Managing transition cows during heat stress

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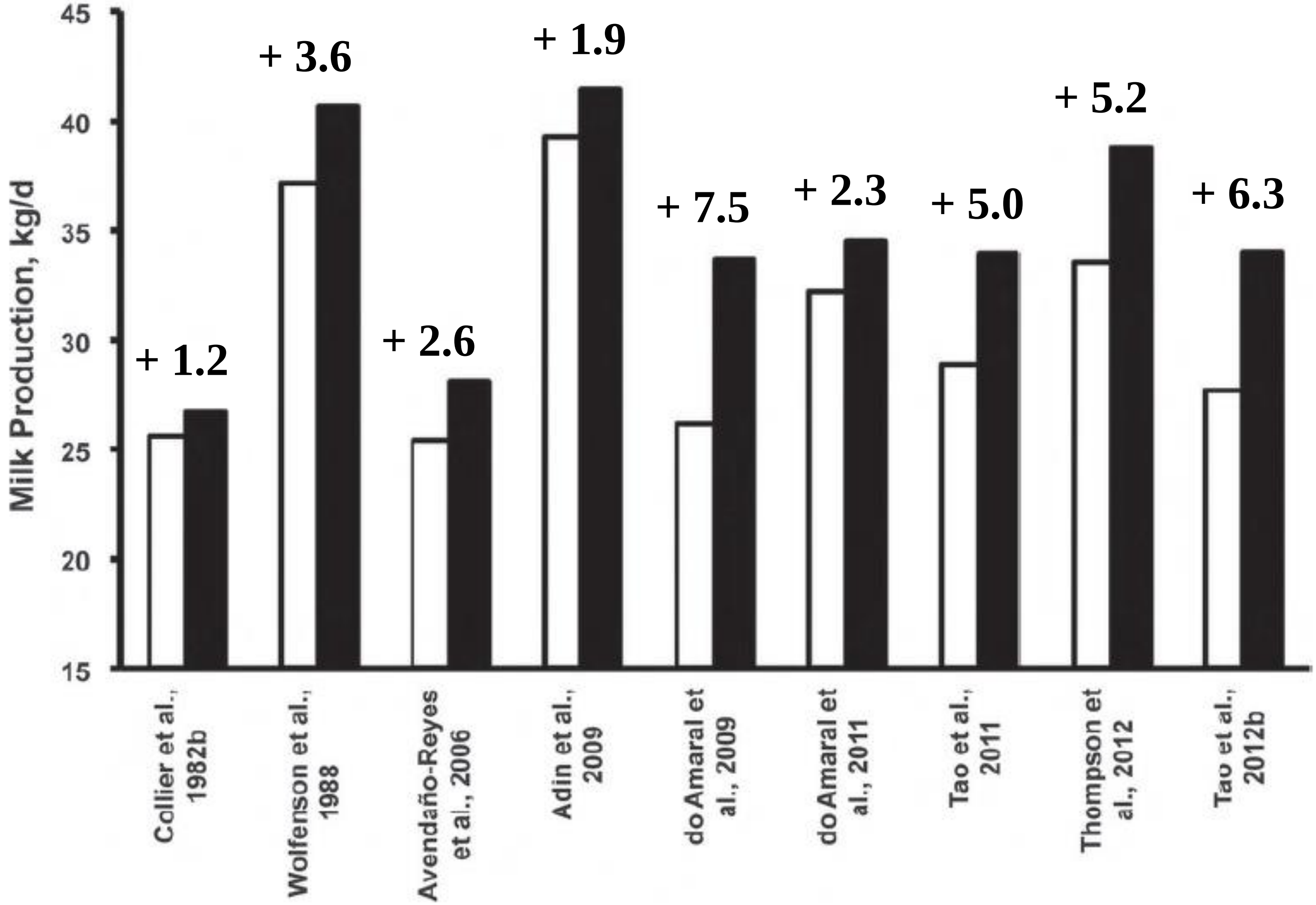
Let’s establish my credibility……

REALITY – Heat stress during the dry and transition period has ***PROFOUND*** implications for the cow (and her calf)

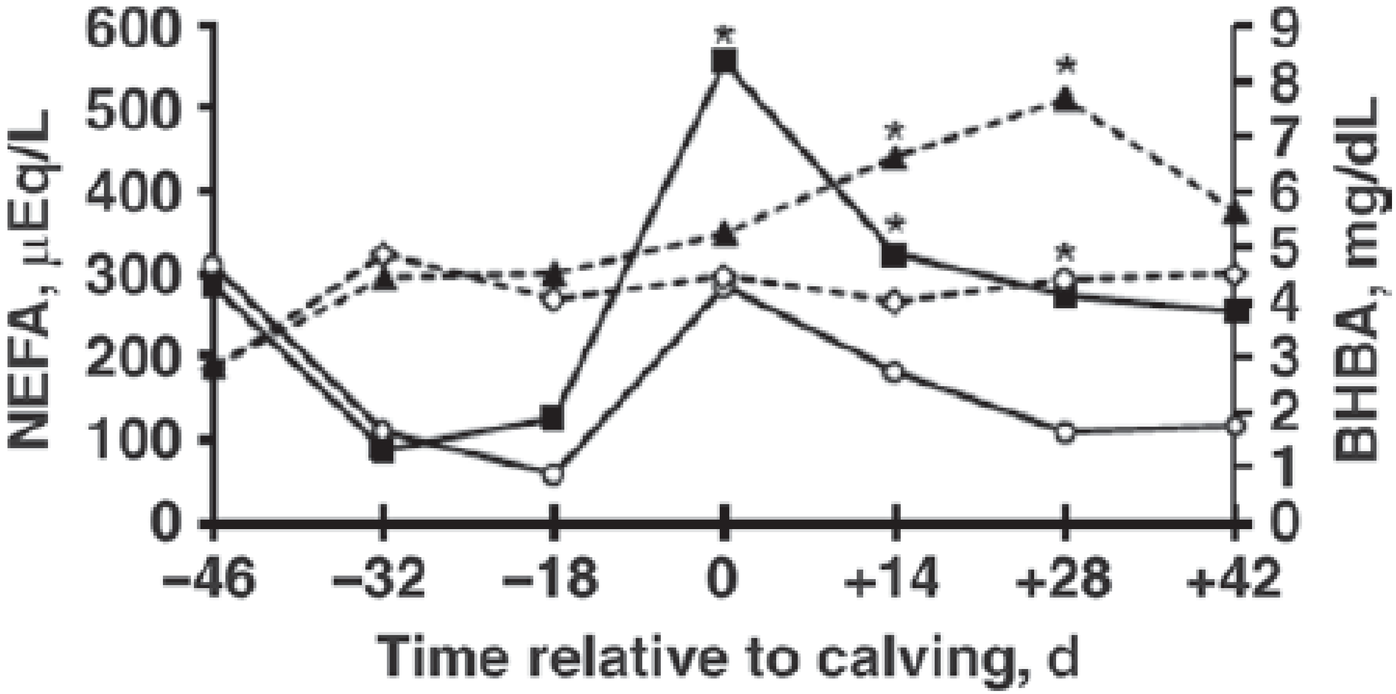
A few topics

- Review recent research focused on heat stress in transition cows
- Consider physiological changes in dairy cattle resulting from heat stress during different phases of the lactation cycle
- Management and nutritional strategies to optimize transition success during heat stress

Cooling during the entire dry period increases subsequent milk production (differences in kg/d above bars)



Tao and Dahl. 2013. J. Dairy Sci 96 :4079–4093



Effect of prepartum cooling (black) or heat stress (white) during the dry period on concentrations of NEFA (solid) and BHBA (dashed) during the transition period. All cows were cooled postcalving.

DMI was decreased for heat stressed cows prepartum (12.0 vs. 14.1 kg/d) but was not different (19.3 vs. 17.7 kg/d) postpartum

From do Amaral et al., 2009. J. Dairy Sci. 92:5988-5999.

Heat stress during the pre-partum period decreases calf birth weight

Heat-stressed	Control	% reduction	Reference
36.6*	39.7	8	Collier et al. (1982b)
40.6*	43.2	8	Wolfenson et al. (1988)
33.7†	37.9	11	Avendaño-Reyes et al. (2006)
40.8*	43.6	6	Adin et al. (2009)
31.0*	44.0	30	do Amaral et al. (2009)
39.5*	44.5	11	do Amaral et al. (2011)
41.6*	46.5	11	Tao et al. (2011)
36.5*	42.5	14	Tao et al. (2012b)

Tao and Dahl. 2013. J. Dairy Sci 96 :4079–4093

J. Dairy Sci. 95:7128–7136
http://dx.doi.org/10.3168/jds.2012-5697

Effect of late-gestation maternal heat stress on growth and immune function of dairy calves

S. Tao, A. P. A. Monteiro, I. M. Thompson, M. J. Hayen, and G. E. Dahl[1]
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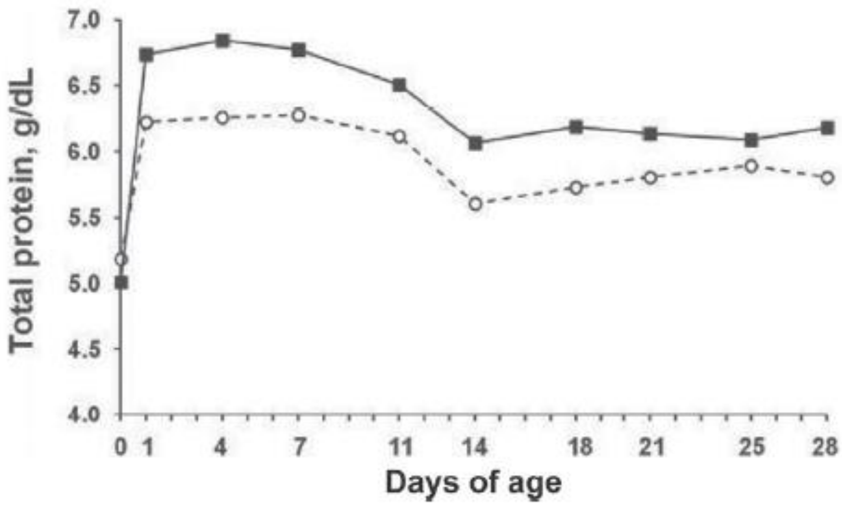
Item	Heat stress	Cooling	SEM	P
Birth weight, kg	36.5	42.5	1.2	<0.01
Weaning weight, kg	65.9	78.5	4.0	0.04
Weaning BW gain, kg	29.4	35.9	3.8	0.25
BW after weaning, kg	146.4	154.6	4.5	0.22
Withers height after weaning, cm	103.4	104.8	1.0	0.33
Colostrum IgG, mg/dL	8681	7727	726	0.36



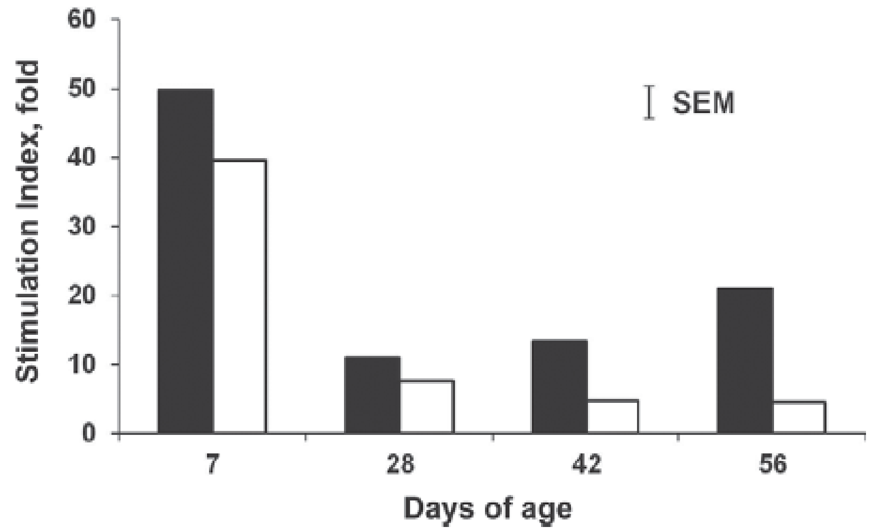
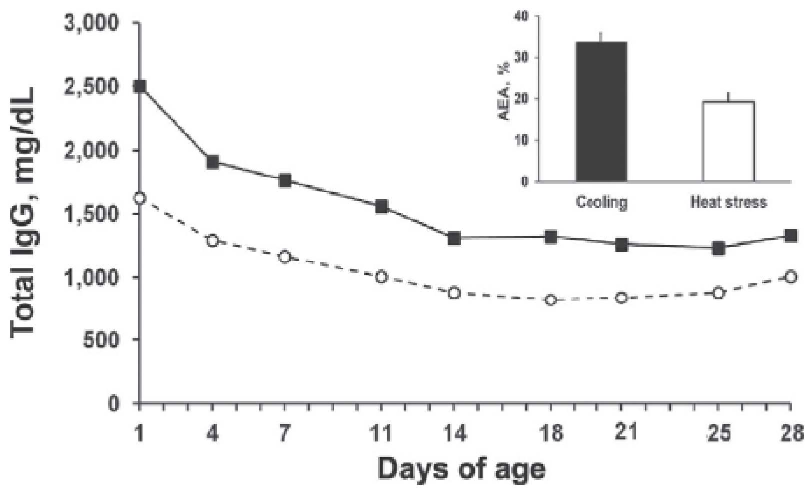


Figure 3. Effect of heat stress and cooling during the dry period on the peripheral blood mononuclear cell (PBMC) proliferation of neonatal calves. Solid bars represent calves from cows exposed to cooling



Prepartum cooling:

-- increased serum total protein and IgG

-- increased PBMC proliferation

Tao et al., 2012. J. Dairy Sci. J. Dairy Sci. 95 :7128–7136

J. Dairy Sci. 99:8443–8450
http://dx.doi.org/10.3168/jds.2016-11072

In utero heat stress decreases calf survival and performance through the first lactation

A. P. A. Monteiro, S. Tao, I. M. T. Thompson, and G. E. Dahl[1]
Department of Animal Sciences, University of Florida, Gainesville 32611

- Data pooled from 5 experiments conducted over 5 consecutive summers
- ~ 45 d dry period
- Cows blocked on milk production and assigned to Heat Stress or Cooled treatments
- Calves fed 3.8 L of colostrum within 4 h of birth
- Pasteurized milk fed 2X/d
  - 1.9 L per feeding from d 1 to 29
  - 3.8 L per feeding from d 30 to 41
  - Gradually weaned from d 42 to 49

J. Dairy Sci. 99:8443–8450
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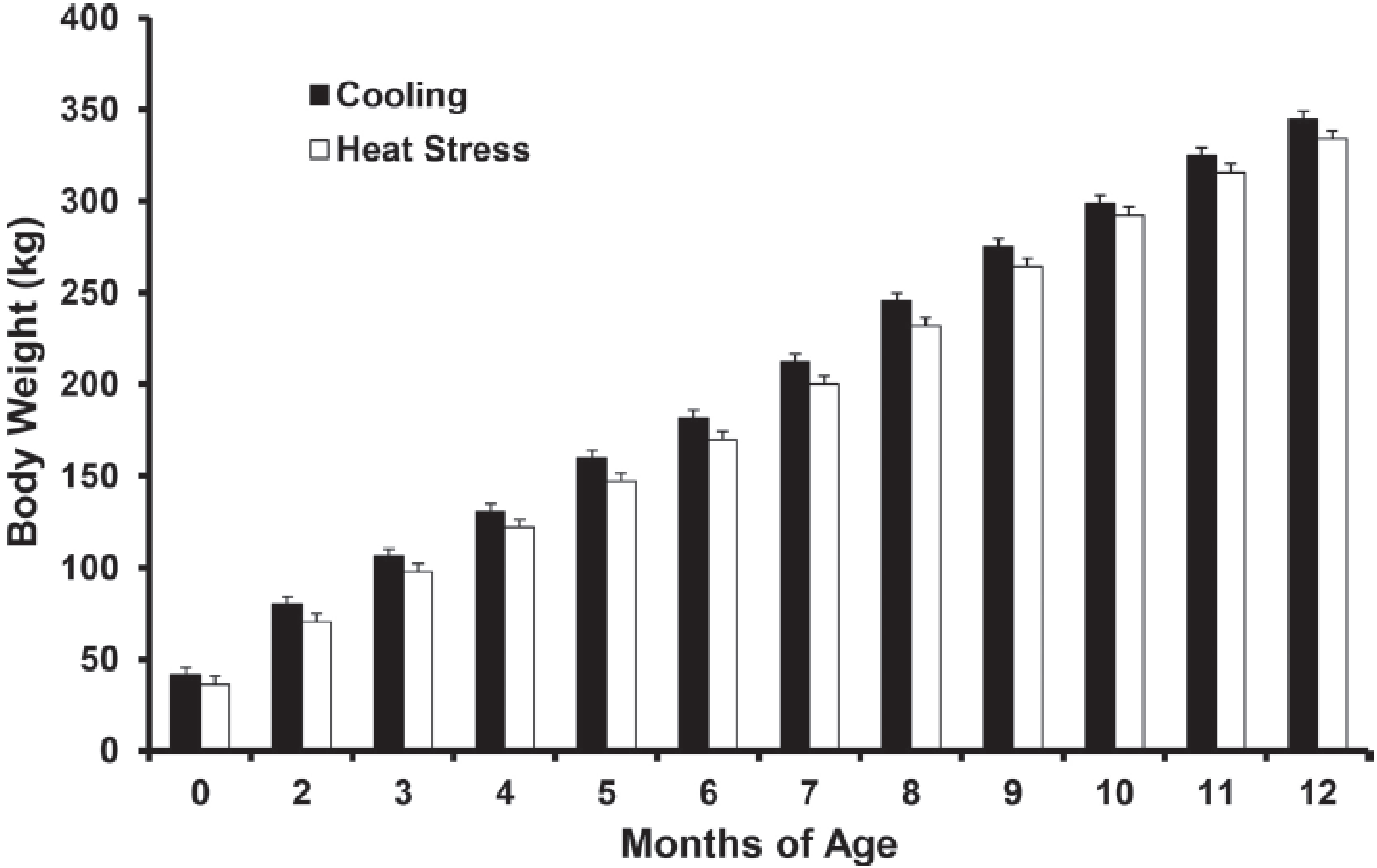
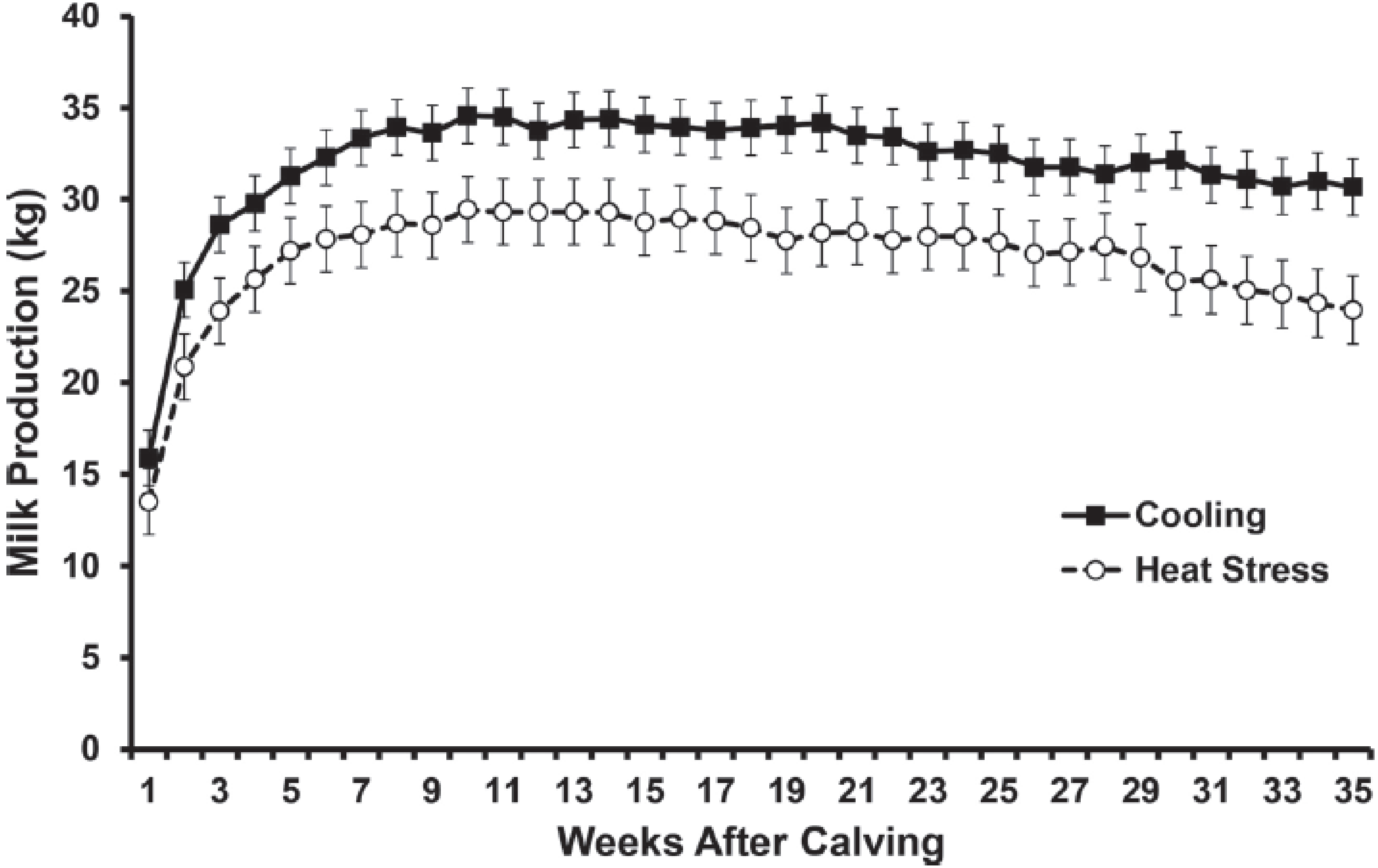
Item	Heat stress	Cooled	P
Bull calves (no)	30	31	
Heifer calves (no)	44	41	
Stillborn	3 (4.1%)	0 (0%)	0.25
Bull calf mortality by 4 mo of age	3 (10%)	1 (3.2%)	0.35
Heifers leaving herd prepuberty	10 (22.7%)	5 (12.2%)	0.26
-- due to health/growth/malform	8 (18.2%)	1 (2.4%)	0.03
Heifers leaving herd postpuberty	3 (6.8%)	1 (2.4%)	0.62
Heifers completing first lactation	29 (65.9%)	35 (85.4%)	0.05
BW at calving	565 ± 11.4 kg	563 ± 11.4 kg	0.89



Effect of maternal heat stress or cooling during the dry period on subsequent growth of heifers up to 1 year of age

Monteiro et al., 2016. J. Dairy Sci. 99:8443-8450.



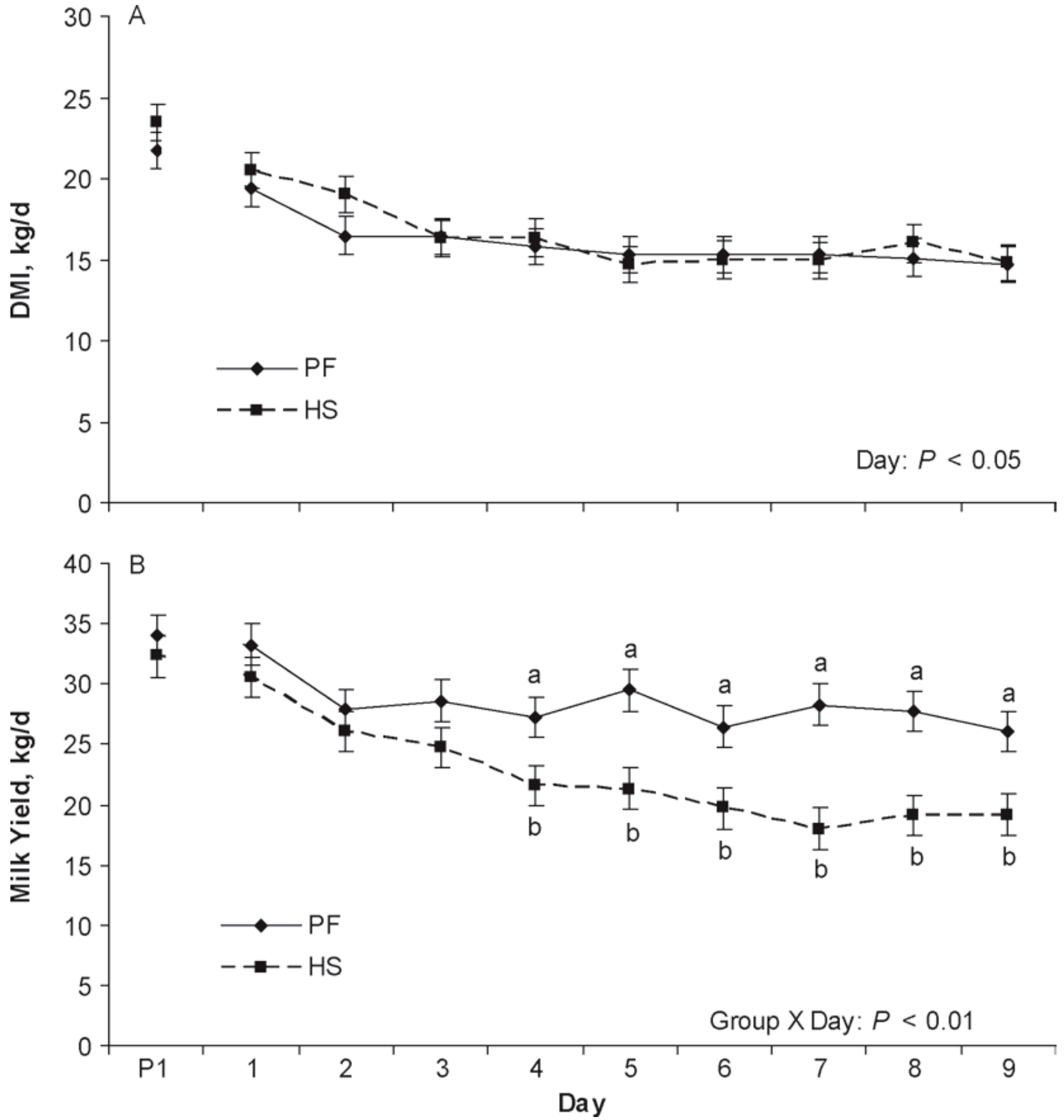
Effect of maternal heat stress or cooling during the dry period on subsequent milk production during first lactation

Monteiro et al., 2016. J. Dairy Sci. 99:8443-8450.

A few topics

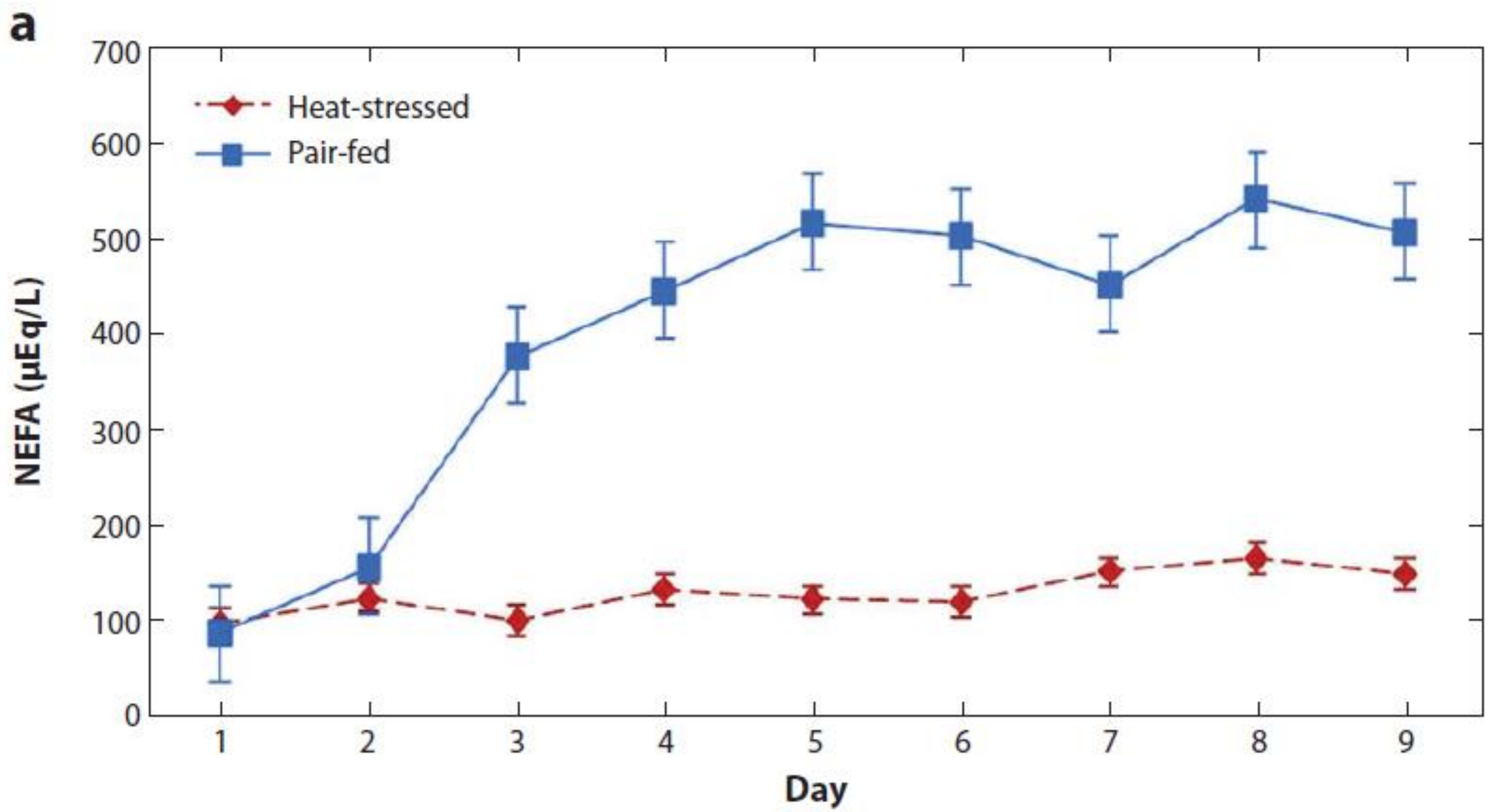
- Review recent research focused on heat stress in transition cows
- Consider physiological changes in dairy cattle resulting from heat stress during different phases of the lactation cycle
- Management and nutritional strategies to optimize transition success during heat stress

Heat stress results in marked physiological changes and altered nutrient use in midlactation cows



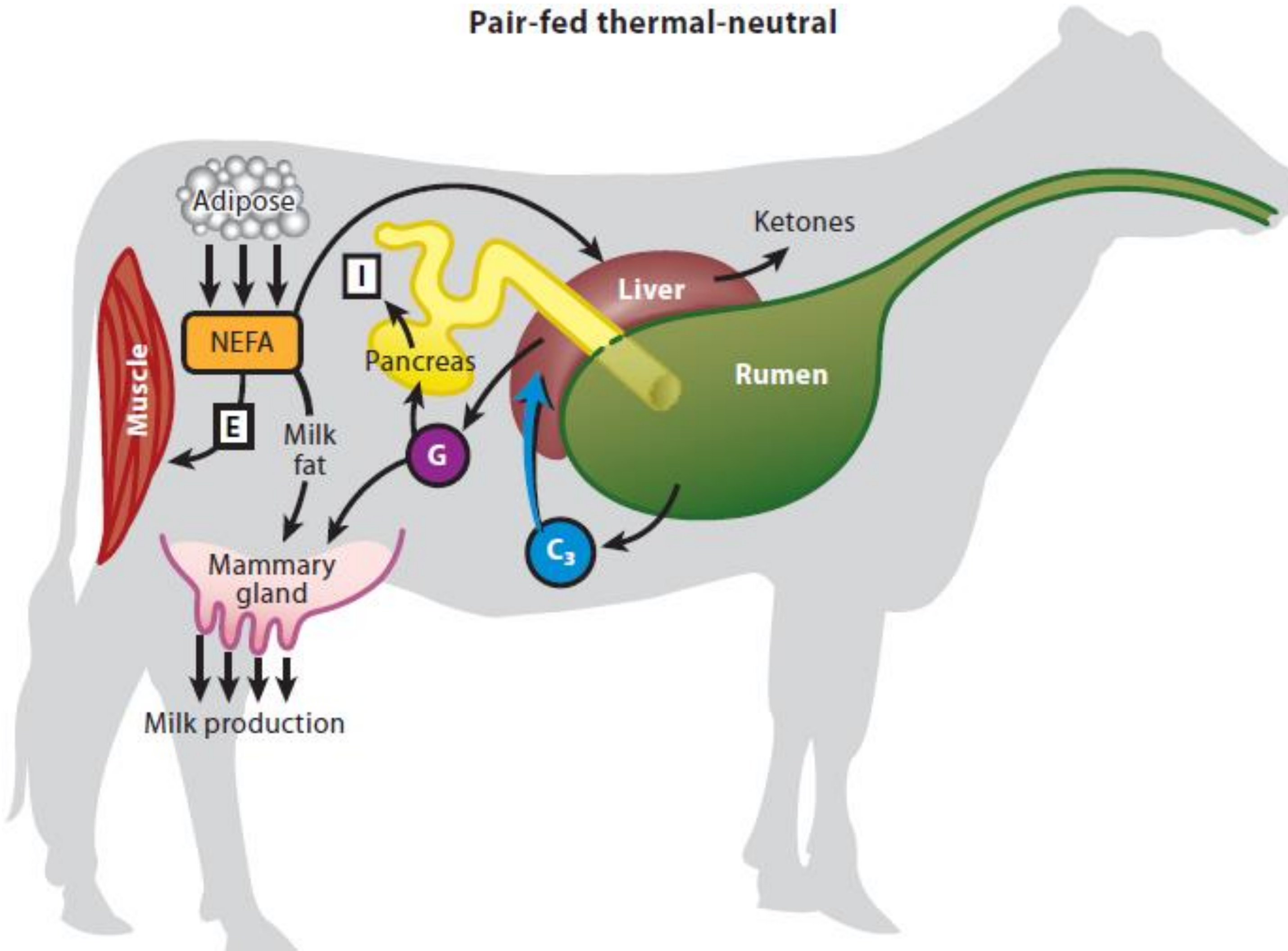
Effects of heat stress (HS) and pair-feeding (PF) on DMI and milk yield in midlactation cows

Rhoads et al., 2009. J. Dairy Sci. 92:1986–1997



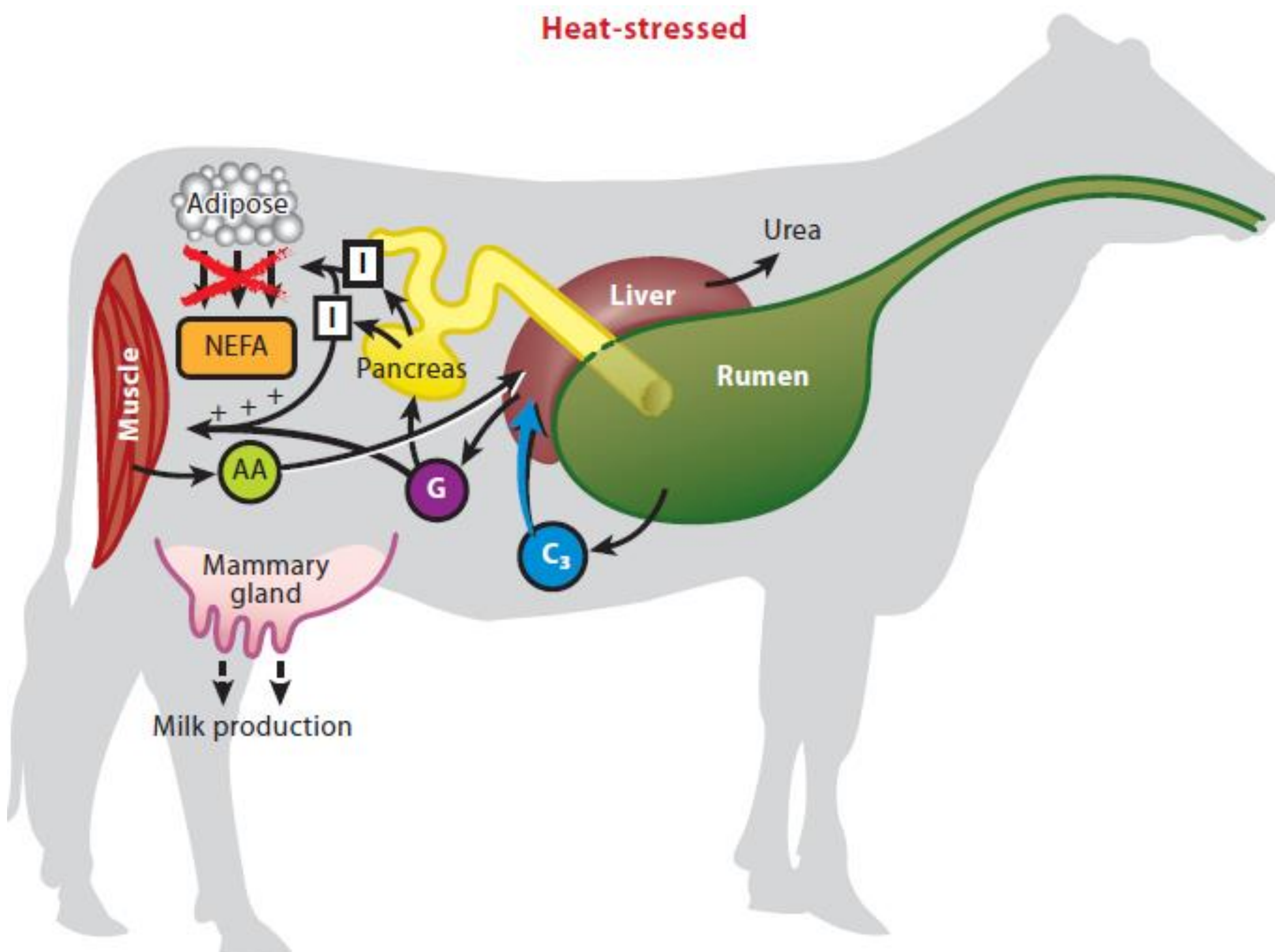
NEFA concentrations are elevated in pair-fed controls but not heat-stressed cows during midlactation.

Rhoads et al., 2009. J. Dairy Sci. 92:1986–1997



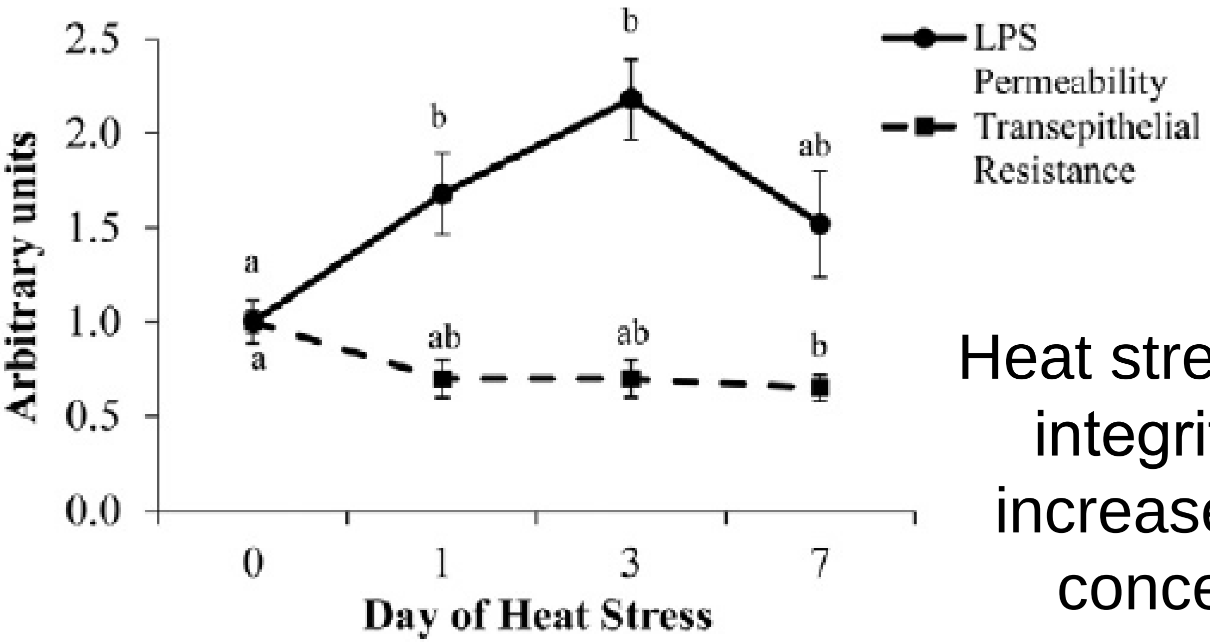
Effect of DMI restriction on metabolism in midlactation cows. Insulin concentrations decrease, NEFA increase and meet fuel needs, ketones potentially increase. Cow is "metabolically flexible"

From Baumgard and Rhoads, 2013. Ann. Rev. Anim. Biosci. 1:311-337.

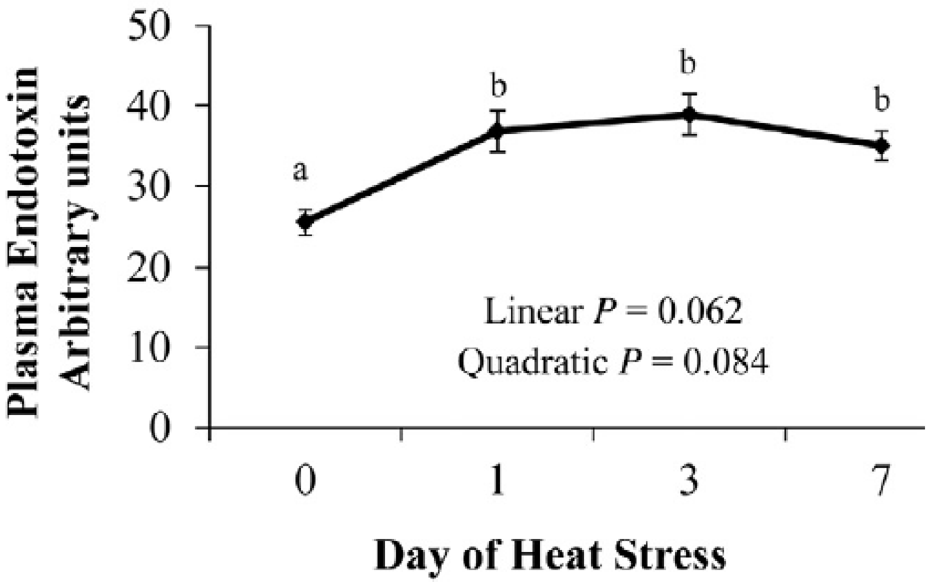


Effect of DMI restriction and heat stress on metabolism in midlactation cows. Insulin concentrations INCREASE, NEFA don't increase to meet fuel needs, glucose directed to meet energy needs. Cow is "metabolically <u>inflexible</u>"

From Baumgard and Rhoads, 2013. Ann. Rev. Anim. Biosci. 1:311-337.



Heat stress impairs intestinal integrity “leaky gut” and increases blood endotoxin concentrations in pigs



Pearce et al., 2013. J. Anim. Sci. 91:5183-5193.

Zn-AA complex supplementation improved intestinal integrity during heat stress in pigs

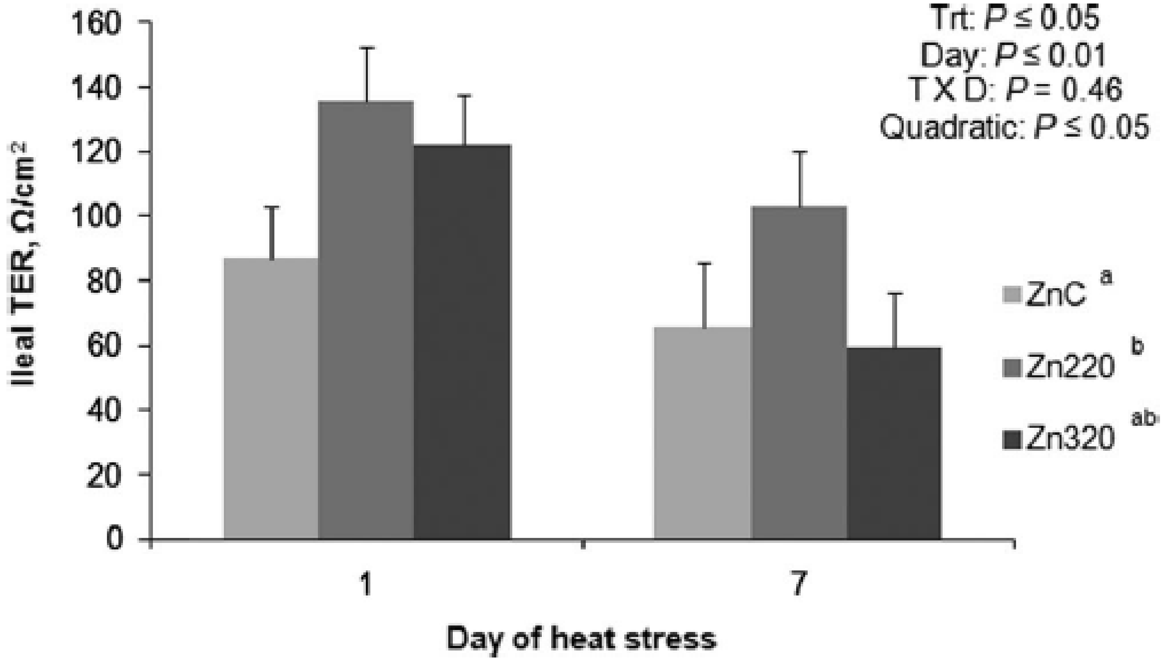
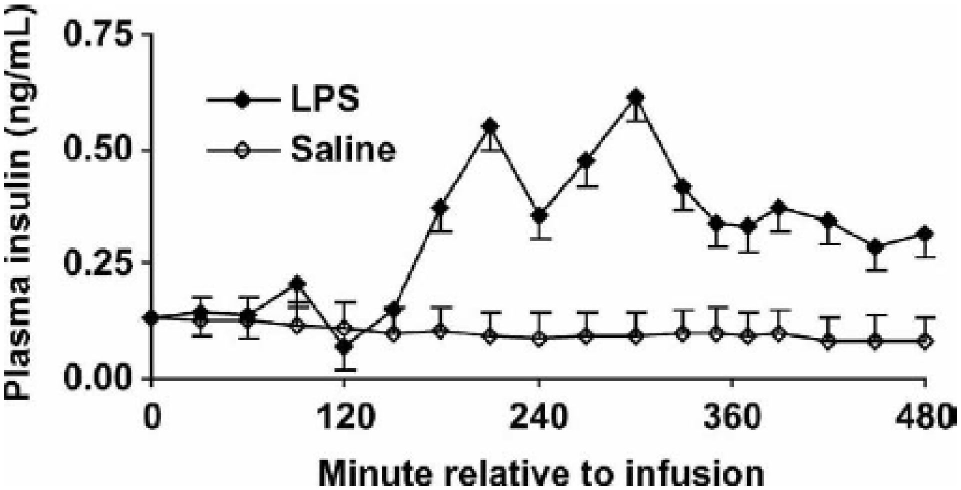
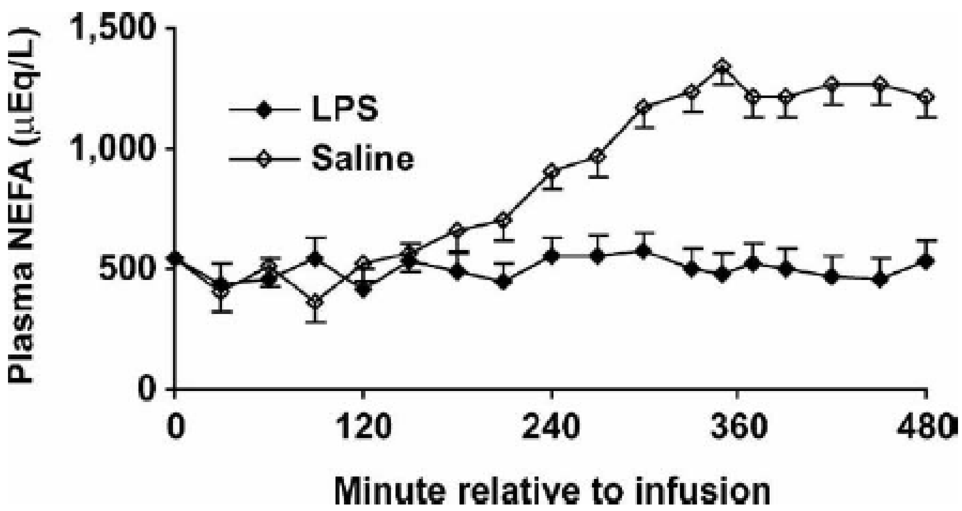


Figure 3 Effects of feeding 120 ppm Zn from $ZnSO_4$ (ZnC), 120 ppm Zn from $ZnSO_4$ + 100 ppm Zn from Zn amino acid (ZnAA) complex (Zn220), and 120 ppm Zn from $ZnSO_4$ + 200 ppm Zn from ZnAA complex (Zn320) on ileal transepithelial electrical resistance (TER). [a,b]Represent differences between dietary treatment ($P \leqslant 0.05$).

Sainz Fernandez et al., 2014. Animal. 8:43-50.





Plasma insulin and NEFA concentrations following intramammary LPS challenge in early lactation cows

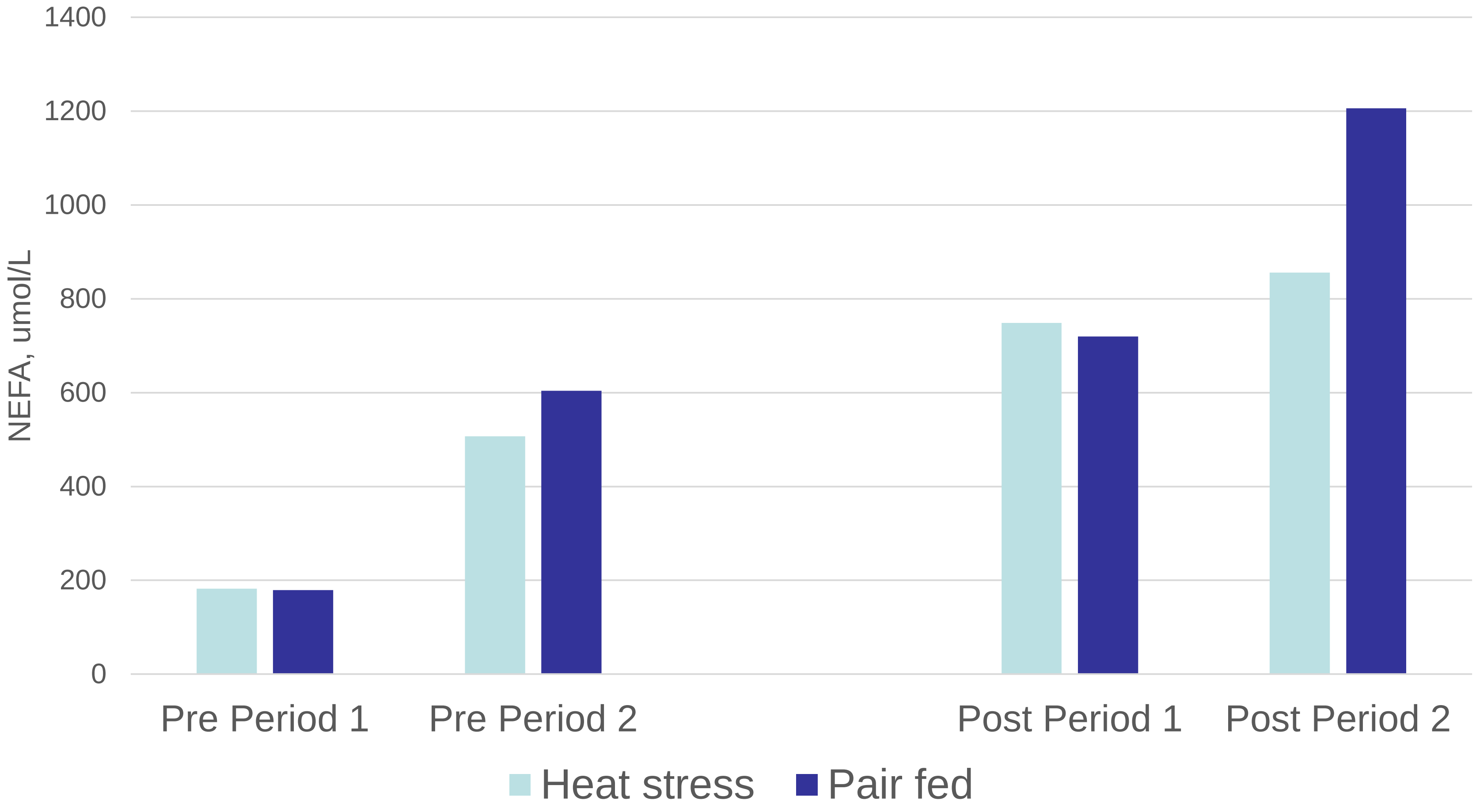
Waldron et al., 2006. J. Dairy Sci. 89:596-610.

What do we know about heat stress and effects on metabolic regulation in the transition cow?

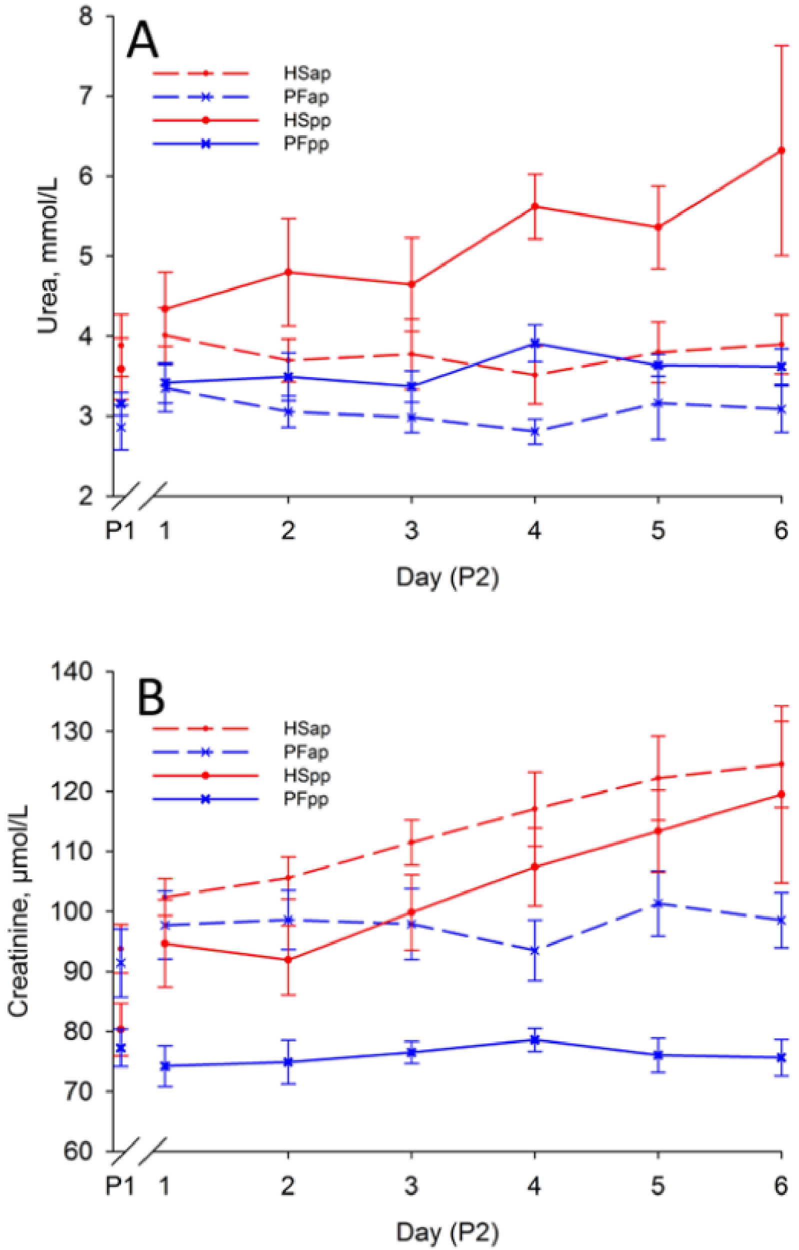
Lamp et al., 2016. PLOS ONE | DOI:10.1371/journal.pone.0125264

- 14 German Holstein cows entering 3rd lactation assigned to two groups
  - Heat stressed (6 days @ 82°F; 52% RH)
  - Control (thermoneutral; 59°F; 69% RH) pair-fed to match heat-stressed cows
- Treatments applied in climactic chambers
  - At week 3 prepartum
  - At week 3 postpartum
- During both prepartum and postpartum periods
  - 6 days both groups thermoneutral
  - One day temperature transition
  - 6 days in heat stress and control treatments

Effects of heat stress and pair-feeding on NEFA concentrations during the prepartum and postpartum periods



Lamp et al., 2016. PLOS ONE | DOI:10.1371/journal.pone.0125264



Heat stress increased plasma urea postpartum and plasma creatinine both prepartum and postpartum

Lamp et al., 2016. PLOS ONE | DOI:10.1371/journal.pone.0125264

J. Dairy Sci. 98:6865–6875
http://dx.doi.org/10.3168/jds.2014-9281

Late-gestation heat stress abatement on performance and behavior of Holstein dairy cows

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‡Department of Animal Sciences, University of Illinois, Urbana 61801

Item	Heat stress	Cooled	SEM	P
Prepartum DMI, kg/d	13.7	15.5	0.82	0.04
Eating time, min/d	147.4	166.2	12.1	0.13
Rumination time, min/d	243.2	282.5	17.2	0.03
Total chewing time, min/d	390.6	448.7	28.8	0.06
Standing time, min/d	474.0	390.4	28.9	0.007

Summary – physiological and behavioral changes in heat-stressed transition cows

- Prepartum
  - Lower DMI during heat stress
  - NEFA increases same in heat-stressed and pair-fed cows
  - Evidence of skeletal muscle mobilization/changes in protein metabolism
  - Heat stress decreases chewing time and increases standing time
- Postpartum
  - Adipose tissue more refractory to mobilization in heat stress (similar to midlactation cows)
  - Greater demand for glucose as fuel and partition away from milk synthesis
  - Evidence of skeletal muscle mobilization/changes in protein metabolism

A few topics

- Review recent research focused on heat stress in transition cows
- Consider physiological changes in dairy cattle resulting from heat stress during different phases of the lactation cycle
- Management and nutritional strategies to optimize transition success during heat stress

Facility/management strategies to optimize success during heat stress

- COOLING AND SHADE!!!!!
  - Beginning during far-off dry and continuing into lactation

- Manage stocking densities and cow/heifer competition
  - Ideally 24” bunk space far-off and 30” bunk space if cows/heifers together
  - If cows/first calf heifers segregated, likely can decrease to 18 and 24”, respectively
  - Heat-stressed cows will stand more, overstocking likely makes this worse

- Water, water, water
  - Clean and plentiful
  - 4” minimum of water space per cow across multiple waterers in group?

Common changes in lactating cow rations during heat stress

- Strategies to decrease heat of digestion
  - Replace lower digestibility forage sources with nonforage fiber sources with higher digestibility
  - Include/increase supplemental dietary fats to provide energy
- Strategies to mitigate risk of ruminal acidosis
  - Decrease/moderate starch content
  - Include/increase yeast/yeast culture
- Strategies to manage mineral balance changes
  - Increase dietary K/dietary DCAD
  - K carbonate sources

Controlled feeding studies conducted in heat-stressed transition cows are essentially nonexistent

Potential implications of metabolic/physiological changes during heat stress for transition diet formulation

- Altered ruminal fermentation/propensity for ruminal acidosis
  - Increase nonforage fiber sources while controlling starch to promote feed intake and overall energy availability
  - Yeast/yeast culture to improve efficiency of fermentation and aid in ration transitions from prepartum to postpartum
  - Consider use of (low sodium) mineral sources beginning prepartum that likely have buffering capacity – e.g. Ca-Mg dolomites, other slow-release buffers
- Increased tissue demands for glucose
  - Ensure adequate propionate supply for liver
  - Monensin supplementation
    - Target 400 mg/d prepartum and 450 to 500 mg/d postpartum
  - Starch levels
    - 16 to 20% prepartum; 22 to 24% postpartum with higher nonforage fiber?

Potential implications of metabolic/physiological changes during heat stress for transition diet formulation (continued)

- Focus on efficient delivery of metabolizable protein and AA
  - 1200 to 1400 g/d of MP prepartum with dietary CP < 15%
  - Balance Met and Lys at similar levels to lactating cows
- Dietary fat sources
  - Opportunities for individual fatty acids?
- Impaired intestinal/gut integrity as a result of heat stress
  - Focus trace mineral (e.g., Zn) formulation on use of improved sources
  - Ensure dietary antioxidants are adequate (Vitamin E, Se, Cu) but not excessive (Cu < 20 ppm total diet)
  - Cow may be very sensitive to anti-quality factors in feeds
    - Toxin issues, poor silage fermentation, etc.

Potential implications of metabolic/physiological changes during heat stress for transition diet formulation (continued)

- Manage dietary DCAD
  - Prepartum – use anionic supplements to decrease DCAD (monitor urine pH)
  - Postpartum – potentially include K sources to increase DCAD

- Other nutrients
  - Chromium – immune function, DMI, milk yield
  - Choline – liver FA metabolism
  - Niacin and betaine -- results seem to be mixed

Summary and conclusions

- Heat stress has profound implications for both the transition cow AND her calf
  - Estimating opportunity based only upon cow performance and reproductive performance dramatically underestimates the economic implications of heat stress during the dry and transition period
- Heat stress significantly alters the physiology and metabolism of dairy cows during lactation and during the dry period, with potential implications for diet formulation
- Facility/cooling strategies as well as implementation of dietary strategies to mitigate the potential effects of heat stress are critical for success

Thanks!!

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