Mitigating the detrimental effects of heat stress in your herd

As climate change becomes an omnipresent issue in global agriculture, heat stress is becoming an increasingly common concern in not only areas traditionally associated with this problem, such as the US, Asia and the Mediterranean but also in more temperate countries, like the UK, Germany and France. Heat stress results from a combination of temperature and humidity levels that exceed the thermoneutral zone of the cow.

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The NRC (2007) defined a temperature and humidity index (THI) that correlates with rectal temperature and illustrates the thresholds above which animals will suffer heat stress.

However, much of the early heat stress research was carried out in the US, where animals would likely have already adapted to higher temperatures. Hence, animals from traditionally cooler climates may start to suffer the physiological effects of heat stress at a lower THI than animals from regions with higher average temperatures and humidity.

Biological effects

Heat stress results from the combined effect of elevated ambient temperature and humidity, which compromises the cow's ability to dissipate body heat. Cows are relatively adept at coping with short-term increases in temperature and humidity as long as they return to lower levels relatively quickly afterwards. Heat stress mainly affects performance through reduced feed intake, which is associated with reduced rumination and decreased buffering capacity of saliva. These effects are cumulative and result in increased negative energy balance and the potential for ruminal sub-acute acidosis (SARA).

Cows initially rely on non-evaporative cooling methods, such as convection. However, in increasingly hot and humid environments these methods are less effective, meaning the cow must use other means, such as panting, but even these methods become less effective as humidity increases. Additionally, drooling animals will lose saliva, which includes HCO_3, one of the main buffers for the rumen.

Heat stress mainly affects milk yield and milk fat percentage, but also lowers feed intake, reproductive performance and, often, bodyweight. If heat stress occurs prior to insemination, it can be associated with decreased fertility in cattle, which can persist well after temperatures have cooled down. High-yielding animals are more susceptible due to their higher milk production and dry matter intake (DMI). In the modern dairy industry, there is a trend towards increasingly larger farms with more cows producing more milk, a situation that will increase susceptibility to the negative impacts of heat stress.

Affected animals will try to lose heat by maximising the body surface area that is exposed to air. As a result, they will opt to stand instead of lying down, which has implications for both claw and udder health.

Management strategies

Environmental and nutritional modifications can be implemented to address the challenges of heat stress. Genetic selection for more effective thermoregulation and more efficient heat loss has also been cited as a potential mechanism for reducing the impact of heat stress on farms.

Environmental strategies

Proven methods for combatting heat stress are neither new nor very scientific. Providing sufficient shade, as well as cooling and good ventilation (air flow) are the basic principles. In terms of outside shade, West (2003) suggests providing 4-6m^2 per cow.

Cooling is often accomplished by spraying the animals with either a fine mist or a heavier spray of water. Both these options require adequate ventilation to be effective and that can be provided via either natural or forced (fans) ventilation. Reduced stocking density is also another simple method that can be employed.

Nutritional strategies

The main goal of nutritional management during heat stress is to maintain healthy rumen function while providing optimal nutrient supply to limit negative energy balance. This relies mainly on providing highly digestible feed while maintaining a safe forage-to-concentrate ratio. As DMI drops during heat stress, the energy and

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nutrient density of the feed often need to be increased. However, resist the temptation to simply add more energy as concentrates (starch) to avoid further compromising rumen function.

Fat is a useful ingredient to use for increasing energy density of the feed without generating additional metabolic heat. However, fat should make up no more than 7-8% of the total diet. Encouraging feeding during cooler periods of the day and at night can often help offset the reduced DMI during the day. This also helps preserve the shelf life of ensiled forages, which is reduced in higher THIs.

Only high-quality forages should be used and protein digestibility should also be addressed. Additionally, management of conserved forage, especially the clamp face and feed left out in the feed passage, should be addressed. Keeping the clamp face as flat as possible and potentially feeding smaller amounts more often to prevent spoilage can help encourage DMI.

Feeding protein and nitrogen sources that promote microbial activity and provide some bypass element without unnecessarily increasing blood or milk urea nitrogen levels can also help increase overall protein digestibility.

Requirements for certain minerals (potassium, sodium and magnesium) lost through sweating, panting and drooling increase during heat stress and should be addressed through the diet.

The dietary cation:anion balance should be closely monitored. Several feed additives, such as live yeast cultures, buffers, fat-soluble vitamins (A, D, E), niacin and selenium, can be considered to improve rumen function, immune response and promote energy utilisation and feed conversion efficiency. Live yeasts have been shown to have beneficial effects on DMI, as well as subsequent milk production during periods of heat stress.

Selenium

Selenium plays a crucial role in metabolism. The majority of selenoproteins function as part of antioxidant enzymes, such as glutathione peroxidase, and protect body tissues from the harmful effects of reactive oxygen species (ROS), also known as free radicals.

These proteins are also thought to be involved in the communication between cells, as well as the first part of the process of protein production. Selenium is also part of the enzymes involved in thyroid function. These enzymes affect the basal metabolic rate and are important for surviving cold stress.

Heat stress has been reported to induce the production of ROS, resulting in some of the deleterious effects associated with heat stress. There is damage to DNA, proteins and lipids. Selenium helps protect these tissues and also aids in the recycling of other antioxidants, such as vitamins E and C. A study in lactating dairy cows found lower levels of a by-product of lipid oxidation when cows were fed selenium in the form of Sel-Plex (Alltech Inc, Kentucky), a selenised yeast product, compared with those fed sodium selenite, indicating a potential improvement in the antioxidant status of animals fed Sel-Plex.

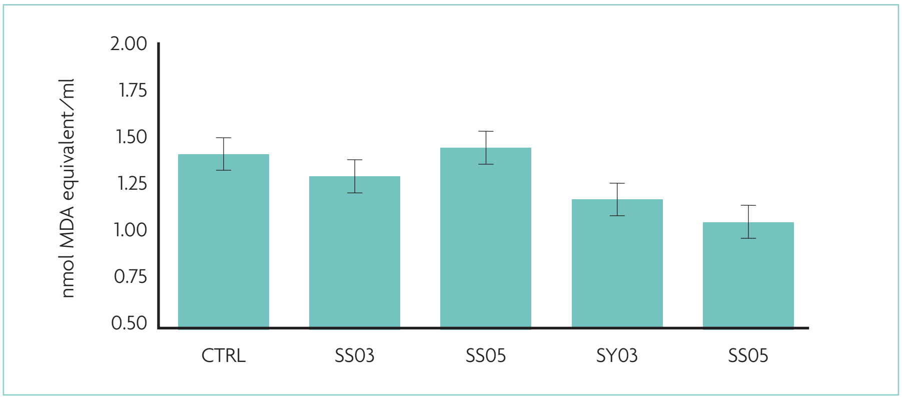

Fig. 1. Plasma thiobarbituric acid reactive substances (TBARS) during the hotter period in dairy cows that received diets containing either no additional Se (empty bars), or Na selenite provided 0.31, and 0.50mg of total Se kg-1 DM (SS) or Sel-Plex (SY) provided 0.31, and 0.50mg of total Se kg-1 DM.

Protein in diets

One important aspect of the diet is protein. Excess protein can increase the energy requirements of the cow, which is not ideal when DMI is already reduced. Additionally, excess protein can lead to elevated blood urea nitrogen levels, which are known to negatively affect fertility.

Using protein ingredients that allow for the decrease of overall dietary crude protein level by increasing the production of microbial protein, as well as providing some bypass element to the ration, can be a good strategy for helping animals cope with heat stress.

One example of this is Optigen (Alltech Inc, Kentucky), a specific non-protein nitrogen (NPN) source designed to meet the nitrogen requirements of the rumen microflora. This boosts the activity of the rumen microbes, leading to an increased supply of microbial protein, as well as optimal digestibility of the diet.

Reformulating the ration with Optigen can also allow increased use of forage, which may help reduce risk factors associated with SARA and promote rumen function. It can also potentially increase the use of home-grown feed materials.

Optigen allows dietary protein to be used more efficiently and can thereby reduce the risk of feeding excess protein, resulting in more energy partitioned into body condition and production. In a field trial in northern Italy, Optigen was reformulated into the diet of lactating dairy cows during a heat stress situation.

There were improvements in both milk yield and the percentage of milk casein with a total return on investment of 3:1.

Water, the most neglected nutrient, is probably the most important. Water requirements can increase significantly during heat stress, so providing adequate clean, fresh water is critical. During periods of heat stress, it is even more crucial to provide adequate drinking space and to keep troughs clean.

Ensuring that troughs refill with sufficient speed is also important. Anything that reduces the palatability of the water will also pose a risk.

Much like animals, plants also become stressed at higher temperatures, which can increase the risk of mycotoxin production both on the plant and during the storage of raw materials and conserved forage. Mycotoxin contamination is unlikely to be avoided, so a management programme that reduces the risk should be implemented.

Assessing the operation's risk factors and working to control them, as well as analysing feed for the presence of mycotoxins, will help minimise the negative impact of mycotoxin production.

Additionally, the use of a proven, fast-acting and broad-spectrum binder, such as Mycosorb A+, will further reduce the likelihood of any negative impacts on the animal.

Conclusion

As climate change continues to develop, heat stress is likely to become an increasingly common issue, even in more temperate climates. The thresholds at which animals succumb to the effects of heat stress are likely to be lower in Europe (and other areas with more temperate climates) compared with the thresholds outlined in published work derived from data from, for example, the US. ■

References are available from the author on request