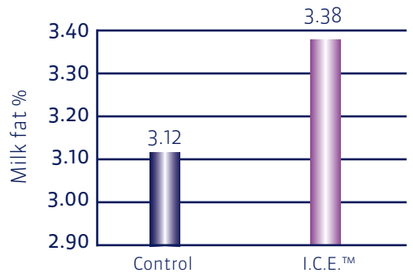
Heat stressed cows increase respiration rate (panting) in an effort to lose heat. One indirect consequence is a reduction in the availability of bicarbonate in saliva. With lower salivation as feed intake falls, this predisposes the cow to ruminal acidosis and the accompanying milk fat depression. Feeding I.C.E.™ to heat-stressed cows in Brazil mitigated this problem (Figure 4).

Figure 4. I.C.E.™ improves milk fat %.



Source: Provimi/ Better Nature Research Center, Lavras (2011)

This improvement in milk fat is consistent with the observation, in a trial at our research centre "De Viersprong" in The Netherlands during the summer of 2010, that cows fed I.C.E.™ were better able to maintain rumen pH (daily mean = 5.91 for control, 6.01 for I.C.E.™, $P<0.001$).

We have also observed trends ($P<0.15$) towards higher dry matter intake in cows fed I.C.E.™ (improvements over control of 0.5kg DM/d and 0.8kg DM/d in Brazil and The Netherlands, respectively).

Conclusion:
The combination of heat and humidity can overwhelm the cow's adaptive responses, especially when milk yield is high, resulting in a decrease in dry matter intake, milk yield and reproductive success. Provimi has developed I.C.E.™ technology (patent pending) that helps the animals to stay hydrated. University research and field trials have shown that the physiological effect of I.C.E.™ (lower core body temperature) mitigates effects of heat stress on acidosis, milk quality and pregnancy rate.

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I.C.E.™ - an innovative specialty to assist cows in heat stress conditions

RUMINANT
I.C.E.™

High heat and humidity limit the ability of the cow to keep cool. This is especially true for high-yielding cows, which generate a lot of heat through their own digestion and metabolism. Heat stress can depress dry matter intake, reduce milk yield, increase reproductive problems and increase susceptibility to disease. Heat stress represents a major threat to the profitability and sustainability of dairy farming in many parts of the world. For example, heat stress has been estimated to cost the US dairy industry between $0.9B and $1.5B annually (St.Pierre et al., 2003).

One consequence of heat stress is that the cow diverts blood away from her core to her surface, in an effort to dissipate heat, and this can impair gut function and nutrient absorption.
To address this problem, Provimi has developed **I.C.E.™** (Internal Cooling Elements), a technology (patent pending) combining key ingredients including an osmolite compound that helps animals stay hydrated under heat stress.

Dealing with high environmental temperature is a challenge for dairy cows, especially if high humidity restricts their ability to lose heat. Temperature and humidity can be combined mathematically in a single index of environmental heat load – the Temperature Humidity Index, or THI (Figure 1). In addition, cows generate significant body heat through their own metabolism and, in particular, through fermentation in the rumen. When total heat load (external and internal) exceeds the cow's ability to lose heat, it becomes heat stress.

Dairy cattle experience heat stress when the Temperature Humidity Index reaches a threshold of 68 to 72 depending on production level: the threshold is lower for higher yielding cows. Heat stress reduces feed intake and milk production, increases loss of body condition, is a major risk factor for acidosis and hits fertility hard. For example, an increase in body temperature of about 0.50°C above the normal level of 38.5°C is estimated to cause a decline in conception rate of 12.8% (Gwasdauskas et al., 1973).

The primary strategy to mitigate heat stress must be the provision of a physical environment – shade, fans and sprinklers - that protects cows from heat and helps them lose it. However, even when such measures are in place, nutrition also has a role to play.

Figure 1. Temperature Humidity Index (THI)

Temperature (°C) \ Relative Humidity	30%	35%	40%	45%	50%	55%	60%	65%	70%	75%	80%
40	86	87	89	90	91	92	94	95	96	98	99
38	84	85	86	87	89	90	91	92	93	95	96
36	82	83	84	85	86	87	88	89	90	91	92
34	79	80	81	82	83	84	85	86	87	88	89
32	77	78	79	80	81	82	83	83	84	85	86
30	75	76	77	77	78	79	80	81	81	82	83
28	73	74	74	75	76	76	77	78	78	79	80
26	71	71	72	72	73	74	74	75	75	76	76
24	68	69	69	70	70	71	71	72	72	73	73
22	66	67	67	67	68	68	69	69	69	70	70
20	64	64	65	65	65	65	66	66	66	67	67

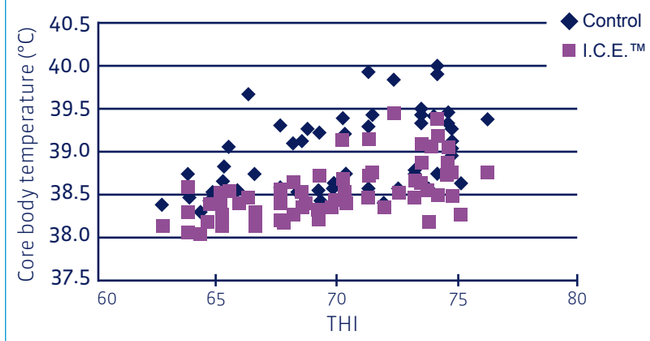
Normal | Mild stress | Severe stress | Emergency

I.C.E.™ – helping the cow stay cool

I.C.E.™ echnology is a combination of key nutritional ingredients including an osmolite that helps animals stay hydrated. I.C.E.™ works at the cellular level to maintain the structural integrity of proteins sensitive to changes in body temperature. As a result elevation of body temperature in ruminants during heat stress is moderated.

One of the first demonstrations of the power of I.C.E.™ involved beef cows grazing at The University of Missouri in the summer of 2008 (Figure 2). All cows showed the expected increase in core body temperature as THI increased – however, this effect was significantly moderated in cows fed I.C.E.™

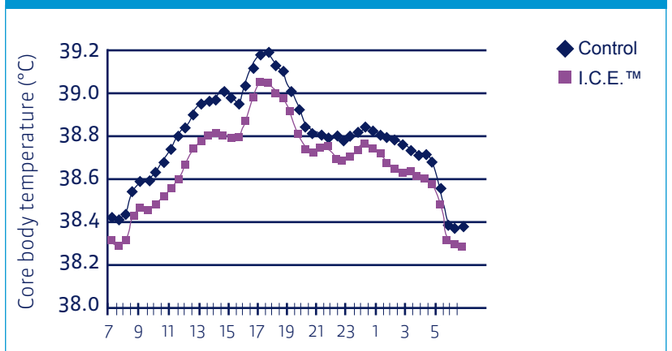
Figure 2. I.C.E.™ moderates core body temperature in beef cows.



Source: Provimi / The University of Missouri (2008)

More recent work by Provimi in Brazil has reproduced the same temperature-moderating effect of I.C.E.™ – but this time in lactating dairy cows (Figure 3). On average, core body temperature (measured over 24h on multiple occasions over 12 weeks) was reduced from 38.87 to 38.64 °C in cows fed I.C.E.™ ($P<0.01$).

Figure 3. I.C.E.™ moderates core body temperature in lactating dairy cows. (data Figure 3 I.C.E.™ hourly data)



Source: Provimi / Better Nature Research Center, Lavras (2011)

I.C.E.™ – cool cows perform better

Moderating the effects of heat on core body temperature is expected to result in benefits in terms of cow performance and reproduction – but does it?

I.C.E.™ was tested on a large commercial dairy farm in Texas during the summer of 2009. Cows fed I.C.E.™ showed better expression of heat and had a higher pregnancy rate compared with controls (Table 1).

Table 1. I.C.E.™ improves pregnancy rate in dairy cows

		Control	I.C.E.™
Multiparous cows	Cows inseminated	175	197
	Cows pregnant	24	41
	%	13.7[a]	20.8[b]
Primiparous cows	Cows inseminated	37	222
	Cows pregnant	7	60
	%	18.9	27.0

a,b means in the same row with different superscripts differ ($P<0.10$)

Source: Commercial farm Texas, 2009