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# the AMAFERM Review

## Maintaining Production During Heat Stress

Research shows AMAFERM®

1 Fiber Digestion

2 Microbial Protein

3 Lactate Utilization

4 Energy (VFA)

5 Heat Stress

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Heat stress impacts performance of beef and dairy cattle, with estimated annual economic losses of $369 million and $897 million, respectively (St-Pierre et al., 2004). Animal responses to heat stress include reduced dry matter intake, decreased average daily gain, decreased milk yield and decreased fertility and poor reproduction (Kadzere et al., 2002; Amundson et al., 2006; Hansen, 2007). The reductions in energy availability and poor rumen function observed in cattle during heat stress can be improved by feeding Amaferm®.

The degree of heat stress is commonly estimated by temperature-humidity indexes (THI) (Dairy eXtension; Figure 1). The original THI was proposed by Thom (1959) and modifications have been proposed since (McDowell et al., 1976; Zimbelman, 2008; Collier et al., 2011).

relative humidity

| temperature, °F | 0 | 5 | 10 | 15 | 20 | 25 | 30 | 35 | 40 | 45 | 50 | 55 | 60 | 65 | 70 | 75 | 80 | 85 | 90 | 95 | 100 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 75 | no stress | | | | | | | | | | | | | 72 | 72 | 73 | 73 | 74 | 74 | 75 | 75 |
| 80 | | | | | | | 72 | 72 | 73 | 73 | 74 | 75 | 75 | 76 | 76 | 77 | 78 | 78 | 79 | 79 | 80 |
| 85 | | | 72 | 72 | 73 | 74 | 75 | 75 | 76 | 77 | 78 | 78 | 79 | 80 | 81 | 81 | 82 | 83 | 84 | 84 | 85 |
| 90 | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 79 | 80 | 81 | 82 | 83 | 84 | 85 | 86 | 86 | 87 | 88 | 89 | 90 |
| 95 | 75 | 76 | 77 | 78 | 79 | 80 | 81 | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 | 91 | 92 | 93 | 94 | 95 |
| 100 | 77 | 78 | 79 | 81 | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 98 | 99 | 100 |
| 105 | 79 | 80 | 82 | 83 | 84 | 86 | 87 | 88 | 89 | 91 | 92 | 93 | 95 | 96 | 97 | 99 | 100 | 101 | 102 | 103 | 105 |
| 110 | 81 | 83 | 84 | 86 | 87 | 89 | 90 | 91 | 93 | 94 | 96 | 97 | 99 | 100 | 101 | 103 | 104 | 106 | 107 | 109 | 110 |
| 115 | 84 | 85 | 87 | 88 | 90 | 92 | 93 | 95 | 96 | 98 | 99 | 101 | 102 | 104 | 106 | 107 | 109 | 110 | 112 | 113 | 115 |
| 120 | 86 | 88 | 89 | 91 | 93 | 95 | 96 | 98 | 100 | 101 | 103 | 105 | 106 | 108 | 110 | 111 | 113 | 115 | 117 | 118 | 120 |

mild stress | moderate stress | severe stress | extreme stress

*Fig. 1 Temperature-Humidity Index (THI) and heat stress categories.*

## The negative impacts of heat stress include:

- increased metabolic disorders
- compromised milk components
- reduced reproductive performance
- slowed growth
- rumen acidosis
- decreased milk production
- cow death

## The cow responds to heat stress with:

- drooling and sweating
- circulatory adjustments
- endocrine changes
- altered eating patterns, including decreased feed intake
- panting and an increased respiratory rates

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# Heat Stress

Other authors have hypothesized that it is not the extent of heat stress alone that affects animals, but also the duration of the heat stress (Figure 2). This is supported by anecdotal evidence from the field, where it is commonly observed that adequate night cooling reduces the impact of heat stress during multiple-day periods of elevated temperature and humidity.

It is also hypothesized that the minimum threshold where animals begin experiencing heat stress is a function of production level of the animals. In growing steers, the threshold is considered to be a THI of 84, whereas THI of 72 is commonly held as the minimum for lactating dairy cattle, but has recently been proposed to be 70 or lower with the increased production levels of modern dairy cattle. Endogenous heat production increases with the increased dry matter intakes and metabolism associated with increased milk yields. At the same ambient temperature, a higher-producing dairy cow will have to dissipate more heat to the environment than a lower-producing cow of the same size. Ragnovolo & Misztal (2000) found a negative genetic correlation between the heritability for milk yield and heat tolerance. This finding suggests that as U.S. dairy cattle have been selected for improved milk yields, their tolerance to heat stress has decreased.

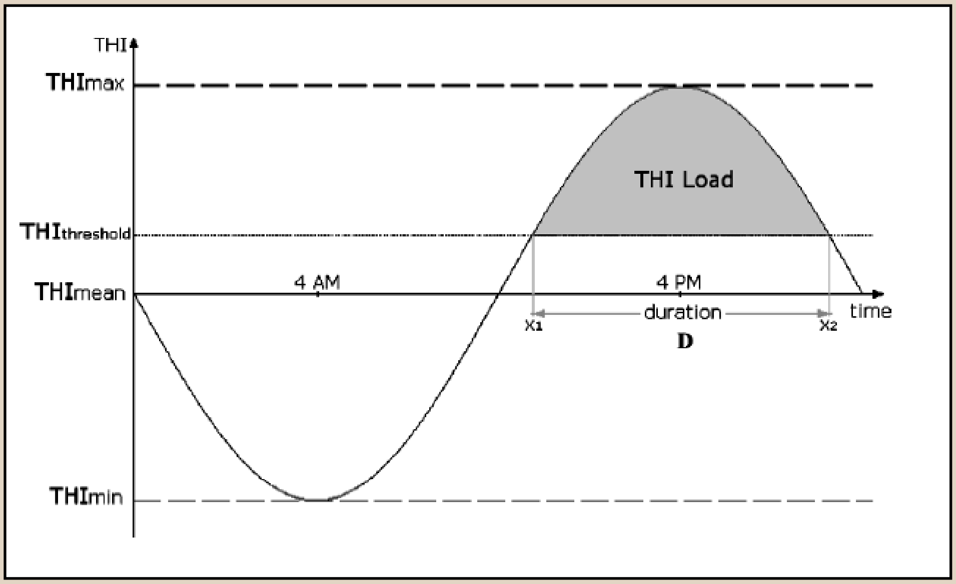


*Fig.2 Impact of heat stress as a function of the temperature-humidity index (THI) and the duration of heat stress. THI impact (load) is calculated as the area under the curve above a THI threshold. THI threshold may vary with milk yield.* From St-Pierre et al., 2004.

In addition to reduced performance, physiological responses to heat stress include increased respiration rates and body temperatures elevated above 39°C. Body temperature rises when cows are no longer able to dissipate body heat to the environment, and is a very sensitive indicator of heat stress.

Cows may exhibit panting and drooling as behavioral and physical responses to heat stress.

Metabolic and endocrine responses include decreased blood glucose and IGF-1 (insulin-like growth factor 1 concentrations (Rhoads et al., 2009), which may be in part, but not wholly, a reflection of reduced dry matter and energy intakes. The metabolic responses to heat stress are likely to be regulated through endocrine mechanisms; however, the exact signals are unknown at this time (Rhoads et al., 2009).

Research on the suppression of dry matter intake during heat stress with pair-fed animals demonstrated that many of the metabolic responses in heat stress are additive to and different from the responses to reduced dry matter (DM) intake (Rhoads et al., 2009). The reduction in dry matter intake under heat stress accounted for only 35% of the decrease in milk yield in this research. Other endocrine responses affect reproduction, and are manifested as decreased estrus, reduced ovulation, increased embryonic mortality, and lower pregnancy rates in both dairy and beef cattle (Amundwon et al., 2006; Hansen, 2007).

# Heat Stress

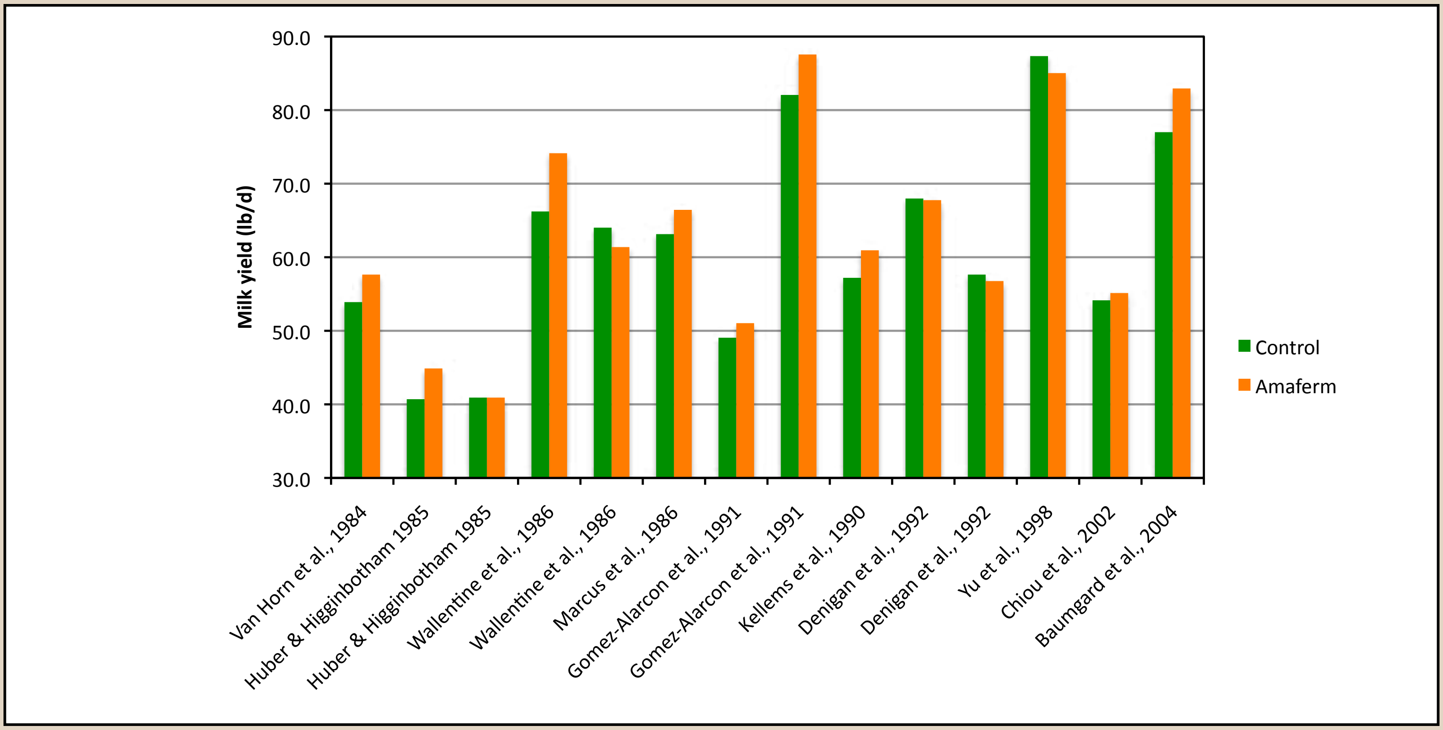


*Fig.3 The benefits of feeding Amaferm® during heat stress can be seen in 14 experiments. Larger benefits are seen in early lactation when rumen fill may be limiting. Wallentine et al.,1986; Gomez-Alarcon et al., 1991; Baumgard et al., 2004.*

The heat increment includes the heat of fermentation, heat of digestion, and the heat produced from maintenance and production and is thus a function of intake, body size and production level.

Eating and digestion are estimated to account for 25 to 30% of the heat increment in dairy cattle (Kadzere et al., 2002).

Over the past two decades, feeding fat has been proposed and used in the dairy industry as a means to increase energy intake during heat stress, as it does not generate any heat of fermentation or digestion. Also, it has been commonly suggested to feed lower NDF diets during heat stress and increasing NFC (non-forage carbohydrate) to increase energy density of the ration.

However, both of these approaches potentially have the negative side effect of compromising rumen function. Fats, if fed at more than 3-4%DM and not rumen-protected or fully saturated, inhibit growth of the rumen microbes, reducing fermentation capacity in the rumen and microbial protein flows to the small intestine.

Feeding fat results in very small differences in calculated heat production, differences that are so small they would not be detectable either in research or in the field. For example, replacing corn grain with 0.5 lb fat to achieve the same NEl intake would decrease predicted heat production from 37.6 to 37.4 Mcal/d for a cow producing 25,000 lbs. milk/year and consuming ~54 lbs. DM/day.

Depending on the feed ingredients used, lowering NDF and increasing NFC may result in lower rumen pH and compromise fiber degradation, with little impact on body temperatures. This has been shown recently in beef cattle research (Arias et al., 2011), where only 0.1 to 0.2°C differences in tympanic temperatures were observed between steers consuming a high concentrate ration (82% concentrate: 18% forage) vs. a high forage ration (25% concentrate:75% forage) during hot summer weather.

While it is counter-intuitive to the approaches of fat feeding and increasing ration NFC, improving NDF digestibility and energy availability by feeding Amaferm® may be an alternative to increase energy intake and milk yield in heat-stressed cattle. Increasing NDF digestibility does not negatively affect DM intake, and in fact, it may improve DM intake if rumen fill is limiting. Additionally, feeding Amaferm® has been shown to improve rumen function by increasing lactic acid utilization, moderating pH swings, and improving microbial growth (Wiedmeier et al., 1987; Caton et al., 1993; Gomez-Alarcon et al., 1990; Beharka & Nagaraja, 1998).

Feeding Amaferm® during heat stress has multiple benefits including improved ruminal NDF digestibility, increased energy availability, improved rumen function, and less loss of milk yields. The improved NDF digestibility observed with Amaferm® feeding provides more energy to the animal during heat stress when DM intake is reduced. While there is a small increase in heat produced during NDF digestibility, it is minute in comparison to the total heat produced in lactating dairy cattle. Amaferm® has been shown to improve milk yield performance with lactating cows under heat stress (Figure 3) and help maintain body condition (Chiou et al., 2002).

The benefits of Amaferm® in dairy cattle production can also be translated to beef brood cow and feedlot performance.

In summary, feeding Amaferm® during heat stress can:

- increase NDF digestibility
- increase energy availability
- improve microbial protein yields
- help stabilize rumen function and pH during periods of slug-feeding
- improve milk yields and help maintain body condition
- increase dry matter intake

*For a complete list of references cited in this newsletter, visit our website: www.amaferm.com*

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# BEAT THE HEAT

## feeding Amaferm® during heat stress can:

- increase NDF digestibility
- increase energy availability
- improve microbial protein yields
- help stabilize rumen function and pH during periods of slug-feeding
- improve milk yields and help maintain body condition
- increase dry matter intake

*make sure your feeding program includes*
the Amaferm advantage!

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