Heat stress in dairy cows across Europe – how concerned should we be?

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It is now well established that heat stress is a major cause of milk production loss, but should we all feel concerned about this risk?

To answer this question, Lallemand Animal Nutrition conducted a survey to encompass different European climate types, from north to south and east to west (UK, Spain, France, Switzerland, Italy, Czech Republic and Poland).

This survey monitors continuous THI (Temperature- Humidity Index, an indicator of heat stress) throughout the day, during the summer months of 2013 and 2014. This was done using specific sensors positioned in real-life dairy cow environments (barns of different types, with or without cooling systems in place).

This survey proves that heat stress is a reality in Europe (Fig. 1) and as a result, dairy farmers could experience immediate loss of milk production (70-550kg milk/day for 100 cows!) as well as mid and long term health and performance issues (somatic cells count, mastitis, fertility).

Appropriate herd management practices are important to reduce the impact of heat stress on summer dairy production. In addition, adapted nutritional programs which can help optimise rumen and feed efficiency and antioxidant strategies are effective tools in this period.

Fig. 1. Overview of the European heat stress survey: potential milk losses associated with heat stress in various areas (Lallemand Animal Nutrition, 2015).

Diagnosing heat stress

It is generally admitted that the cow's comfort zone is between 5-20°C. But external temperature is not the only parameter: relative humidity is also important to define the cow's comfort zone.

Moreover, a cow's thermo-neutral zone is dependent upon its physiological status and level of production: higher producing cows are more sensitive to thermal stress.

It is referred to as heat stress when environmental conditions exceed the cow's thermal zone of comfort.

There are two types of parameters to diagnose heat stress in dairy cows, either based on animal observations, or on environmental signs.

Animal signs

In practice, cows subject to moderate heat stress (around 25°C and 50% relative humidity) show visible signs such as:

- Decreased feed intake.
- Reduced milk production (around 10%).
- Shallow breathing.
- Profuse sweating.
- Lethargic behaviour.
- Open mouth.
- Breathing with panting and tongue hanging out.

Under severe heat stress (for example at 34°C and high humidity), the milk production drop can reach 35% and feed intake is severely reduced.

Environmental signs

The environmental indicator of heat stress risk is the Temperature Humidity Index (THI). It takes into account the combined effects of environmental temperature and relative humidity.

Each THI value has been linked to a level of stress, associated to potential damages on cow's production and health status (Table 1).

How much heat stress?

The heat stress survey was performed using electronic temperature/humidity probes placed inside farm buildings, out of reach of the animals, during the summer months. The probes recorded ambient temperature and humidity values every 30 minutes, 24 hours a day for 2-3 months.

Data were compiled for each farm and used to evaluate daily variations of THI.

Using Burgos and Collier's (2011) THI scale, the cumulative time spent under mid, moderate or severe heat stress conditions was calculated and potential associated milk losses evaluated.

Table 2 summarises the results of the heat stress survey.

- In the south of Europe (Spain, Italy, South of France), dairy cows spent more than half of the day (between 13 and 18 hours) under heat stress. The estimated milk loss in these regions is huge: up to 5.5kg/cow/day.

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Table 1. Potential impact of the various heat stress levels on milk production with practical examples (from Burgos Zimbelman and Collier, 2011).

Heat stress level and THI range	Practical examples of temperature; relative humidity	Duration (hours/day)	Potential associated milk loss (kg/h; kg/cow/day)
Stress threshold THI (68-71)	22°C (72°F); 50%	4	-0.283kg/h; -1.1kg/cow/day
Mild-moderate stress THI (72-79)	25°C (77°F); 50%	9	-0.303kg/h; -2.7kg/cow/day
Moderate-severe stress THI (80-89)	30°C (86°F); 75%	12	-0.322kg/h; -3.9kg/cow/day
Severe stress THI (90-99)	34°C (93°F); 85%	–	Not measured

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- Under higher latitudes, such as north of France (Brittany), Switzerland, Czech Republic or Poland, where dairy farmers may be less aware of heat stress issues, dairy cows can still spend between six and 10 hours under heat stress conditions, leading to important milk loss.
- In the north (UK), cows can still spend two hours under heat stress.

This survey indicates that all cows can face heat stress, on a higher or lower level, even in places where this kind of stress is not well recognised.

Impact on productivity

Milk production loss is an immediate consequence of heat stress but it may only be the tip of the iceberg!

Reduced milk yield results from a combination of reduced feed intake, alterations in endocrine profiles, energy metabolism and other unidentified factors.

In addition, heat stress, as any other stress situation, generally increases the production of free radicals, leading to oxidative stress.

In dairy cows, oxidative stress has a negative impact on immune and reproductive functions: increased mastitis frequency and higher somatic cells count in milk, decreased fertility, increased embryo mortality, post-partum retained placenta, and early calving, with consequences on the calves' live weight, mortality and health.

Thus, heat stress consequences at longer term will be linked to the effects of heat stress on cow health, immune function (mastitis risks and increased somatic cell count in milk), reproduction, and even death.

A 1999 study (Hansen and Aréchiga) showed that conception rate dropped under severe heat stress in dairy herds. It is currently estimated that conception rate decreases by around 50% under heat stress.

These effects are linked to the impact of heat stress:

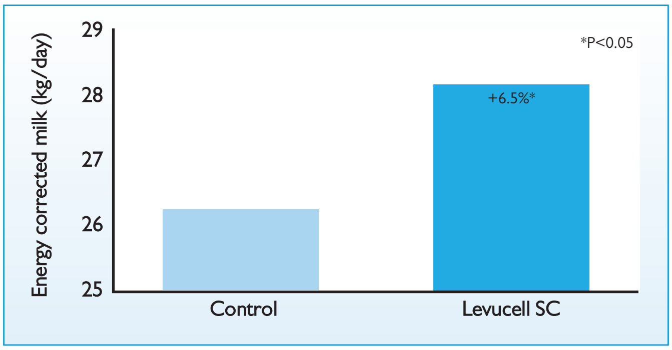

Fig. 2. Effect of supplementation of dairy cows diet with Levucell SC on energy corrected milk yield under moderate heat stress (Fustini et al., 2013).

- On oxidative stress.
- On the decreased buffer capacity of the rumen, due to reduced efficient fibre intake and drooling.

Under heat stress, subacidosis risks are increased, with further consequences such as lameness etc.

In 2003, Saint Pierre et al. evaluated the overall financial consequences of heat stress for the US dairy industry. This study analysed data for each of the 48 American states and showed huge discrepancies according to climate and heat stress level, with overall losses close to $700/cow/year for the most affected states (Texas, Florida).

Based on milk loss alone, they have calculated overall annual losses of $897 million, equivalent to almost $100 per dairy cow per year on average. To this must be added the costs linked to reproduction, early culling, health issues and mortality.

Nutritional management

Appropriate nutritional programs are important to help limit the impact of heat stress. One of the goals should be to improve feed efficiency to compensate for the reduced feed intake, while protecting the rumen environment from acidosis risks.

First of all, increasing the energy density of the diet can be considered to compensate in part for the decreased DMI. High quality, highly digestible and palatable forage should be made available. More starch or added fat can be useful too. Feeding of a high quality fibre source in the diet that helps maintain a stable rumen, but still contributes energy rather than just gut fill, is also essential, especially for high-producing herds receiving high starch diets.

Rumen modifier

The use of ruminant specific live yeast Saccharomyces cerevisiae CNCM I-1077 (Levucell SC, Lallemand Animal Nutrition) is proven to improve and protect the rumen environment and enhance rumen efficiency, lowering acidosis risk. Its benefits on feed efficiency in dairy cows under non-stressful conditions have been validated through a meta-analysis: overall, feed efficiency is improved by 3%.

Moreover, several trials conducted under heat stress have shown that it is a valuable solution to help reduce the impact of heat stress on rumen environment, animal behaviour and performance: milk production and feed efficiency are improved.

In 2013, the latest trial under heat stress was published in the Journal of Animal Science. It reported an increase of 6.7% Energy Corrected Milk Yield, equivalent to an extra 1.7kg ECM/day (Fig. 2), when Levucell SC was fed to dairy cows under moderate heat stress.

This trial confirmed previous data and indicates positive effects on several indicators of rumen efficiency and reduced acidosis risk: rumen pH, rumination activity and fibre degradation were all improved.

Cows spent on average less time with a rumen pH below the critical value of 5.8 in the Levucell SC group.

Antioxidants

Under heat stress, respiration rate is increased, leading to higher production of reactive oxygen species (ROS). It is recommended to increase antioxidant supply to help maintain the antioxidant status of the animals.

A recent trial conducted in Switzerland under non-stressful conditions (Lallemand Animal Nutrition, 2014 unpublished) has shown that an antioxidant supplement containing a blend of melon superoxide dismutase (SOD) Melofeed, and organic selenium yeast Alkosel, strengthened the cows antioxidant status by 9% on average (plasma Total Antioxidant Status measured for 20 cows, before and after four weeks supplementation).

This was translated in a reduced somatic cell count in milk: the number of cows with low SCC was increased, while the number of cows with high SCC (rejected milk) decreased. As a result, the farmer's milk revenue was significantly improved.

Minerals

Another important aspect is to properly balance the mineral electrolytes in the dairy cow diet since excessive sudation leads to losses of sodium and potassium.

Table 2. Time spent under heat stress condition in the barn showing the estimated milk production loss.

Location	Average heat stress duration/24 hours			Overall heat stress duration/ 24 hours	Potential milk loss (kg/milk/ cow/day)
	Low/moderate	Moderate/severe	Severe		
Gloucestershire (UK)	1h 39m	39m	_	2h 18m	-0.7
Ille et Vilaine (France)	4h 06m	2h 14m	_	6h 20m	-1.8
P. Atlantiques (France)	5h 55m	5h 34m	29m	11h 58m	-3.5
Asturias (Spain)	8h 41m	5h 2m	_	13h 43m	-4.0
Fribourg (Switzerland)	5h 35m	4h 22m	36m	10h 33m	-3.1
Piemonte (Italy)	8h 58m	9h 41m	10m	18h 49m	-5.5
Sztum (Poland)	6h 16m	3h 59m	10m	10h 25m	-3.0
S. Bohemia (Czech Rep.)	5h 06m	3h 58m	1h 01m	10h 05m	-3.0

Conclusion

Dairy production can be heavily impacted by heat stress and recent surveys indicate that even under temperate climate it can represent a problem.

Based on recent trials with live yeast Saccharomyces cerevisiae CNCM I-1077, it is shown that once the best herd management practices are respected (barn management, cooling systems, water supply and nutrition), it represents an effective tool to further limit the impact of heat stress on cow health and productivity. ■

References are available on request from animal@lallemand.com