Consequences of Heat Stress During Late Gestation for the Dairy Cow and Her Calf

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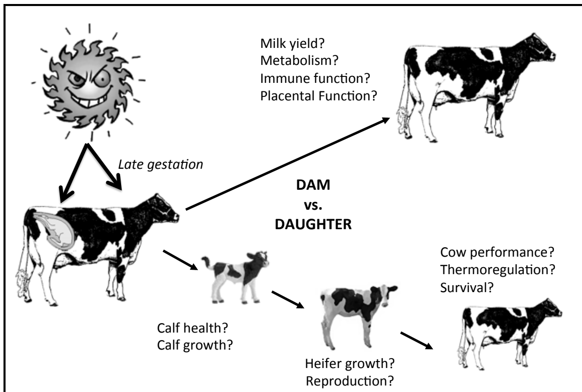
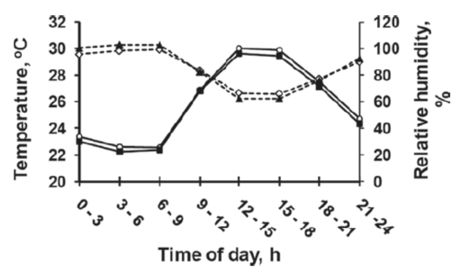
8 April 2021



Gainesville, Florida, USA

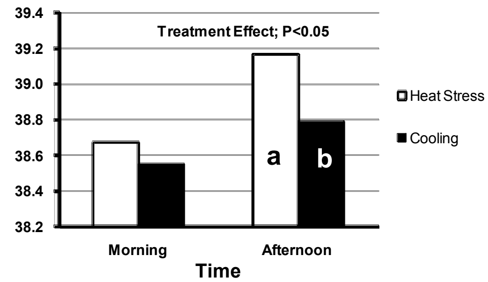
- **Sand bedded free stalls**
- **Fans over stalls**
- **Soakers over feedline**
- **Fans on at 70° F (21.1°C)**
- **Soakers on 1.5 min every 5 min at 72° F**

Study Design: Heat Load of Dry Cows



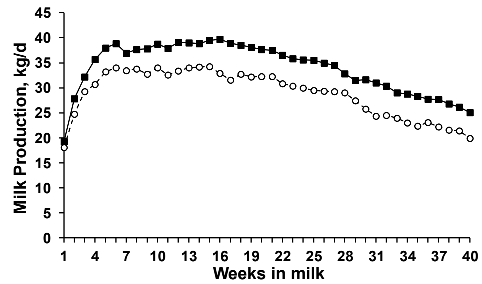
Do Amaral et al., *J. Dairy Sci.* 94:86–96

Heat Stress Increases Mean Rectal Temperature



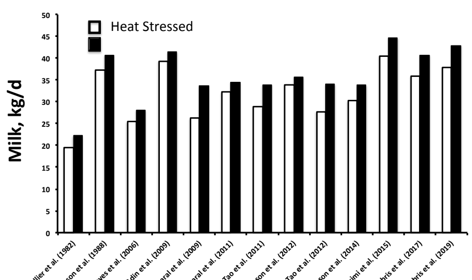
Do Amaral et al., *J. Dairy Sci.* 94:86–96

Cooling Dry Cows Increases Milk

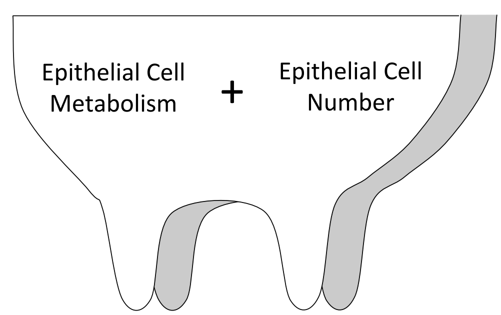


Tao et al., *J. Dairy Sci.* 94:5976–5986

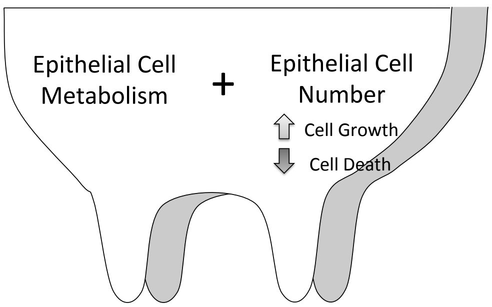
Cooling Dry Cows Increases Milk



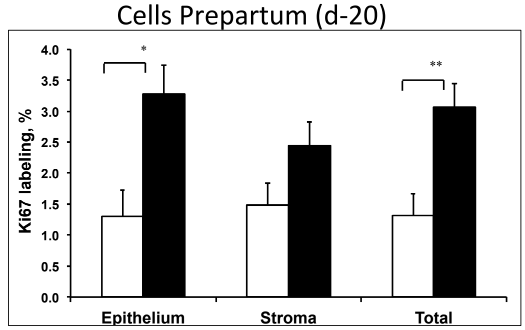
Milk Production



Milk Production

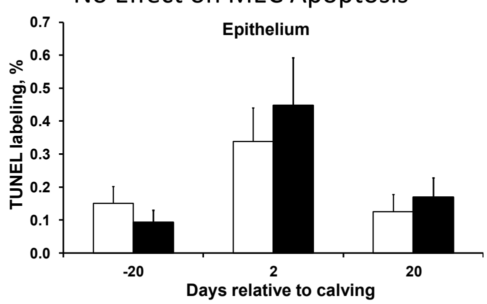


Cooling Increased Proliferation of Mammary Cells Prepartum (d-20)



Tao et al., *J. Dairy Sci.* 94:5976–5986

Heat Stress During Dry Period – No Effect on MEC Apoptosis

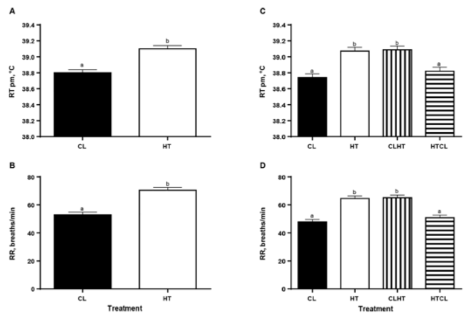


Tao et al., *J. Dairy Sci.* 94:5976–5986

Late Gestation Cooling

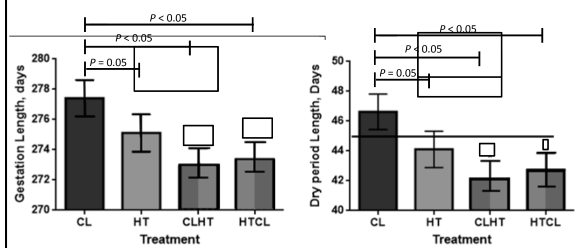
- Do I have to cool cows the entire dry period?
- Do heifers need to be cooled pre-partum?

Heat Stress Increases Rectal Temperature and Respiration Rate



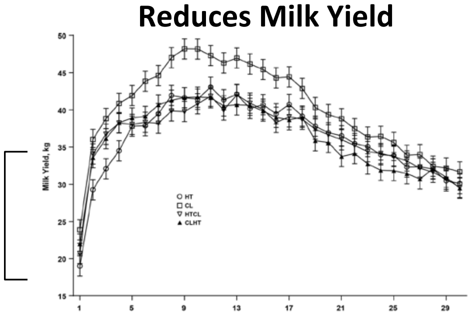
Fabris et al. , *J. Dairy Sci*. 102:5647-5656.

Heat Stress at Any Time Decreases Gestation Length and Dry Period Length



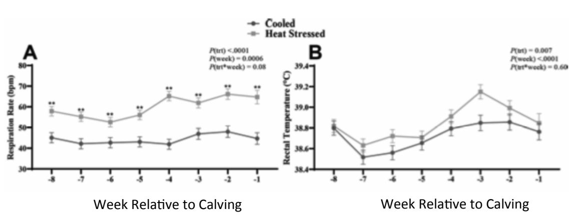
Fabris et al. , *J. Dairy Sci*. 102:5647-5656.

Heat Stress at Any Time When Dry Reduces Milk Yield



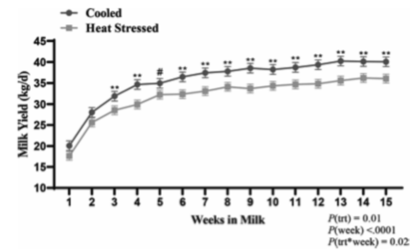
Fabris et al. , *J. Dairy Sci*. 102:5647-5656.

Heat Stress Effects on First Calf Heifers:
Cooling Decreases RR and RT



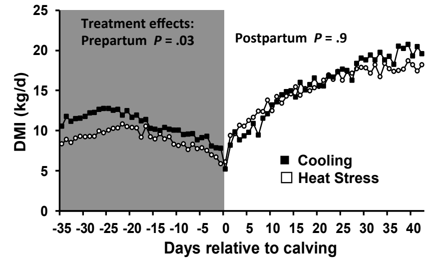
Davidson et al, *J. Dairy Sci.* 104:2357-2368

Heat Stress Effects on First Calf Heifers: Cooling Increases Yield



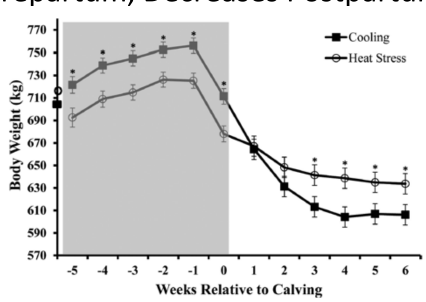
Davidson et al, *J. Dairy Sci.* 104:2357-2368

Heat Stress Reduces DMI Prepartum But Not Postpartum



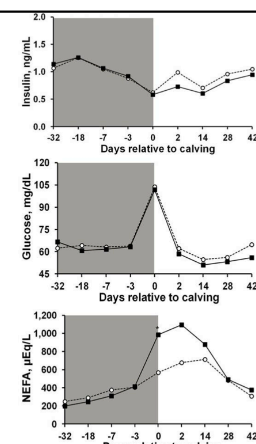
Tao et al., *J. Dairy Sci.* 94:5976–5986

Cooling Dry Cows Increases BW Prepartum, Decreases Postpartum



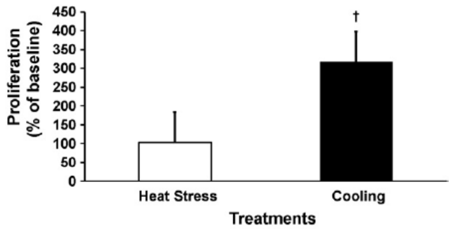
Thompson et al., *J. Dairy Sci.* 97:7426-7436

Effect of Cooling Dry Cows on Metabolic Profile



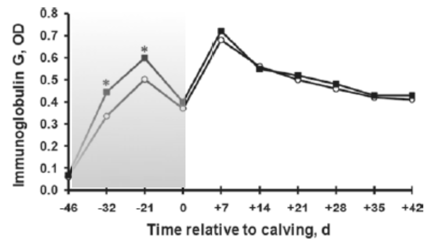
Tao et al., *J. Dairy Sci.* 95:5035-5046

Cooling Dry Cows Increases Lymphocyte Proliferation



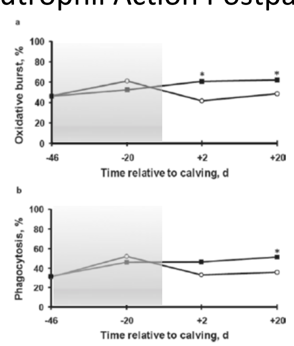
Do Amaral et al., *Domest. Anim. Endo.* 38:38-45

Cooling Dry Cows
Effects on Acquired Immunity



Do Amaral et al., *J. Dairy Sci.* 94:86–96

Cooling Dry Cows Increases Neutrophil Action Postpartum



Do Amaral et al., *J. Dairy Sci.* 94:86–96

Dry in COOL Months Improves Performance

Table 1. Milk production and occurrence of mastitis, digestive and respiratory problems, retained fetal membranes, and metritis in cows dried during HOT months (Jun, Jul, Aug) or COOL months (Dec, Jan, Feb) in the first 80 DIM of the subsequent lactation

	Dry during HOT months (Jun, Jul, Aug), n = 1,569				Dry during COOL months (Dec, Jan, Feb), n = 1,044				
Item	Value	Disease[1]	n	%	Value	Disease[1]	n	%	*P*-value
Milk production (kg)	10,351 ± 59.8				10,902 ± 73.3				0.01
Mastitis		0	1,286	82.0		0	950	91.0	0.01
		1	283	18.0		1	94	9.0	
Digestive		0	1,516	96.6		0	973	93.2	0.01
		1	53	3.4		1	71	6.8	
Respiratory		0	1,346	85.8		0	942	90.2	0.01
		1	223	14.2		1	102	9.8	
Retained fetal membranes		0	1,500	95.6		0	1,013	97.0	0.06
		1	69	4.4		1	31	3.0	
Metritis		0	1,500	95.6		0	1,007	96.4	0.35
		1	67	4.2		1	38	3.5	

[1]Disease: 0 = cows without the disease; 1 = cows with the disease.

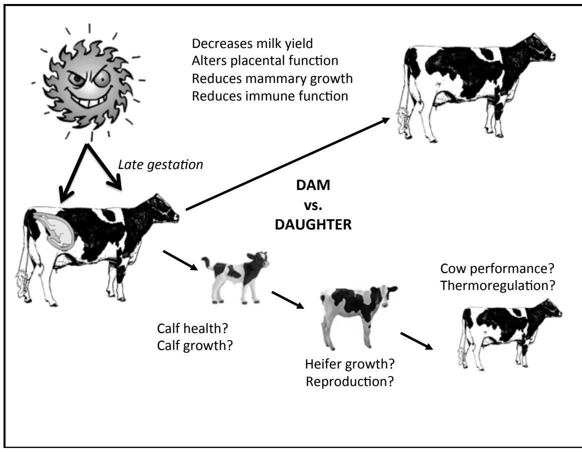
Thompson & Dahl, *Prof. Anim. Sci.* 28:628-631

Dry in COOL Months Improves Reproductive Performance

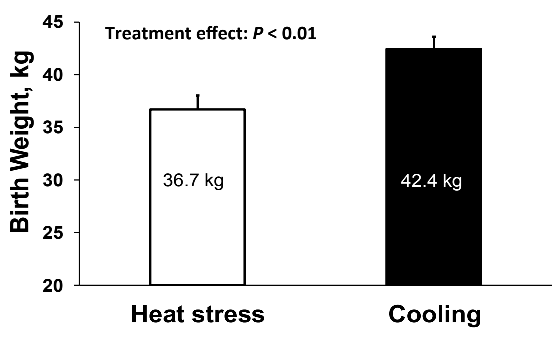
Table 3. Milk production and reproductive performance of cows dried during HOT months (Jun, Jul, Aug) or COOL months (Dec, Jan, Feb) in the first 150 DIM of the subsequent lactation on a commercial farm in Florida

Item	Dry during HOT months (Jun, Jul, Aug)	Dry during COOL months (Dec, Jan, Feb)	*P*-value
Milk production (kg)	10,547 ± 67.0	11,005 ± 83.38	0.01
Number of breedings (n)	1,048	676	0.03
Mean (no.)	1.59 ± 0.02	1.51 ± 0.03	
DIM to breeding (n)	1,047	676	0.01
Mean (d)	97.0 ± 0.74	91.8 ± 0.92	
DIM to pregnancy (n)	1,051	679	0.01
Mean (d)	131.1 ± 0.85	125.9 ± 1.06	

Thompson & Dahl, *Prof. Anim. Sci.* 28:628-631

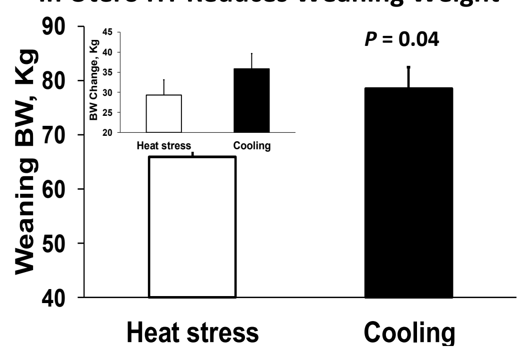


Cooling Increases Calf Birth Weight



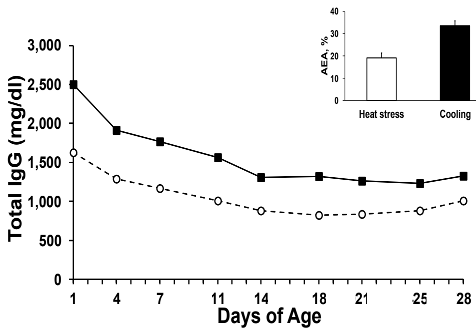
Tao et al., *J. Dairy Sci.* 95:7128-7136

In Utero HT Reduces Weaning Weight



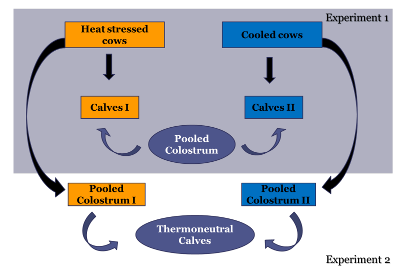
Tao et al., *J. Dairy Sci.* 95:7128-7136

Cooling Improves Total IgG and AEA



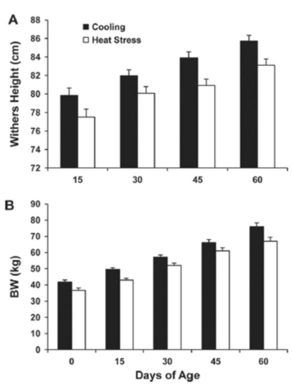
Tao et al., *J. Dairy Sci.* 95:7128-7136

Why Does Cooling Affect AEA? Calf or Colostrum Effect?



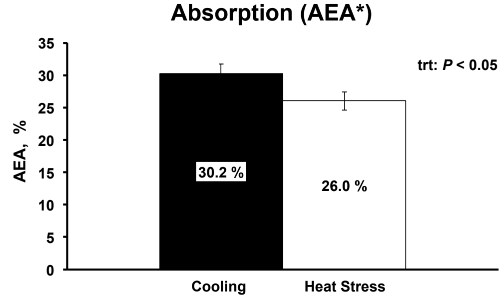
Monteiro et al., *J. Dairy Sci.* 97:6426-6439

Experiment 1 - In utero heat stress for ~6 weeks reduces body weight and height to weaning



Monteiro et al., *J. Dairy Sci.* 97:6426-6439

Cooling Increased Apparent Efficiency of IgG Absorption (AEA*)



* AEA = [Serum [IgG] (g/L) * birth weight (kg) * 0.091 / IgG fed (g)] x 100

Monteiro et al., *J. Dairy Sci.* 97:6426-6439

Experiment 2 – **No Effect** of Colostrum from Cooled or Heat Stressed Cows on Calf Performance

Growth performance of calves born to cows under thermoneutral conditions during the dry period and fed frozen colostrum from cows exposed to either heat stress or cooling during the dry period

Parameter	Heat Stress LSM ± SE	Cooling LSM ± SE	*P*-value
Birth Weight (kg)	38.8 ± 1.4	39.2 ± 1.5	0.8
Weaning Weight (kg)[1]	68.4 ± 2.5	64.8 ± 2.6	0.4
Preweaning BW Gain (kg)[2]	29.6 ± 2.3	25.6 ± 2.4	0.3
Avg. Daily Gain (kg/d)	0.49 ± 0.7	0.43 ± 0.8	0.2
Weaning Withers Height (cm)[1]	84.3 ± 0.8	83.0 ± 0.9	0.4
Preweaning Height Increase (cm)[2]	7.8 ± 1.1	6.2 ± 1.0	0.3

[1]Weaning weight and weaning height were measured at d 60 of age.
[2]Preweaning BW gain and height increase was calculated by individually subtracting data at d 60 of age by data at birth.

Monteiro et al., *J. Dairy Sci.* 97:6426-6439

J. Dairy Sci. 92:5988–5999
doi:10.3168/jds.2009-2343

Heat-stress abatement during the dry period: Does cooling improve transition into lactation?

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†Bovine Functional Genomics Laboratory, USDA-ARS, Beltsville Agricultural Research Center, Beltsville, MD 20705

J. Dairy Sci. 94:86–96
doi:10.3168/jds.2009-3004

Heat stress abatement during the dry period influences metabolic gene expression and improves immune status in the transition period of dairy cows

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J. Dairy Sci. 94:5976–5986
doi:10.3168/jds.2011-4329

Effect of heat stress during the dry period on mammary gland development

S. Tao, J. W. Bubolz, B. C. do Amaral,[1] I. M. Thompson, M. J. Hayen, S. E. Johnson, and G. E. Dahl[2]
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J. Dairy Sci. 95:5035–5046
http://dx.doi.org/10.3168/jds.2012-5405

Effect of cooling heat-stressed dairy cows during the dry period on insulin response

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J. Dairy Sci. 97:7426–7436
http://dx.doi.org/10.3168/jds.2013-7621

Effect of cooling during the dry period on immune response after *Streptococcus uberis* intramammary infection challenge of dairy cows

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Retrospective analysis of records of calves from 5 studies between 2007 and 2011

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

J. Dairy Sci. 92:5988–5999
doi:10.3168/jds.2009-2343
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Heat-stress abatement during the dry period: Does cooling improve transition into lactation?
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Heat Stress Experiments 2007 - 2011

	Bulls	Heifers	**Total**
Cooling	31	41	72
Heat Stress	30	44	74
Total	61	85	147

J. Dairy Sci. 97:7426–7436
http://dx.doi.org/10.3168/jds.2013-7621
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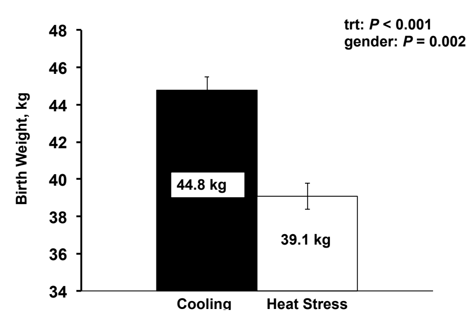
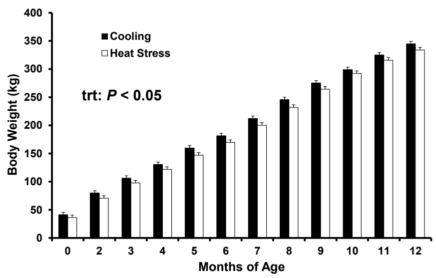
Birth Weight



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

In Utero Heat Stress Decreases Calf Bodyweight to Puberty



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

In Utero HS Decreases Calf Survival

Table 1. Effect of maternal heat stress (HT) or cooling (CL) during late gestation on calf survival

	CL				HT				*P*
Parameter	AI	IVF[1]	Total	%[2]	AI	IVF	Total	%	Trt[3]
Bull calves, n	30	1	31	---	28	2	30	---	---
Heifer calves, n	29	12	41	---	29	15	44	---	---
DOA[4]	0	0	0	0.0	2	1	3	4.1	0.25
Males mortality by 4 mo of age	1	0	1	3.2	3	0	3	10.0	0.35
Heifers leaving herd before puberty	1	4	5	12.2	3	7	10	22.7	0.26
Due to sickness, malformation or growth retardation	1	0	1	2.4	3	5	8	18.2	0.03
Heifers leaving herd after puberty, before first lactation	1	0	1	2.4	3	0	3	6.8	0.62
Heifers completing first lactation	27	8	35	85.4	22	7	29	65.9	0.05

[1] IVF = in vitro fertilization.
[2] Percentage of animals (AI + IVF) affected out of total animals (males or females) in the respective treatment.
[3] Treatment.
[4] Dead on arrival. Includes male and female calves.

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

In Utero Heat Stress Decreases Reproductive Performance

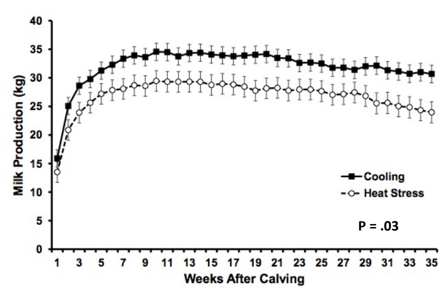
Table 2. Effect of maternal heat stress (HT) or cooling (CL) during late gestation on reproductive performance before first lactation of heifers born to HT or CL dams

Parameter	CL	HT	SEM	*P*
N	36	32	---	---
Age at first AI, mo	13.6	13.8	0.2	0.32
Services per pregnancy d[1] 30	2.0	2.5	0.2	0.05
Age at pregnancy d[1] 30, mo	16.1	16.9	0.3	0.07
Services per pregnancy d[1] 50	2.3	2.6	0.2	0.32
Age at calving, mo	24.8	25.0	0.4	0.72

[1] Days after insemination.

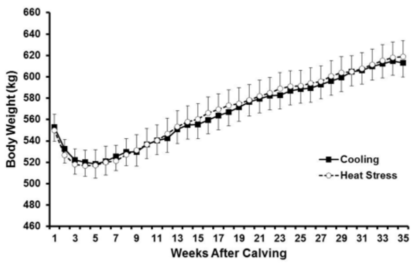
Monteiro et al. , *J. Dairy Sci*. 99:8443-8450.

In Utero Heat Stress Reduces Milk Production



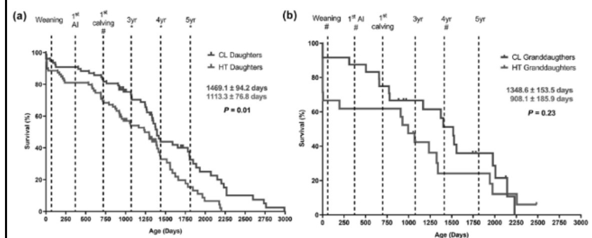
Monteiro et al. , *J. Dairy Sci*. 99:8443-8450.

In Utero Heat Stress Does Not Affect Mature Bodyweight



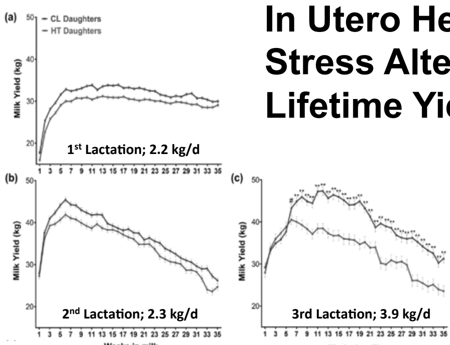
Monteiro et al. , *J. Dairy Sci*. 99:8443-8450.

In Utero Heat Stress Reduces Survival in Herd



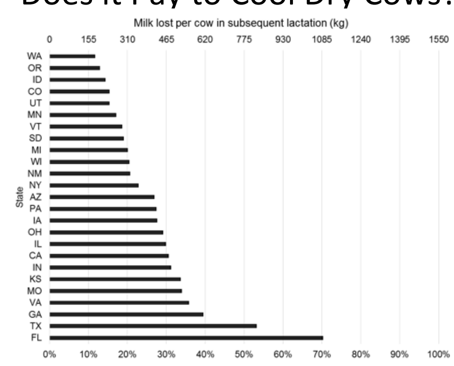
Laporta et al. , *J. Dairy Sci*. 103:7555-7568.

In Utero Heat Stress Alters Lifetime Yield



Laporta et al. , *J. Dairy Sci*. 103:7555-7568.

Does it Pay to Cool Dry Cows?



Ferreira et al., *J. Dairy Sci.* 99:9931–9941.

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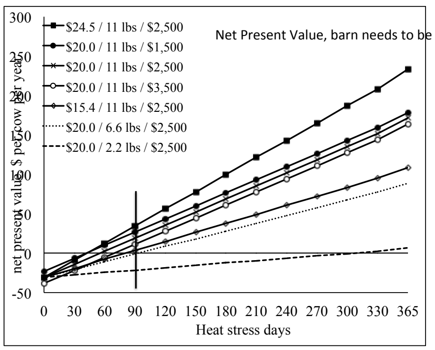
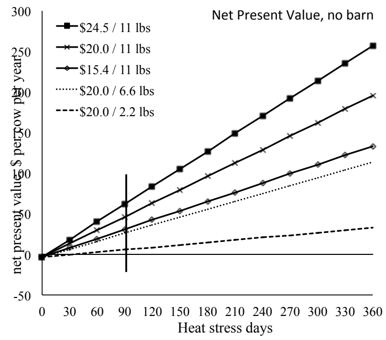


Ferreira et al., *J. Dairy Sci.* 99:9931–9941.

Does it Pay to Cool Dry Cows?



Ferreira et al., *J. Dairy Sci.* 99:9931–9941.

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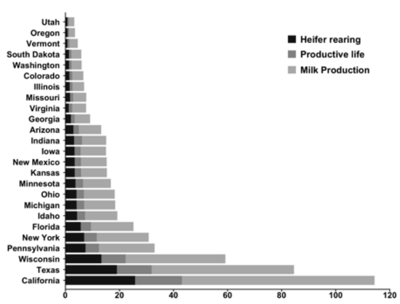

Laporta et al., *J. Dairy Sci.* 103:7555–7568.