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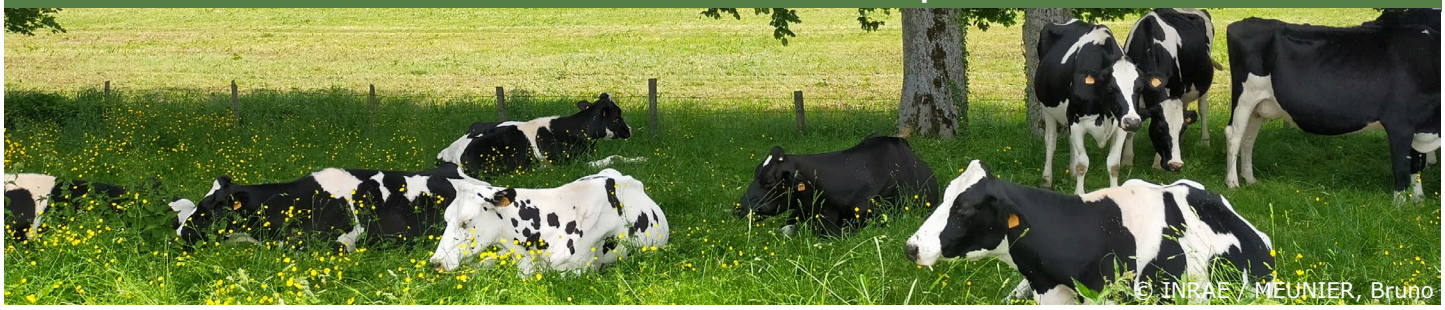
# Thermal comfort in ruminants and equines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## Introduction

In all EU countries, ruminants and equines can be exposed to weather conditions that affect their thermal comfort. Thermal comfort, and especially heat stress, is a growing issue in most EU countries due to climate change that has led to increased average temperatures as well as more frequent and prolonged heat waves.

Ruminants and equines are homeotherms, meaning they can maintain a stable body temperature despite changes in ambient conditions within a certain range. This is achieved through thermoregulatory mechanisms. Ruminants and equines generate internal heat during e.g. digestion or physical activity. Thermoregulation is also achieved in ruminants and equines through behavioural adaptations, such as seeking shade or huddling together.

Heat exchange between an animal and its environment occurs through radiation, conduction, or convection. Radiation corresponds to heat transfer by electromagnetic waves (e.g. solar radiation). Conduction refers to heat transfer from more to less energetic particles through direct contact (e.g. skin to environment). This process is important during evaporation, whereby liquid water is converted into vapour. The energy required for evaporation is conductively transferred from the animal to water, resulting in a cooling effect. Convection is the transfer of heat through the bulk movement of a fluid (e.g. air or water), which can further support conductive heat loss.

Thermal comfort therefore depends on the temperature of the ambient air, but also on its humidity, speed (wind), and on solar radiation. Indices that combine these parameters are commonly used to determine whether animals are at risk of heat or cold stress. The most commonly used climatic index is the temperature humidity index (**THI**), which combines air temperature and humidity. Nevertheless, for practical reasons, temperature is commonly used to describe the thermal conditions.

## Legal requirements

Council directive 98/58/EC concerning the protection of animals kept for farming purposes states that:

> 'Air circulation, dust levels, temperature, relative air humidity and gas concentrations must be kept within limits which are not harmful to the animals.'
> (Annex, Paragraph 10.)
> 'Animals not kept in buildings shall where necessary and possible be given protection from adverse weather conditions…'
> (Annex, Paragraph 12.)

EC Regulation 1/2005 on the protection of animals during transport states that:

> 'Means of transport, containers and their fittings shall be designed, constructed, maintained and operated so as to: (…) b) protect the animals from inclement weather, extreme temperatures and adverse changes in climatic conditions…'
> (Annex 1, Chapter II, Paragraph 1.1.)

## Additional information

For more detailed information, see the review ***'Thermal comfort in ruminants and equines'.***

For more information, please refer to the ***Thematic factsheet 'Thermal comfort'***.

# Indicators of thermal stress

When assessing thermal comfort on a farm or similar premises, the first step is to establish whether the ambient conditions on that particular day fall out of the thermoneutral zone. This involves comparing the ambient temperature where the animals live to the thermoneutral zone for the animals present on the farm (see Figure 1).

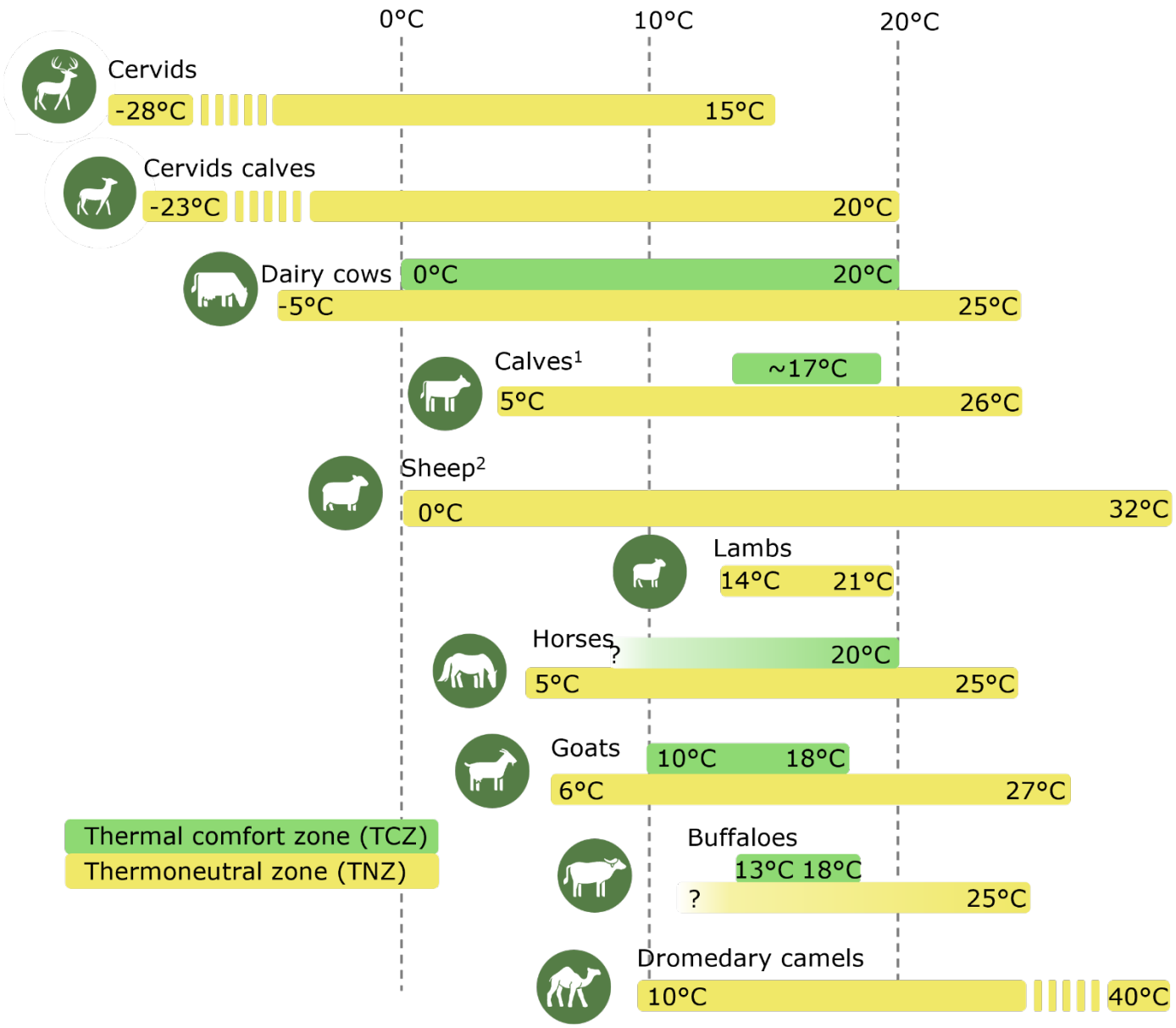


*Figure 1: Thermal comfort and thermoneutral zones of ruminant and equine animals based on air temperature ("?" indicates that the boundary of the zone is unknown). The thresholds vary according to weather conditions (e.g. humidity, wind speed), environmental conditions (e.g. presence of straw bedding, shade area), physiological state of the animals (e.g. lactation stage in dairy cows), breed, habituation of the animals, and animal condition.*
*[1]The values are for a healthy calf with a dry coat not exposed to draughts. Lower critical temperature may be as low as -8 °C for a fully fed calf in calm air bedded on ample dry straw.*
*[2]The lower temperature is for a fully fleeced sheep and the higher temperature for a shorn sheep in dry conditions.*

If the temperature during the visit is outside the thermoneutral zone, then animal-based indicators can be used to check if animals show signs of discomfort (Tables 1 and 2). For example, increased respiratory rate indicates heat stress under hot conditions. In dairy cows, a respiratory rate above 60 breaths/min indicates heat stress and above 120 breaths/min severe heat stress.

The ambient conditions during the visit may be adequate. However, this may not be the case on other days. It is important to determine if the geographical zone is at risk of cold or heat at least for some periods of the year. This will help to check if environmental protections in place are relevant.

*Table 1: Animal-based indicators of thermal discomfort and indicators of risk mitigation.*

| | Cold conditions | Hot conditions |
|---|---|---|
| Animal-based indicators (to be used only if the ambient conditions are outside the thermoneutral zone of the animals) | • Shivering<br>• Huddling<br>• Piloerection<br>• Increased heart rate<br>• Decreased body core temperature | • Sweating<br>• Increased respiratory rate (>60 breaths/min)<br>• Open-mouthed breathing, panting and drooling (for cattle, sheep and goats)<br>• Flared nostrils, head nodding and apathy (especially for equines)<br>• Increased core body temperature<br>• Reduced feed intake and milk production<br>• Increased time spent standing[1] |
| Environmental and management-based indicators of risk mitigation[2] | • Shelter against adverse weather<br>• For most vulnerable animals: radiant lamps, jackets<br>• Deep dry bedding<br>• Animals in group<br>• Distribution of large amount of good quality roughage and warm drinking water under cold conditions | • Protection against radiation available for all animals (shade, cool roof…)<br>• Fans, sprinklers<br>• Dry litter or ground<br>• Large space allowance per animal<br>• Avoidance of physical exercise (handling, moving, transport, work)<br>• Distribution of low-fibre diet and large amount of cool or cold drinking water available under hot conditions |

[1]Detected by the high proportion of cows standing immobile vs. low proportion of cows lying at a time when cows generally rest
[2]The benefits of the presence of such mitigation measures depend on the prevalence of the risk in a given area

*Table 2: Signs of heat stress in cattle, sheep and goats*

| Score of heat stress | Description |
|---|---|
| 0 = no stress | Normal respiration, no panting |
| 1 = mild stress | Slight panting, no drooling, closed mouth |
| 2 = moderate stress | Moderate panting, drooling, closed mouth |
| 3 = severe stress | Heavy open-mouthed panting, drooling, neck extended (Pictures 1) |
| 4 = extreme stress | Severe open-mouthed panting, excessive drooling, tongue fully extended, head extended and often held down |
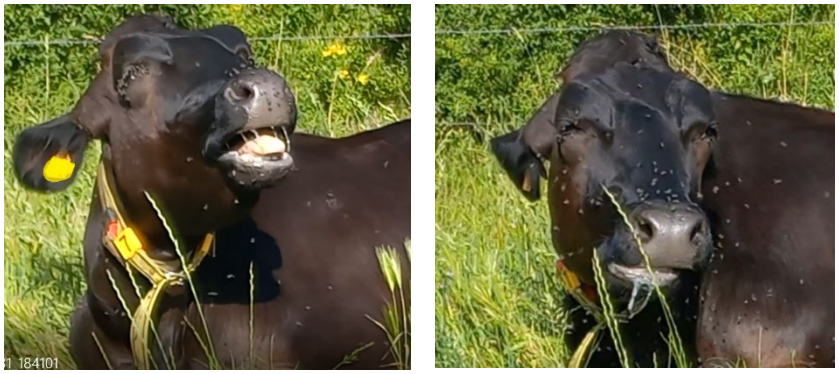
*Figure 1: A cow in severe heat stress with open-mouthed breathing and drooling. ©INRAE/BRANCATO, Giacoma*