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Managing Sheep and Goats for Heat Stress

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Box Summary

Heat stress impacts health and performance of sheep and goats during the summer months and when temperatures are unseasonably warm. This guide discusses the factors that contribute to heat stress, the warning signs that animals are distressed by heat, and methods to alleviate the stressor.

Factors Causing Heat Stress

Heat stress occurs when the build-up of heat inside an animal's body exceeds the animal's biological ability to dissipate it, causing core body temperature to rise. The collective sum of all heat inputs is referred to as the animal's *heat load*. This consists of external heat from the environment and internal heat from the animal's own metabolism, as illustrated in **Figure 1**. Environmental heat is generated by solar radiation from the sun and from the surrounding air when ambient temperature exceeds that of the animal's skin and body. Little to no wind speed and high relative humidity substantially worsen heat stress during high ambient temperatures. When sheep and goats overheat, panting and sweating help reduce body temperature by increasing evaporative cooling across the moist surface of the respiratory tract and the skin of the ears and lower legs. The effectiveness of panting and sweating on reducing heat stress is determined by how quickly the "wet air" moves away from the body surface. Wet air movement is increased by breeze and is hampered by high relative humidity. Metabolic heat load is created inside the animal's body during digestion and metabolism of feedstuffs. As ruminants, sheep and goats have particularly high metabolic heat production from microbial fermentation. The amount of heat generated by a specific feed or feed component is referred to as its heat increment. Feedstuffs with larger heat increments release more energy as heat during digestion and thus contribute more to the metabolic heat load of the animal. Roughage and fibrous feeds like hay, grass, cornstalks, and husks have greater heat increments than concentrate feeds like corn and soybeans.

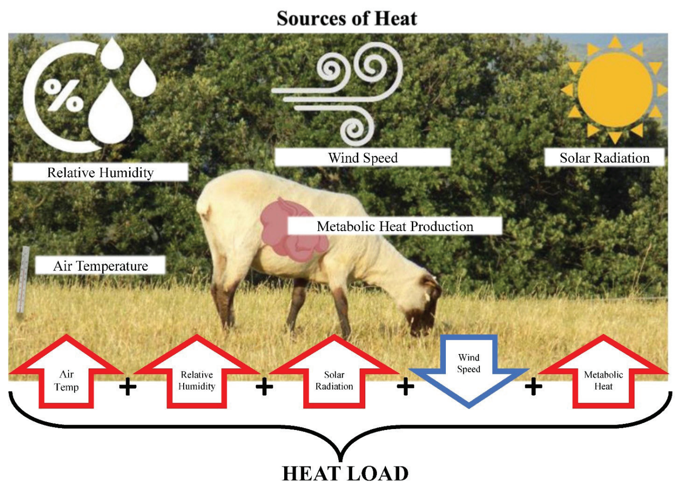

Fig. 1. Multiple environmental and internal factors contribute to the presence and severity of heat stress.

Regardless of the magnitude of heat inputs, some livestock species are more susceptible to heat stress than others for several reasons. Sheep and goats generally tend to be more resilient to heat stress than cattle, pigs, and other livestock species. However, variation in heat resistance exists among different breeds of sheep and goats, as those that originate from desert or tropical regions near the equator are more tolerant of environmental heat and less prone to heat stress. Heat resistance can also vary among animals of the same breed due to factors like age, stage of production, coat color, and wool length. For example, very young animals have less capacity to regulate their body temperature and are at greater risk for hyperthermia and hypothermia than older animals even when under the same environmental conditions. Feeder lambs with high body fat during finishing are likewise less efficient at self-cooling. For wool sheep, regulation of body temperature is correlated to wool length. Wool is an effective natural barrier against extreme weather conditions (heat or cold) due to its insulating properties. In warmer seasons, wool has a unique ability to absorb and internalize moisture, which reduces the negative impact of relative humidity. However, fleeces shorter than 1 inch lose much of their moisture-absorbing capacity, and they also block less solar radiation. Thus, it is advisable for wool sheep to be sheared in spring to provide time for enough wool growth to help withstand summer heat and winter cold.

Fig. 2. Insufficient shade causes sheep and goats to crowd, which exposes them to body heat from herdmates.

Rates of internal heat production can also differ among production stages. For meat breeds on high-grain diets, lambs and kids have elevated metabolic rates during peak growth, making them particularly sensitive to high ambient temperatures. Gestating and lactating females are likewise at greater risk for heat stress because of the greater heat produced by their increased metabolic rates. Pregnant animals that experience heat stress for sustained periods of time can transfer the effects to their fetuses, which can impair growth potential, feed efficiency, and carcass quality of offspring after birth. How prenatal heat stress affects offspring in livestock is a major research area of the Animal Science Department at the University of Nebraska–Lincoln. Heat stress can harm reproductive success even when it occurs prior to breeding by disrupting ova development and ovulation in females and sperm production in males. During the breeding season, heat stress can also affect male libido.

Sheep and goats have developed biological mechanisms to counter increased heat load during hot environmental conditions. Many of these include visible changes in behavior or appearance that can help identify affected animals. Elevated body temperature is detected by the brain, which signals responses facilitated by the adrenal glands and other stress-responsive tissues. These responses include increased respiration rates, activated sweat glands, and redirected blood flow from the gut and other organs to the skin. These mechanisms increase the dissipation of body heat and create reliable visual indicators of heat stress (panting, sweating, flushing). In addition, sheep and goats implement behavioral changes to cool themselves, such as seeking shaded areas when available, which reduces heat input from solar radiation. However, if only small areas of shade are available, animals may crowd together as shown in **Figure 2**, which exposes them to the body heat dispelled by herdmates and offsets much of the benefit provided by the shade. Animals on range often shift their grazing times to the cooler evening and nighttime periods to minimize heat produced by physical activities and by digestive processes during the hottest hours of the day. Heat-stressed sheep and goats markedly increase their water intake to make up for water lost to evaporative cooling and to reduce rumen temperatures elevated by metabolic heat production. These biological and behavioral protective mechanisms reduce but often do not eliminate heat stress, making it necessary for livestock managers to understand their options for further alleviating heat stress in their herds and flocks or even preventing it altogether.

Identifying Heat-Stressed Animals

The outward signs of heat stress exhibited by animals can vary due to the severity of the heat stress. Reduced feed intake is among the best indicators of *mild* heat stress in sheep and goats. Research at the University of Nebraska-

Fig. 3. Open-mouth panting is an important visual indicator of severe heat stress.

Air Temp, °F	Relative Humidity, %															
	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95
50	54	53	53	53	53	52	52	52	52	52	51	51	51	51	50	50
55	56	56	56	56	56	56	56	56	56	56	55	55	55	55	55	55
60	59	59	59	59	59	59	59	60	60	60	60	60	60	60	60	60
65	62	62	62	62	63	63	63	63	63	64	64	64	64	64	65	65
70	65	65	65	66	66	66	67	67	67	68	68	68	69	69	69	70
75	68	68	68	69	69	70	70	71	71	72	72	73	73	74	74	75
80	70	71	72	72	73	73	74	75	75	76	76	77	78	78	79	79
85	73	74	75	75	76	77	78	78	79	80	81	81	82	83	84	84
90	76	77	78	79	79	80	81	82	83	84	85	86	86	87	88	89
95	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94
100	82	83	84	85	86	87	88	90	91	92	93	94	95	97	98	99

Moderate | Severe | Extreme

Fig. 4. Heat stress-associated risk to animal health and well-being based on Temperature-Humidity Index (THI). Adapted from information provided by Keyy Froehlich, SDSU Extension.

Lincoln found that heat-stressed wether lambs consumed on average 0.7 lbs. less feed per day than unstressed lambs, which was a reduction of about 26 percent. Conversely, their daily water intake increased by about 65 percent. For dry lot animals, this makes the feed bunk and water tank valuable indicators of heat stress, as feed will disappear slower and water will disappear quicker when animals are heat-stressed. During mild heat stress, animals typically spend more time standing and less time lying down to reduce body contact with hot surfaces. Respiration rates may not be noticeably different during mild heat stress but along with other symptoms will progressively increase during moderate heat stress. When animals become severely heat stressed, respiration shifts to the shallow, open-mouth panting illustrated in **Figure 3**. Heat stress research studies at the University of Nebraska-Lincoln found that breathing rates in sheep may quadruple in sheep experiencing severe heat stress, which can lead to a blood gas imbalance known as respiratory alkalosis. Core body temperatures, estimated by rectal temperature, also increase proportionally based on the severity of heat stress. Mild heat stress may only increase rectal temperatures by 0.5°F or less, which is often difficult to detect with most commercial home thermometers. Moderate heat stress usually results in increases of 0.5 to 1.1°F. Severe heat stress results in rectal temperature increases greater than 1.1°F, and warrant immediate intervention. Behavioral changes are also indicators of heat stress, such as when animals are lingering in shade near water sources rather than grazing or foraging.

Managing Heat-Stressed Animals

There are several potential strategies available for producers to help reduce the risk and impact of heat stress in sheep and goats. These strategies include providing infrastructure for physical protection, genetic selection for heat resistance, and dietary management. In addition, monitoring daily weather conditions and temperature-humidity indices is essential for any strategy to reduce heat stress in sheep and goat operations. These key considerations include:

Weather tracking. Understanding and tracking local weather trends can provide producers with the critical information needed to make informed decisions regarding their production system. Before taking any corrective action, the risk for heat stress must be determined from the environmental conditions. The temperature-humidity index (THI), which has long been Nebraska Extension's recommended heat metric for cattle producers, combines air temperatures with relative humidity values, both of which can be obtained from daily news reports or inexpensive home weather stations. The THI is a more accurate predictor of the risk for heat stress than air temperature alone because changes in air temperature and relative humidity additively affect the risk category for heat stress, as illustrated in **Figure 4**.

Protective infrastructure. Sheep and goats increase water intake during heat waves. Thus, adequate water supply and trough space must be available. For dry lots or other sites that require water to be hauled, heat events may require water delivery to be done more frequently. Water levels should be checked at least daily. Automatic pumps, windmills, and other equipment must be in reliable condition and capable of producing water pressures and flow rates that keep tanks refilled during times of high demand. Sheep and goats typically water in groups, thus metal or rubber stock tanks should be large enough to provide at least one linear foot of space for every 20 head. Research by Terry Mader and others at the University of Nebraska-Lincoln has comprehensively shown that shade availability is among the most effective infrastructural components for preventing or reducing heat stress. Pastures and grazing lands with plenty of mature trees generally provide adequate shade. Moreover, trees help cool the ambient air temperature via evaporation of water from their leaves. However, it is often necessary to construct temporary or permanent shade structures for sheep and goats on open fields or in confinement, as they have little ability to move out of direct sunlight. Effective shade structures can be built from a variety of materials and can take any number of forms. Shades should be constructed so as not to impede air movement and should typically be oriented north-south to allow the shaded area to shift with the movement of the sun. This orientation reduces muddy conditions caused by animals by bunching in the same place for too long.

In Nebraska and throughout the Midwest, the space near south-facing walls of enclosed or semi-enclosed housing structures will be markedly hotter during summer months than the space near north-facing walls. Outdoor pens adjacent to the south side of buildings will also experience higher temperatures due to solar radiation reflected off the building, thus shade for south-wall pens is particularly important. Windbreaks are helpful during colder months but must be oriented so as not to stifle air flow during the summer, as breeze increases the effectiveness of evaporative sweating and panting. Temporary windbreaks can be removed and reinstalled after the warm season. For animals kept indoors, fans can be used to circulate air, which benefits evaporative cooling similarly to the wind. Sheep and goats that are effectively coping with heat stress should be disturbed as little as possible. Intensive handling procedures such as vaccinations, ear tagging, shearing, or transporting should be postponed if possible or performed during early morning or late evening, when THI has dropped.

If heat stress becomes severe enough that animals show clear signs of distress, they should be moved into a shaded area with good ventilation and provided clean, cool water to drink. Sheep with short wool and goats may be sprinkled with room temperature water to promote evaporative cooling. Sheep with wool longer than one inch should only be wetted on the lower legs and inside flanks, as wet wool slows body heat dissipation. Wetting with cold water should be avoided as it may lead to temperature shock for the animal. Contact a local veterinarian for additional directions, especially if the animals' heat stress symptoms do not begin to improve following these steps.

Dietary management. Heat increments differ for individual feed components, thus manipulating the composition of the diet can combat heat stress by reducing the animal's own metabolic heat production. Fibrous roughages produce more heat during digestion than grain-based feeds, and thus animals grazing rangelands or being fed primarily roughages will need to be monitored closely during hot weather. Slowly replacing dietary roughage with grain using a step-up approach is an effective pre-planned preventive strategy, but abrupt increases of grains can induce ruminal acidosis and exacerbate heat stress symptoms. Manipulating the amount fed and the time of feeding may have the greatest benefit on heat-stressed animals. Sheep and goats instinctually restrict their feed intake under hot conditions to limit internal heat production, and producers can enhance this effect by intentionally limit-feeding for short periods of time. Ruminal heat production varies based on heat increment of the feedstuff but generally peaks 4 to 6 hours after feeding. Thus, feeding in the evening rather than in the morning or at mid-day shifts peak ruminal metabolic heat production from the hottest hours of the day to the cooler overnight hours. This is best accomplished by feeding one-half of the usual ration in the morning and the remaining half in the evening for the first several days before moving the entire ration to evening feeding. As always, animals will need access to clean, cool water throughout the day. Several pharmaceuticals and nutritional supplements to relieve heat stress are being tested at the University of Nebraska-Lincoln and other institutions. Although some of these supplements show promising results, the research has not advanced to the point of making conclusive recommendations as of this writing.

Genetic selection. Just as specific breeds and bloodlines are selected for growth and reproductive performance, they can also be selected for their resilience in hot environments. Breeds developed in desert and tropical regions are intrinsically tolerant of heat stress. Of course, genetic improvements in heat stress resistance must be outweighed by any potential reductions in productivity. Hair sheep breeds, such as Katahdin and Dorper, are not only more heat-resistant but are more pathogen-resistant and heavier-muscled. However, these breeds do not produce an economically-relevant wool crop. Goat breeds, such as Spanish and Nubian, are quite heat-tolerant but are also lighter-muscled and thus produce less-valuable carcasses.

Producers of multi-colored breeds should also consider the influence of coat color, particularly when shade is scarce. Animals with lighter coats absorb less solar radiation, making them more tolerant of heat stress than those with darker coats. Breed and breeding decisions help to position flocks/herds for better resilience in hot climates but do not eliminate need for management, especially in instances of extreme heat events.

Summary

In summary, sheep and goat producers must remember that heat stress is a normal and expected part of summer but can also occur during other times of the year if ambient temperatures are unseasonably warm. Heat stress can result from chronically hot conditions or from abrupt heat events and occurs when the animal's cooling capacity is exceeded by environmental and internal heat build-up. In addition to air temperature, environmental factors to be wary of include clear skies that create full sun exposure, high relative humidity, and lack of nighttime cooling. Animals in certain production stages such as newborns, rapidly-growing animals, and pregnant/lactating animals are more prone to heat stress and should be monitored closely when conditions for heat stress are favorable. Infrastructural, nutritional, and genetic strategies can improve heat stress outcomes when appropriately utilized, with the most crucial element being animal access to adequate water and shade.

Additional Resources

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