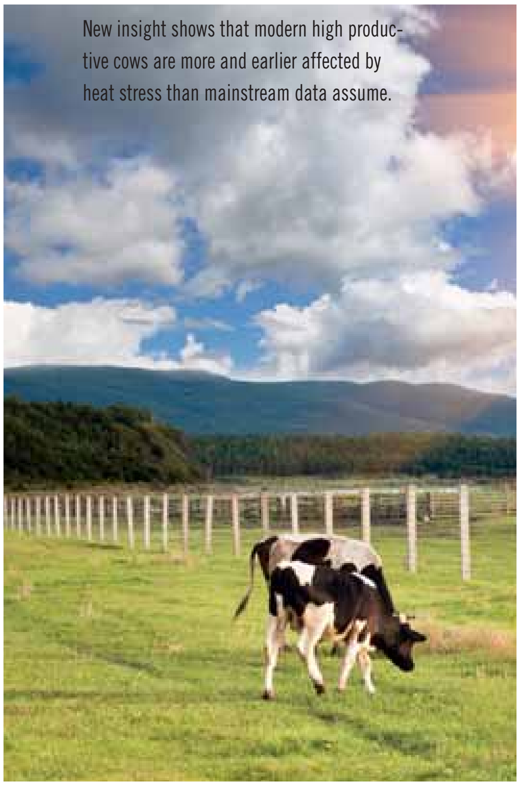
Heat stress in dairy cows rev

A 2011 Arizona University study recalculated the thermal stress zone for dairy cows and found out that it is higher than previously thought. Even in a temperate climate this problem is more pervasive than we think, with more severe financial consequences. Microbial solutions might help counteract the negative effects of heat stress. A trial at the University of Florida using live yeast showed improved feed efficiencies.


New insight shows that modern high productive cows are more and earlier affected by heat stress than mainstream data assume.

By Dick Ziggers

Heat stress is an underestimated issue and is costing the dairy industry millions. First of all due to important production losses, which can attain 35% attributable to severe heat stress, but also to extra costs incurred following the mid- and long-term impact heat stress can have on bovine health status and reproduction. In 2011, Prof Collier et al. from University of Arizona revealed that we were in fact underestimating the severity of heat stress - especially for high producing cows - and consequently lowered the heat stress threshold.

It thus appears that heat stress is more common than previously thought, and can impact dairy production even under temperate climates.

The first, short-term impact of heat stress is a reduction in milk yield. Heat stress leads to decreased dry matter intake and increased need of maintenance energy to regulate the cow's body temperature. It is concluded that the reduced milk yield results from a combination of reduced feed intake, alterations in endocrine profiles, different energy metabolism and other unidentified factors. It is usually admitted that milk production can decrease between 10 to 35% during warm summer months.

Consequences on a longer term will be linked to the effects of heat stress on the cow's health, defences and finally reproduction. A 1999 study (Hansen and Aréchiga) showed that under heat stress conception rate drops in dairy herds.

Financial impact

Saint Pierre et al. (2003) evaluated the financial impact of heat stress and estimated that the economic impact of heat stress on the US dairy industry amounted to an average annual loss of over $800 million as a result of reduced performance and increased incidence of disease. But, in unusually warm summers, these costs can rapidly increase. For example, during the summer of 2006 a 2-week heat wave in California caused an estimated $1 billion loss in production and animals. The Saint Pierre study evaluated the financial impact of severe heat stress to be up to €422/cow. An estimated 80% of these losses are associated with loss of productivity, and 20% with health issues: reproduction and immunity problems, which translates into increased mortality and frequency of mastitis in particular.

New assessment method

In previous assessment methods an indicator was used to assess the risk of heat stress: the Temperature Humidity Index (THI). This index takes into account the combined effects of environmental temperature and relative humidity. Each THI value corresponds to a level of risk of damages linked to heat stress.

In 2011, Burgos & Collier from the University of Arizona proposed a revised THI scale to assess the impact of heat stress on cow's health status and dairy production. The currently used THI scale for dairy cows was established in the 1960s, when dairy cows were less productive than today's modern breeds. Indeed, increased milk yield increases sensitivity of cattle to thermal stress and reduces the 'threshold temperature' at which milk losses occur. This is because metabolic heat production increases with the production level of the cow. This calls for an updated scale to predict when the cow's performance is compromised.

Collier et al. conducted an experiment in controlled environments to assess the impact of various temperature/humidity levels on various parameters of the cow's production and metabolism. They found that the impact of heat stress was actually underestimated for today's high producing dairy cows. They suggested a revised scale of THI-heat stress level (*Figure 1*), which is now adopted by the dairy industry. According to their re-evaluation, it appears that a THI of 68 is low enough to cause adverse affects, while heat stress was previously thought to kick in when the THI attained 72.

They showed that after only 17 hours of exposure to such conditions, milk yield loss becomes highly significant. A THI of 68 corresponds for example to only 22°C with 45% of humidity, a rather common condition even in northern Europe.

In practice, cows subject to moderate

isited: Can microbials help?

Figure 1 – University of Arizona's revised heat stress scale (2011): each temperature/humidity ratio corresponds to a level of thermal stress for the dairy cow.

Themperature		% Relative Humidity																		
°F	°C	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90
72	22.0	64	65	65	65	66	66	67	67	67	68	68	69	69	69	70	70	70	71	71
73	23.0	65	65	66	66	66	67	67	68	68	68	69	69	70	70	71	71	71	72	72
74	23.5	65	66	66	67	67	67	68	68	69	69	70	70	70	71	71	72	72	73	73
75	24.0	66	66	67	67	68	68	68	69	69	70	70	71	71	72	72	73	73	74	74
76	24.5	66	67	67	68	68	69	69	70	70	71	71	72	72	73	73	74	74	75	75
77	25.0	67	67	68	68	69	69	70	70	71	71	72	72	73	73	74	74	75	75	76
78	25.5	67	68	68	69	69	70	70	71	71	72	73	73	74	74	75	75	76	76	77
79	26.0	67	68	69	69	70	70	71	71	72	73	73	74	74	75	76	76	77	77	78
80	26.5	68	69	69	70	70	71	72	72	73	73	74	75	75	76	76	77	78	78	79
81	27.0	68	69	70	70	71	72	72	73	73	74	75	75	76	77	77	78	78	79	80
82	28.0	69	69	70	71	71	72	73	73	74	75	75	76	77	77	78	79	79	80	81
83	28.5	69	70	71	71	72	73	73	74	75	75	76	77	78	78	79	80	80	81	82
84	29.0	70	70	71	72	73	73	74	75	75	76	77	78	78	79	80	80	81	82	83
85	29.5	70	71	72	72	73	74	75	75	76	77	78	78	79	80	81	81	82	83	84
86	30.0	71	71	72	73	74	74	75	76	77	78	78	79	80	81	81	82	83	84	84
87	30.5	71	72	73	73	74	75	76	77	77	78	79	80	81	81	82	83	84	85	85
88	31.0	72	72	73	74	75	76	76	77	78	79	80	81	81	82	83	84	85	86	86
89	31.5	72	73	74	75	75	76	77	78	79	80	80	81	82	83	84	85	86	86	87
90	32.0	72	73	74	75	76	77	78	79	79	80	81	82	83	84	85	86	86	87	88
91	33.0	73	74	75	76	76	77	78	79	80	81	82	83	84	85	86	86	87	88	89
92	33.5	73	74	75	76	77	78	79	80	81	82	83	84	85	85	86	87	88	89	90
93	34.0	74	75	76	77	78	79	80	80	81	82	83	85	85	86	87	88	89	90	91
94	34.5	74	75	76	77	78	79	80	81	82	83	84	86	86	87	88	89	90	91	92
95	35.0	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93
96	35.5	75	76	77	78	79	80	81	82	83	85	86	87	88	89	90	91	92	93	94
97	36.0	76	77	78	79	80	81	82	83	84	85	86	87	88	89	91	92	93	94	95
98	36.5	76	77	78	80	80	82	83	83	85	86	87	88	89	90	91	92	93	94	95
99	37.0	76	78	79	80	81	82	83	84	85	87	88	89	90	91	92	93	94	95	96
100	38.0	77	78	79	81	82	83	84	85	86	87	88	90	91	92	93	94	95	96	98
101	38.5	77	79	80	81	82	83	84	86	87	88	89	90	92	93	94	95	96	98	99
102	39.0	78	79	80	82	83	84	85	86	87	89	90	91	92	94	95	96	97	98	100
103	39.5	78	79	81	82	83	84	86	87	88	89	91	92	93	94	96	97	98	99	101
104	40.0	79	80	81	83	84	85	86	88	89	90	91	93	94	95	96	98	99	100	101
105	40.5	79	80	82	83	84	86	87	88	89	91	92	93	95	96	97	99	100	101	102
106	41.0	80	81	82	84	85	87	88	89	90	91	93	94	95	97	98	99	101	102	103
107	41.5	80	81	83	84	85	87	88	89	91	92	94	95	96	98	99	100	102	103	104

Yellow: Stress Threshold; Orange: Mild-Moderate Stress; Red: Moderate-Severe Stress; Purple: Severe Stress

Table 1 – Practical examples of heat stress levels and impact on milk production (adapted from Burgos & Collier).

Practical examples of heat stress	THI	Temperature	Relative Humidity	Duration (hrs/day)	Milk loss/cow	
					kg/h	kg/day
Stress Threshold	68-71	22°C (72°F)	50%	4	0.283	1.1
Mild-Moderate Stress	72-79	25°C (77°F)	50%	9	0.303	2.7
Moderate severe stress	80-89	30°C (86°F)	75%	12	0.322	3.9
Severe Stress	90-99	34°C (93°F)	85%			

heat stress show visible signs such as:

- shallow breathing
- profuse sweating
- lethargy
- 10% reduction of milk production
- decreased feed intake

More significant signs of heat stress are open mouth and breathing with panting and tongue hanging out. Under severe heat stress milk production drops to around 25% and feed intake is severely reduced. Heat stress also increases the risk of acidosis. *Table 1* summarises these measurements, the associated level of stress and consequences on milk production.

Microbials to bring relief

There are nutritional options to help the animal to cope with heat stress. A trial was conducted by the Department of Animal Sciences of the University of Florida (Gainesville, USA) to evaluate the impact of live yeast *Saccharomyces cerevisiae* SC I-1077 (Levucell SC, Lallemand Animal Nutrition) on feed efficiency and rumen condition of high producing dairy cows under severe heat stress conditions. Results of these trials were presented at the ADSA joint annual meeting in June 2010 (dos Santos et al., ADSA 2010). The trial was conducted between May and September 2009, under severe heat stress conditions (THI 80 on average). The basal diet was: corn silage (41.1%), alfalfa hay (10.4%), wet brewer's grains (5.2%) and grain mixture (43.0%). Addition of high concentration of rumen specific live yeast (1 g/cow) resulted in a 7% improvement of feed efficiency (energy corrected milk per kg DMI, control 1.66 vs. Levucell 1.78) bringing a ROI for the producer of 1:6. The live yeast also significantly decreased the number of cows at risk of acidosis. Both the percentage of cows with a rumen pH<5.8 and rumen lactate level >1mM were significantly reduced. Finally, during period of heat stress, anti-oxidants intake should be increased, such as organic selenium, Vitamin E, etc. to enhance the animal's anti-oxidant protection. AAF

References are available on request.