GESTATIONAL HEAT STRESS: PROLONGED EFFECTS ON CALVES

- What is heat stress?
  - Impact on daughter milk production
- Heat stress during late gestation
  - Passive transfer of immunity
  - Growth and production performance

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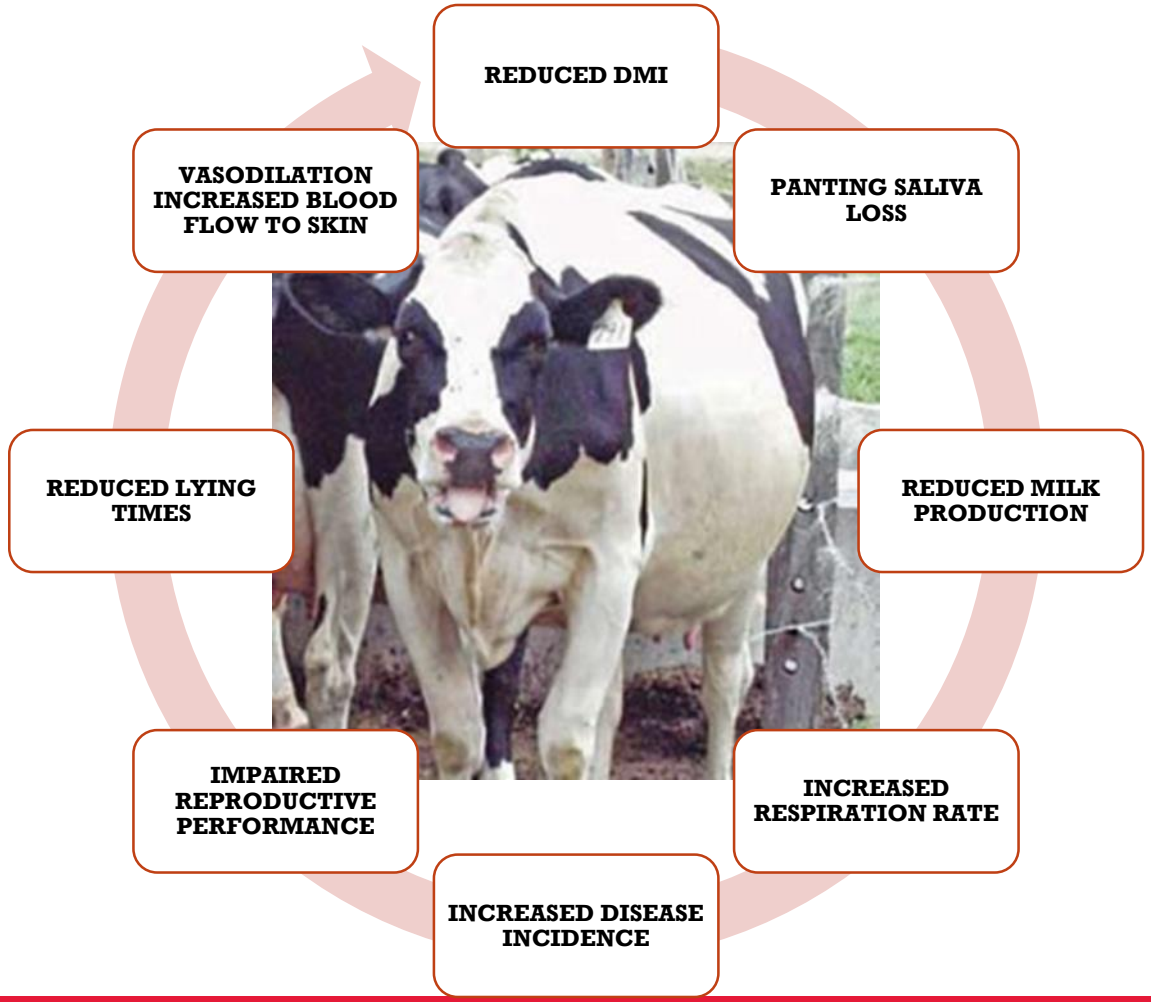
What is Heat Stress?

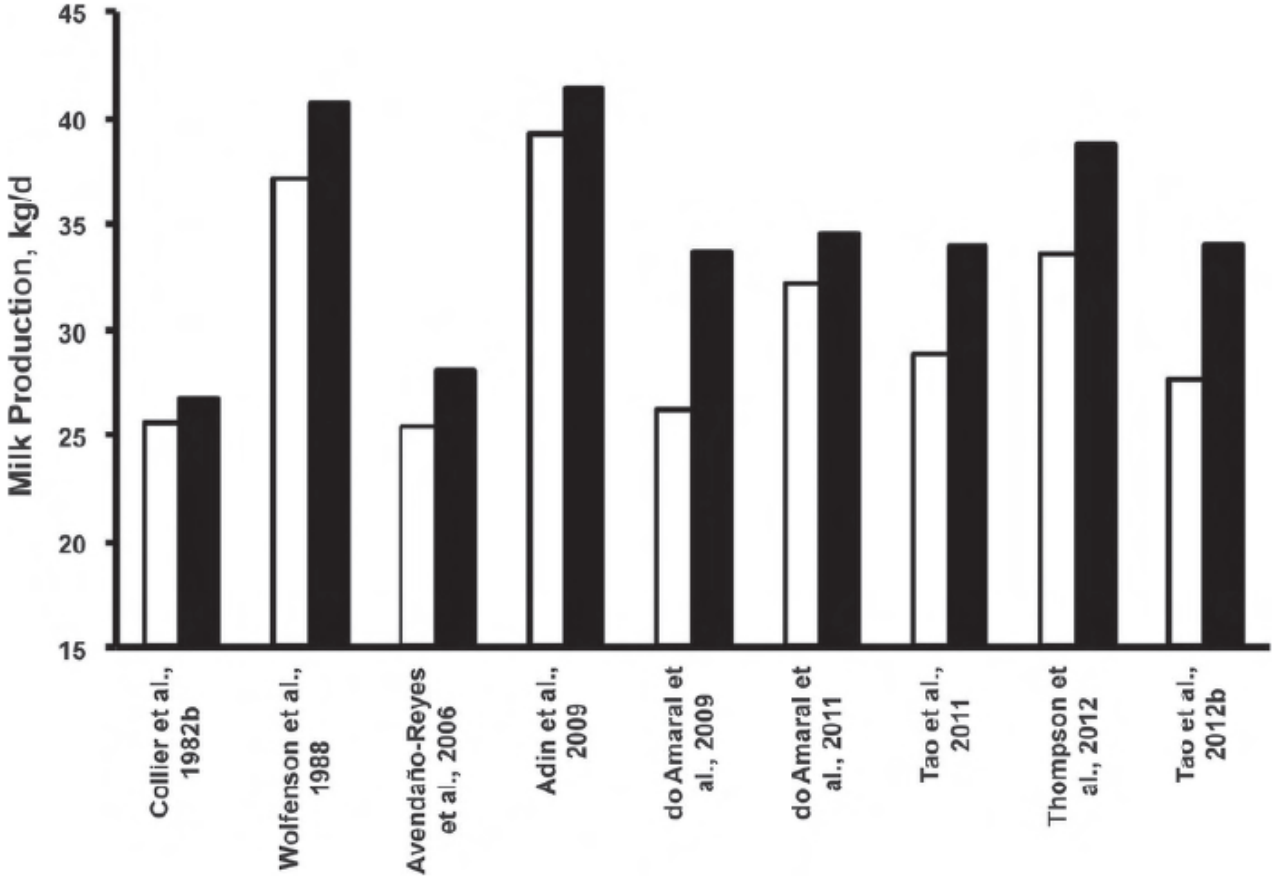
- When a cow's heat load exceeds her capacity to dissipate heat.
  - Most heat is lost via the skin, in times of heat stress, blood will be redirected to the skin to aid heat loss, and away from internal organs.

PHYSIOLOGICAL RESPONSES TO HEAT STRESS



HEAT STRESS DURING THE DRY PERIOD

- Heat stress
- Cooled



Tao and Dahl, 2013

The degree of heat stress exposure for dairy cattle is considered as a temperature humidity index (THI).
At a THI of 68, and relative humidity of 50%, cows may experience heat stress and an associated drop in milk yield at temperatures as low as 72°F.

DAIRY COW TEMPERATURE HUMIDITY INDEX (THI)

	Humidity %																		
Temp °F	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90
72	64	65	65	65	66	66	67	67	67	68	68	69	69	69	70	70	70	71	71
74	65	66	66	67	67	67	68	68	69	69	70	70	70	71	71	72	72	73	73
76	66	67	67	68	68	69	69	70	70	71	71	72	72	73	73	74	74	75	75
78	67	68	68	69	69	70	70	71	71	72	72	73	73	74	74	75	75	76	76
80	68	69	69	70	70	71	72	72	73	74	75	75	76	76	77	78	78	79	79
82	69	69	70	70	71	72	73	73	74	75	75	76	77	77	78	79	79	80	80
84	70	70	71	72	73	73	74	75	75	76	77	78	78	79	80	80	81	82	83
86	71	71	72	73	74	74	75	76	77	78	78	79	80	81	81	82	83	84	84
88	72	72	73	74	75	76	76	77	78	79	80	81	81	82	83	84	85	86	86
90	72	73	74	75	76	77	78	79	79	80	81	82	83	84	85	86	86	87	88
92	73	74	75	76	77	78	79	80	81	82	83	84	85	85	86	87	88	89	90
94	74	75	76	77	78	79	80	81	82	83	84	86	86	87	88	89	90	91	92
96	75	76	77	78	79	80	81	82	83	85	86	87	88	89	90	91	92	93	94
98	76	77	78	80	80	82	83	83	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
102	78	79	80	82	83	84	85	86	87	89	90	91	92	94	95	96	97	98	100
104	79	80	81	83	84	85	86	88	89	90	91	93	94	95	96	98	99	100	101
106	80	81	82	84	85	87	88	89	90	91	93	94	95	97	98	99	101	102	103
108	81	82	83	85	86	88	89	90	92	93	94	96	97	98	100	101	103	104	105
110	81	83	84	86	87	89	90	91	93	95	96	97	99	100	101	103	104	106	107

HUMAN HEAT INDEX

	Humidity %									
Temp °F	40	45	50	55	60	65	70	75	80	85	90
72											
74											
76											
78											
80	80	80	81	81	82	82	83	84	84	85	86
82	81	82	83	84	84	85	86	88	89	90	91
84	83	84	85	86	88	89	90	92	94	96	98
86	85	87	88	89	91	93	95	97	100	102	105
88	88	89	91	93	95	98	100	103	106	110	113
90	91	93	95	97	100	103	105	109	113	117	122
92	94	96	99	101	105	108	112	116	121	126	131
94	97	100	103	106	110	114	119	124	129	135	
96	101	104	108	112	116	121	126	132			
98	105	109	113	117	123	128	134				
100	109	114	118	124	129	136					
102	114	119	124	130	137						
104	119	124	131	137							
106	124	130	137								
108	130	137									
110	136										

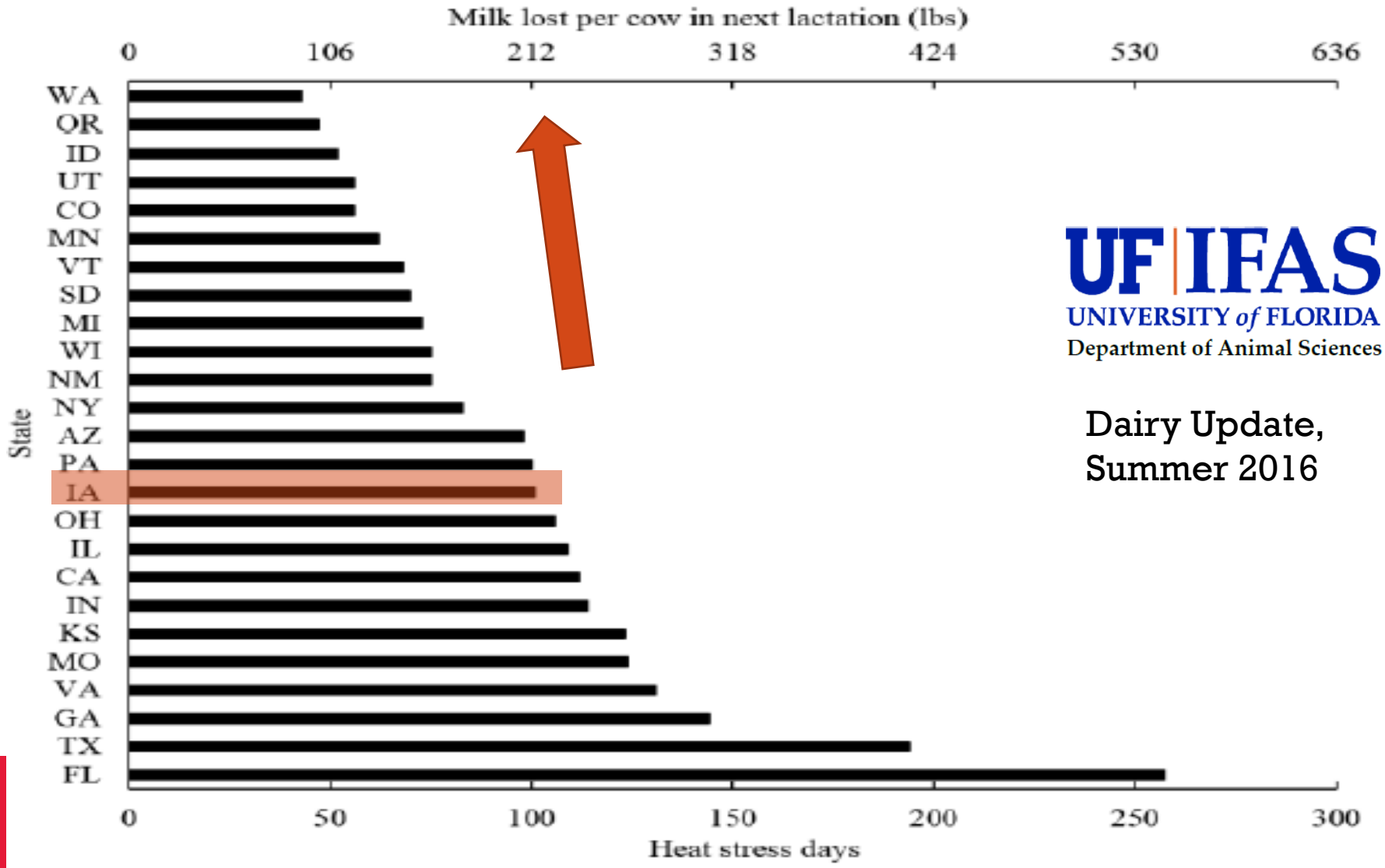
Stress threshold for lactating cows. Respiration rate may exceed 60 BPM. Milk loses begin ~ 2.5 lbs/cow/day. Reproductive loses are detectable and rectal temperature exceeds 101.3°F. Caution for people depending on age, exposure and activity. People may not feel heat stress until 80°F and 40% humidity.

Mild to moderate stress for lactating cows. Respiration rates may exceed 75 BPM. Milk loses ~ 6 lbs/cow/day. Rectal temperatures will exceed 102.2°F. Extreme Caution for people depending on age, exposure and activity.

Moderate to severe stress for lactating cows. Respiration rate exceeds 85 BPM. Milk loses ~ 8.7 lbs/cow/day. Rectal temperature exceeds 104°F. Danger for people depending on age, exposure and activity.

Severe stress! Life threatening conditions for lactating cows. Respiration rates are 120-140 BPM. Rectal temperatures may exceed 106°F. Extreme Danger of heat exhaustion and/or heat stroke for people when working in these conditions.

HEAT STRESS DAYS BY STATE



UF IFAS
UNIVERSITY of FLORIDA
Department of Animal Sciences

Dairy Update,
Summer 2016

RESEARCH ARTICLE

2015

Periconceptional Heat Stress of Holstein Dams Is Associated with Differences in Daughter Milk Production and Composition during Multiple Lactations

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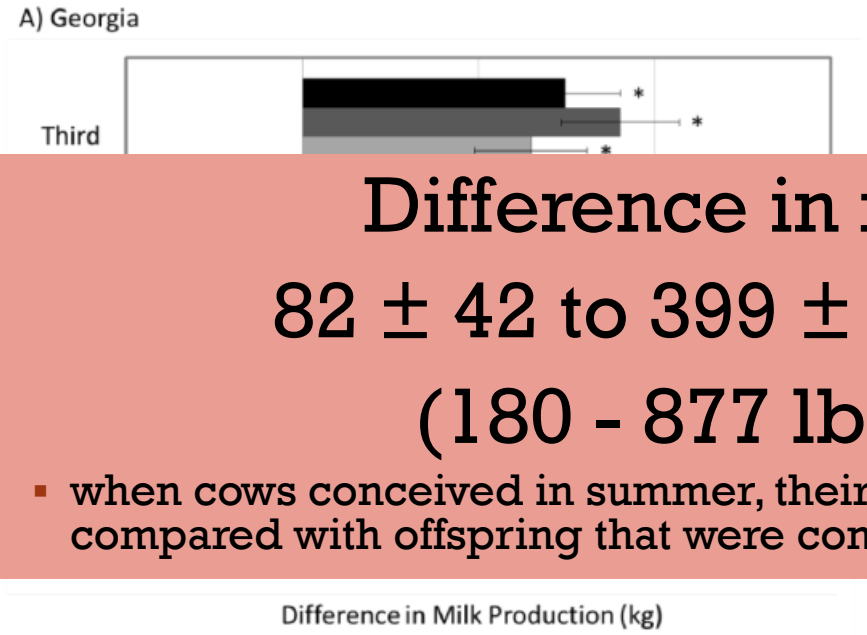
METHODS

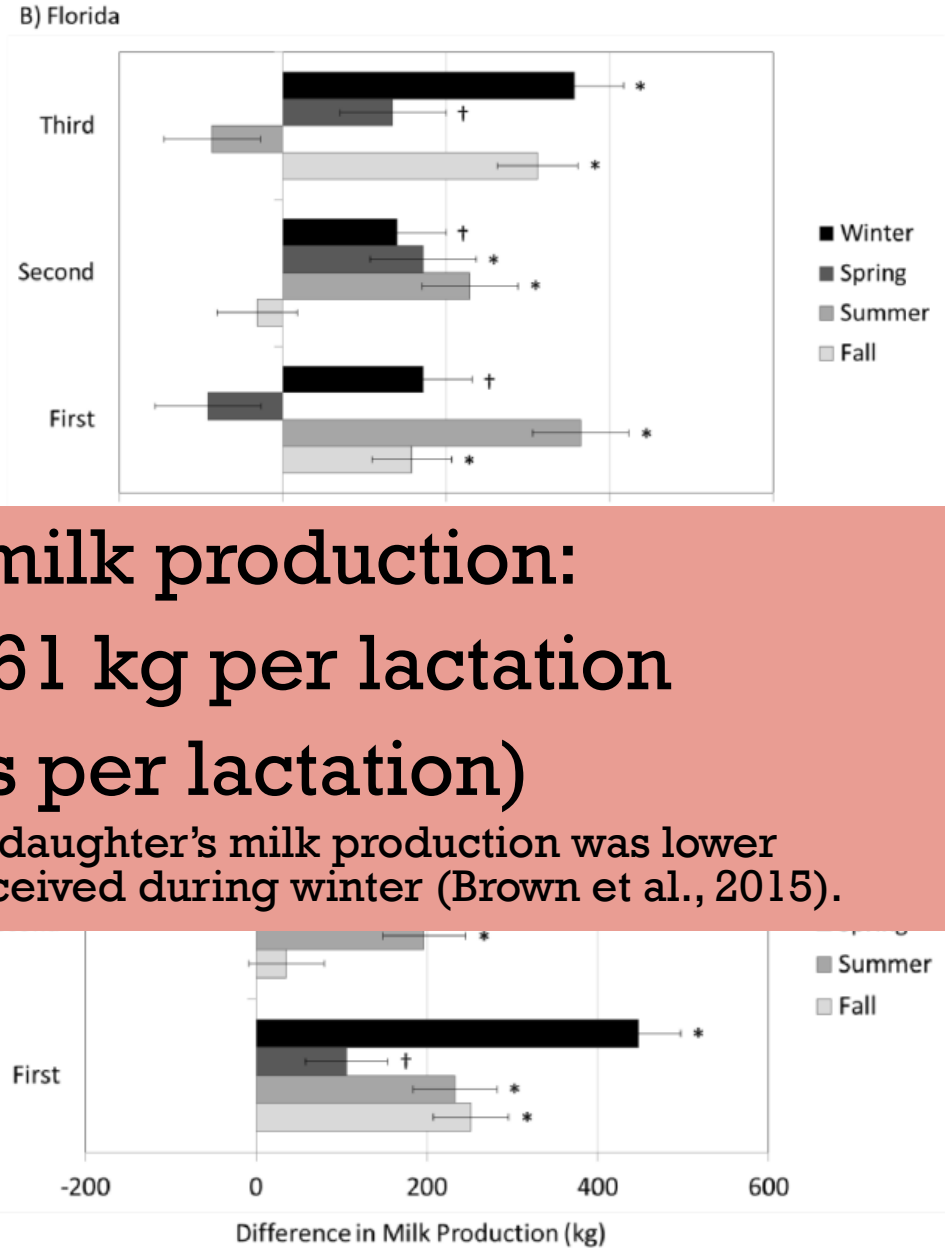
- DHIA data for GA, FL and TX: 2000-2010
- Holstein cows with first 3 full lactations
- Herd size >10 cows

- Thermoneutral conception: TNC (n = 47,000)
  - Conceived December-February
- Heat stressed conception: HSC (n = 29,000)
  - Conceived June-August
- Estimated gestation length = 276 days
- Production – 75,000 records
  - 305-day adjusted mature-equivalent milk
  - % protein and % fat

Brown et al. 2015

MILK PRODUCTION





Difference in milk production:

82 ± 42 to 399 ± 61 kg per lactation

(180 - 877 lbs per lactation)

- when cows conceived in summer, their daughter's milk production was lower compared with offspring that were conceived during winter (Brown et al., 2015).

Brown et al. 2015

J. Dairy Sci. 95:7128–7136
http://dx.doi.org/10.3168/jds.2012-5697
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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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J. Dairy Sci. 99:8443–8450
http://dx.doi.org/10.3168/jds.2016-11072
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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]
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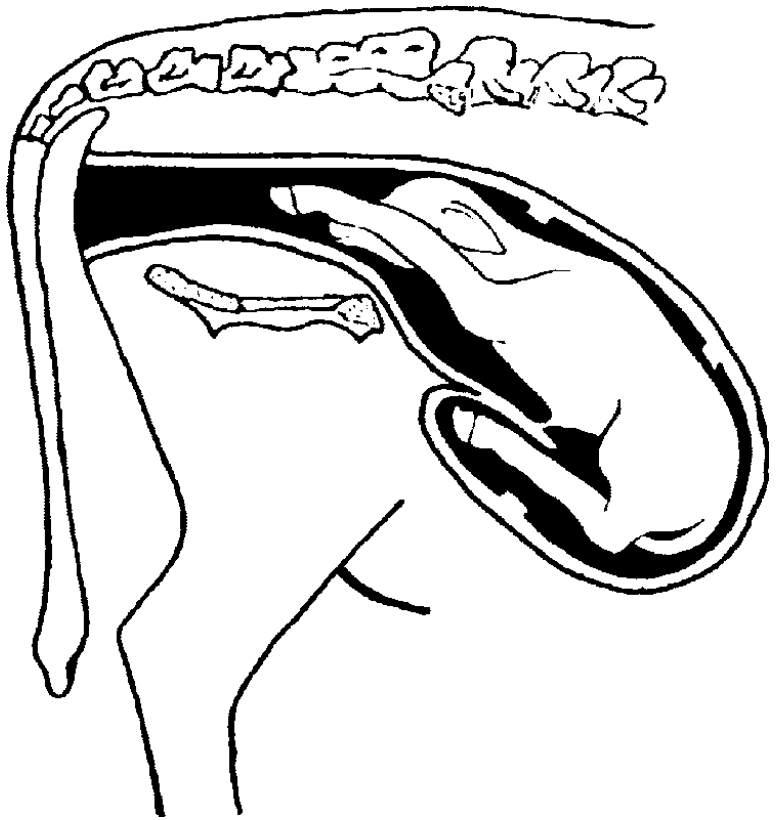
THE FETUS IN LATE GESTATION

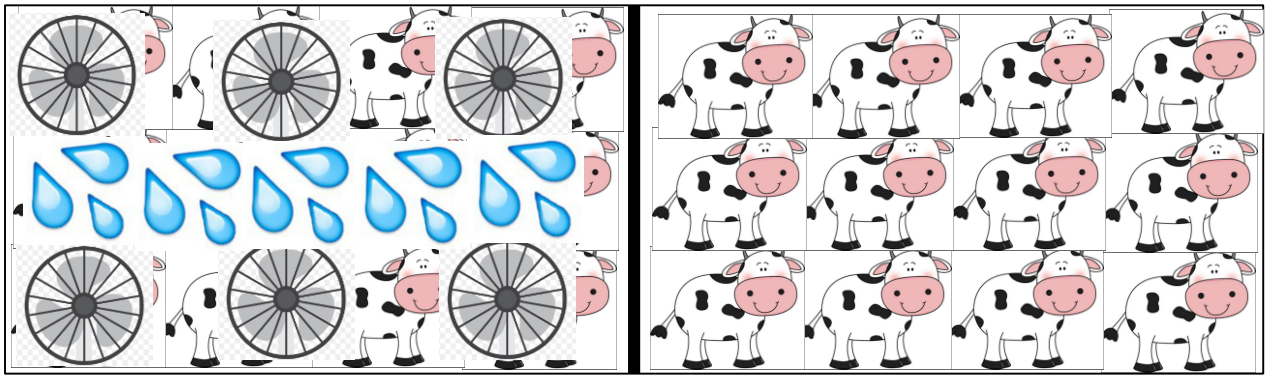
- 60% of body weight gained in last 2 months
- 0.6°C higher body temp
- Higher metabolic rate
- 85% heat loss through fetal-placental circulation



METHODS FOR UF EXPERIMENTS

- For 5 consecutive summers:
  - Cows dried off 46 days before calving date
  - Freestall barn
  - Assigned randomly to CL or HT group

CL



HT

Tao et al. 2012; Monteiro et al. 2016

CALF MANAGEMENT

- Calves fed 1 gallon (3.8 L) of colostrum within 4 h of birth

- D 1-29: 1.9 L pasteurized milk, twice daily
- D 30-41: up to 3.8 L / twice daily
- D 42-48: 1.9 L once daily
- D 49: weaned

- Management same for both HT and CL calves

Tao et al. 2012; Monteiro et al. 2016

Birth weight

HT	CL	SEM	*P* value
36.5 kg	42.5 kg	1.2	<0.01

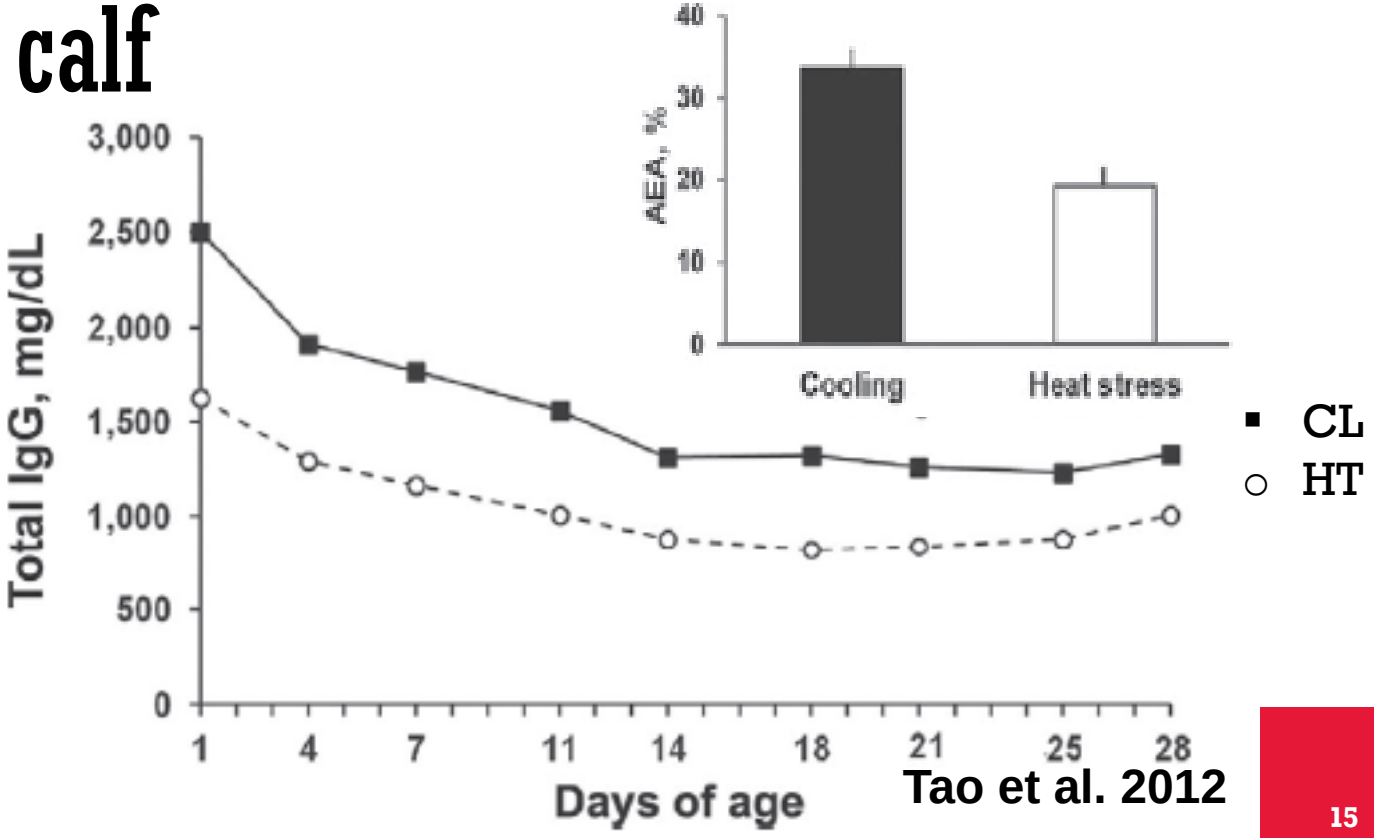
	HT	CL	SEM	*P* value
No. dams	16	16		
THI	78.3	78.3		
Rectal temperature (°C) AM PM	 38.64 39.34	 38.55 38.98	 0.04 0.05	 0.12 <0.01
Respiration rate (breath/min)	69.2	48.3	2.8	<0.01
DMI (kg/d)	10.2	11.4		0.10
BW gain over dry period (kg)	9.6	26.0	4.5	0.01
Gestation length (d)	272	276	1.2	0.02
Milk yield in subsequent lactation (kg/d)	27.7	34.0		<0.01

Tao et al. 2012a, b

COLOSTRUM IGG: DAM

	HT	CL	SEM	*P*-value
Colostrum IgG (mg/dL)	8,681	7,727	726	0.36

Serum IgG: calf



Tao et al. 2012

COLOSTRUM QUALITY OR CALF ABSORPTIVE CAPACITY?

Monteiro et al. 2014

1. HT and CL calves fed pooled colostrum from non-heat stressed cows
   - CL calves had greater AEA
2. Calves born in winter (not heat-stressed)
   - Fed HT or CL colostrum
   - No difference in AEA or growth

→ Issue with absorption of IgG

CONCLUSIONS

- Cooling cows did reduce exposure to heat stress
- Calf birth weight reduced when cows were heat stressed during late gestation
- Passive transfer of immunity was compromised

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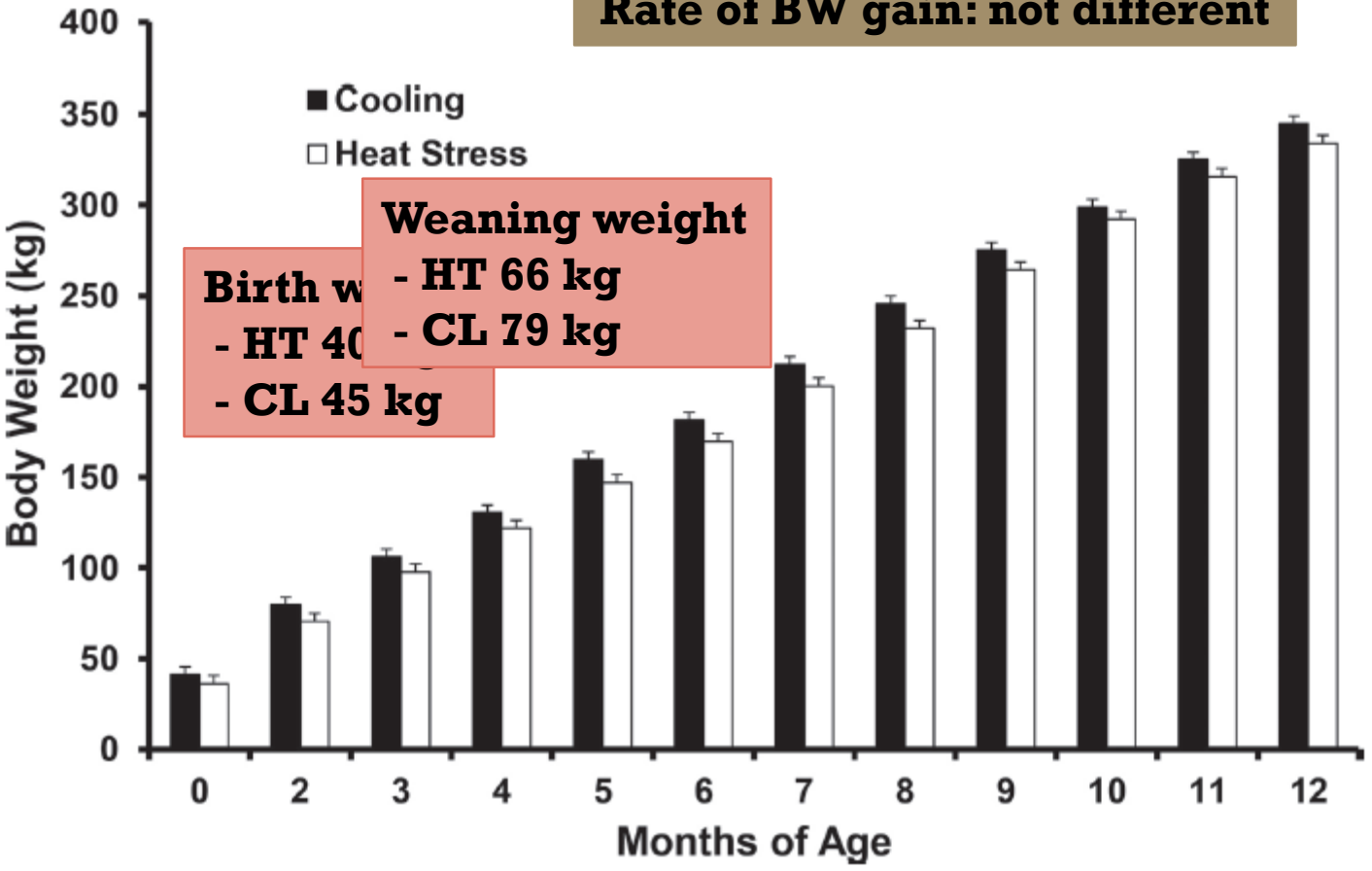
METHODS

- Results pooled from 5 consecutive summers

	No. animals	HT	CL
Birth weight	146	74	72
Calf survival	146	74	72
Monthly body weight (2-12mo)	72	34	38
Fertility outcomes	72	34	38
Milk production	64	29	35

GROWTH PERFORMANCE

Rate of BW gain: not different



Weaning weight
- HT 66 kg
- CL 79 kg

Birth w
- HT 4(
- CL 45 kg

SURVIVAL TO FIRST LACTATION

	HT	CL	*P* value
No. heifers	44	41	--
Still born	3	0	0.25
% leaving pre-puberty	22.7%	12.2%	0.26
% leaving due to sickness, malformation, growth	18.2%	2.4%	0.03
% leaving after puberty, before 1st lactation	6.8%	2.4%	0.62
% completing 1st lactation	65.9%	85.4%	0.05

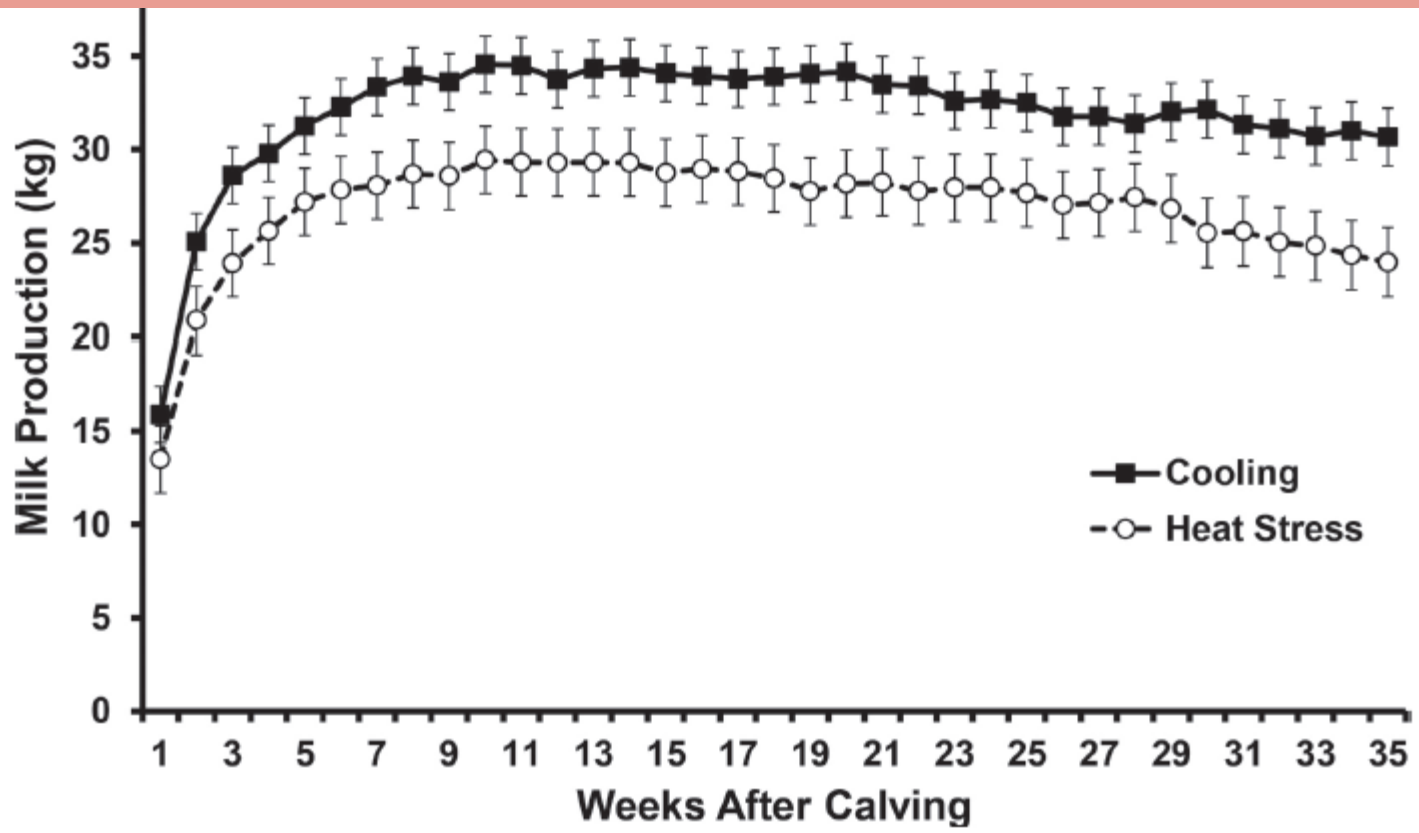
FERTILITY OUTCOMES

	HT	CL	SEM	*P* value
No. heifers	32	36	--	--
Age at first AI (mo)	13.8	13.6	0.2	0.32
Services per pregnancy (d30)	2.5	2.0	0.2	0.05
Age at pregnancy (mo)	16.9	16.1	0.3	0.07
Services per pregnancy (d50)	2.6	2.3	0.2	0.32
Age at calving	25.0	24.8	0.4	0.72
BCS at calving	3.5	3.5	0.2	--

27 kg/d for HT vs. 32 kg/d for CL

Over 35 weeks = 1,250 kg milk difference

Heifers from heat-stressed dams produced, on average, 11 lbs. of milk/d less than those from cooled dams, equating to a total difference of approximately 2750 lbs. of milk/cow during the first 245 DIM.



Monteiro et al. 2016

CONCLUSIONS

Calves from heat stressed cows:

- Were lighter at birth, through to 12 mo
- Fewer survived to complete the first lactation
- Had poorer fertility outcomes
- Lower milk production in the first lactation

SUMMARY

- Heat stress conditions at **conception** or **late gestation** reduces daughter milk production
- Lower birth weights and compromised transfer of immunity compromised calves heat stressed in utero
- Cooling cows during late gestation effective to lessen impacts of heat stress on calves