Management Barriers to High Fertility

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Extension
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Outline

- Effect of mastitis on fertility
  - Fuenzalida et al., 2015
- The High Fertility Cycle
- Heat stress and reproduction

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J. Dairy Sci. 98:3791–3805
http://dx.doi.org/10.3168/jds.2014-8997

The association between occurrence and severity of subclinical and clinical mastitis on pregnancies per artificial insemination at first service of Holstein cows

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Department of Dairy Science, University of Wisconsin, Madison 53706

DEPARTMENT OF
DAIRY SCIENCE
University of Wisconsin-Madison

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Introduction

The specific mechanisms by which mastitis affects reproduction remain unclear

- **Cytokines could lead to induction of $PGF_{2\alpha}$ release and induce an early luteolysis of corpus luteum, thus jeopardizing establishment of pregnancy** (Hansen et al., 2004).

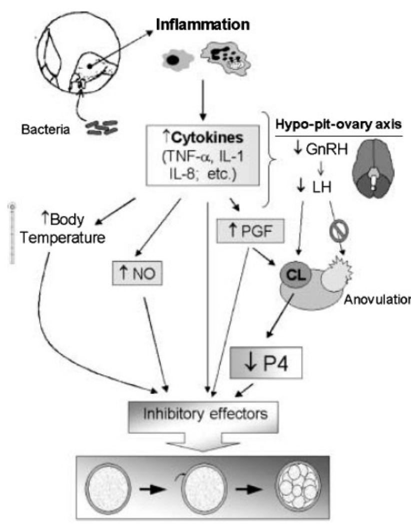

Figure adopted from Hansen et al., 2004

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Herd Characteristics

Table 1. Descriptive characteristics of enrolled cows (n = 3,164) from 4 Wisconsin dairy herds

Farm	Number of cows per herd	Eligible for the study	Enrolled in the study	Used for analysis	P/AI (%)	Use of TAI (%)	Milk yield (kg per cow)	SCC (cells per mL)
A	1,429	913	889	888	39.0^{a}	93.9^{c}	46.1^{b}	$51{,}823^{b}$
B	1,382	1,017	981	965	44.7^{b}	87.6^{b}	46.0^{b}	$47{,}492^{ab}$
C	817	761	735	734	48.7^{b}	99.5^{d}	48.6^{c}	$44{,}723^{a}$
D	750	586	559	557	38.6^{a}	57.6^{a}	43.0^{a}	$72{,}639^{c}$
Overall	4,378	3,277	3,164	3,144	42.9	86.7	46.1	51,788

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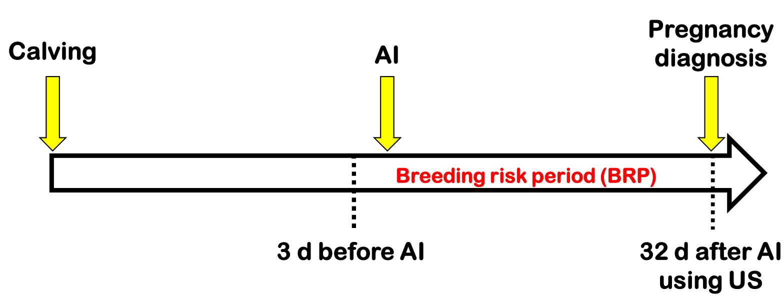
Breeding Risk Period



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Microbiological analysis

- **UW Milk quality laboratory** (NMC, 1999)
- **Microbiological diagnosis was defined at the quarter level**
- **Bacteria were identified at the species level**
- **An intramammary infection was defined as the isolation of 100 cfu/ml of identical colonies**

MJ1

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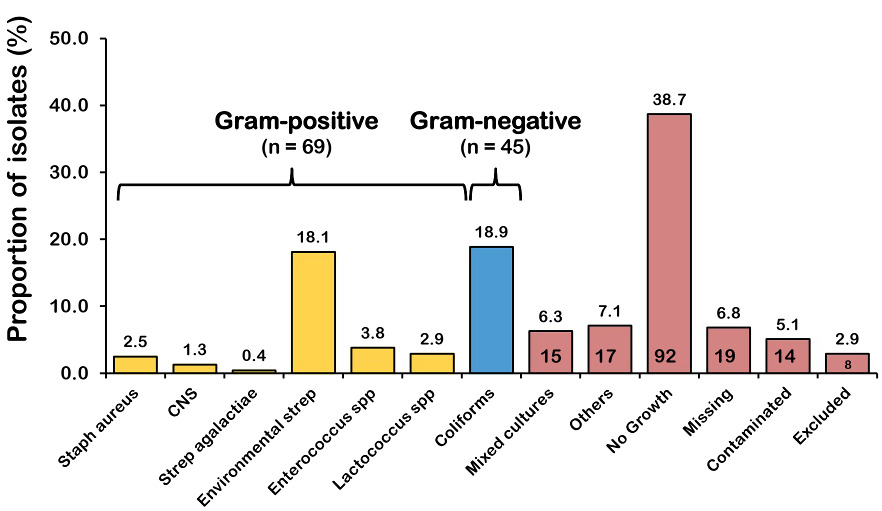
Microbiological diagnosis of quarter milk samples from clinical mastitis cases (n=279) occurring during the Breeding Risk Period on 4 WI dairies



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Slide 7

MJ1 Staph aureus was defined with at least 10 cfu/ml
María Josesita, 7/13/2014

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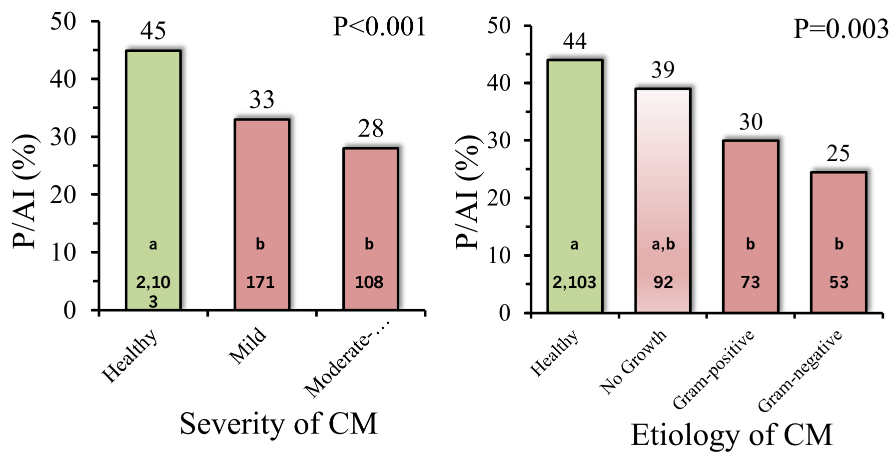
Relationship between P/AI and Severity and Etiology of CM



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J. Dairy Sci. 98:3791–3805
http://dx.doi.org/10.3168/jds.2014-8997

The association between occurrence and severity of subclinical and clinical mastitis on pregnancies per artificial insemination at first service of Holstein cows

M. J. Fuenzalida, P. M. Fricke, and P. L. Ruegg[1]
Department of Dairy Science, University of Wisconsin, Madison 53706

Effect of mastitis on fertility

- Mastitis events occurring during the breeding risk period have a profound negative effect on fertility
- Prevention and control of mastitis is essential for high fertility

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J. Dairy Sci. 101:10142–10150
https://doi.org/10.3168/jds.2018-14619

Epidemiologic and economic analyses of pregnancy loss attributable to mastitis in primiparous Holstein cows

Mohammad O. Dahl,*† Albert De Vries,‡ Fiona P. Maunsell,* Klibs N. Galvao,*§ Carlos A. Risco,*# and Jorge A. Hernandez*[1]
*Department of Large Animal Clinical Sciences, College of Veterinary Medicine, University of Florida, Gainesville 32611-0910
†Department of Medicine and Preventive Medicine, College of Veterinary Medicine, University of Mosul, Mosul, Iraq 41002
‡Department of Animal Sciences, University of Florida, Gainesville 32611-0910
§D. H. Barron Reproductive and Perinatal Biology Research Program, University of Florida, Gainesville 32610
#Center for Veterinary Health Sciences, Oklahoma State University, Stillwater 74078-2005

- **A total of 687 primiparous Holstein cows from 1 dairy farm were included in a matched case-control study.**
- **Mastitis before breeding was not associated with pregnancy loss.**
- **The odds of pregnancy loss were 2.21 times greater in cows affected with clinical mastitis during gestation compared with cows without mastitis.**

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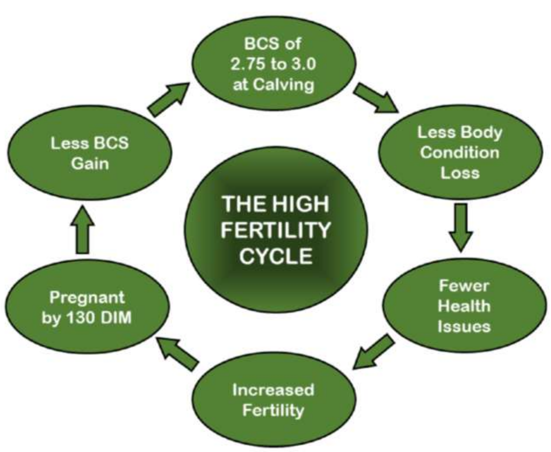
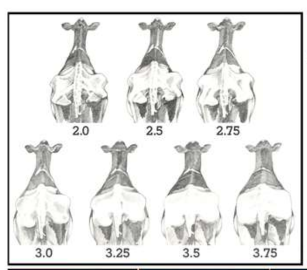
JDS Communications®
2022; 3
https://doi.org/10.3168/jdsc.2022-0280
Mini-Review
Physiology

Mini-Review: The high fertility cycle

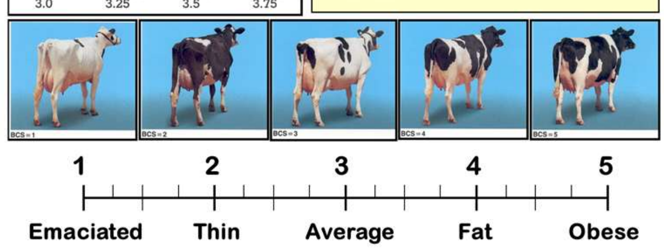
P. M. Fricke,[1]* M. C. Wiltbank,[1] and J. R. Pursley[2]





Body Condition Scoring

- BCS is a noninvasive method for estimating fat stores in live cows.
- Define: Ratio between amount of fat to the amount of nonfat matter (water, protein, ash) in the body of a living animal.
- Body condition change is an easy way to assess energy balance on farms.



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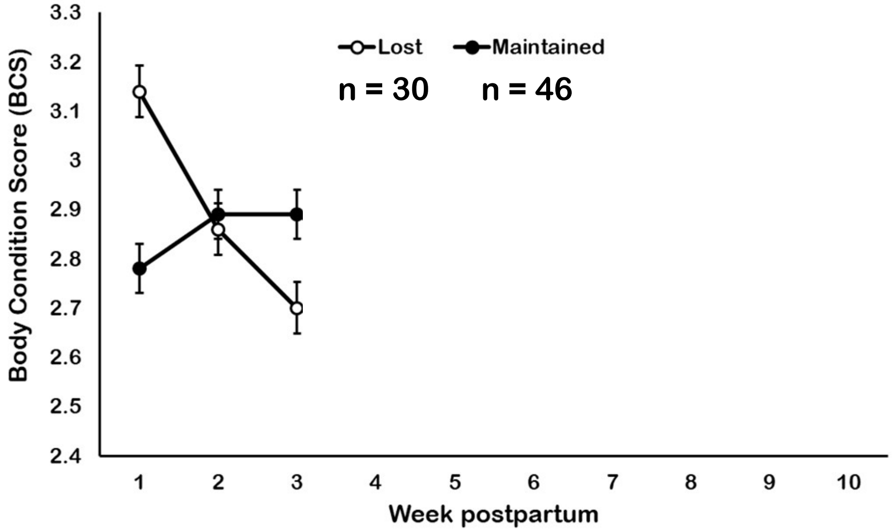
Jack H. Britt

AABP 24th Annual Convention, 1992



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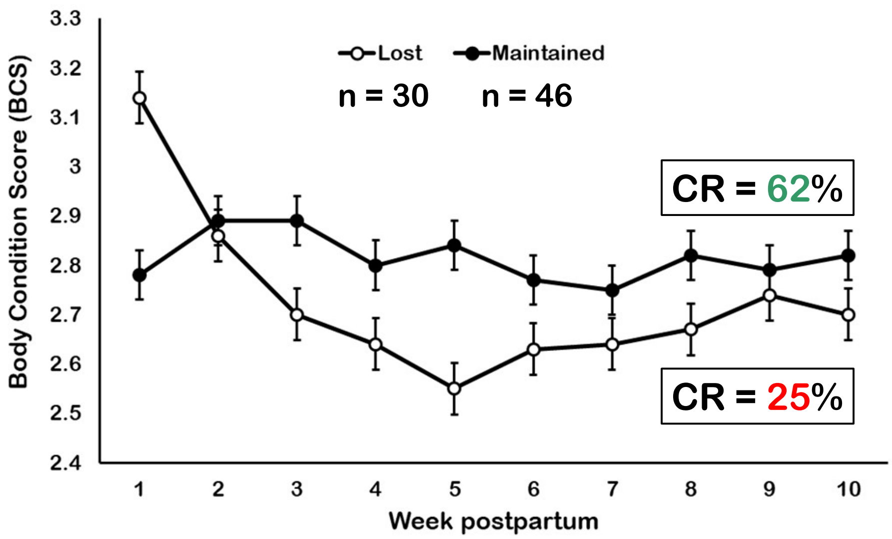
Jack H. Britt

AABP 24th Annual Convention, 1992



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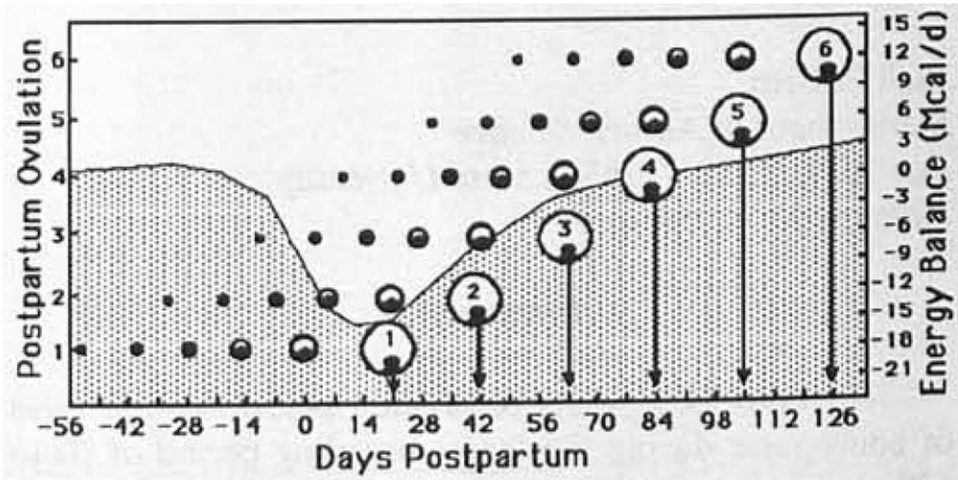
Jack H. Britt

AABP 24th Annual Convention, 1992



"The Britt Hypothesis"

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Four Studies:

Relationships among changes in body condition score (BCS) or body weight during the transition period and subsequent reproductive performance in lactating dairy cows

- **Carvalho et al., 2014**
  J. Dairy Sci. 97:3666-3683
- **Barletta et al., 2017**
  Theriogenology 104:30-36
- **Middleton et al., 2019**
  J. Dairy Sci. 102:5577-5587
- **Lauber and Fricke, 2024**
  J. Dairy Sci. 107:2524–2542

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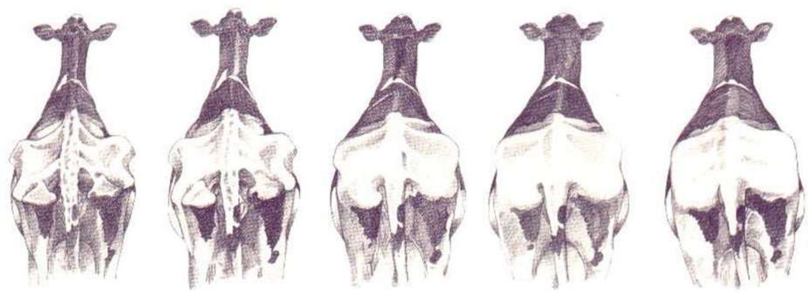
J. Dairy Sci. 97:3666–3683
http://dx.doi.org/10.3168/jds.2013-7809

Relationships between fertility and postpartum changes in body condition and body weight in lactating dairy cows

P. D. Carvalho,* A. H. Souza,*[1] M. C. Amundson,* K. S. Hackbart,* M. J. Fuenzalida,* M. M. Herlihy,* H. Ayres,* A. R. Dresch,* L. M. Vieira,* J. N. Guenther,* R. R. Grummer,† P. M. Fricke,* R. D. Shaver,* and M. C. Wiltbank*[2]
*Department of Dairy Science, University of Wisconsin-Madison, Madison 53706
†Balchem Corporation, New Hampton, NY 10958



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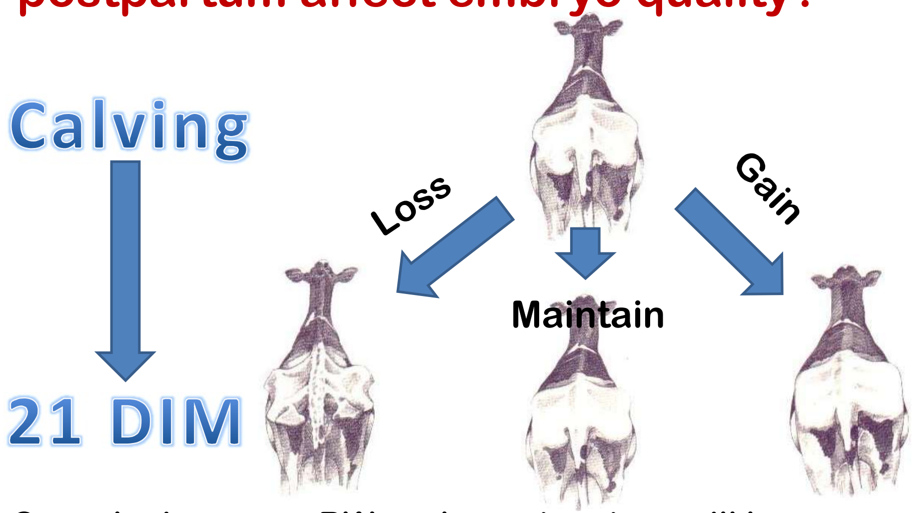
Does Body Weight change early postpartum affect embryo quality?



Cows losing more BW early postpartum will have poor embryo quality

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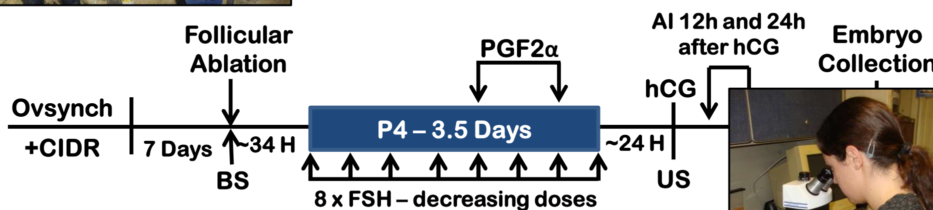
Materials & Methods

dairy cows from 1

ed and superstimula



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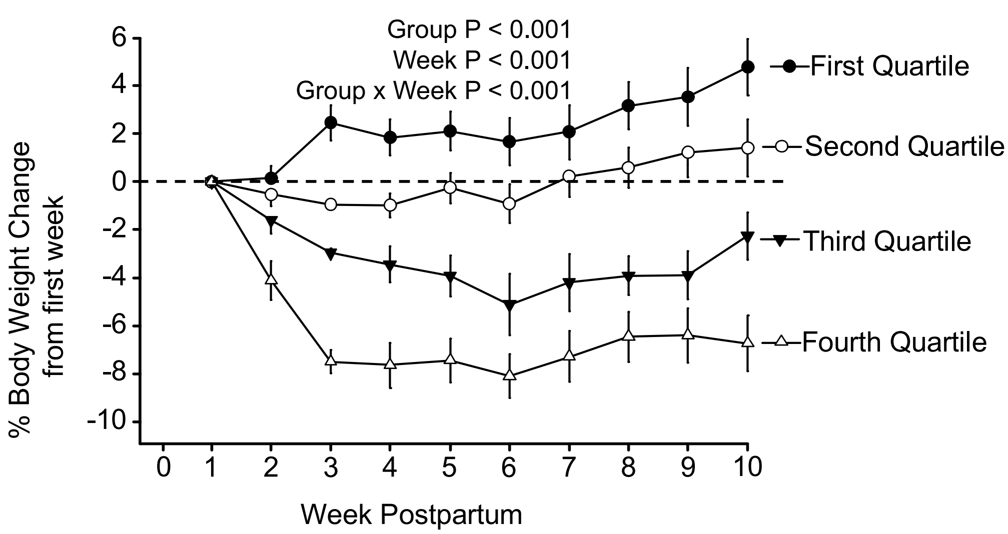
% Body weight change



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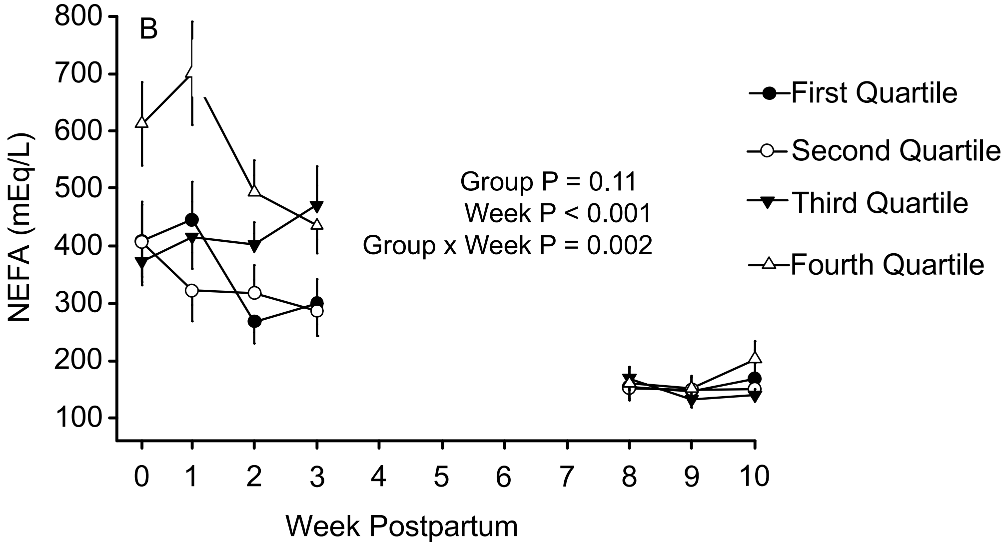
NEFA concentrations



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Embryo Characteristics

	Quartile				
	Fourth Q Lost +	Third Q Lost	Second Q Maintain	First Q Gain	P-value
CL (no.)	18.4 ± 2.6	18.4 ± 1.7	19.0 ± 1.7	16.0 ± 2.0	0.67
Fertilized embryos (%)	76.9 ± 7.1	77.0 ± 6.6	77.6 ± 7.6	78.4 ± 7.1	0.99
Quality 1 & 2 embryos (%)	38.0 ± 8.7	61.3 ± 8.2	60.6 ± 9.4	63.4 ± 8.6	0.14
Degenerate embryos (%)	35.2 ± 8.5[a]	12.6 ± 4.6[b]	14.5 ± 6.3[b]	9.6 ± 3.7[b]	0.02
Qual 1 & 2 of Fertilized (%)	48.4 ± 9.5[a]	78.3 ± 6.6[b]	72.6 ± 9.5[b]	77.7 ± 7.4[b]	0.05
Degenerate of Fertilized (%)	46.9 ± 9.6[a,A]	17.4 ± 6.4[b,B]	24.8 ± 9.3[ab,A]	16.2 ± 7.0[b,B]	0.04

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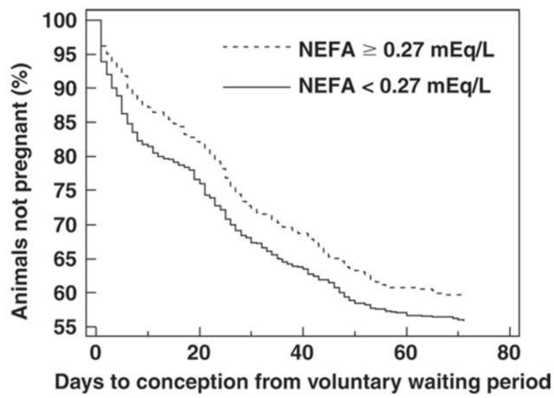
J. Dairy Sci. 93:1596–1603
doi:10.3168/jds.2009-2852

Associations of elevated nonesterified fatty acids and β-hydroxybutyrate concentrations with early lactation reproductive performance and milk production in transition dairy cattle in the northeastern United States

P. A. Ospina,* D. V. Nydam,†[1] T. Stokol,† and T. R. Overton*
*Department of Animal Science, College of Agriculture and Life Sciences, and
†Department of Population Medicine and Diagnostic Sciences, College of Veterinary Medicine, Cornell University, Ithaca, NY 14853

- Cows from 91 dairy herds were sampled for NEFA and BHBA prepartum (n = 1,164) or postpartum (n = 1,095).
- Cows with NEFA concentrations > 0.27 mEq/L resulted in 16% decreased risk of conception within 70 d after the VWP (P = 0.05).



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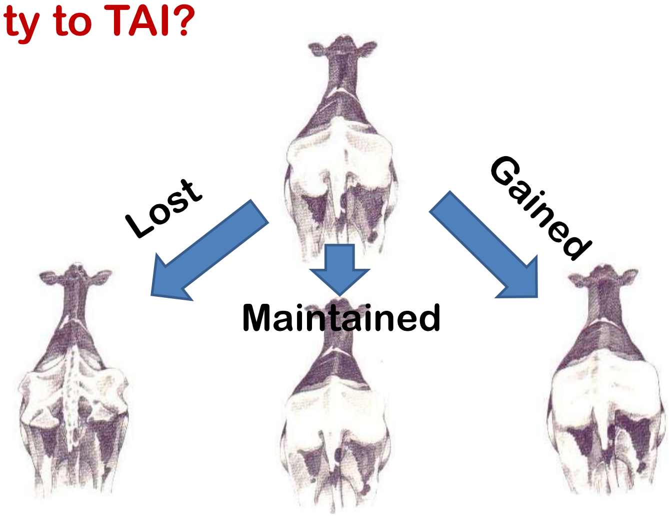
Does a change in BCS early postpartum affect fertility to TAI?

Calving

21 DIM



Cows losing more BCS early postpartum will have decreased fertility at first TAI

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% of cows, BCS at calving and 21 DIM

	BCS Change			P-Value
	Lost	Maintained	Gained	BCS
% cows	42 (789/1887)	36 (675/1887)	22 (423/1887)	-
% Primi.	47 (373/789)	53 (356/675)	55 (233/423)	0.02
BCS at calving	2.93±0.01[a]	2.89±0.02[ab]	2.85±0.02[b]	0.005
BCS at 21 DIM	2.64±0.01[c]	2.89±0.02[b]	3.10±0.02[a]	<0.001
BCS Δ	-0.29	0.0	+0.25	
ECM (kg/d)[1]	30.9±0.4	31.5±0.4	28.7±0.4	0.3

[1]From calving to 21DIM

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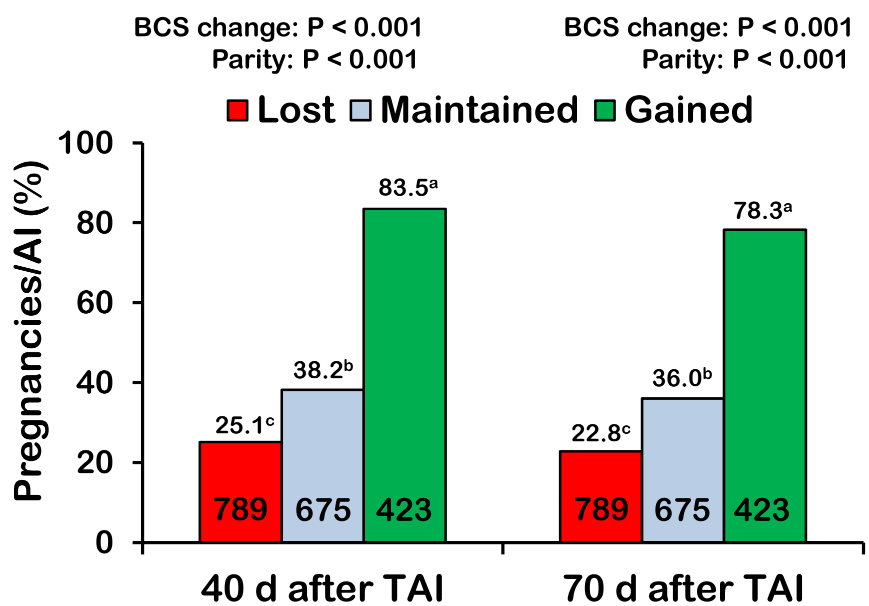
P/AI to Double-Ovsynch



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Case Study Extreme Example

A nutritionist called me about a 450-cow dairy with severe repro problems

- 21-d Pregnancy Rate: 8%
  - <20% = poor
  - 21% to 25% = OK with room for improvement
  - 26% to 30% = excellent
  - >30% = outstanding
- 21-d Service Rate: 33%
  - Goal: >60%
- Conception Rate: 39% overall
  - No sexed semen used in lactating cows
  - CR is difficult to benchmark; many factors are involved
  - Goal: 45% to 55%

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Far-Off Dry Cows

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Early Lactation Cows

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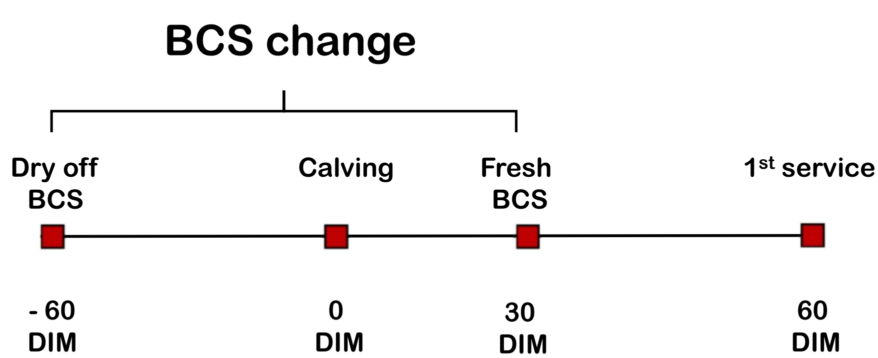
Unpublished Analysis

Megan Lauber, PhD Candidate

7,000-cow dairy in the upper Midwest



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Demographics by BCS change

	BCS Change from Dry off to 30 DIM			
	Q1 n = 608	Q2 n = 672	Q3 n = 650	Q4 n = 449
BCS Change	-1.5 to -0.75	- 0.50	-0.25	0 to 0.75
BCS Change (Mean ± SEM)	-0.84 ± 0.01	-0.50 ± 0	-0.25 ± 0	0.04 ±0.01
Parity (Mean ± SEM)	3.47 ± 0.06	3.07 ± 0.05	2.86 ± 0.5	2.73 ± 0.06
Week 8 Milk (lbs)	117	117	113	108
1st F:P Ratio (Mean ± SEM)	1.30 ± 0.02	1.25 ± 0.01	1.21 ± 0.01	1.19 ± 0.01

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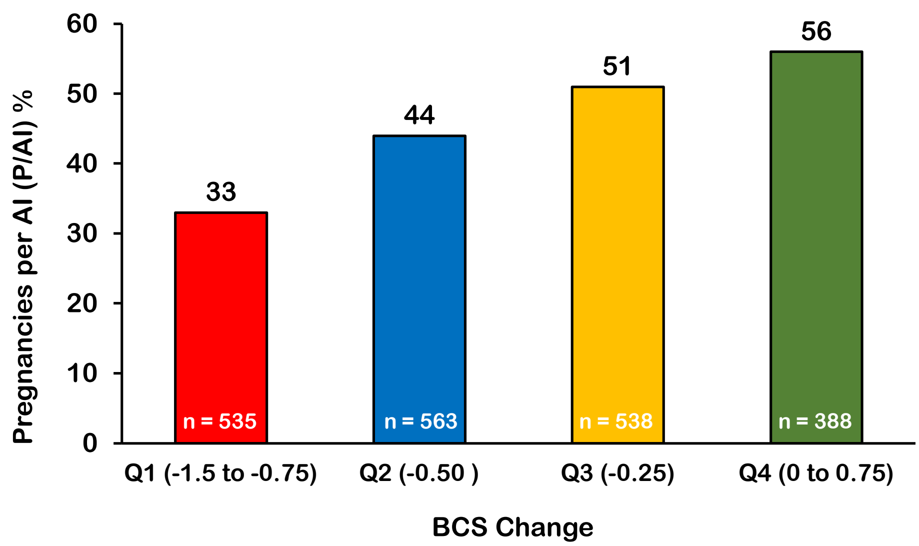
Pregnancy outcomes, d 32



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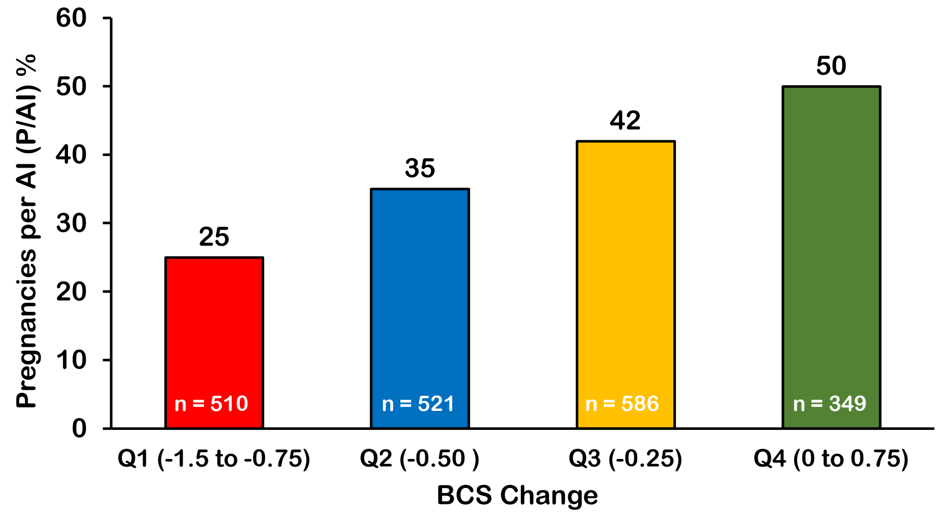
Pregnancy outcomes, d 60



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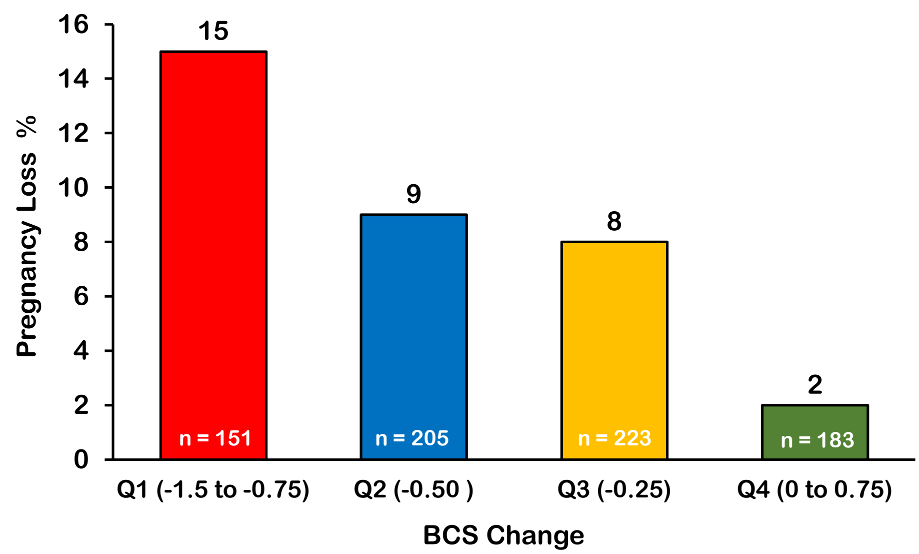
Pregnancy Loss, d 32-60



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Question:

How can we get cows to gain or maintain BCS after calving?

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Theriogenology 104 (2017) 30–36

Contents lists available at ScienceDirect

ELSEVIER

Theriogenology

journal homepage: www.theriojournal.com

THERIOGENOLOGY

Association of changes among body condition score during the transition period with NEFA and BHBA concentrations, milk production, fertility, and health of Holstein cows

R.V. Barletta [a,*], M. Maturana Filho [b], P.D. Carvalho [a], T.A. Del Valle [b], A.S. Netto [b], F.P. Rennó [b], R.D. Mingoti [b], J.R. Gandra [d], G.B. Mourão [c], P.M. Fricke [a], R. Sartori [c], E.H. Madureira [b], M.C. Wiltbank [a]

[a] Department of Dairy Science, University of Wisconsin-Madison, Madison, 53706, USA
[b] Department of Animal Nutrition and Production, University of São Paulo, Pirassununga, 13635-900, Brazil
[c] Department of Animal Science, University of São Paulo, Escola Superior de Agricultura Luiz de Queiroz, Piracicaba, 13418-900, Brazil
[d] College of Agricultural Science, Federal University of Dourados, Dourados, 79804-970, Brazil

BCS change from 21 days before calving to 21 days after calving

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Effect of BCS Change on Health Events

Barletta et al., 2017; Theriogenology 104:30-36.

Event	Lost	Maintained	Gained
	50% (116/234)	22% (52/234)	28% (66/234)
Metritis	23%	21%	20%
Mastitis	29%[b]	17%[a,b]	17%[a]
Ketosis	27%	19%	15%
Pneumonia	15%	12%	9%
>1 Event	63%[b]	46%[a]	39%[a]

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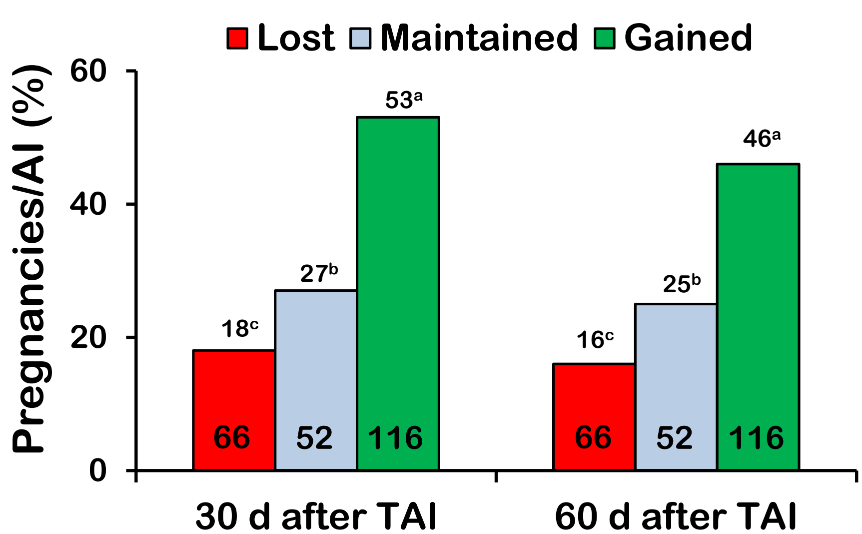
P/AI to TAI after a fertility program

Barletta et al., 2017; Theriogenology 104:30-36



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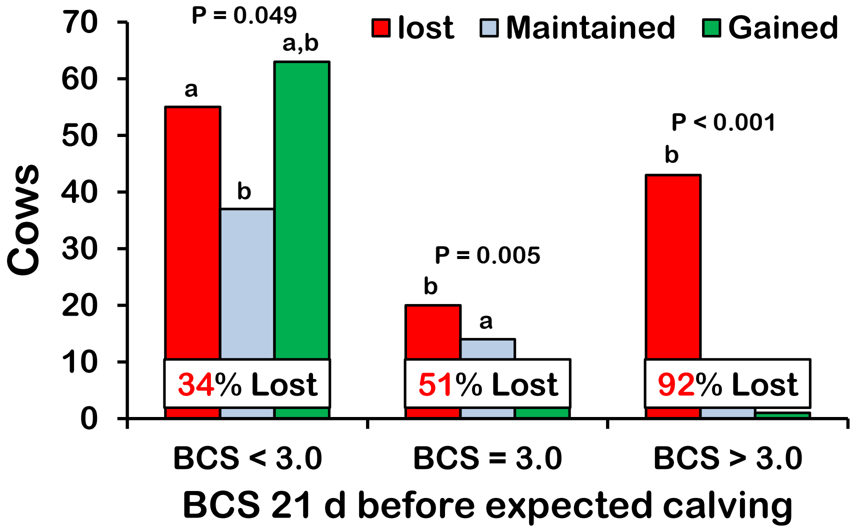
Overall, 50% of cows lost BCS from 21 d before to 21 days after calving

Barletta et al., 2017; Theriogenology 104:30-36



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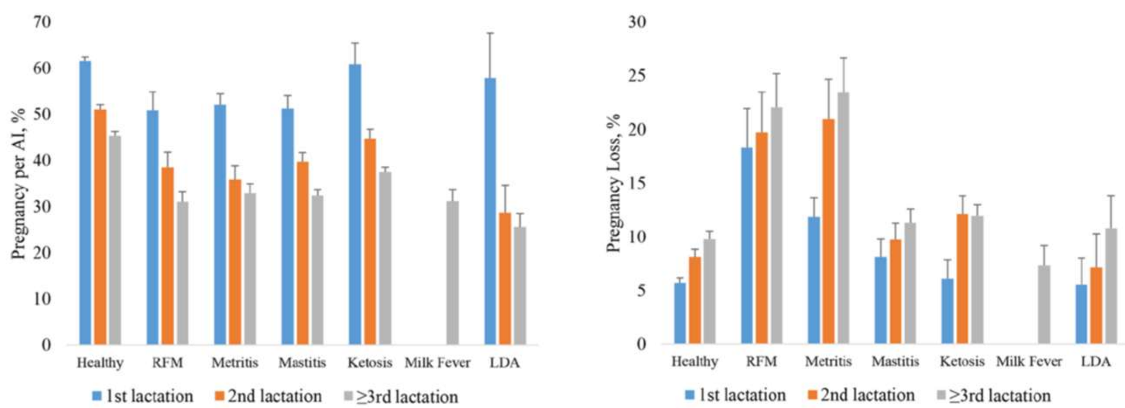
Association of transition cow health with pregnancy per artificial insemination and pregnancy loss in Holstein cows submitted to a Double-Ovsynch protocol for first service

R. Frenkel,[1] P. M. Fricke,[2] A. M. L. Madureira,[3] W. Heuwieser,[1] and S. Borchardt[1]*



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Question:

How can we get cows to gain or maintain BCS after calving?

Answer:

Avoid calving over-conditioned cows!

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Question:

How can we avoid calving over-conditioned cows?

Calving Interval (13 months = 390 d)		
VWP (60 d)	21-d PR (0 to ? d)	Gestation (282 d)
Fixed	Variable	Fixed

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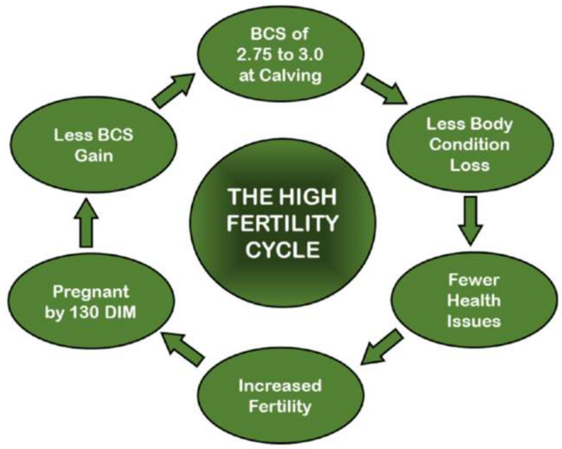
J. Dairy Sci. 102:5577–5587
https://doi.org/10.3168/jds.2018-15828

The high-fertility cycle: How timely pregnancies in one lactation may lead to less body condition loss, fewer health issues, greater fertility, and reduced early pregnancy losses in the next lactation

E. L. Middleton, T. Minela, and J. R. Pursley*
Department of Animal Science, Michigan State University, East Lansing 48824



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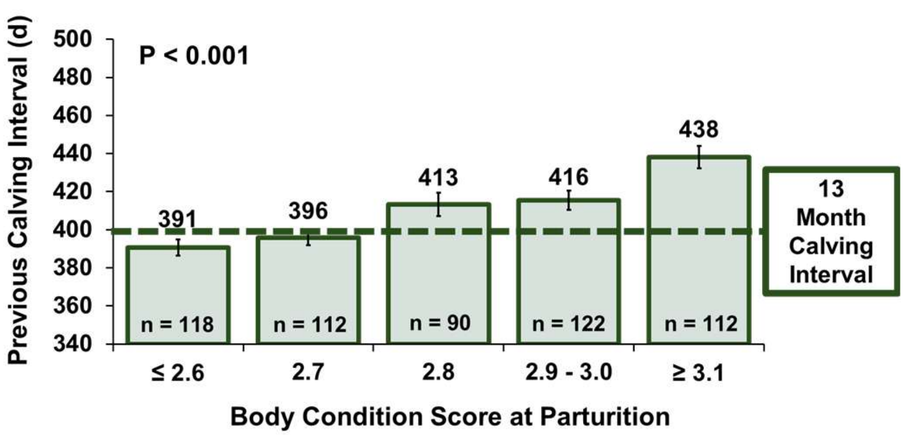
Effect of previous calving interval on BCS at calving

Middleton et al., 2019; J. Dairy Sci. 102:5577-5587



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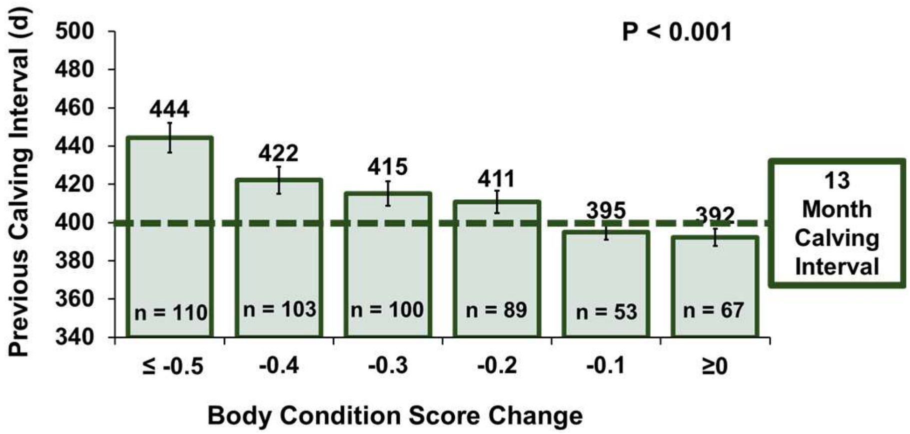
Effect of previous calving interval on BCS change calving to 30 DIM

Middleton et al., 2019; J. Dairy Sci. 102:5577-5587



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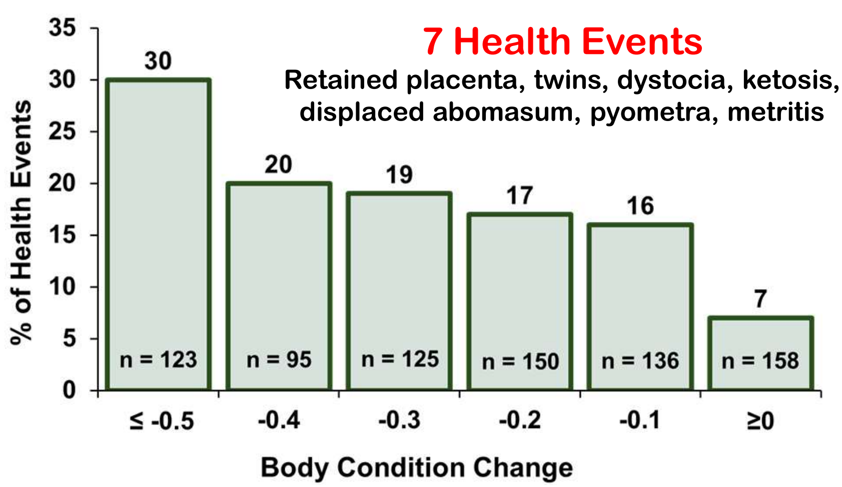
Effect of BCS change on health events

Middleton et al., 2019; J. Dairy Sci. 102:5577-5587



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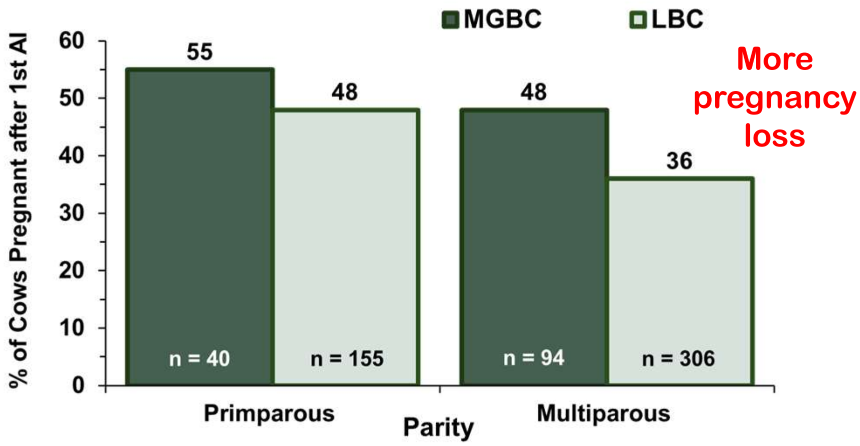
Effect of BCS change after calving on fertility to first TAI

Middleton et al., 2019; J. Dairy Sci. 102:5577-5587



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J. Dairy Sci. 107:2524–2542
https://doi.org/10.3168/jds.2023-23892

Effect of postpartum body condition score change on the pregnancy outcomes of lactating Jersey cows inseminated at first service with sexed Jersey or conventional beef semen after a synchronized estrus versus a synchronized ovulation

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Department of Animal and Dairy Sciences, University of Wisconsin–Madison, Madison, WI 53706

ANIMAL & DAIRY SCIENCES
University of Wisconsin-Madison

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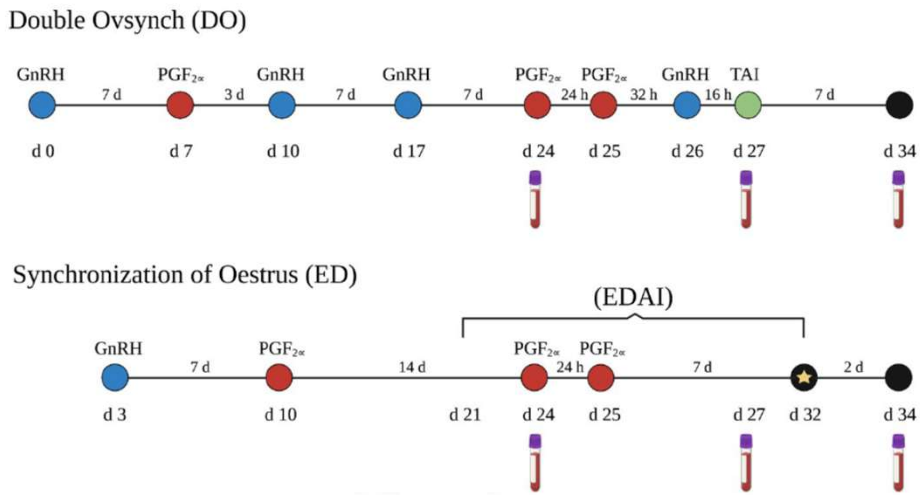
Experimental Design

Sexed and Conventional Beef Semen



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Enrollment

336 primiparous and 950 multiparous Jersey cows

	Treatment		
Semen	DO	EDAI	Total
Beef	317	227	544
Sexed	398	344	742
Total	715	571	1,286

The decision to inseminate cows with sexed vs. beef semen was made by the farm. Mated cows were then randomized to treatment *within* each semen type.

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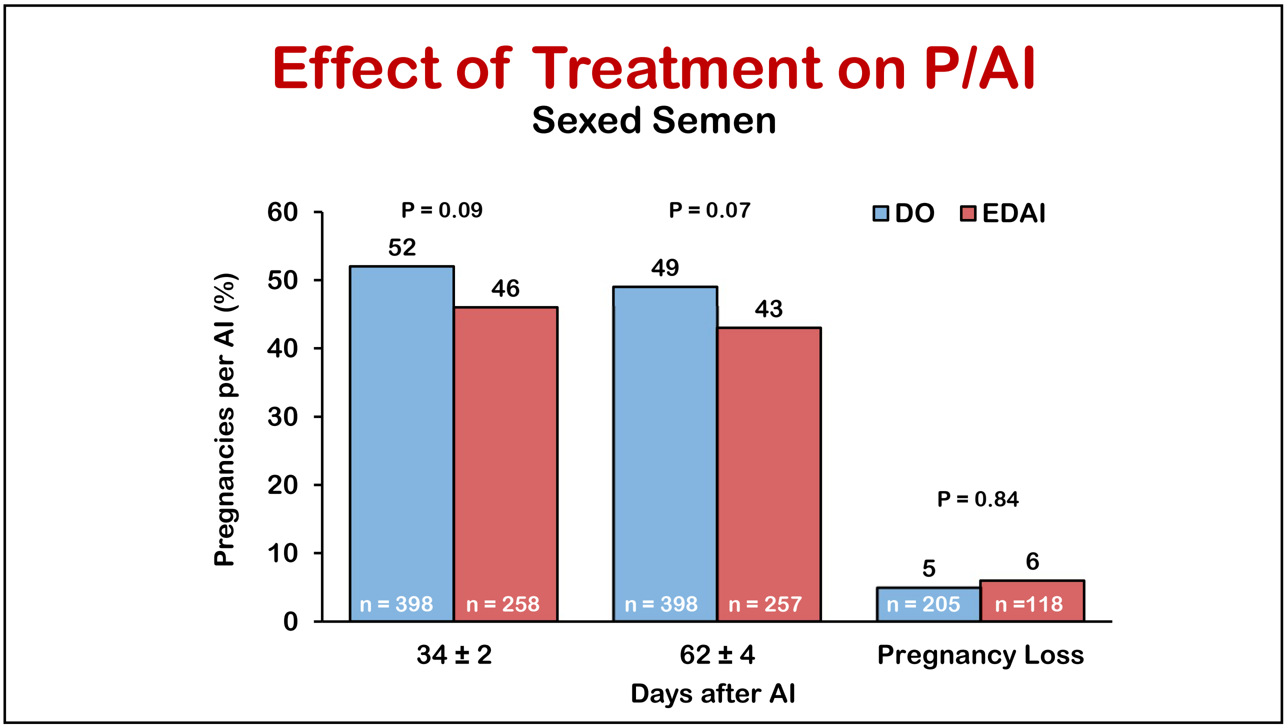
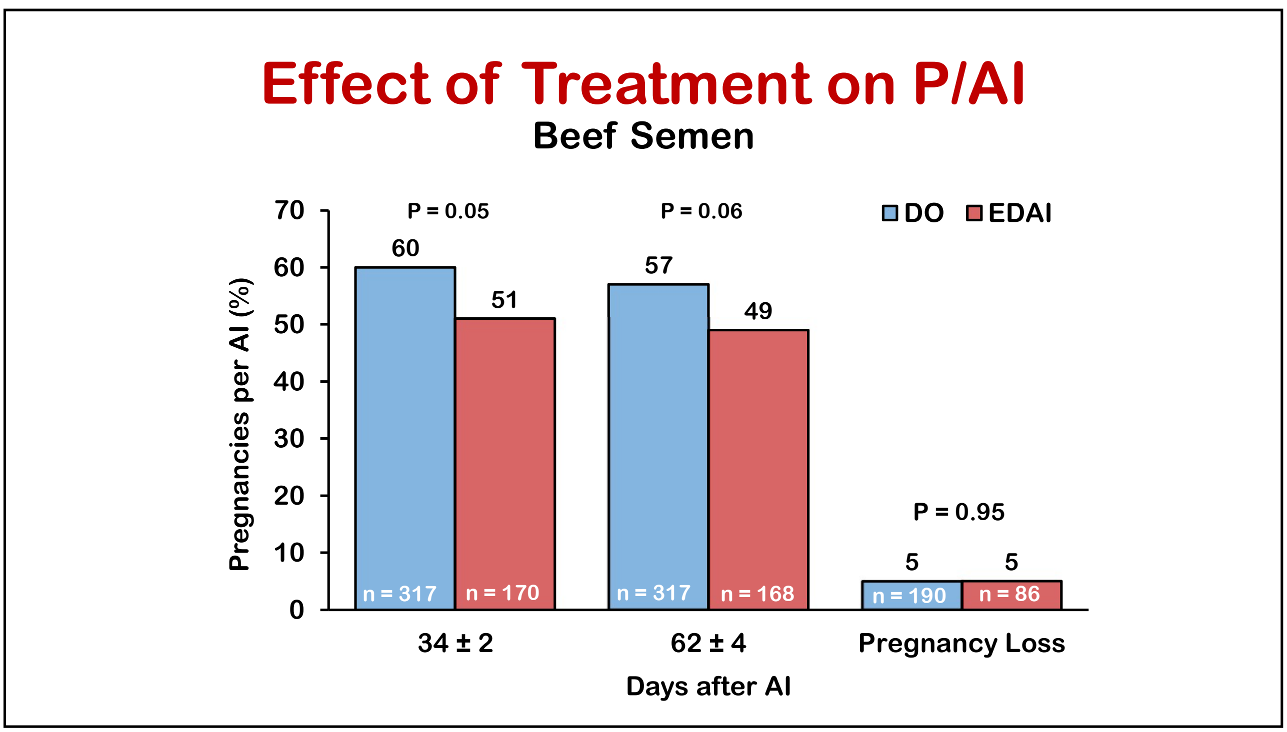
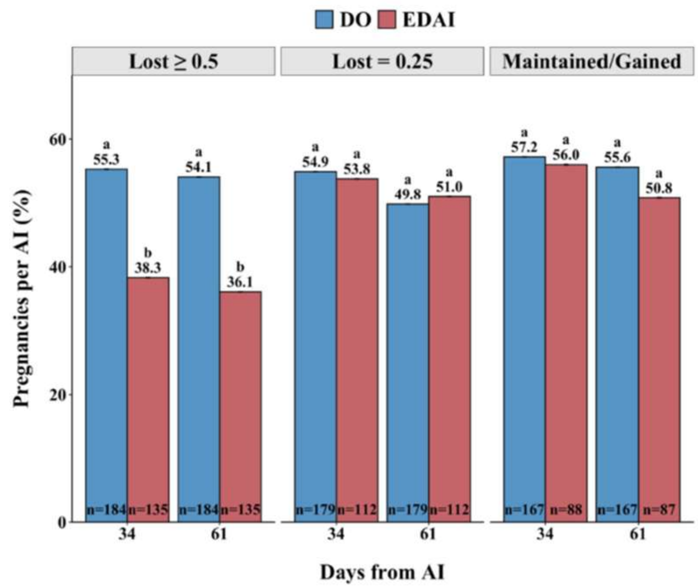

Effect of Treatment on P/AI
Sexed Semen
P = 0.09
P = 0.07
DO
EDAI
52
46
49
43
P = 0.84
5
6
n = 398
n = 258
n = 398
n = 257
n = 205
n =118
Pregnancies per AI (%)
0
10
20
30
40
50
60
34 ± 2
62 ± 4
Pregnancy Loss
Days after AI

51


Effect of Treatment on P/AI
Beef Semen
P = 0.05
P = 0.06
DO
EDAI
60
51
57
49
P = 0.95
5
5
n = 317
n = 170
n = 317
n = 168
n = 190
n = 86
Pregnancies per AI (%)
0
10
20
30
40
50
60
70
34 ± 2
62 ± 4
Pregnancy Loss
Days after AI

52

Effect of postpartum BCS change on P/AI



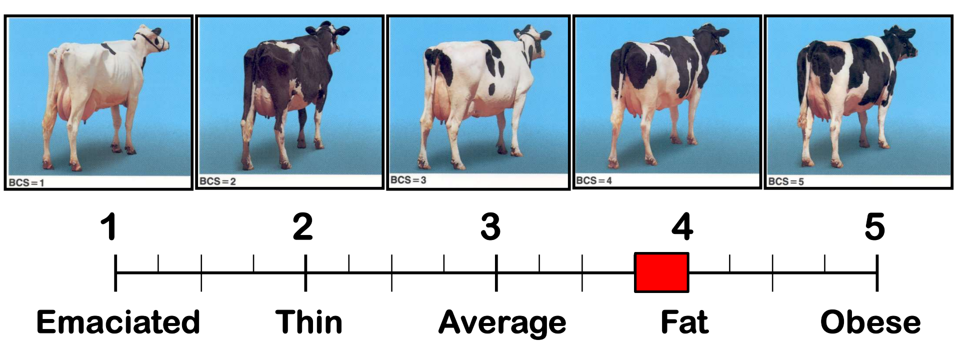
53

Re-think BCS targets

2001 BCS Recommendations:

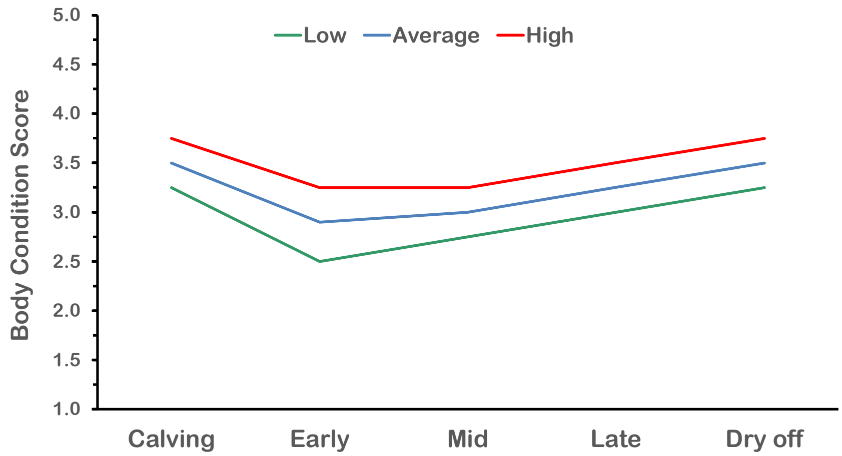
Calving: 3.25 to 3.75
Early: 2.50 to 3.25
Mid: 2.75 to 3.25
Late: 3.00 to 3.50
Dry Off: 3.25 to 3.75

Too High!



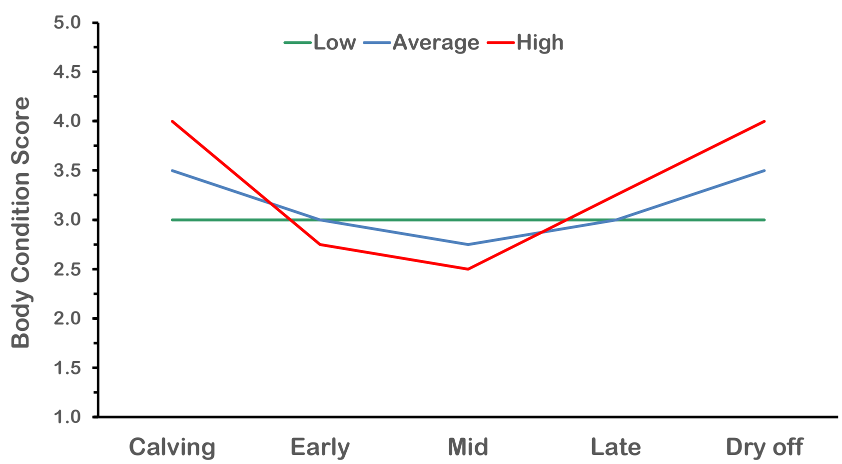
54

BCS Change – Old Paradigm



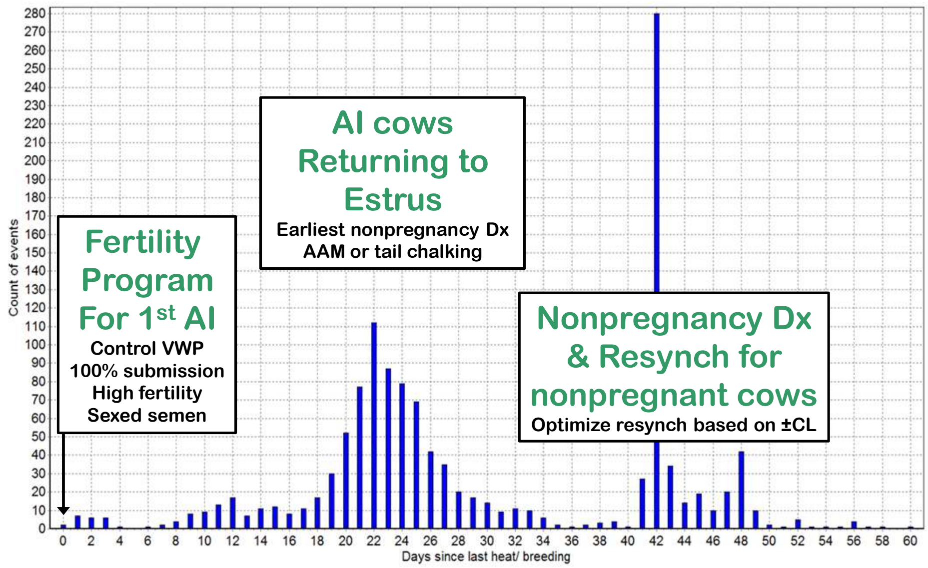
55

BCS Change – New Paradigm



56

Combining Fertility Programs and Estrus



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Double-Ovsynch for first TAI

Sun	Mon	Tue	Wed	Thu	Fri	Sat
					GnRH	
					PGF	
	GnRH					
	GnRH					
	PGF	PGF	GnRH	TAI		

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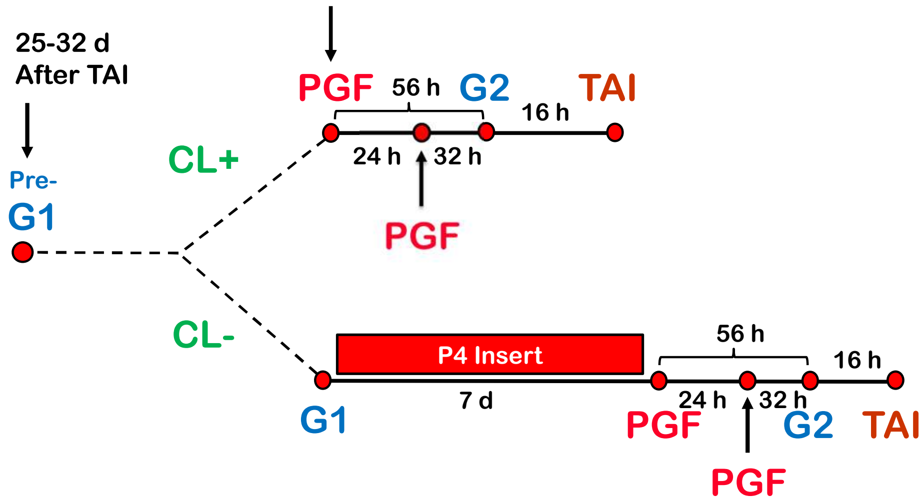
Resynch for 2nd and greater TAI



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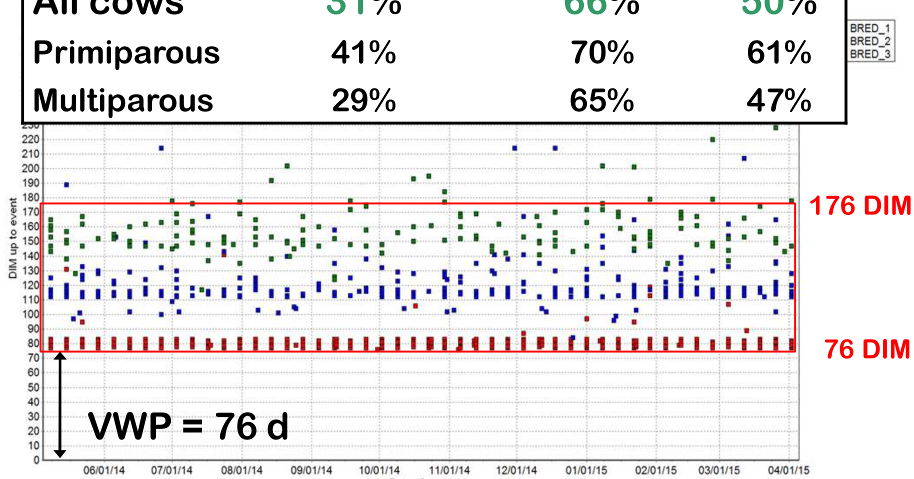
TAI for First Three Inseminations

Parity	21-d Preg Rate	Service Rate	P/AI
All cows	31%	66%	50%
Primiparous	41%	70%	61%
Multiparous	29%	65%	47%



60

BREDSUM By Times Bred

January, 2019 to January, 2020

	95% CI	%Conc	#Preg	#Open	Other	Abort	Total	%Tot	SPC
1	46-55	50	269	266	5	35	540	49	2.0
2	47-58	53	153	137	4	13	294	27	1.9
3	42-58	50	75	75	1	6	151	14	2.0
4	34-57	46	31	37	1	2	69	6	2.2
5	21-54	36	10	18	0	1	28	3	2.8
6	-	62	10	6	0	0	16	1	1.6
7	-	50	1	1	0	0	2	0	2.0
8	-	100	1	0	0	0	1	0	1.0
TOTALS	47-53	50	550	540	11	57	1101	100	2.0

90% pregnant after 3 AI

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BREDSUM 21-Day Preg Risk

April, 2004 to April, 2005

Date	Br Elig	Bred	Pct	Pg Elig	Preg	Pct	Aborts
4/29/04	51	28	55	51	9	18	0
5/20/04	61	30	49	61	9	15	2
6/10/04	64	41	64	63	15	24	4
7/01/04	63	32	51	61	11	18	0
7/22/04	65	36	55	64	9	14	0
8/12/04	79	41	52	78	17	22	1
9/02/04	80	44	55	79	13	16	3
9/23/04	83	40	48	82	12	15	3
10/14/04	89	54	61	89	15	17	4
11/04/04	85	47	55	84	15	18	4
11/25/04	75	43	57	72	11	15	1
12/16/04	79	43	54	79	13	16	1
1/06/05	77	42	55	76	11	14	1
1/27/05	86	45	52	84	13	15	1
2/17/05	86	48	56	86	17	20	0
3/10/05	97	48	49	96	12	12	0
3/31/05	102	49	48	0	0	0	0
4/21/05	78	62	79	0	0	0	0
Total	1220	662	54	1205	202	17	25

Wait Period 50

62

BREDSUM By Times Bred

April, 2004 to April, 2005

	95% CI	%Conc	#Preg	#Open	Other	Abort	Total	%Tot	SPC
1	38-50	44	121	154	14	16	289	36	2.3
2	25-39	31	49	107	8	5	164	20	3.2
3	21-38	29	30	74	3	4	107	13	3.5
4	16-34	24	18	58	3	5	79	10	4.2
5	18-42	28	15	38	2	3	55	7	3.5
6	6-27	13	5	34	1	0	40	5	7.8
7	14-44	27	8	22	0	1	30	4	3.8
8	-	33	6	12	2	1	20	2	3.0
OTHERS	-	31	5	11	3	0	19	2	3.2
TOTALS	30-37	34	257	510	36	35	803	100	3.0

91% pregnant after 6 AI

63

Take-Home Messages

1. Body condition score change during the periparturient period has a profound effect on reproductive performance
2. Get your herds into the High Fertility Cycle!
   - Implement a reproductive management strategy that gets cows pregnant quickly after the end of the voluntary waiting period
   - Culling strategies
   - Grouping strategies

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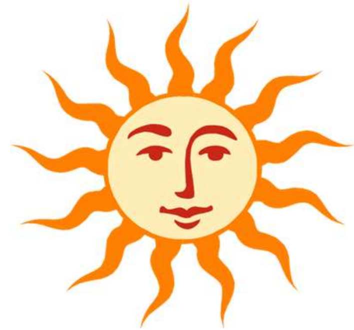
Effects of Heat Stress on Reproduction in Dairy Cows



Paul M. Fricke
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UNIVERSITY OF WISCONSIN–MADISON

Extension
UNIVERSITY OF WISCONSIN–MADISON

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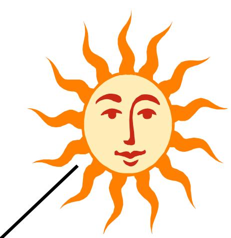
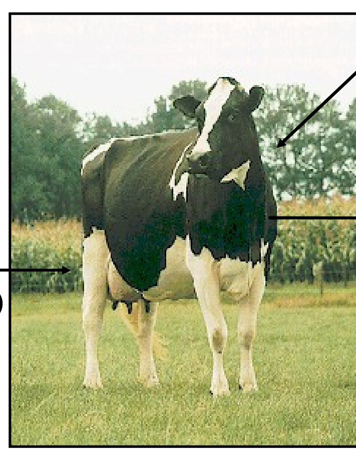
Maintenance of Body Temperature in Dairy Cattle



Homeothermy:
HP + EH = HL

Hyperthermia:
HP + EH > HL



Environmental Heat (EH)

Heat Loss to Environment (HL)

4 methods:
1) Conduction
2) Convection
3) Radiation
4) Evaporation

Internal Heat Production (HP)

Metabolism:
1) Growth
2) Lactation

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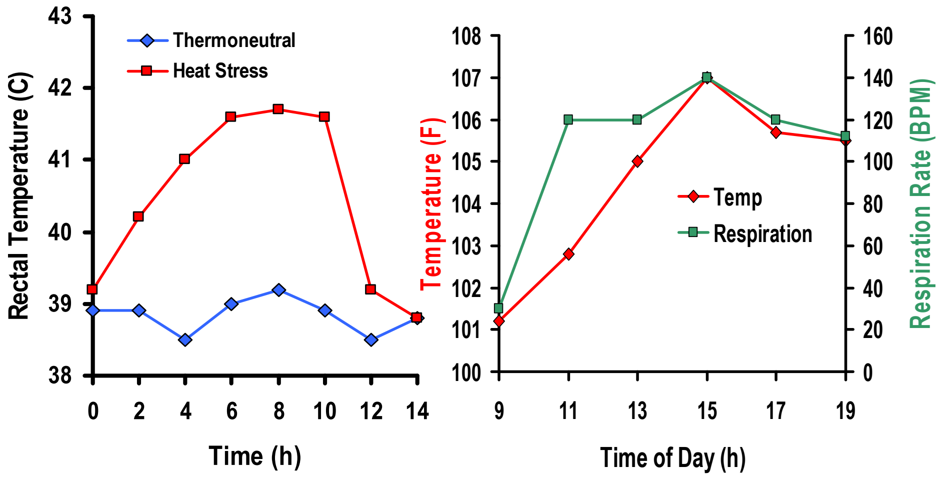
Effects of Heat Stress



Data from Putney et al., 1989

Cole and Hansen, Unpublished

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Temperature Humidity Index >68

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.

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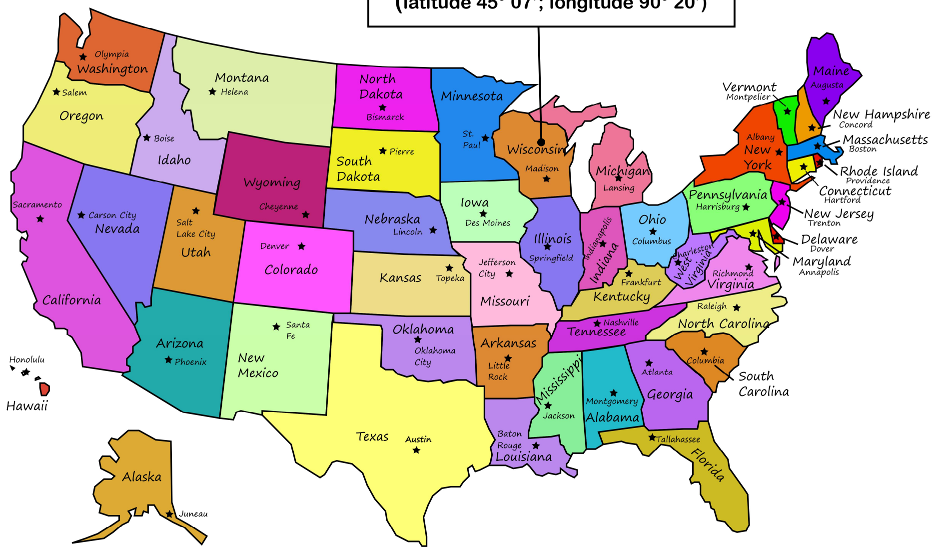
Athens, WI
(latitude 45° 07'; longitude 90° 20')



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J. Dairy Sci. 86:3941–3950

Fertility of Dairy Cows after Resynchronization of Ovulation at Three Intervals Following First Timed Insemination

P. M. Fricke,* D. Z. Caraviello,* K. A. Weigel,* and M. L. Welle†
*Department of Dairy Science, University of Wisconsin, Madison 53706
†Miltrim Farms, Inc., Athens, Wisconsin 54411

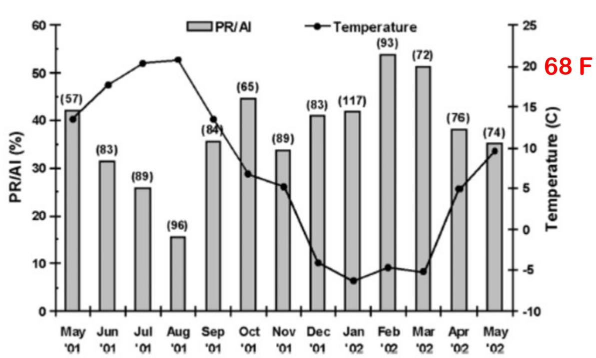

Figure 1. Effect of mean high ambient temperature on pregnancy rates to timed AI (TAI) by month. Pregnancy rate per artificial insemination (PR/AI) represents all Ovsynch and Resynch TAI services during each respective month. Numbers above bars are the total number of TAI services for each month. Temperature data represents the mean high daily temperature at the time of TAI for all TAI services occurring each month. Cows had greater (P = 0.05) pregnancy rates during fall and winter months compared to summer months.

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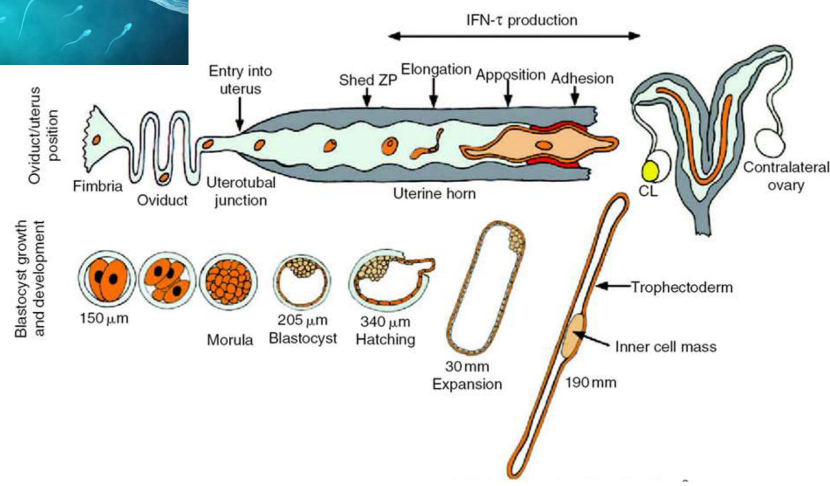
Critical Events During Early Pregnancy

Fertilization



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Effect of dietary organic zinc, manganese, copper, and cobalt supplementation on milk production, follicular growth, embryo quality, and tissue mineral concentrations in dairy cows

K. S. Hackbart, R. M. Ferreira, A. A. Dietsche, M. T. Socha, R. D. Shaver, M. C. Wiltbank and P. M. Fricke

J Anim Sci 2010.88:3856-3870.
doi: 10.2527/jas.2010-3055 originally published online Sep 3, 2010;

Item	Heat-stressed[1]	Thermoneutral	P-value
Fertilized (%)	37 (7/19)	83 (54/65)	<0.001
Viable (%, grades 1 & 2)	20 (4/20)	42 (27/64)	0.110
Embryo stage	3.14 ± 0.46	3.19 ± 0.30	0.981
Embryo quality	2.75 ± 0.49	2.62 ± 0.18	0.766
Nuclie/embryo	37.2 ± 12.2	49.5 ± 5.0	0.548

[1]Cows were classified as heat-stressed when rectal temperatures were ≥39 °C at AI.

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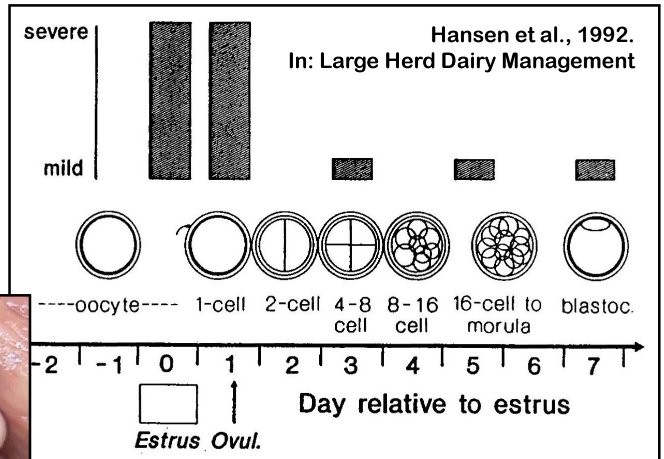
Effects of Heat Stress

Effects on Late Follicular and Early Embryonic Development



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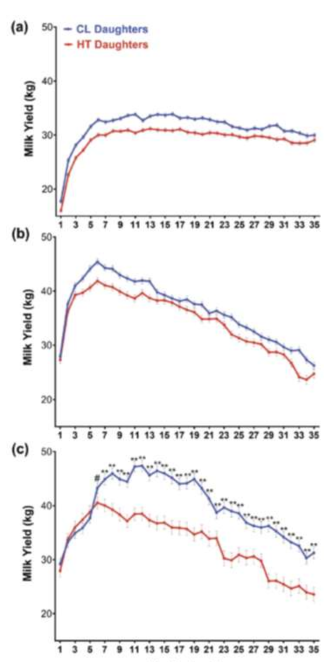
J. Dairy Sci. 103:7555–7568
https://doi.org/10.3168/jds.2020-18154

Late-gestation heat stress impairs daughter and granddaughter lifetime performance

J. Laporta,[1*] F. C. Ferreira,[2] V. Ouellet,[1] B. Dado-Senn,[1] A. K. Almeida,[1] A. De Vries,[1] and G. E. Dahl[1]
[1]Department of Animal Sciences, University of Florida, Gainesville 32611
[2]Veterinary Medicine Teaching and Research Center, School of Veterinary Medicine, University of California, Davis, Tulare 93274

Milk yield in the first (a; n = 108), second (b; n = 54), and third (c; n = 19) lactation of daughters (F1) born to dams under cooling (CL; access to fans, shade, and water soakers) or heat stress (HT; only access to shade) during late gestation (~46 d).

All daughters had access to active cooling (e.g., shade of a freestall barn, fans, and water soakers) during their first, second, and third lactations.



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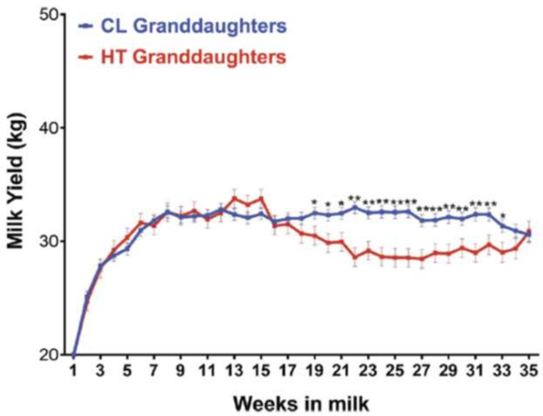
[1]Department of Animal Sciences, University of Florida, Gainesville 32611
[2]Veterinary Medicine Teaching and Research Center, School of Veterinary Medicine, University of California, Davis, Tulare 93274

Milk yield in the first lactation of granddaughters (n = 23) of cows that were exposed to cooling (CL; access to fans, shade, and water soakers; n = 16) or heat stress (HT; only access to shade; n = 7) while pregnant (~last 46 d) with their mothers.

Thus, the mothers experienced heat stress or cooling through the intrauterine environment the last 46 d of gestation.



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J. Dairy Sci. 103:7555–7568
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This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).
Late-gestation heat stress impairs daughter and granddaughter lifetime performance
J. Laporta,[1*] F. C. Ferreira,[2] V. Ouellet,[1] B. Dado-Senn,[1] A. K. Almeida,[1] A. De Vries,[1] and G. E. Dahl[1]
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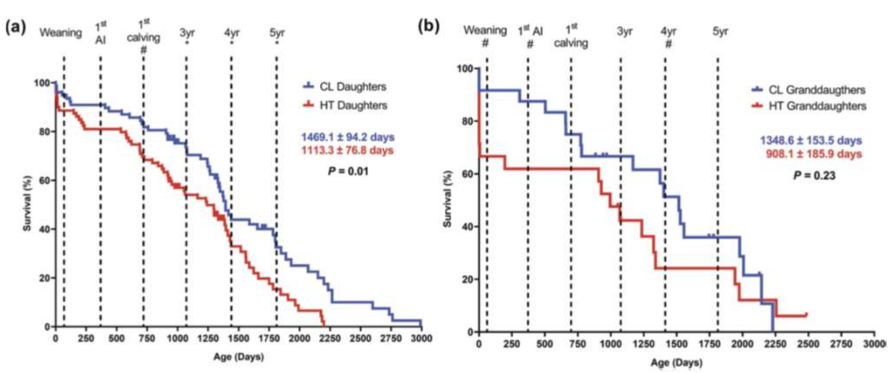

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J. Dairy Sci. 103:7555–7568
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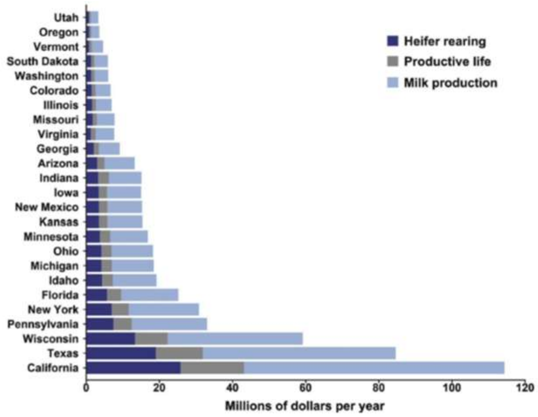

Annual economic loss (millions of dollars) associated with extra heifer rearing costs, reduced productive life length, and milk yield of daughters born to dams exposed to heat stress during late gestation (F1) for the top 24 states with the most dairy cows, and Florida, the state with the most heat stress days per year.

Collectively, in the United States, the economic losses for additional heifer rearing cost, reduced productive life, and reduced milk yield of the F1 offspring were estimated at $134, $90, and $371 million per year, respectively.

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General Considerations

Water

- Water intake can increase by nearly 50% during severe heat stress
- Keep water fresh and clean
- Make water available immediately to cows after returning from the parlor after milking

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Shade

Pregnancy rates were 44% for cows maintained in shade in the summer in Florida versus 25% for cows not given access to shade (Roman-Ponce et al., 1977)

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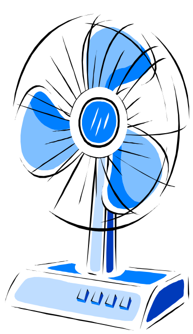
Fans



- ✓ Increase cooling by convection
- ✓ However, air temperature must be lower than the cows body temperature for effective cooling to take place

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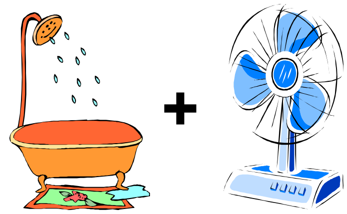
Sprinklers and Fans



Sprinkling systems in combination with fans improve evaporative and convective cooling of cows

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Managing Heat Stress – Timed AI

De la Sota et al., Theriogenology 49:761;1998

Response	Control AI	Timed AI	P <
n	156	148	0.05
Pregnancy rate (%)	4.8 ± 2.5	13.9 ± 2.6	0.05
Estrus detection or service rate (%)	18.1 ± 2.5	100.0 ± 0.0	0.05
Conception rate (%)	22.9 ± 6.4	13.2 ± 3.6	0.05
Overall pregnancy rate to 120 d (%)	16.5 ± 3.5	27.0 ± 3.6	0.05
Days open	90.0 ± 4.2	77.6 ± 3.8	0.05
Services per conception	1.27 ± 0.11	1.63 ± 0.10	0.05
Days to first AI	91.0 ± 1.9	58.7 ± 2.1	0.05

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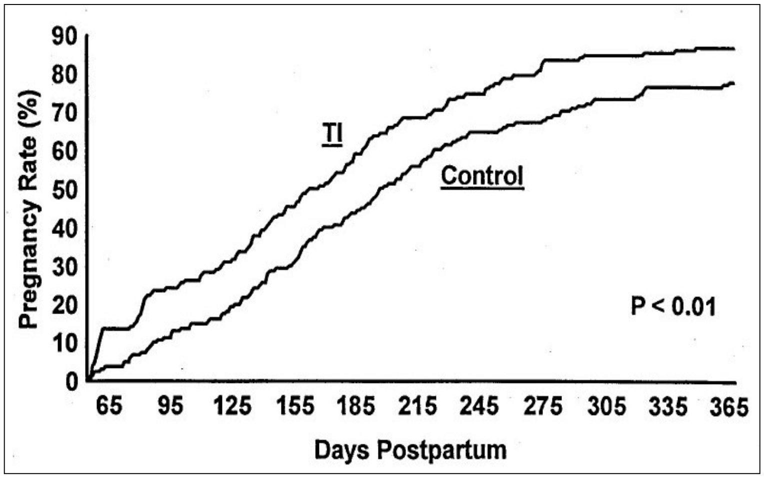
Timed AI and Heat Stress

De la Sota et al., Theriogenology 49:761;1998

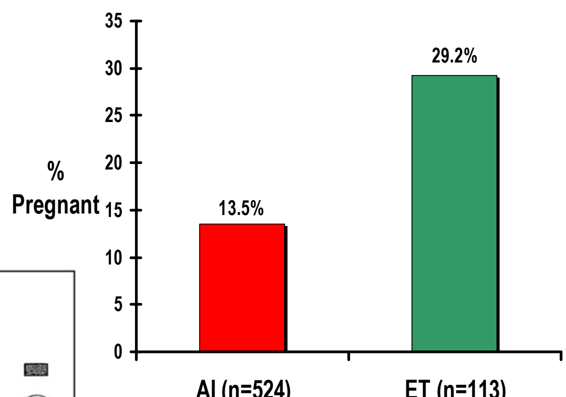


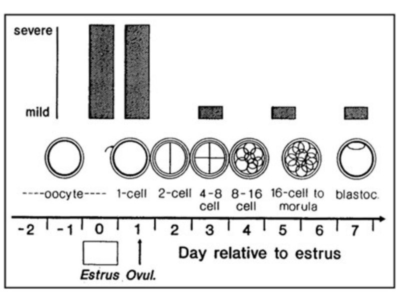
Cumulative pregnancy rates in lactating dairy cows receiving their first postpartum insemination in summer (Florida) as a timed AI or an AI to a detected estrus

83

Embryo Transfer

Percentage of cows pregnant after artificial insemination or embryo transfer using fresh flushed embryos on day 7 during summer in Florida.





Data adapted from Putney et al., Theriogenology 31:765; 1989

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J. Dairy Sci. 94:3437–3445
doi:10.3168/jds.2010-4008

Efficacy of embryo transfer in lactating dairy cows during summer using fresh or vitrified embryos produced in vitro with sex-sorted semen

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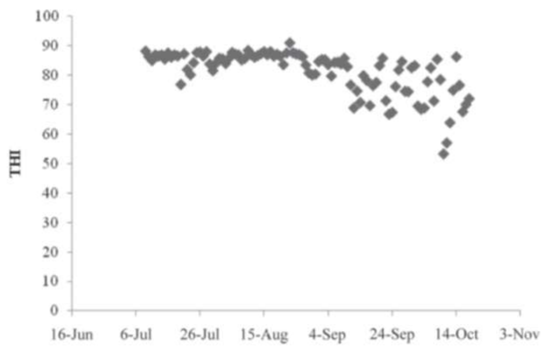

Figure 1. Temperature humidity index (THI) values for farm 1 and farm 2 from July 9 to October 18, 2009.

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	Pregnant cows 40 d (%)		Pregnant cows 97 d (%)		Pregnancy loss d 40 to calving (%)	
Treatment	All cows	Synch cows	All cows	Synch cows	All cows	Synch cows
n	569	485	563	479	143	143
AI	18[a]	25[a]	17[a]	23[a]	11	11
ET-V	29[b]	32[a]	26[b]	28[a]	26	26
ET-F	42[c]	46[b]	36[ac]	39[b]	20	20

[a-c]Within a column, percentages with different superscripts differ ($P < 0.05$)

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	Calves born (%)		Live calves born (%)		Live heifers born (%)	
Treatment	All cows	Synch cows	All cows	Synch cows	All cows	Synch cows
n	550	466	550	466	113	113
AI	15^{a}	20^{a}	15^{a}	20^{a}	50^{a}	50^{a}
ET-V	20^{a}	22^{a}	17^{a}	19^{a}	73^{b}	73^{b}
ET-F	31^{b}	34^{b}	28^{b}	30^{b}	79^{b}	79^{b}

$^{a\text{-}c}$Within a column, percentages with different superscripts differ ($P < 0.05$)

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