Beat the Heat

A Guide to Hot Weather & Shade for Ontario Cattle Producers
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A Guide to Hot Weather and Shade for Ontario Cattle Producers

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Canadian Cataloguing
in Publication Data:
Widowski, T. M., 1958-
Beat the Heat: a guide to hot weather and shade for Ontario cattle producers
Includes bibliographical references.

1. Cattle - Effect of temperature on -
SF206.W52 1998 636.2'083
C97-931206-X

Published by The Colonel K.L. Campbell Centre for the Study of Animal Welfare
University of Guelph,
Guelph, Ontario, Canada N1G 2W1
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Heat Balance: The Basics

Heat gain and loss
Coping in a hot environment

Like all livestock, cattle maintain a fairly constant body temperature over a wide range of environmental extremes. It’s quite amazing that their deep body temperature varies less than a degree Celsius—over the course of day and night, winter through summer, in temperatures ranging from below freezing to well over 20°C. Although cattle are able to cope with many kinds of weather, extremes of heat or cold do reduce productivity, limit reproduction and impair animal health. Therefore, maintaining livestock within their thermal comfort zone is important.

A CRITICAL BALANCE
Maintaining healthy body temperature depends on a balance between the heat produced by the animal and heat gained and lost due to the environment. If the amount of heat gained by the body is greater than the heat that the animal is able to lose, then the animal and its productivity will suffer.

HEAT GAIN
Heat gain by an animal’s body comes from two sources, animal metabolism and environmental heat. Metabolic heat is produced by the physiological processes of feeding and digestion, exercise, growth, lactation and gestation. High rates of these processes result in greater heat production so that the high producing animal also produces more heat.

During daylight hours, nearly all heat gained from the environment comes from the sun. Most solar radiation comes from direct sunlight but heat can also be gained indirectly from sunlight reflected off clouds and the ground.

HEAT LOSS
Heat is lost from an animal through four modes of heat transfer: radiation, convection, conduction and evaporation. Radiation, convection and conduction depend on a temperature gradient, or heat flowing from warmer to cooler matter. Heat loss through radiation occurs when all or part of the surroundings are cooler than the surface of the animals. During hot conditions animal surfaces will radiate heat to the cool sky; this loss is especially important at night. Heat loss through convection occurs when air moves around an animal’s surface. Increased air movement due to wind increases convective heat loss. Animals lose heat through conduction when their bodies are in direct contact with cooler surfaces.

Evaporation involves the loss of heat through the vaporisation of water or sweat. Its rate does not depend on temperature directly, but on
the vapour pressure gradient between the air and the evaporative surface. In hot conditions, when environmental temperatures approach body temperature, evaporation becomes the major route of heat loss. Increased air movement increases evaporative heat loss, while high relative humidity reduces it.

**COPING IN A HOT ENVIRONMENT**

In hot environments, cattle use a variety of thermoregulatory mechanisms that serve to reduce heat gain and increase heat loss so that they can maintain that critical balance. Cattle will change their behaviour by seeking shade and water, changing their orientation to the sun and reducing their activity during the hottest periods of the day. An increase in blood flow to the skin and body periphery allows more heat to be lost to the environment. Cattle increase evaporative heat loss by both sweating and panting, but sweating is much more effective. Cattle have sweat glands associated with each hair follicle over most of their body surface. The rate of sweating is not as great as in humans, so their skin rarely appears wet, but at high temperatures over 80 percent of heat loss is due to sweating. Cattle pant with the mouth closed so that heat exchange occurs over the upper respiratory system. Cattle use a second type of very deep open-mouthed panting when severely heat stressed. Panting requires energy and actually increases heat production.

If cattle are unable to lose enough heat to maintain heat balance they must reduce feed intake to reduce metabolic heat production. A reduction in feed intake is an immediate response to heat stress. At temperatures between 25° and 35°C a noticeable reduction in intake can be expected.

**CLIMATIC FACTORS**

While air temperature is an important determinant of an animal’s thermal status, other environmental conditions influence heat flow and heat balance. The combination of factors acting together is called the *effective environmental temperature*. It tells us much more than what the thermometer reads, it tells us how hot an animal feels.
How Hot Does It Feel?

"It's not just the heat, it's the humidity!"

Climatic factors

Solar radiation: Heat from the sun can add a significant heat load on an animal. Receipt of solar radiation varies with geographical location (it is greater as you move south toward the equator) and altitude (it is greater at higher altitudes). Even in northern locations, receipt of solar radiation can be significant. In Scotland, for example, at a latitude of 55° N, it was estimated that at equinox, the amount of solar radiation reaching a sheep was more than two thirds that reaching a sheep at the equator. This is the same latitude as Polar Bear Provincial Park in Northern Ontario.

Surrounding surfaces: The type of surroundings affect the heat balance because of the different abilities of the ground or built structures to absorb, hold and radiate heat. Grass, trees and other vegetation evaporate moisture and provide a relatively cool environment whereas rock, bare soil and concrete hold and radiate heat. At the same air temperature, a dirt lot feels much hotter than a pasture. (See Table 4, page 12, for ground surface temperatures.)

Wind: Increased air movement facilitates both convective and evaporative heat losses. Hedgerows and fences that block the wind may increase the effective environmental temperature. At the same air temperature, a cow on a windy hill will feel much cooler than a cow in a sheltered paddock.

Relative humidity: Rate of evaporation depends on the amount of water that is already in the air. High humidity reduces the rate of evaporative heat loss and makes an animal feel hotter. The Temperature Humidity Index (see Figure 1), reflects the relationship between air temperature and relative humidity on the thermal comfort of livestock. It is much like the Humidex for humans.

Night cooling: Animals can briefly store some heat in their bodies during the day as long as they are able to lose the stored heat during cooler periods e.g. at night.

A Humidex for Livestock

This temperature-humidity index is a warm-weather discomfort index developed for livestock. Obtain the current or expected temperature and relative humidity by listening to a weather forecast or reading your own thermometer and hygrometer. Find the temperature in the left hand column of the graph and follow the line to the right until you come to the relative humidity that is equal to the one in your area. The area of the graph tells you the weather stress category. The Livestock Conservation Institute has suggested that the terms Alert, Danger and Emergency be used for cattle during handling and transport. For the sake of pasture conditions, we have adapted these terms to be Alert, Caution and Warning.

Animal factors

Acclimatization refers to an animal's ability to adjust to environmental conditions over time. An animal acclimatized to hot conditions will be able to withstand hotter temperatures without suffering from heat stress. In cattle, acclimatization begins within two weeks after a change in temperature and is complete in about four to seven weeks. This is important to remember when sudden changes in weather occur. Cattle are much more vulnerable to heat stress when a wave of high temperature and humidity occurs after an extended period of cool weather. Cattle who have been exposed to gradually increasing temperatures over the spring and summer are better able to cope with a heat wave.

Coat colour and coat type can influence heat balance and performance of cattle on hot, sunny days. Coat colour affects the amount of solar radiation absorbed by an animal. Dark coloured hides can absorb 80 percent of solar radiation compared with only 50 percent for white hides which means dark-coloured cattle can feel much hotter than light cattle in the sun. In one Australian study, light-coloured steers spent more time in the sun, more time grazing and had better gains than dark cattle.10 Deep, woolly coats are associated with resistance to heat loss, high body temperatures and poorer performance during hot weather. Therefore, cattle with dark-coloured, deep and woolly coats are at a disadvantage during hot, humid weather. These types of cattle need shade the most, to reduce the heat load from exposure to solar radiation.

Breed differences can influence ability to cope in hot environments. Many studies have shown that tropical breeds of cattle (Bos indicus) are more heat tolerant than the temperate breeds (Bos taurus). The Bos indicus breeds include Brahman and Zebu, and those which have Brahman blood like the Santa Gertrudis, Brangus, Chabray, Beefmaster and Barzona breeds. Bos Taurus cattle include British breeds such as Shorthorn, Hereford, Angus, and other European or Continental breeds like Charolais and Simmental. It has been suggested that a significant factor in the heat tolerance of the Brahman breeds is that their metabolic rate is 15 to 20 percent lower than the British and European breeds.

<table>
<thead>
<tr>
<th>Ambient air °C / % Relative Humidity</th>
<th>Cow Coat Colour</th>
<th>Average Surface Temperature °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>26.1° / 57.7%</td>
<td>Black</td>
<td>42</td>
</tr>
<tr>
<td>26.1° / 57.7%</td>
<td>Red, Red &amp; White</td>
<td>41</td>
</tr>
<tr>
<td>26.1° / 57.7%</td>
<td>Brown, Brown &amp; White</td>
<td>37.5</td>
</tr>
<tr>
<td>26.1° / 57.7%</td>
<td>Beige</td>
<td>38</td>
</tr>
<tr>
<td>26.1° / 57.7%</td>
<td>White</td>
<td>38</td>
</tr>
<tr>
<td>30.7° / 74.7%</td>
<td>Black cow, part of body in shade</td>
<td>36</td>
</tr>
<tr>
<td>30.7° / 74.7%</td>
<td>Black cow, part of body in sun</td>
<td>47</td>
</tr>
</tbody>
</table>

Table 1. Average surface temperatures of different coloured cows as measured with a non-contact radiation thermometer. Measurements were taken on pasture at the Elora Beef Cattle Research Station (Elora, Ontario) on a sunny afternoon in September. Measurements were also taken on one black cow resting with half of her body under a shade structure.
How Hot Does it Get in Ontario?

A summary of meteorological data

Environmental temperature and humidity at which cattle may suffer from heat stress are discussed in sections on Climatic Factors and Heat Stress. When making decisions concerning summer management for cattle, it is important that Ontario producers be able to put that information in the context of Ontario summers. Everyone remembers some very hot and humid times as well as the cool rainy years, but how often do these extremes really occur?

Meteorological records were obtained from Environment Canada weather stations at Hanover [Bruce County], Renfrew [Renfrew County] and Peterborough [Peterborough County]. These counties represent areas where some of the highest populations of beef cattle are found in Ontario, and give some indication of the variation in summer temperatures across the province. The weather data were summarized for the months of July and August for the years 1991 through 1997.

Average daily temperatures represent the conditions measured over the entire day and night. They include the hottest and coolest parts of the day. Heat stress depends on both intensity and duration of high heat and humidity. When animals experience a regular cooling cycle, like at night, they are better able to cope with hot days. Usually, most of Ontario has cool summer nights. In all of the years and locations summarized in Table 2, the average daily temperatures are well within the range of thermal comfort for cattle.

<table>
<thead>
<tr>
<th>Year</th>
<th>Hanover</th>
<th>Renfrew</th>
<th>Peterborough</th>
</tr>
</thead>
<tbody>
<tr>
<td>1991</td>
<td>19.4</td>
<td>20.2</td>
<td>19.5</td>
</tr>
<tr>
<td>1992</td>
<td>16.4</td>
<td>16.7</td>
<td>16.5</td>
</tr>
<tr>
<td>1993</td>
<td>20.0</td>
<td>20.0</td>
<td>19.3</td>
</tr>
<tr>
<td>1994</td>
<td>17.5</td>
<td>18.4</td>
<td>18.5</td>
</tr>
<tr>
<td>1995</td>
<td>20.6</td>
<td>18.5</td>
<td>19.5</td>
</tr>
<tr>
<td>1996</td>
<td>18.8</td>
<td>19.6</td>
<td>18.2</td>
</tr>
<tr>
<td>1997</td>
<td>18.2</td>
<td>19.8</td>
<td>17.4</td>
</tr>
</tbody>
</table>

Table 2. Average Daily Temperatures in °C for July and August.
Figures 2 and 3 indicate how many days that maximum daily temperatures equalled or exceeded 25°C and 28°C. These are temperatures at which cattle must work to maintain heat balance, or are at risk of suffering from heat stress, especially if they are exposed to the additional heat load of the sun. Maximum daily temperatures represent the conditions during the hottest part of the day and last for a short time. The temperature measurements are taken in the shade and do not include the effects of sun or humidity. Averaged over the seven years, the maximum daily temperatures were equal or above 25°C (Figure 2) on about 35 out of the 62 days in July and August. Maximum daily temperatures were at or above 28°C (Figure 3) far less often—on average only about 16 of the 62 days.

Figures 2 & 3. The data reported on these graphs and Table 2 represent air temperatures only, not the combined effects of temperature and humidity and sun. When maximum daily temperatures were plotted against relative humidities on the Temperature-Humidity Index using 1995 data from Peterborough, we found that 43 days were in the Alert zone, nine days in the Caution Zone and one day in the Warning Zone.
Heat Stress & Nutrition

Heat stress and food intake

An immediate response of cattle to heat stress is to reduce feed intake. By reducing their feed intake, cattle reduce their heat rates of production. At temperatures of 15 to 25°C, cattle have normal levels of feed intake. Above 25°C, feed intake begins to drop with increasing temperature. Cattle exposed to more than six hours per day of temperatures above 30°C will eat significantly less, and above 35°C, feed intake may fall by 10 to 35 percent.

When it comes to heat, not all feeds are the same

The digestive process itself produces heat, and not all feedstuffs produce the same amount of heat. The heat caused by utilization of high fibre forages produces significantly more heat than that of low fibre concentrates, and the animals seem to be able to tell the difference. Dairy cattle will reduce feed intake mainly by reducing consumption of forages or reduced grazing. Therefore, a change in grazing patterns of cattle is a good sign that they are feeling hot. Maximum heat production from digestion occurs four to five hours after eating. Cattle may adjust their grazing times so that this time of high heat does not occur during the hottest part of the day. Producers feeding cattle should adjust the time accordingly.

High summer temperatures also change the quality of forages by increasing the rate of maturity and reducing digestibility of the plants. These differences in forage quality can reduce intake and performance even more.

Keeping cool takes energy

When cattle are heat stressed, they use energy just to maintain body temperature. It has been estimated that cattle suffering mild to moderate heat stress use seven percent more energy than comfortable cattle. Severely stressed cattle at the stage of laboured, open-mouth breathing, use 11 to 25 percent more energy. This is energy that would be going into gains if the cattle were comfortable. Also, if maintenance energy requirements go up while feed intake goes down, cattle may actually lose weight.

Fescue Toxicosis and Heat Stress

Cattle eating tall fescue forage that is infected with endophyte fungus are more sensitive to heat. "Fescue toxicosis" causes less blood flow to the skin so that cattle suffering from it are less able to get rid of body heat. They show signs of heat stress at lower temperatures and should be managed carefully during warm weather.

Every Animal is Different

Individual animals have different abilities to cope with the heat. Some animals are more sensitive than others:

Very young calves have a greater surface area to volume ratio than adults which means that heat flows to and from their body more easily. Newborns are at risk in hot environments as well as in cold ones.

High producers and heavily muscled animals, like bulls have the highest rates of heat production and are more sensitive to heat stress.

Breed differences. Tropical breeds of cattle can cope with the heat much better than temperate breeds.

Coat colour. Cattle with light coloured coats perform better in the sun than do dark-coated cattle.

Cattle that are sick or stressed from handling will find it more difficult to cope with the additional stress of high temperatures.
KEEPPING COOL TAKES WATER
Grazing cattle drink about two to five times per day when water is available free choice. Water requirements depend on diet, productivity and environmental temperature. As air temperature rises so does water intake. When temperatures range from 13 to 28°C, water consumption of grazing cattle vary with maximum daily temperature and hours of sunshine. Over 30°C, increases in water intake are more dramatic. Dairy cattle begin drinking noticeably more at 27°C. Cattle that are used to hot conditions drink less water in the heat than cattle not acclimatized.33

Cooling of drinking water can benefit cattle when temperatures are extremely high. However, below maximum daily temperatures of 31°C, cooling of water does not improve cattle performance.

How Much Water Do Cattle Need?

Table 3. Approximate total daily water intake of beef cattle (Taken from the NRC Nutrient Requirements of Beef Cattle, 1996.)

<table>
<thead>
<tr>
<th>Temperature</th>
<th>Stage of production</th>
<th>Daily Water Intake</th>
</tr>
</thead>
<tbody>
<tr>
<td>21°C 70°F</td>
<td>Growing heifers, steers and bulls (273 kg or 600 lb)</td>
<td>29 litres or 8 gallons</td>
</tr>
<tr>
<td>27°C 80°F</td>
<td></td>
<td>34 litres or 9 gallons</td>
</tr>
<tr>
<td>32°C 90°F</td>
<td></td>
<td>48 litres or 13 gallons</td>
</tr>
<tr>
<td>21°C 70°F</td>
<td>Finishing cattle (364 kg or 800 lb)</td>
<td>40 litres or 11 gallons</td>
</tr>
<tr>
<td>27°C 80°F</td>
<td></td>
<td>47 litres or 12 gallons</td>
</tr>
<tr>
<td>32°C 90°F</td>
<td></td>
<td>66 litres or 17 gallons</td>
</tr>
<tr>
<td>21°C 70°F</td>
<td>Lactating Cows (larger than 409 kg or 900 lb)</td>
<td>64 litres or 17 gallons</td>
</tr>
<tr>
<td>27°C 80°F</td>
<td></td>
<td>68 litres or 18 gallons</td>
</tr>
<tr>
<td>32°C 90°F</td>
<td></td>
<td>61 litres or 16 gallons</td>
</tr>
</tbody>
</table>

Note that the water consumption of lactating cattle decreases at temperatures above 32°C. This is because lactating cows reduce feed intake before cattle at other stages of production. When feed intake goes down, so does water intake.
Shade: What Are the Benefits?

Productivity and reproduction

By blocking the direct rays of the sun, a simple shade can reduce an animal's radiant heat gain by as much as 30 percent. During hot and humid weather this reduction in heat gain can significantly improve the comfort of animals kept outdoors. Improving animal comfort and reducing stress often means better performance.

In the climates of the southern United States and Australia shade is essential for maintaining cattle well-being and productivity. In more moderate climates, shade is not required for survival, but providing trees or artificial shade structures may be a cost-effective way to keep cattle comfortable and maintain high productivity during hot weather. However, most of the research on the effects of providing shade on weight gain, reproductive traits or milk production has been conducted in very hot climates. There is little information available on any benefits of shade on productivity in moderate climates, like that of Ontario.

SHADE IMPROVES GAINS IN HOT (AND NOT SO HOT) PLACES

The greatest benefits from shade on cattle gains have been found in feedlot steers in the hot dry climates of California and Arizona. Pasture and rangeland studies in Louisiana, Mississippi and Oklahoma have also found better growth rates in steers, cows and calves when they had trees or artificial shades. In a two-year study conducted a bit closer to home, at Agriculture Canada’s Lethbridge Research Station in Alberta, yearling steers self-fed ground barley on an irrigated grass-legume pasture ate more and had better weight gains when they had access to shade. During the Alberta study there were not many days over 27°C, and when it did get that hot, it was only for a few hours.

SHADE AND REPRODUCTION

Heat stress can impair reproductive performance in both males and females at almost every stage of reproduction. It can reduce the duration and intensity of estrus behaviour, lower conception rates and increase early embryonic mortality. It can affect sperm production and influence fertility of bulls. When shade is used to reduce heat stress, reproductive performance may not suffer during hot weather. One Florida study found that providing shade to dairy cows resulted in higher conception rates and better lactation performance compared to unshaded cows. An Oklahoma study of Angus bulls on irrigated pastures reported that bulls provided shade had better semen quality compared to bulls without access to shade during the hot summer months.
Manure and ecological considerations

As cattle graze, they recycle a majority of the nutrients they consume by fertilizing the pasture with their manure. This is important for maintaining the productivity and sustainability of pasture systems. The most uniform distribution of dung and urine is achieved when cattle are grazed at high stocking rates and/or by reducing the length of grazing periods on a rotational grazing system.

**SHADE CONCENTRATES MANURE**

Shade structures can affect the natural process of fertilization. Frequent use of shade trees or artificial shade structures can result in an accumulation of manure in that area, especially during warm, humid conditions. As a result, more additional fertilizer may have to be applied to other areas of the pasture in order to maintain fertility. The highest concentration of manure is found within a 15 to 30 m (50 to 100 foot) semi-circle under shade trees. The ground under shaded areas may also become compacted and lack normal plant growth despite high levels of soil nutrients.

**ENVIRONMENTAL CONSIDERATIONS**

An even distribution of animal waste is important, especially on pastures where the soil has a limited capacity to retain Nitrogen (N) and Phosphorus (P). High quantities of N and P found in areas of manure/urine accumulation, can negatively affect soil and water quality. Shade trees like the oak (Quercus spp.) help with the long-term removal of N and P deposited by animal wastes. Certain forages are even more effective at absorbing large amounts of N and P.

**SOME SUGGESTIONS TO REDUCE MANURE ACCUMULATION**

Similar problems of manure accumulation and soil compaction are also seen around water sources. The location and use of both shade and water sources deserves careful attention since eliminating shade and water from the pasture is not a practical solution to the problems which have been discussed here. To help reduce the accumulation of manure in specific areas, use portable mineral feeders and fly-lice wipes. The use of portable shade structures, and changing their location regularly, may also help to reduce problems of manure concentration. Where permanent shade trees are present, be sure other activities (for example, supplemental feeding) are done in different areas of the pasture. Providing uniform shade throughout the pasture will also help even the distribution of dung and urine. Some watering systems can be moved around the pasture, allowing for a more even distribution of manure.
**Building artificial shade structures**

Artificial shades reduce the heat an animal absorbs from the sun but do not reduce air temperature. The building materials, orientation, height and design all influence how well a sun-shade works. Things to consider before building a shade structure:

**NOT ALL ROOF MATERIALS ARE THE SAME**

A California study in the 1960s tested 50 different types of roof materials for effectiveness as livestock shades.\(^{10}\) Hay and straw worked best because of their insulating abilities, and in the dry desert climate was a suitable choice for shade material. In our wetter climate, hay or straw would weather poorly but might be a good choice for building a temporary shade structure during an unusually hot period. Solid metal and plywood shades rated below straw and hay. These materials work best when the tops are painted white (or some other reflective colour) and the bottoms painted dark. Shade cloth, shade fence and snow fencing materials were rated the least effective because they do not provide total shading. However, these materials are relatively inexpensive, easy to work with and reasonably durable.

**SHADE ORIENTATION**

Cattle move to position themselves in the shadow of a shade structure. The orientation of a shade structure is important. In very hot dry places it may be best to orient a shade structure with the long axis in the east-west direction (Figure 5). As the sun moves during the day more of the shadow stays under the shade, keeping the ground under the shade cool. In a wetter, more moderate climate like ours, it may be better to orient a structure with the long axis running north-south (Figure 4). Over the course of the day the shadow will move from one side of the structure to the other allowing the ground underneath the shade to dry out and preventing a mud-hole. Care must be taken when choosing a site, so that cattle can always get to the shadow, therefore it is best not to build a sunshade along a fence line.

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**Figure 4.** Figures 4 and 5 illustrate the changes in shadow over the course of the day. The models are of a 12 ft wide x 24 ft long x 10 ft high slatted roof shelter located at the latitude of Peterborough, Ontario on August 1. The roof is made of a frame of two-by-sixes with vertical slats of two-by-four lumber. Compare the shadow locations, with respect to the shade, and the shading capability of the vertical slats when the structure is oriented with its long axis north-south versus east-west.
SHADE HEIGHT

The higher the shade structure, the greater the air movement underneath. In dry, cloudless climates very high shades (over 3.5 m or 11.5 feet) are recommended because they allow animals to lose heat to the cool sky. In more humid, cloudy climates like ours a lower shade is recommended so that cattle do not receive quite as much indirect sun reflected from the clouds. Shades heights of around 3 m (10 feet) permit plenty of air movement underneath. Another thing to remember is, the higher the shade, the more the shadow moves as the sun passes overhead. Higher shades need to be built farther away from fence lines.

ROOF AND STRUCTURE DESIGN

Roof design influences the size of the shadow it casts. The size of the shadow under a thin flat horizontal shade is about the same as the size of the shade. The shadow of a sloped shade or structure that has large vertical component will change size and shape more as the sun moves across the sky. Care must be taken so that the shadow size cast during the hottest parts of the day allows for minimum space requirements of the cattle.

OTHER BUILDING TIPS

- Choose a flat, well-drained location for a shade structure.
- If building a structure with a roof that is sloped, the open side should face north so that cattle can lose heat by radiating to the exposed north sky.
- Adding walls reduces solar radiation more than just a roof, but also reduces air movement and therefore may not be the best choice.
- A ratio of 2:1 to 10:1 for length to width are most common. Air movement is greatly reduced in a structure that is wider than 12 to 15 m (40 to 50 ft). If a wide structure is needed, it should have several continuous roof openings to allow better air circulation.

Figure 5. Shade structure oriented with its long axis east-west.
Shade Trees

A natural way to cool cattle

Trees offer the greatest benefits for providing protection for cattle during hot weather. Trees not only block the rays of the sun but they also cool the surrounding air as water evaporates from the leaves. Trees also allow for adequate air movement around cattle.

One of the disadvantages of using trees for shade on pasture is that they are subject to severe damage from heavy concentrations of animals around them. Cattle movement and compaction will damage the surface roots which eventually kills the tree. Therefore it is often necessary to keep livestock 10 to 20 feet away from the base of trees by using electric or other types of fencing. For younger or smaller trees this can result in limiting the animals' access to the benefits of shade. For tall or mature trees this means cattle will be forced to move over a much larger area of ground in order to follow the shadow as it moves with the sun over the course of the day (see Figure 6). This is an advantage for spreading out manure, but means that care must be taken that cattle can position themselves in the shadow during the hottest parts of the day.

Aside from any potential benefits for cattle, planting trees on pasture can have other important effects on the farm. Trees aid in the control of soil erosion, and are especially beneficial on fragile or marginal lands. Trees also can be used for wind management, to increase habitat for wildlife and to improve the aesthetic value of the farm.

The Sun and Cancer Eye

Ocular squamous cell carcinoma—cancer eye—is a painful disease of mature cattle and a major cause of partial or whole carcass condemnation. The risk for developing cancer eye depends on genetics and exposure to sunlight. White-faced cattle that lack pigmentation around the eye are prone to developing cancer eye, and the chances increase with increasing exposure to the harmful UVB radiation from the sun. Cattle living at high altitudes or other areas of high solar radiation are most at risk for cancer eye, and the risk is increasing as ozone depletion of the atmosphere continues to allow more and more of the harmful rays of the sun to reach earth. Whether providing shade for cattle can serve as a prevention against cancer eye is not known. Early detection and treatment and selective breeding for increased eye pigmentation are currently the best known measures against cancer eye.²
SPACE REQUIREMENTS

No one seems to agree on the recommended space allowances for shade for cattle, and there have been very few studies that have actually measured how cattle use shadow space or perform under different amounts of shade. The amount of shade that cattle find most comfortable probably depends on climate as well as body size. In more humid climates, cattle need more space per individual to allow for better air movement. Beside causing crowding, an area of shade that is too small can create sanitation problems. Some of the recommended space allowances found in the literature:

1.86 m²/head (20 ft²/head) for feedlot cattle [minimum]

2.5 m²/head (27 ft²/head) for feedlot yearling steers [minimum]

1.86-3.7 m²/head (20-40 ft²/head) feedlot cattle

2.8 m²-5.6 m²/head (30-60 ft²/head) for dairy cows

2.8 m²/head (32 ft²) for steers out on range [minimum]

5.6 m²/head (60 ft²/head) feedlot cattle

Pasture Silviculture

A NEW CONCEPT IN LONG TERM INVESTMENT FOR ONTARIO FARMS

High quality hardwoods continue to return high prices as harvested timber. Open farm land can be an ideal spot to grow trees for profit and can be approached as a long term investment. Hardwoods planted for timber take about 40 years to mature and do require special attention. They need to be protected from livestock and require a specialized pruning system to train them to develop one strong healthy trunk. Not all hardwoods are safe for use on pasture; some are toxic to livestock if ingested. For more information about planting trees for profit on your farm contact the OMAFRA Agroforestry Specialist.
Hot Weather Habits

Grazing, shading and attraction to water

By altering their behaviour, cattle are able to influence heat gains and losses to the environment and maintain thermal comfort. Shade-seeking and camping around water are the most obvious ways that cattle respond behaviourally to hot weather. In Ontario, these changes in behaviour are sometimes considered a nuisance because they are thought to reduce grazing and because they can influence pasture fertility as well as the stability and ecology of watercourses. The behaviour of cattle around shade and water in temperate climates is not very well understood. A basic understanding of cattle behaviour is necessary to clarify whether attitudes about the hot weather habits of cattle are truths or misconceptions.

DAILY GRAZING PATTERNS

Cattle usually have two major grazing periods, one beginning around sunrise and the other occurring before sunset. Shorter periods of grazing take place mainly during the day, and occasionally at night. The timing of these shorter grazing periods is determined by climate and grazing pressure. In warm humid climates, overall grazing time has been observed to decline as temperature rises above 26°C. When temperature and especially humidity are high, cattle may increase night-time grazing. 6

After grazing, ruminating or chewing the cud, is the second most time-consuming activity of cattle and can take from four to nine hours each day. Most ruminating is done when the cows are lying down and appear to be resting or loafing.

SEEKING SHADE TO GAIN RELIEF FROM THE SUN

Cattle will readily use shade on hot, sunny days. Data from behaviour studies in hot climates indicate that shade use is closely related to environmental temperature and cattle comfort. As environmental temperature increases, so does the percentage of cattle found resting in the shade. The amount of time that cattle spend in shade also increases with radiant temperature and cattle’s respiration rates. 6, 8, 18

Breed and coat colour influence shade-seeking behaviour because they affect the cattle’s sensitivity to the sun. In one Florida study, Aberdeen Angus cattle always rested in the shade, while Brahman never did. 6 In another study, light coloured steers spent more time in the
sun and more time grazing than dark coloured cattle. An Australian group studied the shade-seeking behaviour of Brahman and Shorthorn steers under three different densities of shade cloth in a feed yard. The more heat-sensitive Shorthorns spent twice as much time in the shade as the Brahman. Shorthorns also spent the most time under the highest density cloth indicating that they could tell which density of shade cloth was most effective for reducing solar heat gain. Brahman's did not use the shades enough to be able to determine whether they could discriminate between shade cloths.

SHADE SEEKING AND GRAZING

One common notion is that providing cattle with shade reduces the time that they spend grazing. Reports from behaviour studies suggest that the when environmental temperatures are high, cattle do not spend time in shade at the expense of grazing. In a Louisiana study, Hereford and Angus cows and calves spent the same amounts of time grazing when they had abundant trees, scanty trees, artificial shade or no shade. However, time spent standing was greatest in cows without shade whereas cows with abundant shade were observed lying and resting the most. Shaded cows also had better gains. An Oklahoma study on bulls indicated no clear effect of shade on the time spent grazing. One Australian study found that on very hot days, cattle with ample shade in their paddock would graze during the hottest part of the day while cattle in shadeless areas would never do so.

SHADE SEEKING IN COOL WEATHER?

One of the concerns with providing shade for cattle in Ontario is the belief that cattle will use the shade when the weather is cool. Although cattle are sometimes observed to be camped in the shade on cool days, their shade seeking behaviour has not been studied in moderate climates. Therefore is difficult to say how often this behaviour occurs, why it occurs or how it affects other behaviour such as grazing. Cattle are extremely social animals and usually synchronize behaviour in cohesive herds. It is possible that dominant or leader animals who prefer to rest in shaded areas influence the behaviour of the rest of the herd. However, one study of West African cattle indicated that dominance had no influence on the use of shade. In confined situations cattle often prefer to
When temperature and humidity are high enough to cause heat stress, we can expect a reduction in grazing whether cattle have shade or not. Cattle that do not have shade available will camp near water. Lying next to structures appears to offer the animals some sense of comfort or security. Whether cattle on pasture are attracted to structures, trees or shrubs for protection other than that of the sun is not known.

**ATTRACTION TO WATER**

Cattle that do not have shade available will camp near water during hot weather. Results from studies of dairy cows indicated that when the temperature rose, the percentage of cows drinking or simply hanging around the water trough was greater for unshaded than for shaded cows. Whether cattle prefer shade to water is not clear, and probably depends on climate, geography and animal experience. Australian researchers observing cattle behaviour in areas with ample shade located close to water found that some cattle camped near water and never used shade while others used shade away from water. The researchers suggested that learning experience gained in one environment may persist for a long time after animals are moved to another environment.

Results from a recent study of cattle behaviour along streams at five sites in Ontario suggested that cattle spend relatively little time near or in the streams. The one site where cattle were observed to camp near the water was the only with a tree-lined stream suggesting that the cattle gathered near water at that site to be in shade.

**AN EXAMPLE FROM OUR STUDY SITE AT ELORA**

Behavioural observations were conducted during July 1997 at the Elora Beef Research Centre to determine how much time cows spent in shade, in the vicinity of the water trough, grazing or out on pasture when not grazing on 13 days under different weather conditions. Eight identical fields, each holding five cow/calf pairs were used in the study. Half of the fields had a shade structure available and the other half had no shade. Some groups of cattle occasionally used the shade in cooler weather but in general, cows tended to spend more time in shade on days when air temperature was over 24°C. One exception was a day when the temperature was only 23.2°C and the average time spent in shade was 29 percent. However, this average was obtained from only two groups of cattle; one which spent 58 percent of time in the shade and the other only 2 percent. On warmer days, cows without shade tended to spend more time around the water trough. There is no indication from the data that providing shade reduced the time spent grazing. In fact, on the two hottest days, the cattle with shade spent more time grazing.
### Table 5

Percentages of time that cows with and without shade spent in various location/activities during four-hour observation periods on each of 13 days. Temperature (°C) and relative humidity (percent) are for observation periods. The number of fields observed on each day are also given.

<table>
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<th>°C</th>
<th>RH%</th>
<th>Sun</th>
<th>Fields</th>
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*Sun: s=sunny, o=overcast, m=mixture sun & clouds*
Pests and Parasites

Do shaded areas harbour them?

It has been suggested that providing shade for cattle may have a negative impact on cattle health and well-being because accumulated manure in the area of the shade may harbour pests, parasites and disease organisms. Keeping cattle clean is always desirable, especially when tag can account for significant economic losses from hide condemnations. Therefore, siting and managing of shaded areas to prevent wet, muddy conditions and sanitation problems is important. However, there is little information in the veterinary or husbandry literature as to the effects of concentrated manure in shaded areas of pasture on disease or parasite load. In some cases, accumulation of manure into “compact” shaded areas may actually reduce problems as it appears that lack of sunlight or poor vegetation impairs the life cycle of the parasite.

INTESTINAL PARASITES

Young calves are usually the only cattle on pasture who are at risk from nematode infections because older animals develop a resistance to the parasites. Parasite infections depend on the life cycle of the worm. Eggs are laid in the body of host cattle and passed in faeces. The eggs hatch and larvae develop in the droppings. The larvae must then migrate onto herbage to be ingested by new host animals. Abundant moisture and moderate heat favour the development and migration of larvae onto herbage, while drying and exposure to sun kills larvae. Therefore, we might expect poor sanitary conditions around shady areas to harbour the parasite larvae. However, if manure is concentrated in an area of “bare-ground” where cattle do not graze, the likelihood that cattle will ingest the larvae and be infected is reduced.

FACE FLIES

Pastured cattle are the primary host of the face fly (Musca autumnalis). A study done in pastures at Guelph, Ontario showed that these biting pests lays their eggs almost exclusively in bovine faeces and are usually the first insect to reach a fresh dropping.46 Cattle droppings only remain suitable for egg-laying for about three hours, depending on drying rate. Do the concentrated manure and moist conditions in shade increase the population of face flies? On the contrary. The flies in the Guelph study only laid their eggs in open pasture and never in woodlots or under trees. Laboratory tests that followed up the field trials indicated that face flies will only lay eggs in sunlight, they avoid shaded areas for egg-laying.

Why Do Cattle Bunch in Hot Weather?

Bunching behaviour, when cattle huddle in a circle with heads together, has little to do with thermal comfort and is actually a fly-avoidance behaviour. A study from Cornell University indicated the time that Holstein heifers spent bunching was related to pest intensity. Heifers treated with a pesticide performed little bunching compared to untreated cows. Untreated heifers with their heads inside the “bunch” were protected—they had fewer flies on their faces—than heifers outside the group. Bunching behaviour did not affect grazing time. It seems that heifers bunch only after they are finished grazing.
DISEASE ORGANISMS

Most problems in disease and parasite build-ups in the environment are associated with high stocking rates or close confinement. Beef producers experience a higher incidence of disease problems in higher density feed-lot operations than on pasture. Ultra-violet radiation from the sun is a natural disinfectant and large amounts of space and fresh air on pasture tend to dilute the doses of disease organisms. However, the importance of a sanitary water supply is often overlooked. Shade and watering areas should be sited and managed to prevent contamination of the drinking supply. Providing shade may appear to cause cattle to congregate increasing the possibility of disease transmission. However, cattle have a strong herding tendency and will lie close together even when shade is not available.

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Heat Stress

How to spot it and what to do

Heat stress occurs when effective environmental temperature becomes so high that an animal must use special mechanisms, like panting, sweating or reducing feed intake to maintain heat balance. The negative consequences of heat stress depend on its intensity and duration. Mild heat stress over a long period of time can result in reduced performance, but is not life threatening provided the animal has adequate drinking water available. However, when factors of air temperature, sun, and humidity combine to create an environment hot enough to exceed cattle’s ability to maintain body temperature, the result can be heat stroke or heat death.

AT WHAT TEMPERATURE DOES HEAT STRESS BECOME A CONCERN?

Determining an exact temperature where heat stress occurs is difficult, because it depends on climate and animal factors. However, early studies indicated that temperate breeds of cattle begin to have difficulty in transferring excess body heat to the environment when air temperature rises above 25°C, and begin to show signs of heat stress at about 29°C. Environmental temperatures over 27°C exceed the comfort zone of high-producing dairy cows. To identify conditions which may be dangerous for livestock, refer to the Temperature-Humidity Index on page 6.

WHAT YOU CAN DO

Cattle showing symptoms of a heat stress emergency must be cooled down:

- Move cattle to a cooler environment such as shade or the inside of a cool barn. This is the best way to cool heat stressed animals.
- Provide cattle with adequate, preferably cool, drinking water.
- Immerse or spray cattle with water to wet their hides.
- Use fans to increase air movement around cattle or move cattle to a high, open area with plenty of air movement.

An animal that has become dull, stumbles while walking and lies down may be suffering from heat stroke. A persistent rectal temperature of higher than 41°C is critical. Veterinary attention may be required.
Selected References


Selected References


