Cooling Cattle: Combating Heat Stress in a Changing Climate

By Joanna Aitken

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Introduction

Global temperatures have risen steadily over the past century with consequences for the reproductive and physiological welfare of cattle (Root *et al*., 2003). The sustainable production of livestock has therefore become dependent on planning in advance for cooling systems and the ability to implement appropriate practices to alleviate thermal stress (Nienaber & Hahn, 2007). As radiation, air temperatures and humidity rise, heat load must be dissipated to maintain normothermia and cooling methods such as shade, sprinklers and fans can be employed (Gaughan *et al*., 2010). Unless adequate practices are implemented, exposure to heat stress can result in dehydration, reproductive failure, decreased production and, occasionally, mortality (Crescio *et al*., 2010). It is therefore in the best interests of the industry and cattle welfare to develop effective, sustainable cooling methods. Behaviour is a useful tool for evaluating such methods, as cattle will change their behaviour to cope with their surrounding environment (Schutz *et al*., 2010).

Discussion

It has been established that providing simple shade will reduce heat load in cattle by 30% although no significant differences have been found between polyethylene material types (Blackshaw & Blackshaw, 1994; Eigenburg *et al*., 2010). As air temperature and solar radiation increase, cattle are motivated to use shade and will engage in aggressive behaviour to access shaded areas (Schutz *et al*., 2010). Schutz *et al*. (2010) found the area of shade made available to cattle is a critical component of the strategies employed to reduce heat stress. When cattle could use shade simultaneously in times of increased heat load, 70% fewer aggressive interactions occurred and respiration rates and body temperatures were lower when compared to animals with no shade (Schutz *et al*., 2010). However, crowding behaviour under limited shade areas can be counter-productive as it reduces the amount of airflow and convective/evaporative heat loss in the herd (Nienaber & Hahn, 2007).

Although shade is an invaluable tool in reducing heat stress, the use of water cooling has been proved more efficient (Schutz *et al*., 2011). In addition, sprinklers reduce fly numbers and frequency of tail flicking and hoof stamping, both behaviours associated with insect avoidance (Kendall *et al*., 2007). However, while sprinklers reduce heat stress, cattle will not voluntarily subject themselves to this form of cooling over ambient temperatures. This conclusion was reached in a recent study by Schutz *et al*. (2011) in which 96 Holstein-Friesian dairy cows were given the opportunity to choose between pairs of conditions involving combinations of shade, sprinklers and ambient temperature for a treatment time of 10 minutes over a total duration of 40 days. Under these circumstances shade was chosen over sprinklers (62%) and over ambient conditions (65%). However, no preference was shown for sprinklers over ambient conditions (44%) even though sprinklers were the most effective means of reducing the animals' heat load, respiratory rates and surface temperature. Behavioural traits, including a low head position, were consistent with aversive behaviour in an attempt to avoid water infiltrating sensitive areas such as the eyes and ears during the use of sprinklers (Schutz *et al*., 2011; Kendall *et al*., 2007).

These findings reflect the cooling efficiency of evaporative heat loss. Applying water to the external surface of cows allows them to stay within their thermoneutral zone, especially at temperatures exceeding 32°C when more than 85% of total heat dissipation is due to vaporization of water from the surface of the body and lungs (Avendano-Reyes *et al*., 2010). However, the implications of this study are that if sprinklers are to be used as a strategy to alleviate heat stress in cattle, it is an approach that would have to be forcibly imposed.

Such methods were employed by Brown-Brandl *et al*. (2010) to investigate evaporative cooling via sprinklers while working and processing feedlot cattle. Feedlot cattle are fed a high-energy diet and cannot escape their surrounding environment, thus increasing the probability of heat stress (Blackshaw & Blackshaw, 1994). Brown-Brandl *et al*. (2010) assessed the effects of externally applied water on the hair and hides of 64 heifers for 20-30 seconds while being held in a squeeze chute. Cows that were wetted had a body temperature that peaked significantly sooner and lower than control cows. Furthermore, wetting the skin caused the animal to loose heat more effectively, emphasising the need for water to penetrate through the hair to induce efficient cooling (Brown-Brandl *et al*., 2010). However, this has practical labour implications, as water must be applied manually.

The above study confirmed the advantages of spray cooling and suggested that increasing the number of times per day the cattle were treated to two would be beneficial. However, the ambient temperature in this analysis did not peak above 29.1°C. In situations involving high levels of ambient humidity through the day and night, cows are unable to dissipate heat effectively unless they are exposed to at least three hours of cooling in a 24-hour period (Avendano-Reyes *et al*., 2010). Avendano-Reyes *et al*. (2010) studied 32 mid-lactation Holstein cows with a high metabolic rate, similar to feedlot cattle. With body temperatures averaging 48°C during the study, cattle were given one (at 05.00h), two (at 05.00, 11.00h or 05.00, 17.00h) or four periods (at 05.00, 11.00, 17.00, 23.00h) of spray cooling with fans. All cows were found to be exhibiting heat stress when brought in during the afternoon with superphysiological respiration rates at 89 bpm and rectal temperatures above 39°C. These values did not drop to thermoneutral ranges at night, even in cows cooled four times a day. In extreme conditions, repeated cooling can significantly reduce heat stress even if it does not return the animal back to normothermia.

Conclusion

Although it has been well documented that evaporative cooling methods such as sprinklers and shade are effective in reducing heat load in cattle, the literature reported here shows an inconsistency between the efficiency of this technique and cattle compliance. To reduce heat stress in cattle, different sprinkling methods should be investigated, including droplet size and water pressure. Clearly, no one system will work for every herd in every climate.

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