Beef cattle

Dairy cows and heifers

Sheep

Goats

# Webinar Abstract

## Consequences of heat stress on health and performance in dairy cows

Dairy cows are most productive inside a range of temperatures referred to as the thermal neutral zone. When climatic conditions are above their thermal neutral zone (upper critical temperature) they fail to dissipate heat efficiently to the environment and physiological and metabolic adaptation mechanisms are initiated, which always compromise their productive potential.

Once heat stressed, cows display behavioural and physiological symptoms, which may serve as indicators for heat stress identification. Monitoring temperature changes such as rectal temperature, vaginal temperature and thermal imaging techniques, or assessing physiologically related symptoms such as respiration rate may serve as diagnostic tools. Detection of activities related to feed consumption such as rumination time, meal duration and frequency serve as important indicators of heat stress. Furthermore, activities related to drinking (frequency and spatial distribution in relation to the drinkers), time spend standing and lying as well as others are the subject of rigorous research. Some of these activities are directly linked to reductions in performance and health related issues.

The upper critical temperature threshold of the thermal comfort zone is determined by the balance between external heat load, internal heat production and heat dissipation mechanisms. Once heat dissipation mechanisms are activated an increase in maintainance requirements occurs. Furthermore, there is a reduction in Feed Intake in order to reduce the internal heat load production, as feed consumption and digestion are exothermic processes. Independent of feed intake reductions additional losses occur due to the impairement of anabolic processes, such as milk production. Overall, Feed Intake reduction may account for 35-50 % of the milk yield losses and is proportional to the cow productivity level; the higher the productivity the more pronounced it is.

The remaining losses which are due to numerous events.

1) The induction of rumen acidosis is a complex phenomenon caused by the a) move of blood to the periphery to facilitate heat dissipation and the reduced ability to absorb VFA b) the decreased saliva production and reduced HCO3 entering the rumen c) the altered feeding patterns observed.

2) In the small intestine there is oxidative stress, which in turn leads to reduced gut permeability, luminal endotoxin passage to the systemic circulation and inflammation. These events alter post-absorptive metabolism, redirecting nutrients away from milk production to support immune related functions. This metabolic inefficiency is underlined by hyperinsulinemia and a reduced capacity to utilise Non Esterified Fatty Acids (NEFA) for

milk production. At the same time the increased utilization of glucose by the immune system, especially via gluconeogenesis increases extramammary aminoacid utilization, instead of milk protein synthesis.

3) Direct oxidative damage on mammary epithelial cells along with reduced mammary blood flow, further reduces their capacity to synthesize milk constituents. The reduced immunocompetence due to heat stress along with the increased pathogen load due to the environmental conditions (hot and humid) results in increased clinical and sub-clinical mastitis incidence and increased SCCs. Other milk properties are also affected such as reduced protein content and often a decrease in fat content is observed, which along with other modifications reduce cheese yield.

Exposure to heat stress during the dry period affects the capacity of the dam to perform over the subsequent lactation due to adverse effects on the crucial processes of mammary involution and mammary epithelial cell proliferation. In addition, heifers born to dams exposed to heat stress have reduced lifelong performance and increased incidence of health problems and removal rates. Therefore, heat stress induction does not only affect current but also subsequent lactational performance of dairy herds.

Heat stress has profound effects also for the reproductive performance of cows with a reduction of conception rates below 35%. Altered hormonal patterns directly impair ovarian function reducing fertilization rates and resulting in embryonic losses during the early stages of gestation. An increased metritis incidence has also been observed.

In terms of assessing the effects of heat stress, by the use of THI, average, minimum, maximum, and hours above a certain THI can be taken into account. These parameters characterize the intensity and cyclicity of heat stress while its persistence is characterized by its duration. Milk yield depression may persist in the period following the heat wave after temperatures have returned to normal, especially in high producing cows; seasonal effects of heat stress over the summer may persist in the autumn long after THI has recovered. In high producing herds THI thresholds at which production losses are observed are lower than previously thought (THI>68).

As far as individual cow characteristics are concerned, multiparous cows are at greater risk and effects are more pronounced in mid-lactation. As a general rule the higher nutrient intake due to increased requirements for production the higher the dietary related heat load production and mid-lactation cows rely more on feed consumed due to their depleted reserves.

The ability of dairy cattle to acclimate to heat stress defines their thermotolerance in the short term (when faced by heat waves). Acclimatization over generations lead to genetic adaptations, which allow for animals to perform better in thermal stress conditions. Genetically Holstein have less phenotypic plasticity, which is related to certain genetic traits (coat, sweating glands etc.) in comparison to other breeds, but also due to increased baseline production levels. However, their constant exposure to a hot environment (e.g tropical) may acclimatize them and make them more thermotolerant than a cow raised in a temperate environment. This concept, along with local selection schemes, which may be in place, means that a higher THI may be needed to obtain losses in performance under constant heat stress conditions. Regardless, to achieve high productivity, alleviating heat stress via management and nutritional means is necessary as both a cow producing in the tropics and a cow raised in a temperate environment suffer the consequences of heat stress.