate for reduced DMI to meet higher maintenance requirements and maintain milk yield. Effective strategies include feeding additional energy concentrates, high quality forage, or a partial TMR to maintain DMI and nutrient intake. Provision of shade and soaking plus supplemental high quality forage are reported to maintain milk yield through improved DMI while reducing core body temperature. Supplemental energy may be provided by concentrates or fat. The quantity of starch should be limited to avoid subclinical acidosis and the quantity of supplemental fat should be limited to avoid decreased fiber digestibility or reduced DMI. Dietary buffers to provide additional Na, K, and Mg should be increased to replenish losses incurred through increased panting and sweating and provide additional buffering capacity in the rumen. In addition to dietary changes, water consumption increases in response to heat stress and provisions must be made to provide adequate water.

Key Words: heat stress, grazing, feeding