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from John Moran, your ADN Coordinator

Welcome to the eleventh edition (Jul 2015) of the ADN News. This newsletter discusses cow comfort in relation to how milking cows cope with heat stress.

Cow Comfort; what it is and why it is so important

John Moran, Profitable Dairy Systems, Kyabram, Victoria, Australia July 2015

Cow comfort is a relatively new term that is being more commonly used to describe "how a cow is feeling" about its surroundings. Some people just think of it as the type of bedding material available when the cow wants to lie down and rest. Others use it to describe the climatic environment, that is the zone of thermoneutrality or the "comfort zone", in which cows don't need to use their physiological processes (such as increased respiration rate or sweating) to maintain their body temperature. For a Friesian milking cow, this is between 6 and 18 °C. Others consider it is more related to the cows' ability to do what they want to do and when they want to do it. It is generally agreed that cow comfort should also be extended to its psychological as well as its physiological well being. Therefore the complete definition addresses climate stress, poorly designed and constructed housing, stock facilities and the potential behavioural stress arising from herd mates and stock people.

Whatever it is, the most important thing is that it does not upset the cows' appetite for feed or water. Feeding management is devoted to ensuring the quality and palatability of the forage and concentrates are the best possible, so the last thing farmers want is that cows do not want to eat what they offered. The remainder of this article is devoted to the adverse effects of heat stress on cow comfort.

Minimising the adverse effects of heat stress on cow comfort and subsequent cow performance

Heat stress occurs through a combination of high ambient temperature and humidity and other factors such as poor ventilation and high levels of internal body heat production.

Temperature Humidity index

The best single measure of heat stress is the Temperature Humidity Index (THI) as this combines temperature and relative humidity into a single comfort index. The relationship between temperature and humidity is presented graphically on Figure 1. The higher the index, the greater the discomfort, which occurs at lower temperatures for higher humidities.

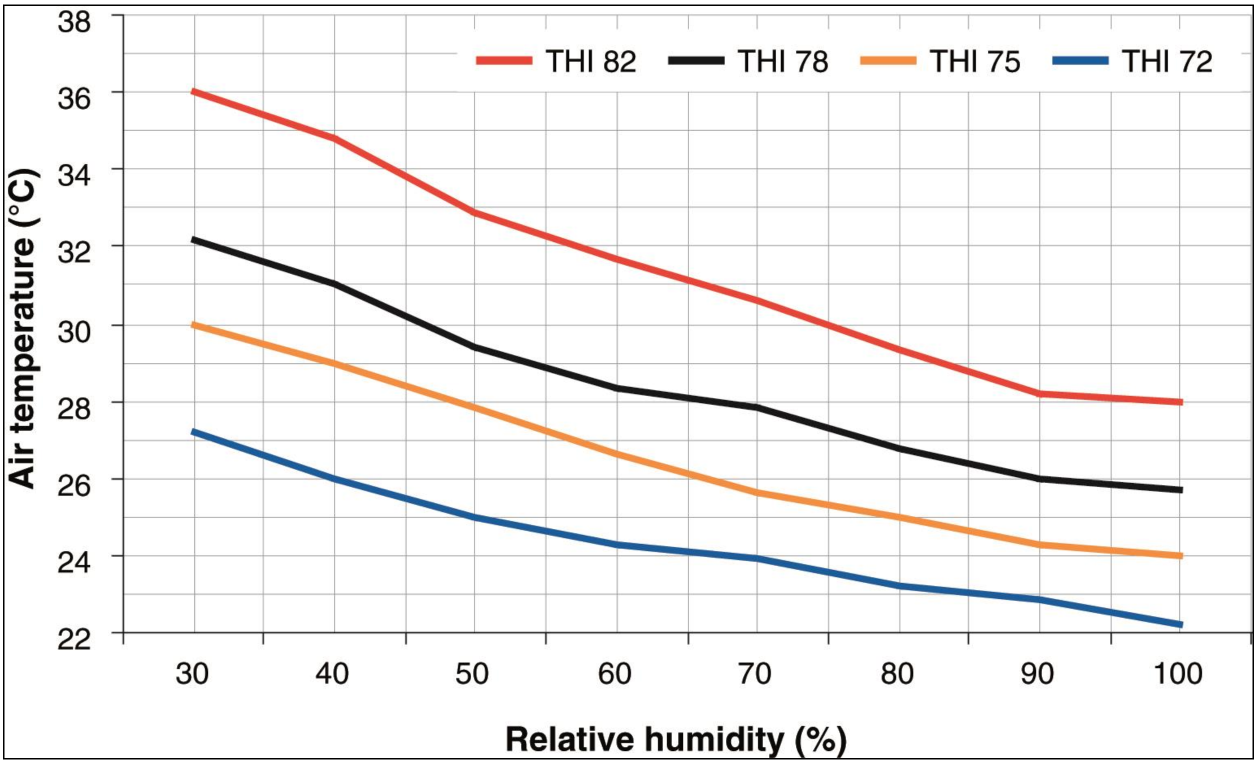

Figure 1. The effect of increasing relative humidity on the temperatureto produce the same Temperature Humidity Index (THI)

Its effects on cow performance are summarised in Tables 1 and 2. An air temperature of 30 °C corresponds to a mild THI of only 74 at 25% humidity or 78 at 50% humidity whereas it produces a severe heat stress (THI 82) when recorded at 75% humidity, a quite common occurrence in the humid tropics. For milking cows, an air temperature of 35 °C equates to severe heat stresses (THI 80) at 25% and (THI 85) at 50% whereas it produces a very severe heat stress (THI 90) at 75% humidity.

Table 1. Effects of Temperature Humidity Index (THI) on dairy cow performance

Comfort zone	THI	Stress	Comments
A	<72	None	-
B	72-78	Mild	Dairy cows adjust by seeking shade, increasing respiration rate and dilution of blood vessels. Cow performance is adversely affected with reproduction more so than milk yield.
C	78-89	Severe	Both saliva production and respiration rates increase. Feed intakes decrease while water intakes increase. Milk production and reproduction are both reduced.
D	89-98	Very severe	Cows will become uncomfortable due to panting, high saliva drooling and high body temperatures. Milk production and reproduction will markedly decrease.
E	>98	Danger	Potential cow deaths can occur

Comfort zone. A: No stress; B, Mild stress; C, Severe stress; D, Very severe stress; E, dead cows.

Table 2. Effects of Temperature Humidity Index (THI) on measures of cow heat stress

Level of heat stress	THI	Respiration rate exceeds (no/min)	Body temperature exceeds (°C)
Zero	68	60	38.5
Mild to moderate	70	75	39.0
Moderate to severe	80	85	40.0
Severe	90	120-140	41.0

Heat Load Index

This is a new measure of heat stress developed specifically for feedlot beef cattle that are normally kept in dirt yards with minimal shade. It is based on a combination of

- black globe temperature, which is a measure of the radiation heat load, taking into account both the ambient temperature and solar radiation
- relative humidity
- wind speed

The index includes several adjustment factors such as genotype, coat colour, access to shade, water temperature in drinking troughs, and whether the animals are sick or healthy. Use of this index over time allows for the calculation of an accumulated heat load and the required heat loss during the night to maintain zero heat balance. However, developing such a Heat Load Index for Asian small holder dairy cows normally maintained in sheds, is unlikely to provide an additional useful management tool.

Adverse effects of heat stress

For Friesians producing 20 kg/d, a THI above 78 leads to a decline in milk yield. There is also a decline in milk composition (milk fat and milk protein contents) but this occurs at 1–2°C higher than corresponding break points for milk yield.

With regard to reproduction, this declines before milk yield, namely, at THI of 72. Cows in early pregnancy (up to 3 weeks) can abort while cows in mid-pregnancy can have reduced birth weights. Cows are also more likely to have shortened and/or silent heats (less than 8 h). Heat stress delays heat (hence submission rates) and, at the time of insemination or during the following 3 to 5 weeks, it can reduce conception rates and increase embryo mortality. By comparing conception rates between seasons (hot v cool or wet v dry), heat stress may be diagnosed as a problem if seasonal conception rates differ by more than 10–12%.

Cows are particularly vulnerable at temperatures above 30°C or, above 25°C with high humidity. Cows producing more than 15 kg/d of milk are more susceptible to heat stress due to their higher metabolic heat load. Zebu cows are less susceptible than Friesians because of their dense flat coat and higher density of sweat glands, however, exactly how less susceptible has not been documented. When planning strategies to minimise heat stress, it is then important to give priority to non-pregnant cows, usually in early lactation.

However recent studies with transition cows (non-lactating and heavily pregnant) has shown that even though heat stress may not greatly reduce their voluntary feed intakes, it reduced subsequent milk yields by up to 10 kg/cow/day. This was attributed to a reduced inability of these cows to partition their body tissues towards milk synthesis during early lactation. Furthermore, the calves born from these heat stressed cows had lower birth weights, reduced growth of mammary cells during early udder development, which led to them also producing less milk, by up to 5 kg/cow/day, in their future lactations.

Recent surveys of the seasonality, particularly the adverse effects of high THI, on dairy cow performance in the United States, have shown marked adverse seasonal impacts on calf birth weight, yields of liquid milk and milk protein as well as conception rates and early foetal losses in pregnant cows. The study also highlighted the threshold THI for death rates of mature Friesian cows. Above the daily minimum THI of 70 and/or the daily maximum THI value of 80, there was a break point (indicating a sudden increase) in the incidence of Friesian cows dying, presumably from the additive adverse effects of heat stress.

Adverse effects of heat stress are delayed by several days. The effect of mean THI two days earlier has the greatest influence on milk yield, while the effect of mean temperature two days earlier has the greatest influence on feed intake. Another good 'rule of thumb' when assessing heat stress for dairy cattle is that air temperature (in °C) added to humidity (in %) should ideally not exceed 90.

Improvements in milk yields of up to 3 to 5 kg are possible through effective cooling strategies. For example in the highlands of East Java in Indonesia (near Malang with altitude 1200 m above sea level), high yielding, feedlot Friesian cows each producing over 30 kg/day and housed in large sheds equipped with tunnel ventilation, were exposed to a THI of only 70 (24°C and 51% humidity) compared to a THI of 75 (28°C and 43% humidity) directly outside the shed. It was estimated that this additional cow comfort produced 3 kg/cow/day extra milk.

The high humidities associated with high daytime temperatures in the humid tropics reduce the effectiveness of using water to cool the air, thus negating the beneficial effects of evaporative cooling. Increasing respiration rates are the cow's natural way to increase evaporation from the alveoli tissues just as actually wetting the cows' skin provides the best opportunity to reduce blood, hence body temperatures, through cutaneous evaporation. Obviously increasing air movement over the skin, using fans, is the best way to stimulate such cutaneous evaporation. Therefore initially using fans, followed by complete saturation of the cows' coat, using a computer/mechanically controlled cycle is the most effective artificial method of dissipating heat stress.

Conclusions

From the above evidence, heat stress clearly adversely affects many aspects of the performance of our modern day, potentially high yielding, milking cows. Therefore when developing dairy development programs in the humid tropics and setting target milk yields, consideration must be given to more than just the type of milking cow and its feeding management. Farm management practices and physical shed designs to minimise the adverse effects of heat stress, are of equivalent, if not greater importance, in achieving such target milk and fertility measures of cow performance.