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Heat stress is costly for dairy farmers

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Heat stress is extremely costly for the dairy industry due to the immediate impact on farm incomes resulting from depressed milk yields, and the longer term financial burdens caused by follow-on health and breeding issues.

A major financial assessment of the impact of heat stress on livestock returns in the United States has put the all-species cost of the condition at up to US$2.36 billion a year.

The same study recorded an annual dairy sector loss of up to US$1500 million, followed by beef on US$370m, swine on US$316m and poultry on US$165m.

These are massive cost figures. Even allowing for the scale of the US industry, they illustrate the extent to which rising global temperatures are imposing a high price on dairy farmers around the world.

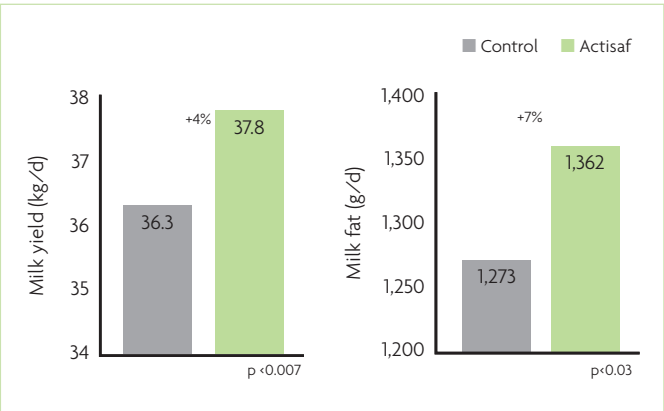
Immediate economic damage, caused by heat stress, is due to falling milk yields which, in the most severe cases, can be reduced by as much as 40%. This is in response to cows not eating normally during heat stress, a reaction which cuts milk output rapidly, while also triggering subsequent energy and rumen concerns. Apart from reduced feed intake, there is also a change in cow's eating behaviour that increases the risk of ruminal acidosis, leading to lower energy intake from the diet.

Recovery from heat stress is also an issue. Restoring pre-stress yields will depend on a number of factors, such as the stage of lactation at which heat stress strikes and the age of the affected cow. There is also evidence that different breeds suffer more than others from heat stress and can take longer to return to normal once temperatures become more manageable.

Another observed negative impact of heat stress is that it can reduce the cow's expression of oestrus behaviour, changing follicular development and affecting the cow's productive cycle. This obviously has implications for an affected herd's calving index and cow replacement costs.

Increased lameness is another high-cost result of heat stress. This is linked to cows spending as much as 60% of the day standing, in an attempt to cool themselves by maximising their exposure to available air flows. This can be a serious problem, as cows which spend more than 45% of their time standing are more likely to suffer subsequent lameness than animals which rest normally.

Fig. 1. Milk yield and milk fat results.



Measures taken by farmers to counter heat stress also impose additional costs, with at-risk dairy farms needing to make higher protective investments than units in lower temperature areas. The challenge is to decide how much to invest in cooling systems, such as fans and sprinklers, knowing that heat stress is weather-induced and will vary from year to year.

However, when the heat rises there is clear evidence that cooling systems deliver positive results. According to research based on dairy herds in north-east Kansas, cooled cows produced 5% more milk during heat stress than non-cooled cows faced with the same conditions.

As for cost-effectiveness, the same research found that the expense of installing fans and sprinklers would be covered within 2-3 years by production increases of 5-10%.

In addition, cooling-induced milk production benefits might carry forward into periods when heat stress is not at its highest level. Only considering the impact of cooling systems during high heat stress conditions may therefore underestimate the economic value of reducing stress during less intense periods.

The same Kansas study reached the conclusion that while heat stress management strategies can generate large economic returns with second or higher lactation cows, the benefit attached to reducing stress in first lactation cows could be considerably less, due to their lower productivity.

Feed treatment cost-benefits also warrant high priority consideration. For example, the inclusion of Actisaf, from Phileo Lesaffre Animal Care, France, as a yeast probiotic for dairy cows during a summer trial in Israel, produced a 10:1 return on investment.

One of three yeast-based products developed by Phileo for use in relation to heat stress, Actisaf has shown improved fibre digestion in trials with affected dairy cows, helping to stabilise the rumen and reduce respiratory rates.

During the product's use in Israel, carried out over a 13-week period, the maximum daily temperature averaged 31.2°C with relative humidity averaging 83.6. In the face of such conditions, the performance difference between cows receiving Actisaf and cows in a non-supplement control group, was considerable.

Results for the Actisaf cows showed 2.5% higher performance than the control for dry matter intake, 3.7% higher for feed efficiency, 4% higher for milk yield and 7% higher for milk fat.

The way Actisaf helps to counter the negative effect of heat stress is by optimising the rumen fermentation, reducing the risk of acidosis, and improving the digestibility of the diet. Having better rumen comfort, cows eat more often and receive more energy from the feed.

References are available from the author on request
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Top yielding dairy cows are feeling the heat

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High performing dairy cows appear to be more susceptible to the damaging effects of heat stress than lower yielding stock.

Although the combination of rising temperatures and high levels of humidity is a major challenge for all milking cows, those at the top of the production league appear to be most at risk of significant milk yield reduction and subsequent health issues, according to a detailed review of current research data carried out by Phileo Lesaffre Animal Care, France.

To quantify high risk periods of heat stress in dairy livestock, specialists use the temperature humidity index (THI) to measure the combined effect of ambient temperature and relative humidity (RH) and calculate a cow's heat load intensity. In this context, it was previously thought that the lowest threshold point at which cows would suffer heat stress was THI 72, a rating which covers a temperature range of 23.9°C-32.2°C and an RH of 65% to zero.

Now, with milk production per cow continuing to increase, the lowest threshold point has shifted to THI 68, covering a temperature range from 22.2°C-26.7°C and an RH from 45% to zero. "Understanding these changing heat stress trigger points is crucial for preserving milk performance in the short term and stock health in the long term," said Christine Julien, Phileo's Ruminant R&D Manager.

While at 22°C and RH 10% (THI 65) most cows will show no stress signs at all, a shift in conditions to 27°C and RH 35% (THI 73) will result in the animal's respiratory rate doubling to 75 pants per minute. Cows are also likely to stand much more than normal in such conditions in an attempt to cool themselves, basically by increasing their exposure to all available air flows.

By the time THI reaches 90 (39°C and RH 50%) the respiratory rate could be as high as 140/min with the cow having a rectal temperature of up to 41°C. "The knock-on effects of this can be devastating with heat stressed cows eating less and standing more," said Dr Julien. "These are both major contributory factors to the development of a negative energy balance in affected cows, resulting in an inevitable and relatively rapid fall in milk yield.

"This immediate impact leads into longer term issues, such as rising rumen acidosis, which is caused by a number of factors. The condition is often triggered by reduced feed intake and the impact of subsequent diet adjustments made in an attempt to retain energy levels in affected cows. Such actions need to be handled with care as the combination of a 'hotter' ration and the cows reduced ability to neutralise the rumen contents, directly increases the risks of rumen acidosis.

"Changes in the cow's natural eating behaviour, such as feeding less frequently than normal, can also contribute to rumen acidosis, especially when decreased frequency is accompanied by larger meals and more acid-producing post-eating. "Cows also typically over-eat the day following a heat wave, which is another well-known cause of rumen acidosis."

To help farmers' minimise such problems, Phileo has developed and tested a range of yeast-based solutions which are designed to enhance rumen efficiency, raise immunity levels and boost the animal's immune competency. Starting with the company's yeast probiotic Actisaf, trial results show that mid-range producing dairy cows, faced with heat stress conditions THI 68-72, produced 5% more milk and milk solids on the treatment than cows in a control group.

In trials with higher producing dairy cows, faced with even more intense heat stress (THI 69-79), feeding Actisaf delivered 2.5% better intake and 3.7% better feed efficiency, both in comparison to control cows. As a result, milk yield was 4% better than the control with milk fat showing a 7% advantage.

Trials with Phileo's premium yeast parietal fraction, Safmannan, used to address immunity issues, showed the product to be effective in triggering a positive immune response. It also helped alleviate a rise in somatic cell count (SCC), which is another standard consequence of heat stress.

Selsaf, the company's selenium-enriched yeast product, tested as a modulator of the negative impacts of heat stress, also showed beneficial results in relation to SCC, alongside helping to maintain better mammary health in treated cows than in a control group. Phileo's conclusion is that all three products offer farmers additional 'promising solutions' for use in alleviating the effects of heat stress in dairy cows.

References are available from the author on request
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Fig. 1. Temperature Humidity Index for lactating dairy cows (Zimbelman and Collier, 2011).

Temperature		% 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	98	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

THI = (Tdb-(0.55-(0.55*RH/100))*(Tdb-58) where Tdb is dry bulb temperature (°F) and RH is relative humidity • °C = (°F - 32)/1.8

- Stress threshold: Respiratory rate exceeds 60/min. Milk yield losses begin. Reproduction losses detectable. Rectal temperature exceeds 38.5°C
- Mild-moderate stress: Respiratory rate exceeds 75/min. Rectal temperature exceeds 39°C
- Moderate-severe stress: Respiratory rate exceeds 85/min. Rectal temperature exceeds 40°C
- Severe stress: Respiratory rate is 120-140/min. Rectal temperature exceeds 41°C

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Helping dairy cows cope with the heat

3

Heat stress is a serious problem on dairy farms across the world, often resulting in sharply reduced milk yields and significant follow-on health issues. The combination of rising summer temperatures and high levels of humidity can result in reduced feed intake in cows as they react to an uncomfortable increase in body temperature.

Immediate distress signs include panting, sweating and standing more than normal. This often leads to cows failing to eat as much as usual, due to the fact that digesting is itself a heat-generating process, especially in ruminants. In such conditions, a decline in performance can follow rapidly with research records showing that milk yield falls of up to 40% are not uncommon.

Once a cow's reaction to heat stress takes hold, a whole series of consequential health issues can follow. Increased standing by stressed cows, sometimes for as much as 60% of the day, has been linked to a subsequent rise in lameness. This is known to be more prevalent in cows which spend in excess of 45% of their time standing, compared to animals which rest normally.

The rise in panting, while a natural reaction designed to dissipate heat, also causes problems as the increase in respiratory rate leads to enhanced CO_2 being exhaled. This reduces blood CO_2 levels, triggering a chain reaction which can make the cow much more susceptible to rumen acidosis.

Rumen health is also affected negatively by the fact that panting cows drool more than normal. This reduces the quantity of saliva that would usually be deposited in the rumen, making digestion less easy. In seeking to manage heat stress in dairy cows, farmers try a range of strategies, such as differing feed regimes, environmental and mechanical strategies and the use of feed supplements.

Useful feeding ideas include altering feeding times to coincide with cooler parts of the day; giving feed in smaller amounts and increasing the number of feeding times; making sure high moisture feeds are dispensed before they undergo secondary fermentation, and minimising sorting of mixed rations by increasing feed presentation and evaluating particle size.

Useful environmental and technical suggestions include improving roof insulation for summer housed herds to reduce solar penetration; increasing the amount of available water; installing fans or opening the sides of the barn to increase air flow and fitting misters in combination with fans to further reduce temperatures.

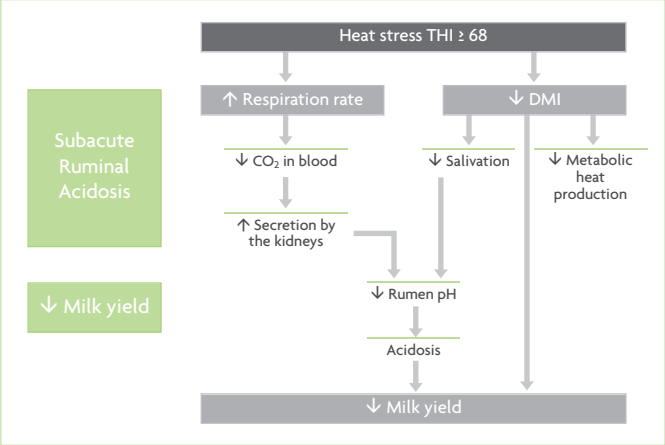

Fig. 1. Effect of heat stress on milk yield.

Useful supplement solutions include adding yeast solutions to diets. According to Valentin Nenov, Phileo's Global Ruminant Manager, trials with yeast probiotic Actisaf, resulted in improved fibre digestion in heat stressed dairy cows; helped stabilise the rumen and reduced respiratory rates, leading in turn to increased milk and milk solids production. The company has also achieved positive results with its premium yeast parietal fraction, Safmannan, and its selenium-enriched yeast, Selsaf.

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Yeast solutions show promise in combatting heat stress damage

4

The use of three different yeast solutions to reduce the damaging effects of heat stress in dairy cows has shown highly promising results according to Phileo Lesaffre Animal Care, France.

The company's solutions, fed as supplements to heat stressed dairy cows, were yeast probiotic, yeast paraprobiotic* and selenium yeast, with all three successfully helping to promote improvements in rumen function, energy balance and immunity.

As a result, Phileo has concluded that the three treatments are 'good candidates' for use in combatting the devastating effects of rising temperatures and high levels of humidity.

The decision to test the potential of yeast-based derivatives was prompted by research showing that while dairy cows produce less milk during heat stress, only about 50% of yield loss is caused by the animals reducing their feed intake. The other 50% is due to metabolic factors, raising the prospect that yeast-based solutions might help alleviate this aspect of heat stress damage.

"Heat stress is wide-ranging in its negative impact on dairy cows, especially those at the top of the production league," said Valentin Nenov, Phileo's Global Ruminant Manager. "It affects feed intake, cow body temperature, maintenance requirements and metabolic processes, feed efficiency, milk yield, reproductive efficiency, cow behaviour and disease incidence."

These effects are well documented, with various strategies being tried to prevent cows from suffering the full consequences of heat stress. These include adjusting feeding regimes and investing in environmental and mechanical measures to keep stock as healthy and productive as possible when temperature and high humidity conditions start to become a problem.

"As a specialist animal health company," said Dr Nenov, "our focus is on nutritional solutions, especially the role which yeast probiotic, yeast para-probiotic and selenium yeast might have in reducing the negative effects of heat stress in dairy herds."

Phileo has three yeast-based products in its portfolio. The first is Actisaf, a live yeast which acts as a probiotic and has been shown, across many studies, to deliver significant improvements in rumen function. Acknowledged for its ability to improve fibre digestion and stabilise the rumen, Actisaf's use with heat-stressed dairy cows helped to reduce the respiratory rate of treated animals while also delivering increased milk and milk solids production. The product is also able to 'preferentially promote' certain 'bacteria of interest' in relation to acidosis, helping to combat a condition which has the capacity to seriously damage heat stressed cows. Another observed Actisaf benefit is its ability to change important blood parameters, such as glucose. This has a direct impact on the physiology and metabolism of cows during heat stress, given that glucose becomes the major source of energy for cows at this point.

The second product is Safmannan. This is a premium yeast parietal fraction which Phileo has assessed according to its potential modulation of the immune system. Fed along with Actisaf, it helped trigger a supportive immune response, which is particularly important during heat stress when the immune function of affected cows can be adversely affected. The combined effect of Actisaf and Safmannan was also tested in relation to their impact on somatic cell count (SCC) levels. This was in response to evidence that rising SCC is a common problem in heat stressed herds. In this context, trials involving eight Dutch dairy farms recorded a reduction in SCC from an average of 280,000 per farm to below 200,000. This was a result of Safmannan being fed as a supplement to cows which had already been receiving Actisaf for a prolonged period.

The third product, Selsaf, is a selenium-enriched yeast which Phileo tested for its effectiveness as an oxidative-stress modulator. Many causes of stress, such as diet, transportation and heat stress, can be traced to an upsetting of the balance between the pro-oxidant and anti-oxidant systems of affected animals.

While extended exposure to such stress potentially reduces animal performance and product quality, giving affected cows an adequate supply of selenium in their diet is seen as essential to maintaining their oxidant balance.

When used by Phileo with heat stressed cows, Selsaf delivered a significant reduction in rectal temperature and respiratory rate and helped produce lower SCC numbers. It also led to a significant increase in the selenium content of milk and raised the active presence of the major antioxidant enzyme, glutathione peroxidase.

The company's conclusion is that giving Selsaf to heat stressed cows successfully boosted both the antioxidant status of the animals concerned and their natural defences, benefits which are seen as being of 'great interest' in helping to combat the negative impact of heat stress on dairy cows.

Phileo also said that its analysis showed that all three of its yeast-based products could be considered by farmers as offering 'additional promising solutions' for use in alleviating the effects of heat stress in dairy cows.

*yeast paraprobiotic: inactivated (non-viable) microbial cells or cell fractions, used to confer a health benefit when administered orally.

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