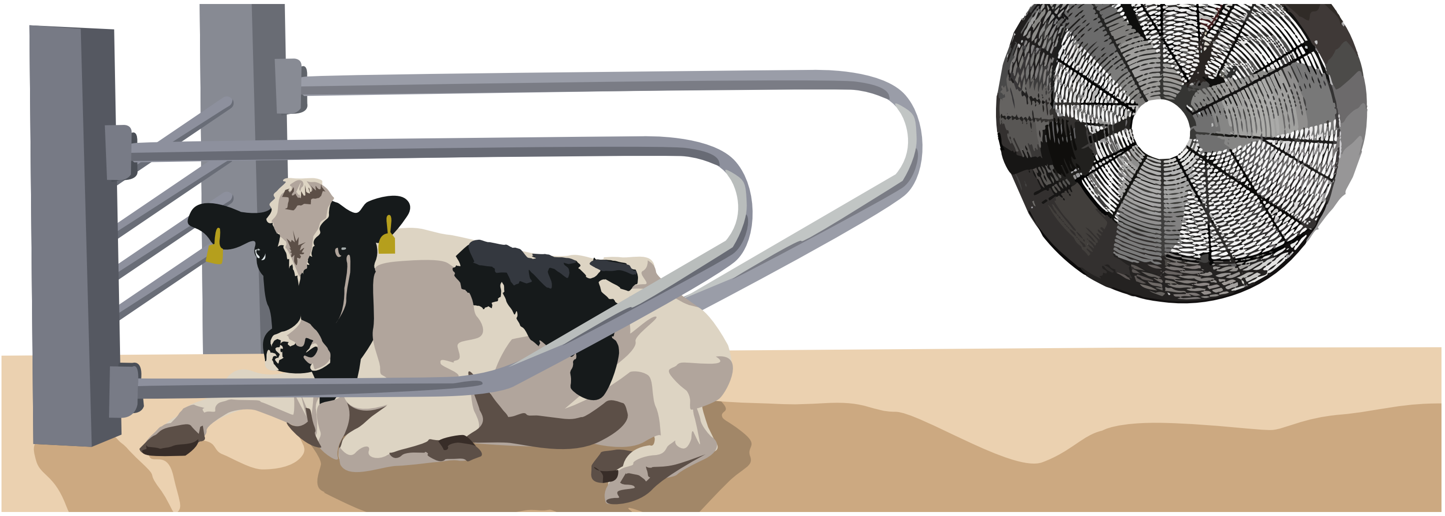
COW BEHAVIOR:



A Critical Factor to Consider Under Heat Stress

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Introduction

Cow behavior is gaining more and more attention as one of the critical factors influencing animal well being and performance. It is also an area that has not been studied extensively compared to other areas, such as nutrition and reproduction. Numerous management decisions, including housing facilities, milking and feeding frequency, stall design and bedding, stocking density, diseases, duration of locking up, diet formulation, environmental factors, etc., alter the cow's behavior and in turn affect animal productivity, health, and welfare (Cook & Nordlund, 2009). This publication focuses on the impacts of environmental heat stress on cattle behavior and the possibly related consequences.

Time Budgets of Lactating Dairy Cows

It is essential to understand how cows budget their time each day. Under thermoneutral conditions, studies conducted in Wisconsin and New York indicate that high producing, lactating cows spend about half of their day lying down in freestalls and the rest of the time is distributed into standing, feeding, and milking (Table 1). Time budgets represent an active response of the animal to her surrounding environment, and disruption of this response may negatively affect her performance (Grant, 2011).

Table 1. Time Budgets of Lactating Dairy Cows in Freestall Housing

Activity	Hours/Day
Lying	11.9 ± 2.4
Standing in Stalls	2.7 ± 2.1
Standing in Alley (including drinking)	2.5 ± 1.5
Feeding	4.3 ± 1.1
Milking (time outside the pens)	2.7 ± 1.1
Rumination	7-10

(Adapted from Cook and Nordlund, 2009, and Grant, 2011).

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Heat Stress Impacts Cow Behavior

One of the most recognized behavioral responses of dairy cows to heat stress is an increase in respiration rate, which is the most common way a cow loses heat during summer. But it also results in respiratory alkalosis. In order to compensate for this disorder, urinary output of bicarbonate increases, but the total amount of bicarbonate in the saliva decreases, reducing the buffer capacity of saliva.

Rumen contractions are also reduced when exposed to heat stress (Attebery & Johnson, 1969), which leads to decreased rumination (Soriani, Panella, & Calamari, 2013) and a reduction in total saliva production of the cow. The passage rate of acid out of the rumen is also reduced due to the slower contraction, which results in acid accumulation in the rumen. Under heat stress conditions, although they are consuming less (West, 2003), cows prefer larger and less frequent meals and develop a preference for concentrate over forage, which negatively affects the rumen environment. Taken together, heat-stressed cows are prone to developing rumen acidosis (Shearer, 2005).

Under grazing conditions, cows exposed to heat stress are always seeking shade (Tucker & Schütz, 2009) and standing longer as solar radiation increases (Tucker, Rogers, & Schütz, 2008). Similarly, when cows are housed in open-fronted buildings, their lying time is also reduced as the temperature-humidity index (THI) increases (Wechsler et al., 2004). This increase in standing time has been suggested as an adaptive behavioral response of cattle to increase heat loss through increased skin surface area exposed to air flow (Tucker & Schütz, 2009). Indeed the cow's core body temperature is positively correlated to her time standing, and a cow standing up during summer always has a higher body temperature than one lying down (Allen, Anderson, Collier, & Smith, 2013).

In a freestall setting, cow behavior is also affected by heat stress. Overton, Sischo, Temple, and Moore (2002) suggested that cows spend less time lying as the ambient temperature increases. Similarly, when a cooling system, including soakers and fans, is provided over the feed bunk in a freestall barn, high producing, lactating cows exposed to mild-moderate heat stress spend more time standing per day in the alley, resulting in a three hour per day decrease in lying time (Cook, Mentink, Bennett, & Burgi 2007). Unlike cows on pasture, heat-stressed cows in freestalls spend more time in the alley beneath the soakers and fans in order to cool themselves off (Cook et al., 2007; Overton et al., 2002). It is also important to mention that barns in studies by Cook et al. (2007) and Overton et al. (2002) were not equipped with any cooling system over the stall area.

Impacts of Behavioral Change on Cow Performance and Disease Incidence

Time spent standing and lying is an important factor for cow comfort and affects health (Cook & Nordlund, 2009) as well as performance. The most common disease associated with cow behavior is lameness, which has been suggested as one of the dairy industry's most important welfare issues and certainly results in a significant economic loss. Change in cow behavior can be used to predict future lameness. A study in Canada indicated that increased standing time around calving is a good early indicator of claw horn lesions in mid-lactation (Proudfoot, Weary, & von Keyserlingk, 2010). For heat-stressed cows, the increase in standing time, coupled with rumen acidosis, may compromise hoof health of cows and increase the incidence of lameness (Cook et al., 2007). An increase in rate of claw horn lesions is typically observed in late summer in Wisconsin (Cook, 2004).

Standing time may also be related to occurrence of mastitis. DeVries and von Keyserlingk (2011) suggest that post-milking standing time is related to environmental bacterial infection in the mammary gland. The study found that cows that lie down within 40-60 minutes after milking tend to have the lowest occurrence of subclinical udder infection by environmental bacteria compared to those that stand for a short (less than 40 minutes) or excessive (greater than 60 min) time post-milking. Lactating cows that stand for a prolonged time after milking may have higher intramammary infection rates. Krawczel and Grant (2009) report that high stocking density, the other factor that alters lying/standing behavior, is also associated with an increase in somatic cell count (SCC), however, it is not known if the shorter lying time is a crucial factor.

Milk Production

Lying behavior may change the lactational performance of cows. Compared with standing, lying is associated with an increase in mammary blood flow. Although total mammary metabolic activity is the ultimate determinant of mammary perfusion in lactating animals, the decrease in mammary blood flow by environmental factors, such as increased standing time, may result in reduced nutrient uptake by the mammary gland, reducing milk synthesis.

Results of a New York study suggest that a one-hour increase in lying time is related to a 2- to 3.5-pound increase in milk yield each day (Grant, 2011). However, such a relationship between lying time and milk production was not observed by Cook (2008) in Wisconsin. The reasons for these discrepancies between studies are unknown. To the best of our knowledge, a well-controlled study to examine the impact of lying behavior on mammary blood flow and milk production, especially under heat stress conditions, is not available. In terms of heat-stressed, lactating cows, the increased incidence of lameness (Cook, 2004) may also cause lower milk yield because lame cows produce less milk (Hernandez, Garbarino, Shearer, Risco, & Thatcher, 2005). The bottom line is that cows should rest at least ~12 hours per day (Cook, 2008; Grant, 2011) to prevent a possible loss in milk production.

Reproduction

Studies directly connecting cattle behavior and reproductive performance are limited, but lameness negatively impacts reproductive performance. Lame cows show less estrous behavior than healthy cows (Walker et al., 2008). Compared with healthy cows, lame cows have delayed resumption of ovarian cyclicity (Garbarino, Hernandez, Shearer, Risco, & Thatcher, 2004), longer days open, and an increased number of breedings per conception (Hernandez, Shearer, Risco, & Webb, 2001). Increased stocking density in the breeding pen is also associated with reduced conception rates (Schefers, Weigel, Rawson, Zwald, & Cook, 2010), but it is not clear if there is a direct link between lying time and reproductive performance. Cow comfort is an important consideration for a farm operation's reproductive program, and is listed as one of the top 10 concerns for successful reproductive management by the Dairy Cattle Reproduction Council (www.dairylandvet.net/NewsletterFeb09.pdf).

Implications

It is important to provide supplemental evaporative cooling in the freestall barn during the summer when heat stress conditions persist. Soakers and fans over feed bunks are efficient to cool cows, but it also results in extended standing time in the alley. Providing supplemental cooling over freestalls should be considered to further cool cows and bring cows back to stalls (Overton et al., 2002).

First, fans should be placed over the stall area to provide forced ventilation. Second, foggers or misters produce smaller water droplets than soakers or sprinklers and can be placed in front of fans to provide evaporative cooling, which is more effective in cooling cows than fans alone (Nickerson, 2014). However, it is important to make sure that the water system over freestalls don't wet the bedding material because wet bedding also reduces lying time and increases the risk of intramammary infection. A humidity controller should be used to automatically deactivate the misters or foggers over the stall area whenever ambient relative humidity exceeds 85 percent.

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References

Allen, J. D., Anderson, S. D., Collier, R. J., & Smith, J. F. (2013). Managing heat stress and its impact on cow behavior. 2013 Western Diary Management Conference Proceedings (pp. 150-162). Reno, NV.

Attebery, J. T., & Johnson, H. D. (1969). Effects of environmental temperature, controlled feeding and fasting on rumen motility. Journal of Animal Science, 29, 734-737. doi:10.2134/jas1969.295734x

Cook, N. B. (2004). Lameness treatment rates in Wisconsin dairy herds. Proceedings of the 13th International Ruminant Lameness Symposium (pp. 50-51). Maribor, Slovenia.

Cook, N. B. (2008). Time budgets for dairy cows: How does cow comfort influence health, reproduction and productivity. Proceedings of the Dairy Cattle Reproduction Council Meeting (pp 1-7). Omaha, NE.

Cook, N. B., & Nordlund, K. V. (2009). The influence of the environment on dairy cow behavior, claw health and herd lameness dynamics. The Veterinary Journal, 179, 360-369. doi:10.1016/j.tvjl.2007.09.016

Cook, N. B., Mentink, R. L., Bennett, T. B., & Burgi K. (2007). The effect of heat stress and lameness on time budgets of lactating dairy cows. Journal of Dairy Science, 90(4), 1674-1682. doi:10.3168/jds.2006-634

DeVries, T., & von Keyserlingk, M. A. G. (n.d.). Predicting and Identifying Illness Through Changes in Dairy Cow Behavior. Retrieved from http://www.livestocktrail.illinois.edu/dairynet/paperDisplay.cfm?ContentID=10331

Garbarino, E. J., Hernandez, J. A., Shearer, J. K., Risco, C. A., & Thatcher, W. W. (2004). Effect of lameness on ovarian activity in postpartum Holstein cows. Journal of Dairy Science, 87(12), 4123-4131. doi:10.3168/jds.S0022-0302(04)73555-9

Grant, R. (2011). Taking Advantage of Natural Behavior Improves Dairy Cow Performance. Retrieved from http://www.extension.org/pages/11129/taking-advantage-of-natural-behavior-improves-dairycow-performance

Hernandez, J. A., Garbarino, E. J., Shearer, J. K., Risco, C. A., & Thatcher, W. W. (2005). Comparison of milk yield in dairy cows with different degree of lameness. Journal of the American Veterinary Medical Association, 227(8), 1292-1296. doi: 10.2460/javma.2005.227.1292

Hernandez, J. A., Shearer, J. K., Risco, C. A., & Webb, D. W. (2001). Effect of lameness on the calving-to-conception interval in dairy cows. Journal of the American Veterinary Medical Association, 218(10), 1611-1614. doi: 10.2460/javma.2001.218.1611

Krawczel, P., & Grant, R. (2009). Effects of cow comfort on milk quality, productivity and behavior. Proceedings of the NMC 48th Annual Meeting (pp 15-24). Charlotte, NC.

Nickerson, S. C. (2014). Management strategies to reduce heat stress, prevent mastitis and improve milk quality in dairy cows and heifers (UGA Extension Bulletin 956). Retrieved from http://extension.uga.edu/publications/detail.cfm?number=B956.

Overton, M. W., Sischo, W. M., Temple, G. D., & Moore, D. A. (2002). Using time-lapse video photography to assess dairy cattle lying behavior in a free-stall barn. Journal of Dairy Science, 85(9), 2407-2413. doi:10.3168/jds.S0022-0302(02)74323-3

Proudfoot, K. L., Weary, D. M., & von Keyserlingk, M. A. G. (2010). Behavior during transition differs for cows diagnosed with claw horn lesions in mid lactation. Journal of Dairy Science, 93(9), 3970-3978. doi:10.3168/jds.2009-2767

Schefers, J. M., Weigel, K. A., Rawson, C. L., Zwald, N. R., & Cook, N. B. (2010). Management practices associated with conception rate and service rate of lactating Holstein cows in large, commercial dairy herds. Journal of Dairy Science, 93(4), 1459-1467. doi:10.3168/jds.2009-2015

Shearer, J. K. (2005). Rumen acidosis, heat stress and laminitis. Proceedings of the 4th Annual Arizona Dairy Production Conference (pp. 25-32). Tempe, AZ.

Soriani, N., Panella, G., & Calamari, L. (2013). Rumination time during the summer season and its relationships with metabolic conditions and milk production. Journal of Dairy Science, 96(8), 5082-5094. doi:10.3168/jds.2013-6620

Tucker, C. B., Rogers, A. R., & Schütz, K. E. (2008). Effect of solar radiation on dairy cattle behavior, use of shade and body temperature in a pasture-based system. Applied Animal Behaviour Science, 109(2-4), 141-154. doi:10.1016/j.applanim.2007.03.015

Tucker, C., & Schütz, K. (2009). Behavioral responses to heat stress: Dairy cows tell the story. Proceedings of the 24th Southwest Nutrition and Management Conferences (pp. 13-21). Tempe, AZ.

Walker, S. L., Smith, R. F., Routly, J. E., Jones, D. N., Morris, M. J., & Dobson, H. (2008). Lameness, activity time-budgets, and estrus expression in dairy cattle. Journal of Dairy Science, 91(12), 4552-4559. doi:10.3168/jds.2008-1048

Wechsler, B., Zahner, M., Keck, M., Hauser, R., Langhans, W., & Schrader, L. (2004). Impact of climatic conditions on dairy cows kept in open buildings. Book of Abstracts of the 55th Annual Meeting of the EAAP (pp. 150).

West, J. W. (2003). Effects of heat-stress on production in dairy cattle. Journal of Dairy Science, 86(6), 2131-2144. doi:10.3168/jds.S0022-0302(03)73803-X

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