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Alleviating summer stress in dairy cattle

through advance housing management

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Summer stress is one of the major factors which negatively affect the production and reproduction performance of dairy cattle under tropical climatic conditions. The summer stress can be reduced by providing proper shelter and altering the existing nearby environment (micro-climate). The most common way to alleviate heat stress in dairy animals is through modified environment and by facilitating evaporative cooling. Any cooling mechanism must take into consideration the intense solar radiation, high ambient temperature and the relative humidity, which increases to almost saturation during hot–humid condition.

Key words: *Bos taurus*, Cattle, Dairy, Housing, Stress, Summer

INDIA has one of the largest populations of cattle in the world which consists of 166 million indigenous cattle, 33 million crossbred cattle and ranks number one in milk production. In 2013-14, the country produced about 137.7 million tonnes of milk of which 45% is contributed by dairy cattle (Indigenous/Non-descript (20%) and Crossbred/Exotic (25%)) and the annual per caput consumption of 307 g/day. The dairy industry is spread across the country and it is growing at an annual growth rate of 4%. Climatic conditions in India are tropical and summer stress is the major limiting factor to achieve maximum production level from the dairy animals. Though our native animals (*Bos indicus*) are well known for their resistance to summer stress, problem started when our native breeds are crossed with exotic animals. These exotic/crossbred animals (*Bos taurus*) are more prone to summer stress which in dairy cows is caused by high temperature with or without high humidity that reduces both the cow comfort and milk production. It is difficult for stressed dairy cattle to meet its full potential for either milk yield or fertility. The housing management practices to alleviate summer (heat) stress in dairy cattle under Indian conditions have been described step-by-step below.

Impact of summer stress on dairy cattle

Some of most important effects of summer stress in dairy cattle are mentioned below.

Increased water intake: Increased sweating during the summer stress leads to increased water intake due to high water loss. During that time the high-yielding dairy cows may drink up to 200 liters/day.

Reduced feed intake: Reduction in feed intake is the most important sign of elevated heat in tropical and subtropical conditions. Under summer stress conditions, the flow of blood to the internal organs is reduced. So activities of digestive organs are decreased which leads to sub-optimal appetite finally results in reduced feed intake.

Decreased milk production: Milk production declines due to direct and indirect effects of summer stress which reduces the profitability of farmers.

Change in milk composition: During the summer stress, the fat content of the milk is decreased. This ultimately reduces the farmers income because in India the milk is priced based on the fat content of milk.

Poor reproductive performance and decreased fertility: Cattle experiencing summer stress tend to have lower estrogen level which reduces the conception rate and depresses fertility.

Lower birth weight of calf: Summer stressed pregnant cows consume less feeds during late pregnancy. So the nutrient requirements of cow can not be met due to low available nutrients in feeds and higher demands of nutrients for foetal growth which ultimately leads to lower birth weights in calves.

Housing management practices to reduce summer stress

A broad spectrum of practices can be used to reduce the impact of a hot climate on livestock production and dairy profitability, but physical modification of the environment is the primary means. The typical methods can be divided into two groups:

(*a*) Those modifying the environment to prevent or limit the degree of summer stress to which cows are exposed; and

(*b*) Those enhancing heat exchange between cows and their environment. Practically, this means of alleviating heat stress works on the principle of increasing the evaporative cooling rate by wetting cows or the air around them (e.g., misters and sprinklers) and increasing convective heat transfer rate by increasing air speed over cows (e.g., fans).

Heat stress alleviation through modifying the environment

(*i*) *Housing design and orientation*: At the time of planning of the animal shelter, the orientation of the building must be considered. If the shelter is located in north–south orientation, the building is exposed to greater solar radiation than with an east–west orientation. This is because sunlight can enter north–south-orientated buildings in the morning and afternoon. In the afternoon, the sun is low in the sky and therefore most detrimental. Also the summer stress on the livestock is usually maximum or at its greatest magnitude in the afternoon. So the preferred orientation of the buildings is an east–west orientation to avoid solar radiation and to achieve maximum shade. The wall height and eave extension of the building should also be considered. With greater sidewall heights, more direct afternoon sun can hit the building. The direct irradiation on the side walls can be reduced with greater eave extensions. A big eave extension can provide shade to the building. The eave extension should be one-third the height of the sidewall.

(*ii*) *Provision of shade*: It reduces the 30% of heat load compared to the house without shade. Trees can be very effective for providing shade to animals. Artificial shades (e.g., cloth roof on metal or wood frame with wheels or skids and gable roof structure) have also been used with success since they significantly reduce the temperature inside animal house. There are various types of roofing materials and the most effective is a reflective roof made of aluminum or galvanized with insulation beneath the metal. Thatch and agro-net are able to reduce the negative effect of environmental variables and can be effective in warding off the hot and humid environmental condition than asbestos.

(*iii*) *Bedding*: In commercial dairy farms, bedding material is selected based on economic feasibility, cow comfort, cleanliness, and udder health. However, few producers consider the thermal comfort that the bedding material provides. It is suggested that the bedding material in a dairy farm should be part of their summer stress alleviating practices; lower temperatures are reported for limestone (25.9°C) and sand (26.9°C) compared to wood shavings (28.6°C) at 2.5 cm thickness of bedding material. The sand bedding had higher summer flux for cows when compared with straw and mattresses filled with rubber granules. Paddy straw can be used as the best bedding material under Indian conditions where it is cheaply available and best suited.

Alleviating heat stress by facilitating heat exchange mechanism

(*i*) *Foggers and misters*: A fogging system is effective in hot areas with low humidity. High Pressure Foggers (>200 psi) disperse very fine droplets of water which quickly evaporate and cool the surrounding air, but they also raise the relative humidity. A ring of fog nozzles is attached to the exhaust side of the fan, and then the cooled air is blown down over the animal's body. This system is expensive and requires a lot of maintenance, and the water must be kept very clean; otherwise, fogging nozzles get clogged or plug.

A misting system consists of a series of misting nozzles placed in a sequence in tubing and pressurized to provide a fine spray of water droplets between 15 and 50 mm in size. A mist droplet is larger than a fog droplet. Misting systems are used with good success where humidity is typically low. The animal is primarily cooled by breathing in the cooler air. This system is not very effective for humid environments, because the mist droplets are too large to evaporate before they reach the floor and the bed or feed becomes wet. Globally, ambient temperature in the facilities using misting technologies was 2° to 9°C cooler then the barns without evaporative cooling, while humidity was increased by 8 to 50 units of percentage with misters.

(*ii*) *Sprinklers*: This method does not attempt to cool the air but instead uses a large droplet size to wet the skin of the livestock resulting into water evaporation and cooling skin. Sprinkling is most effective when combined with air movement. Nozzles (10 psi, 180° spray) are spaced above cows approximately at every 8 ft (2.4 m). Sprinklers should be located immediately below the fans so that water is thrown just under the bottom of the fans which run continuously. Cows are sprinkled for 1–2 min at 15-min intervals. Concrete floors must be sloped to handle water run-off. In hot–humid conditions, sprinklers alone do not effectively cool animals and also it leads to cause 10-fold times more waste water that of misting system.

(*iii*) *Evaporative cooling pads*: Evaporative cooling through water evaporation in the incoming air flow is an economical method resulting in a temperature reduction of 8° to 10°C, but it causes an increased relative humidity up to 90%. Cooled air must have a short way through the building to avoid high temperature and high humidity. It should be installed in an adequate insulated building. Cooling efficiency is about 55 to 75% for most evaporative cooling pads. These water-based systems are prone to plugging and algal growth.

(*iv*) *Fans*: Panel or basket fans are usually selected for cooling. Typically, these low volume (235 to 470 l/s), high speed (1.0–2.5 m/s) fans (LVHS) are 0.6–1.2 m in diameter. They should be spaced at a distance of 10 times their diameter and positioned to blow air in the direction of the prevailing winds. The addition of LVHS fans to open-sided house benefit the dairy cows by reducing rectal temperature, respiratory rate and by increasing DMI, conception rate.

An alternative to panel or basket fans for hot weather ventilation is high volume, low speed (HVLS) fans. Typically, 2.4 to 7.5 m dia

ceiling fans are installed 12 to 18 m apart, along the length of a house. Fans run at 50 rpm and move 50,000 to 200,000 L/s of air. Air speed is more evenly distributed throughout the barn with the HVLS system. These ceiling fans do not provide the desired air speed within critical areas of the barn. LVHS fans are more efficient in reducing respiratory rate and rectal temperature than HVLS fans during summer.

(*v*) *Tunnel ventilation*: In tunnel ventilation, the entire air inlet is located on one end wall of the barn with all of the exhaust fans located on the opposite end. Tunnel ventilation is another option that increases airflow to reduce summer stress. With a tunnel ventilation system, large fans (1.2 to 1.8 m in dia) are used to move air through a house at an air speed (1 to 3 m/s) fast enough to provide a beneficial wind chill effect that cools the cows by convection. The advantage of tunnel ventilation is that the cows get access to fresh air flow in the whole building, while the disadvantage is the electricity consumption. The system provides a combination of high air exchange rates and high air flow speeds to help the cows to remove body heat by increasing the heat loss by convection.

(*vi*) *Low-profile cross ventilated barns*: Low-profile, cross-ventilated barns were developed to move air parallel to the body of the cows when they are lying in stalls while traditional tunnel ventilation moves air parallel to the ridge of the building. A ceiling could be used to limit the size of the cross sectional area. However, most often, vertical baffles are used to accelerate the air at cow level to the desired velocity. In fact, baffles can increase air speed to 2 to 3 m/s from 0.5 to 1 m/s.

(*vii*) *Water-cooled summer exchangers*: Conductive cooling with water-cooled summer exchangers has the advantages of recycling water as a working fluid in a closed-loop system and requiring less energy than evaporative cooling units. This application may also improve animal hygiene and reduce humidity in the house compared with evaporative cooling systems. A summer exchanger placed under the bedding will contribute to 20% of the cooling effect under cool air conditions (18 ^{o}C), whereas under hot air conditions (38 ^{o}C) the contribution increases to nearly 90%.

(*viii*) *Air conditioning and zone cooling*: Air conditioning is the most effective option for reducing air temperature and relative humidity. It maintains conditions inside a dairy house at appropriate level and found that fertility was improved. Increase in 4% fat-corrected milk yield is there when the shed is air-conditioned compared with cows kept outside. When environmental conditions in an air-conditioned house are compared with evaporative cooled sprinkler including fan and tunnel-ventilated buildings all cooling methods generally provided conditions more comfortable. However, only the air-conditioned house maintained both the temperature and humidity well below the optimum level than other methods.

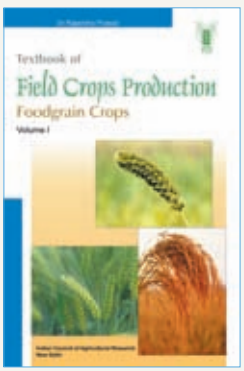
Inspired air or zone cooling applies a jet of cooled air onto the head and neck of the animal. The air may be cooled by evaporative cooling or by mechanical refrigeration. Because of the installation costs and lack of compatibility with housing systems, this has not become a common cooling system. Air cooled by refrigeration to around 15°C, supplied @ 0.7–0.85 m^3/min, has been observed to increase milk production.

SUMMARY

Summer stress affects dairy cattle in several ways and finally causes decreased milk production and performance. Important consideration in all the systems should be water economy and recycling. Improved systems capable of either cooling the animal directly or cooling the surrounding environment are necessary for better performance and welfare of dairy animals during summer season.

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