CIR782

Methods To Relieve Heat Stress For Florida Dairies[1]

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Hot, humid weather causes declines in Florida's milk production each summer. Reducing heat stress for cows can reduce or eliminate these production losses. The most practical methods to reduce heat stress can be grouped into three main areas; shade, ventilation, and cooling. These methods can be used alone or in any combination. They are most effective when located in areas of high heat stress. Common areas that will benefit are feed barns, loafing areas and holding areas.

SHADE

Shade can be either natural or artificial. In most cases, the best method for relieving heat stress is natural shade in the form of shade trees. When not enough natural shade is available, artificial shades can provide needed shelter from the effects of solar radiation. Several factors should be considered when constructing shades. The orientation of shade structures is very important. During the summer, a higher percentage of shadow lies under a shade structure with an east-west orientation than with a north-south orientation. During the winter, the amount of floor that is sunlit for drying is about the same. If you want the driest possible conditions for nonconfined situations, a north-south orientation with a large fenced-in area is best.

If the cows are to be confined under a shade structure, it should be oriented east-west. Each cow should be provided with 40 to 60 square feet of shade. The floor should be four-inch concrete grooved to provide firm footing. It should be sloped about 1.5 to 2% for proper operation of flush systems. Earthen floors under shades quickly can become mud holes in Florida, and so are not generally recommended. If earth floors are used, the structure should be located on a well-drained location, such as a mound. If cows are not confined under the shade, the concrete slab needs to be larger than the area of the shade roof. This is because the orientation of the sun varies with the season and even with an east-west orientation, the shadow will not always be entirely under the structure. The slab should extend 8 feet on the north side, and 20 feet on the east and west sides if the eave height is 12 feet. Higher eaves will require that the slab be extended further. In Florida, the shade pattern will fall on the south side only in the early morning and late afternoon, so the slab does not need to be extended to the south.

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Several factors influence the selection of shade structure height. Air movement under the shade is increased as eave height is increased, but the cost of the structure also increases with height, and the shade pattern moves more with tall structures. The recommended eave height in Florida is 12 feet for structure up to 40 feet wide. Structures wider than 40 feet should have eave heights of at least 14 feet. The site of the shade structure should provide at least 50 feet of clearance on each side between adjacent buildings, trees, or other obstructions. Gable roofs should have a continuous open ridge as shown in Figure 1 to promote natural ventilation.

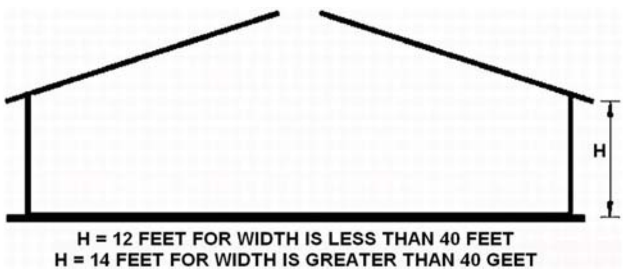

Figure 1. Shade Structure.

The most effective shade roof is an aluminum or white colored galvanized metal roof with about one inch of insulation directly beneath the metal roofing. The insulation reduces the radiation heat load on the cows but can cause problems if birds or other pests establish themselves in the insulation and damage the material. The top surface of the roof always should be painted white to reflect solar radiation.

Shade cloth can be used as the material for shade roofs. These cloths are available in patterns providing 30 to 90% shade and fabricated from a variety of yarn materials. The most common materials used for animal shades is woven polypropylene fabric providing 80% shade. Knitted and non-woven materials are entering the market and some show promise for use as shade cloth. Shade cloth is considerably less expensive than solid roofing material but does not provide as much protection from solar radiation as a solid roof. The fabric tension must be tightened whenever slack in the shade cloth is noticed or it will quickly be torn apart by the wind.

To achieve the most benefit from the shade structure, feed and water must be available to the cows under the shade. A waste management system must be planned as an integral part of any shade structure. Waste can be removed by scraping or flushing. Even if flushing is not desired originally it is still a good idea to design the slab for flushing so that a flush system can be added easily at some later time.

AIR MOVEMENT

An important factor in the relief of heat stress is air movement. Air movement can be natural or forced. Air movement can reduce the temperature in a building or under a shade structure to that of the outside air. A ventilation system that provides at least one air change per minute is recommended.

Many agricultural buildings can be ventilated adequately by natural means. Natural ventilation is caused by two effects. The first is air movement caused by breezes moving through open sides of sidewall vents. The second is air movement caused by thermal buoyancy. This also is referred to as the stack or chimney effect. Air enters the structure through side or eave vents, is heated and then rises and exits through a ridge vent. This method is effective even on a totally still day. It is not effective in a building with sidewalls. The air movement caused by thermal buoyancy in a building without sidewalls will occur at the eave height, not at animal level. Air movement at eave height will reduce the roof temperature and thus the radiation load on the cows, so it is still beneficial. The stack effect is most effective in structures with steep roofs and large ridge vents. Roof slopes between 4:12 and 6:12 are the most effective. Roofs with slopes of less than 4:12 often leak and don't have enough slope to generate a good stack effect. Roofs steeper than 6:12 will still have a good stack effect but are expensive to construct and difficult to work on.

Ridge vents in Florida should be at least one foot wide plus two inches for each ten feet of structure width over twenty feet. A vent functions best when it is totally open without a cap. If a cap is necessary, the eave of the cap should have at least one foot of clearance between it and the roof peak. Most commercially available ridge vents are undersized for Florida conditions. Several ridge vent types are illustrated in Figure 2. Overshot designs are not recommended. Under most conditions they reduce rather than promote air flow through a structure. If a flat or nearly flat roof is desired, a ridge vent will be of little benefit if the structure is less than 40 feet wide. Buildings with flat roofs with widths greater than forty feet may benefit from ridge vents or openings in the roof, but will probably require mechanical ventilation to be satisfactory.

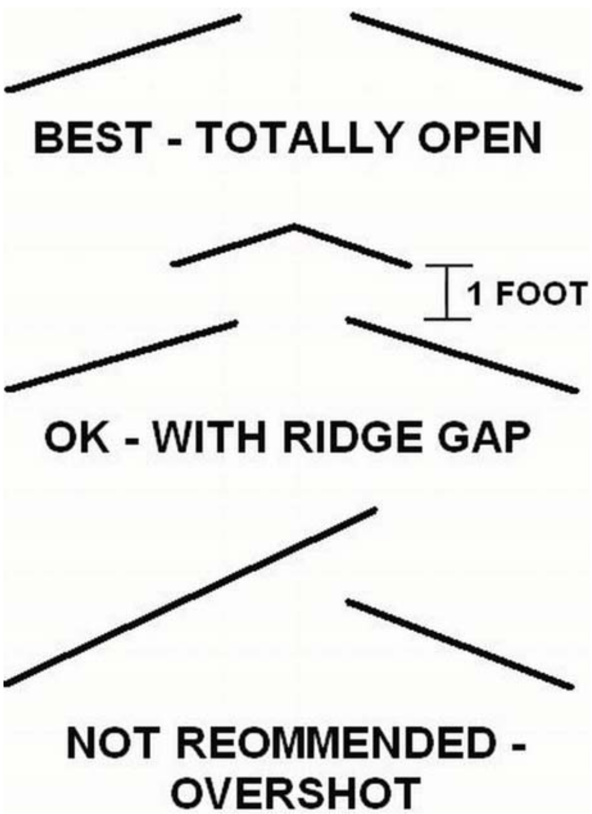

Figure 2. Ridge Vent Types.

COOLING

Summer conditions in Florida may require cooling below ambient temperatures for optimum production. A cow loses heat through its skin surface and respiratory tract. A cow does not have a large number of sweat glands, so if supplemental cooling methods are not used it must lose a large amount of heat through its respiratory tract.

There are several methods available that can reduce air temperatures below outside ambient temperatures. The most familiar is mechanical air conditioning or refrigeration. This method generally is too expensive to use with livestock operations.

A more economical method is evaporative cooling. Evaporative cooling works by using energy from the air to evaporate water. This lowers the temperature of the air and raises its relative humidity. Evaporative cooling is most effective in areas of low humidity. However, even in muggy Florida, daytime humidities are low enough to allow for beneficial cooling to occur when the air temperatures are the highest.

Several evaporative cooling methods are available. The most common method is the fan and pad system used in many greenhouses. This is a fairly expensive system but it may be economically practical to use with high yielding animals. This system requires fans, evaporative cooling pads, and pumps to circulate water to the pads. A disadvantage of these systems is that the pads require maintenance and have a limited lifetime.

Other evaporative cooling methods can be grouped into mist, fog, and sprinkling systems. The difference between a mist and a fog system is in droplet size. A mist droplet is larger than a fog droplet and will drop slowly to the floor, evaporating as it falls. A fog particle stays suspended in the air and evaporates before it touches the ground. Fog systems are very efficient methods of cooling air but also are more expensive than mist systems and require more maintenance. A mist or fog system that sprays small water droplets into the air, cools the air as the droplets evaporate. When an animal inhales the cooled air it can exchange heat with the air and remove heat from its body. This type system can be effective, but is difficult to use under windy conditions or in combination with fans. If a misting system does not wet the hair coat to the skin, an insulating layer of air can be trapped between the skin and the layer of water. This effect can cause a harmful heat buildup. Cooling studies involving mist systems also have reported respiratory and pneumonia problems when cows were exposed to mist or fog particles for long times. Systems in which the cow inhales cool air from an air duct have been tested with some success but are expensive.

An alternative to mist and fog systems is the sprinkling system. This method does not attempt to cool the air, but instead uses a large droplet size to wet the hair coat and skin of the cow, and then water evaporates and cools the hair and skin. This allows the cow to lose heat more effectively through its skin.

Sprinkling is most effective when combined with air movement. This promotes evaporation of water from the skin and hair coat. An air velocity of 400 to 600 feet per minute over the cow is recommended. At least one 36 inch fan for each forty animals is needed to provide this velocity. Each fan should provide an airflow of about 11,000 cfm. A fan of this size will move air effectively for about 10 diameters or 30 feet. Other fan sizes also can be used. Dairy production trials with a system of this type at the University of Florida's Diary Research Unit at Hague compared a sprinkling and fan system under a freestall shade structure and in the holding area to no cooling system under the same structure during summer conditions. The treated cows consumed 2.8 pounds per day more feed than the uncooled controls and produced 4.6 pounds per day more milk. This was an 11.6 % increase in milk production. This system combines fans and sprinkling, with the animals being sprinkled for one and one-half minutes at fifteen-minute intervals when the ambient temperatures were above 78°F. A typical cooling system is shown in Figure 3. The fans should be located as low as possible above the height necessary for cow and equipment clearance. Sprinklers should be located immediately below the fans so that the water is thrown just under the bottom of the fans. If the fans blow water onto areas that must be kept dry, they should be shut off when the sprinklers are activated. This can be done by using a double-pole switch to control both the fans and water pump. The nozzles selected to sprinkle the desired flow rate should operate at a low pressure such as 10 psi. This inhibits the formation of undefine mist. An amount of water equal to 0.05 inches rainfall should be applied during each sprinkling. Care must be taken when using mist, fog, or sprinkling systems that the nozzles do not become clogged. Trash and minerals in the water can be harmful to pumps and nozzles. Proper nozzle, pump and filter selection is important.

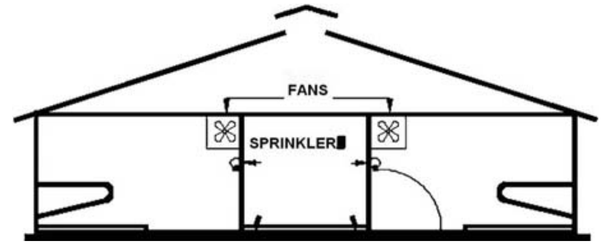

Figure 3. Fans and Sprinklers.

SUMMARY

If optimum production is to be achieved in Florida, dairy cows must be provided relief from hot summer conditions. Several methods are available for doing this. The most cost effective is the use of shade structures. Supplemental cooling will provide additional benefits, especially when it is used at points of high heat stress, such as feed barns, loafing areas, and holding areas. The cooling system that has the widest application in Florida is sprinkling combined with fans.