Reproduction of Dairy Cows:

How Much Depends on the Transition Period?

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Sponsored by Josera Polska

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Presentation Objectives

- Identify key reproductive performance control points and relate to influence of transition nutrition
- Explain mechanisms of transition nutrition and peripartum disease characterizing impact on herd reproductive performance
- Summarize areas of needed research to address reproductive performance through good nutrition

The Transition Challenge

"The transition from the pregnant, nonlactating state to the nonpregnant, lactating state is too often a disastrous experience for the cow..."

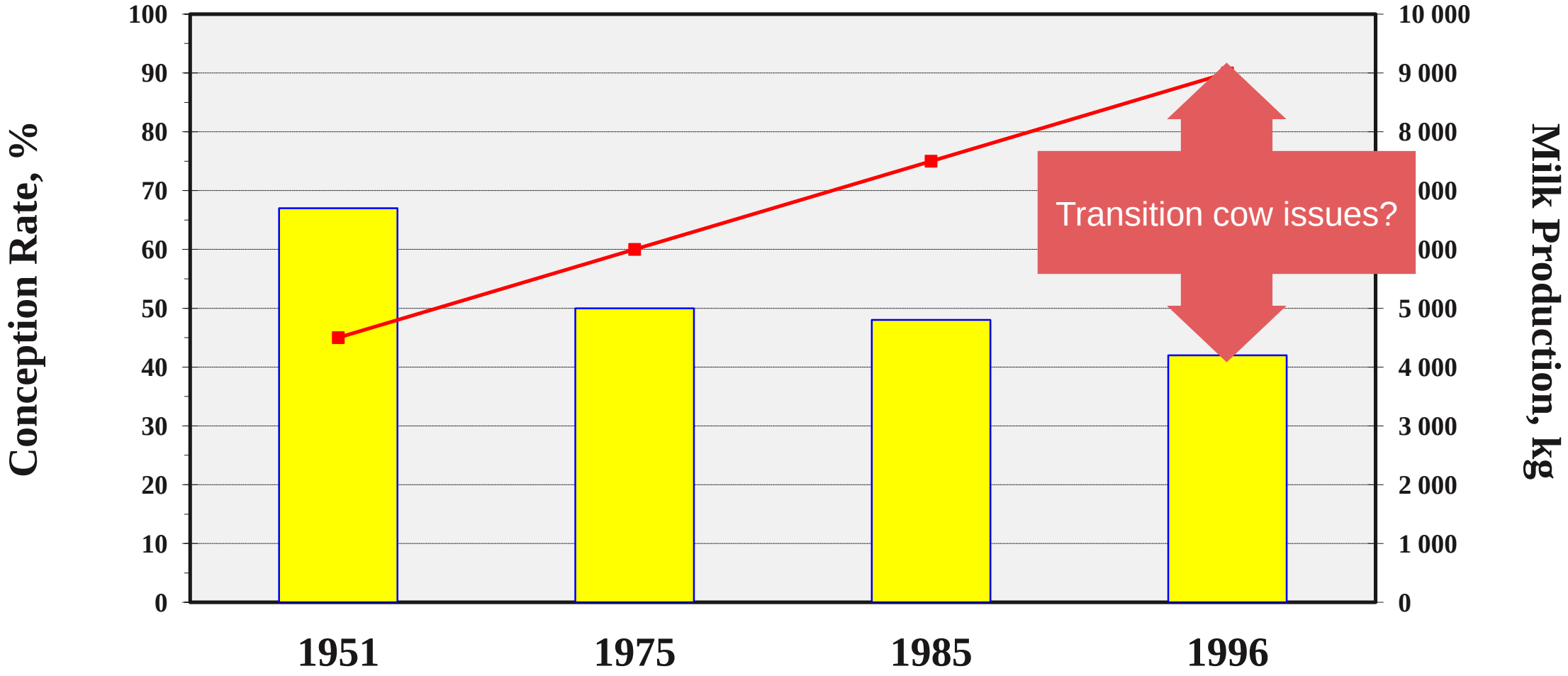
J.P. Goff and R.L. Horst. JDS 1997;80:1260-1268

More than 50% of all calvings experience one or more health events during transition – highly variable between herds

Transition Period Goals

- Encourage high (efficient) milk production
- Minimize loss or maintain BCS postpartum
- Achieve low postparturient disease prevalence
- Minimize loss of immunocompetency
- Control/decrease days to first ovulation and maintain/enhance fertility
- Low stillborn rate and healthy calves

Lactational Antagonism?



Butler, JDS 1998

Role of High Milk Production?

Item	Fagan and Roche 1986; traditional moderate yielding Friesian cows	Opsomer et al. 1998; modern high yielding Holstein cows
No. of cows/post-partum periods	463	448
Normal cyclic patterns (%)	78	53.5[a]
Prolonged interval to 1st ovulation (%)	7	20.5[a]
Prolonged luteal phase (%)	3	20[a]
Temporary cessation of ovulation (%)	3	3
Short cycles (%)	4	0.5
Other irregular patterns (%)	4	2.5

[a]Categories with a major disparity between the two studies.

- These data would suggest modern higher producing cows have impaired reproductive metrics
- Altered cyclic patterns and prolonged luteal phase would suggest underlying endocrine issues

Crowe, Repro Dom Anim 2008

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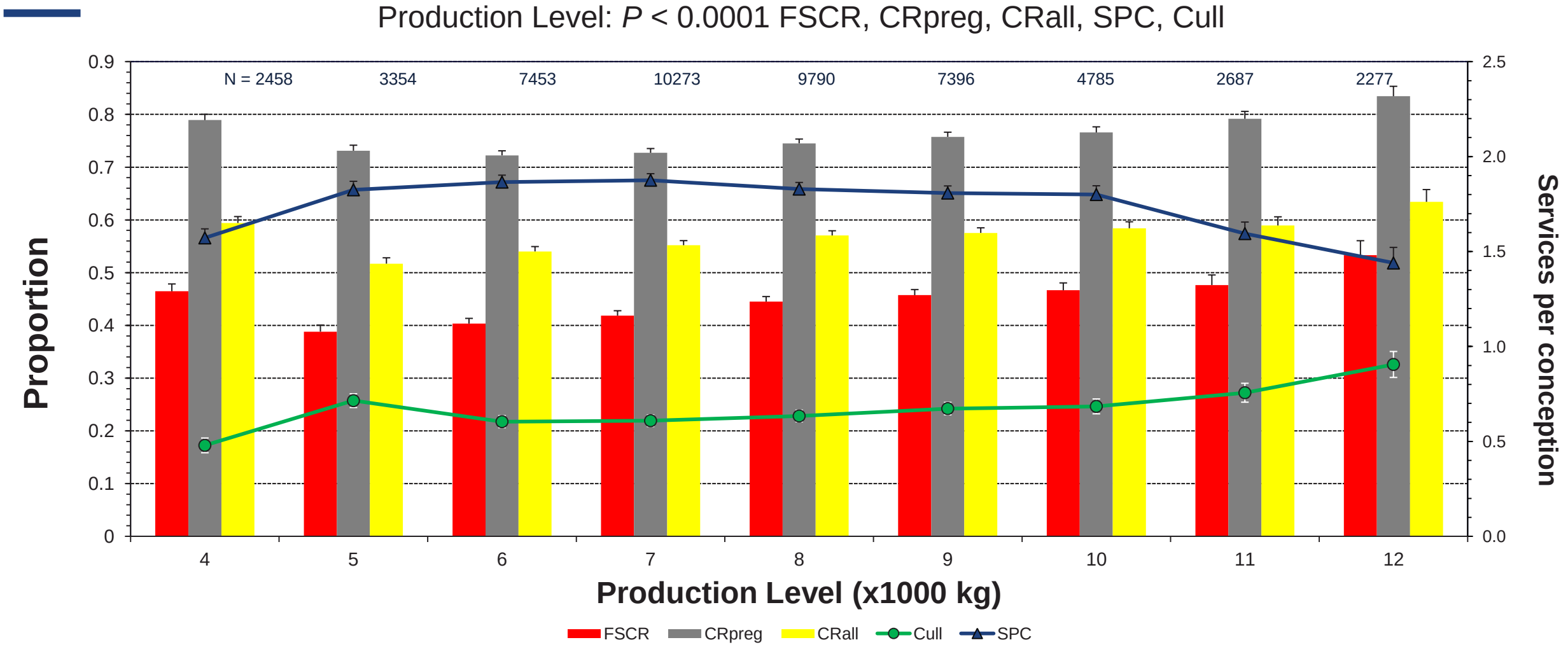
Production Effects



Van Saun and Leitgeb, 2010

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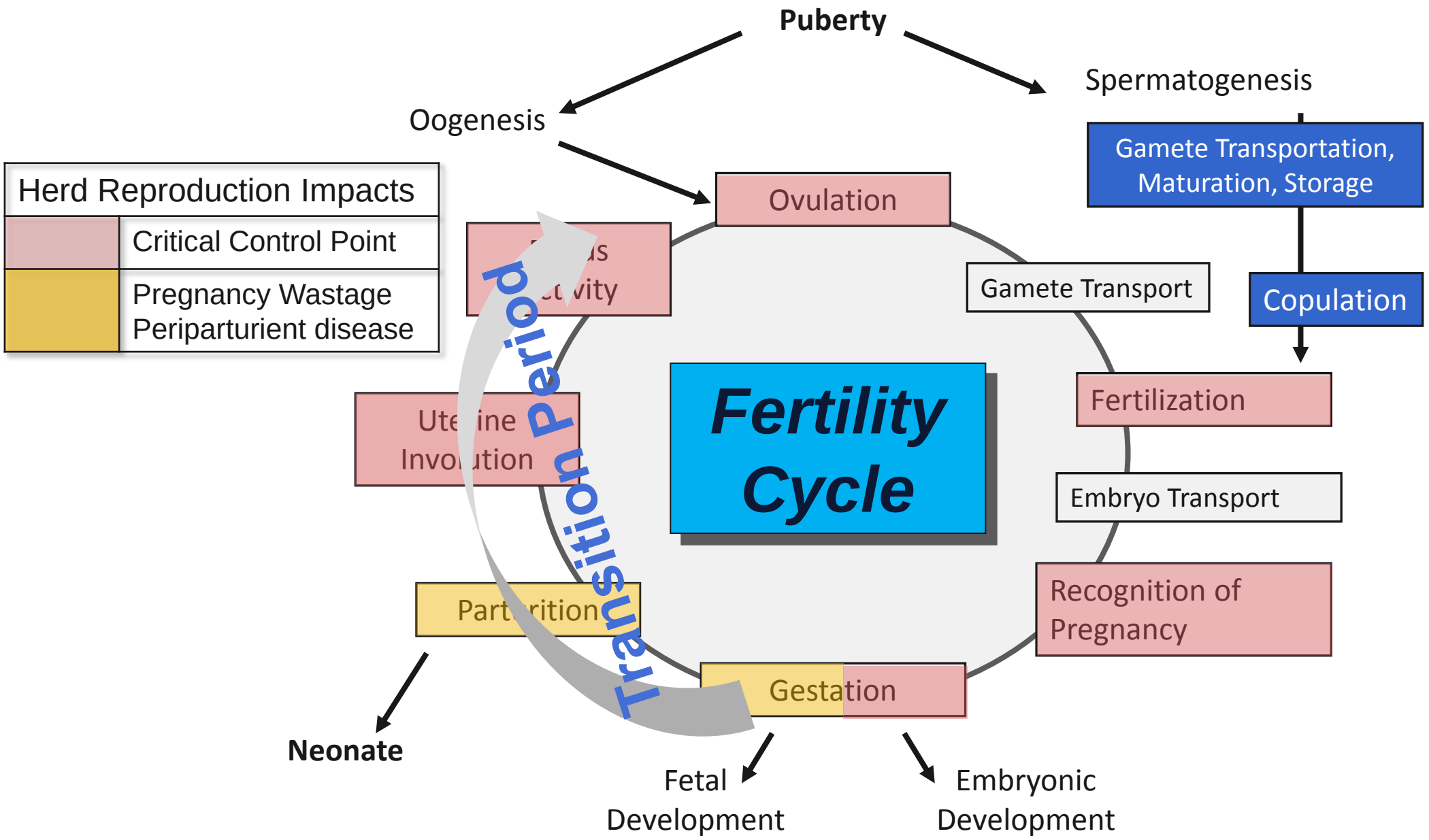
Herd Fertility

A function of:

- Conception rate in normal cows
- % of normal calvings

Critical control points:

- Uterine involution and recovery
- Estrus activity
- Time to first ovulation
- Conception rate
- Progesterone maintenance



Van Saun, 1992

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Santos et al., Reprod Domes Anim 2010

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Health Event Impacts on Cyclicity by d 65

5,719 postpartum dairy cows evaluated daily for health disorders on seven dairy farms in the United States.

Health Status	Cyclic, %	Adjusted OR (95% CI)	*P*
Health Problem			
Healthy	84.1	1.00	----
1 disease event	80.0	0.97 (0.72 – 1.30)	0.83
> 1 disease events	70.7	0.60 (0.44 – 0.82)	0.001
Type of disease problem			
Calving problem	70.5	0.52 (0.40 – 0.68)	< 0.001
Metritis	63.8	0.37 (0.28 – 0.50)	< 0.001
Clinical endometritis	68.9	0.51 (0.37 – 0.71)	< 0.001
Fever postpartum	80.0	0.55 (0.40 – 0.74)	< 0.001
Mastitis	81.5	0.87 (0.55 – 1.36)	0.53
Clinical ketosis	77.7	0.71 (0.47 – 1.07)	0.10
Lameness	85.0	0.82 (0.52 – 1.30)	0.40

Santos et al., Reprod Domes Anim 2010

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Impact of Health Events on Pregnancy at 1st AI

5,719 postpartum dairy cows evaluated daily for health disorders on seven dairy farms in the United States.

Health Status	Pregnant, %	Adjusted OR (95% CI)	*P*
Health Problem			
Healthy	51.4	1.00	
1 disease event	43.3	0.79 (0.69 – 0.91)	0.001
> 1 disease events	34.7	0.57 (0.48 – 0.69)	< 0.001
Type of disease problem			
Calving problem	40.3	0.75 (0.63 – 0.88)	< 0.001
Metritis	37.8	0.66 (0.56 – 0.78)	< 0.001
Clinical endometritis	38.7	0.62 (0.52 – 0.74)	< 0.001
Fever postpartum	39.8	0.60 (0.48 – 0.65)	< 0.001
Mastitis	39.4	0.84 (0.64 – 1.10)	0.20
Clinical ketosis	28.8	0.50 (0.36 – 0.68)	< 0.001
Lameness	33.3	0.57 (0.41 – 0.78)	< 0.001

Periparturient Disease Effects on Pregnancy Risk

Disease	Time	OR (95% CI)	*P*
Milk Fever	At calving	0.85 (0.69-1.04)	.12
LDA	Before AI	0.25 (0.07-0.91)	.04
RFM	At calving	0.55 (0.37-0.83)	.004
Mastitis	≤ 21 d after AI	0.48 (0.34-0.69)	.0001
	≤ 30 d before AI	0.82 (0.61-1.09)	.17
Metritis	≤ 30 d before AI	0.53 (0.41-0.69)	.0001
	≥ 31 d before AI	0.83 (0.73-0.95)	.006
Cystic Ovaries	≤ 21 d after AI	0.36 (0.16-0.82)	.02
	≤ 30 d before AI	0.78 (0.65-0.95)	.01
Lameness	< 21 d after AI	0.82 (0.67-1.04)	.1

.63 = Average

Loeffler et al., JDS 1999;82:2589

Santos et al., Reprod Domes Anim 2010

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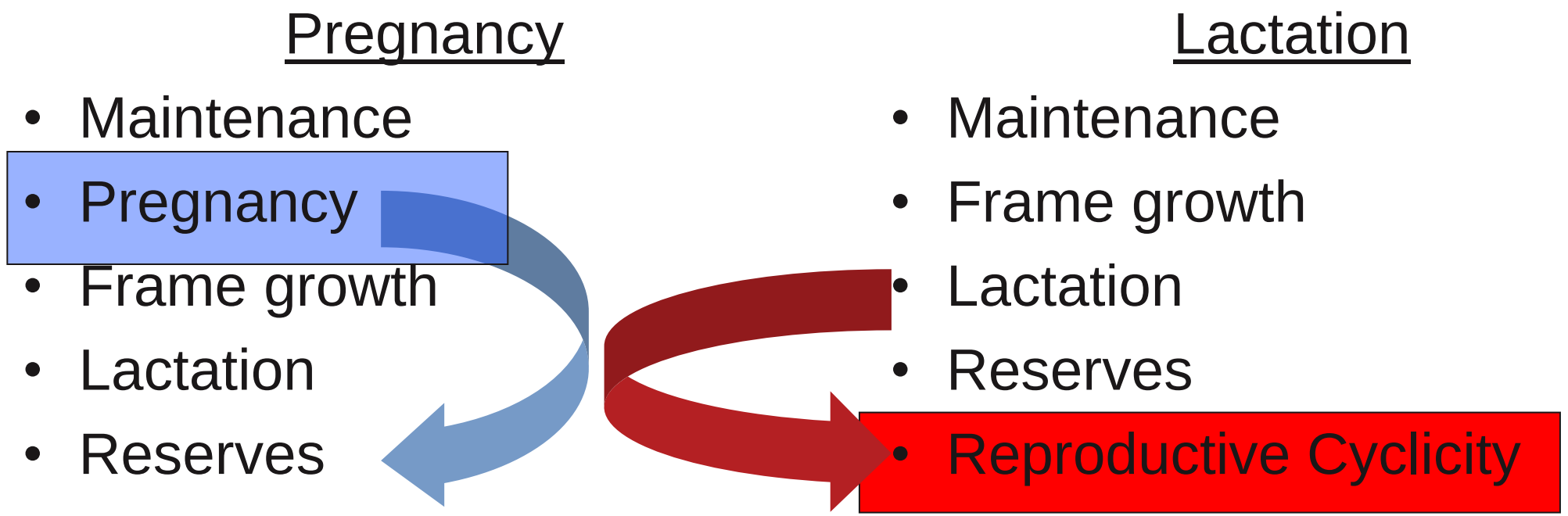
Impact of Health Events on Pregnancy Loss

5,719 postpartum dairy cows evaluated daily for health disorders on seven dairy farms in the United States.

Health Status	Pregnancy Loss, %	Adjusted OR (95% CI)	P
Health Problem			
Healthy	8.9	1.00	----
1 disease event	13.9	1.73 (1.25 – 2.39)	< 0.001
> 1 disease events	15.8		< 0.001
Type of disease problem			
Calving problem	15.9	1.67 (1.16 – 2.40)	< 0.01
Metritis	11.3	1.01 (0.71 – 1.60)	0.76
Clinical endometritis	15.1	1.55 (1.04 – 2.32)	0.03
Fever postpartum	18.0	2.00 (1.24 – 3.14)	< 0.01
Mastitis	19.8	2.62 (1.48 – 4.64)	< 0.001
Clinical ketosis	14.6	1.64 (0.75 – 3.59)	0.22
Lameness	26.4	2.67 (1.38 – 5.12)	< 0.01

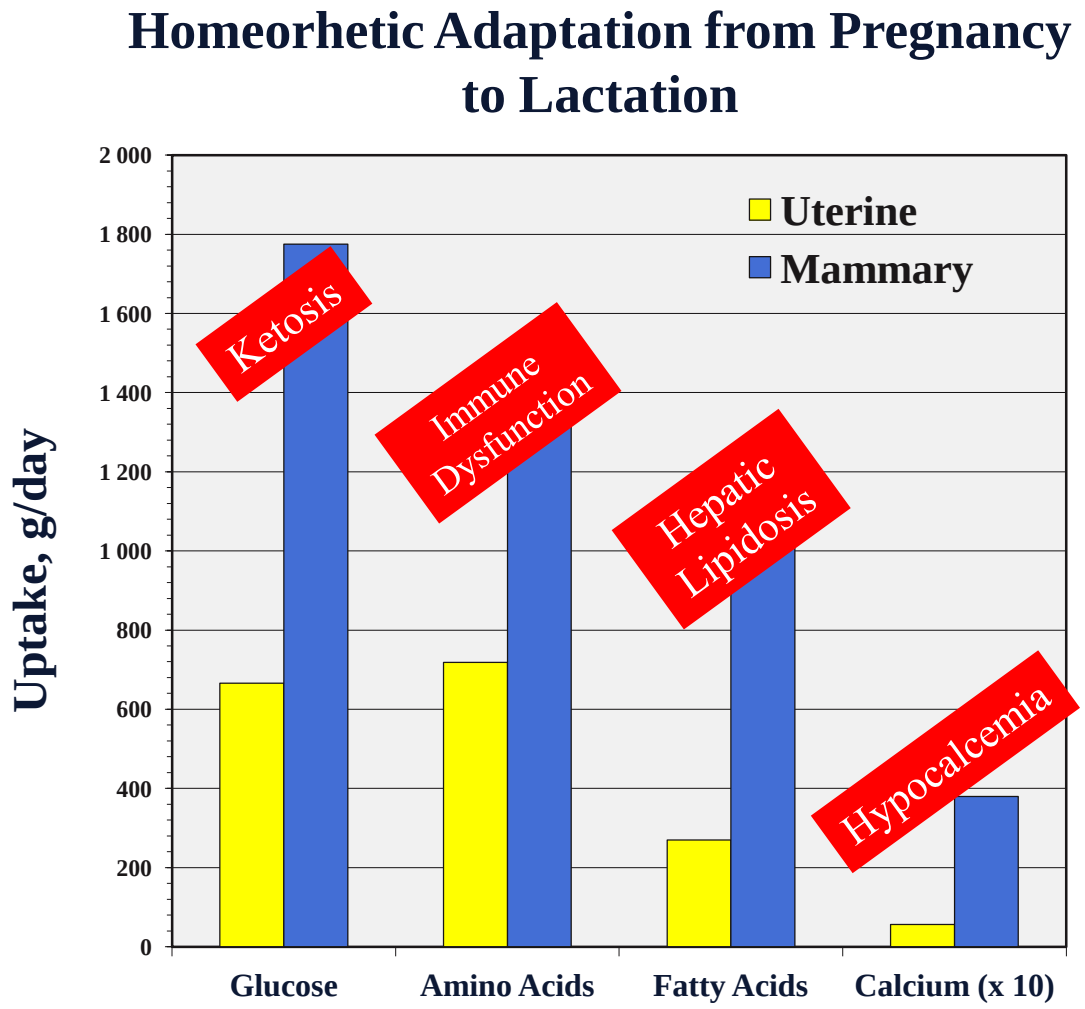
Productive State Prioritization

Homeorhetic Regulation Relative to Nutritional Deficits



Bauman and Currie, J Dairy Sci 1980

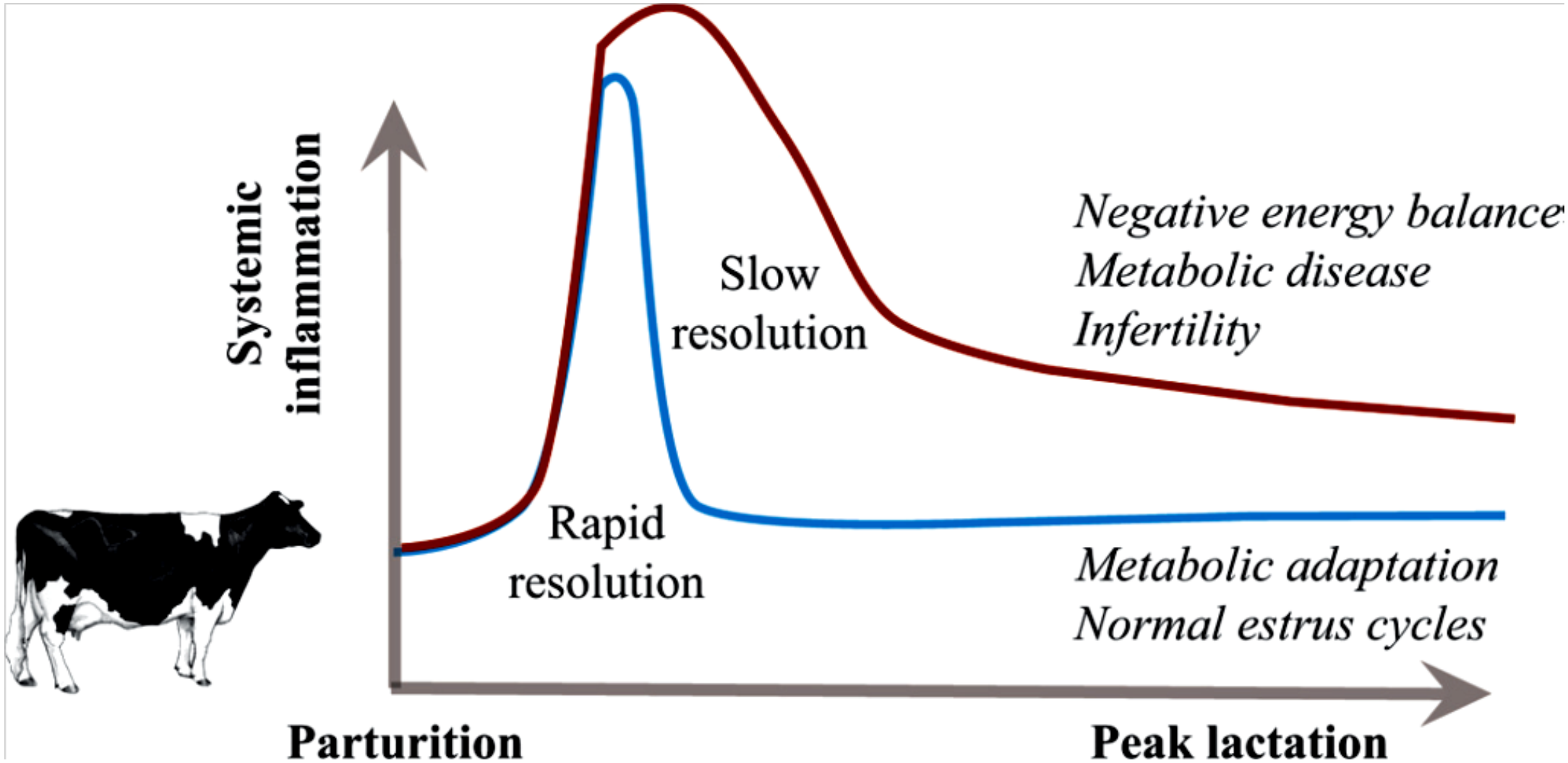
Periparturient Disease



- Glucose
  - Energy currency
  - Insulin regulation of tissues
  - Regulator of ketogenesis
- Fatty acids
  - Excessive mobilization
  - Hepatic processing
  - Insulin sensitivity & stress factors
- Amino acids
  - Gluconeogenesis
  - Hepatic lipid transport
  - Immune function
- Calcium
  - Intake controller
  - Disease contributor

Bell, JDS 73:2804; 1995

Role of Inflammation



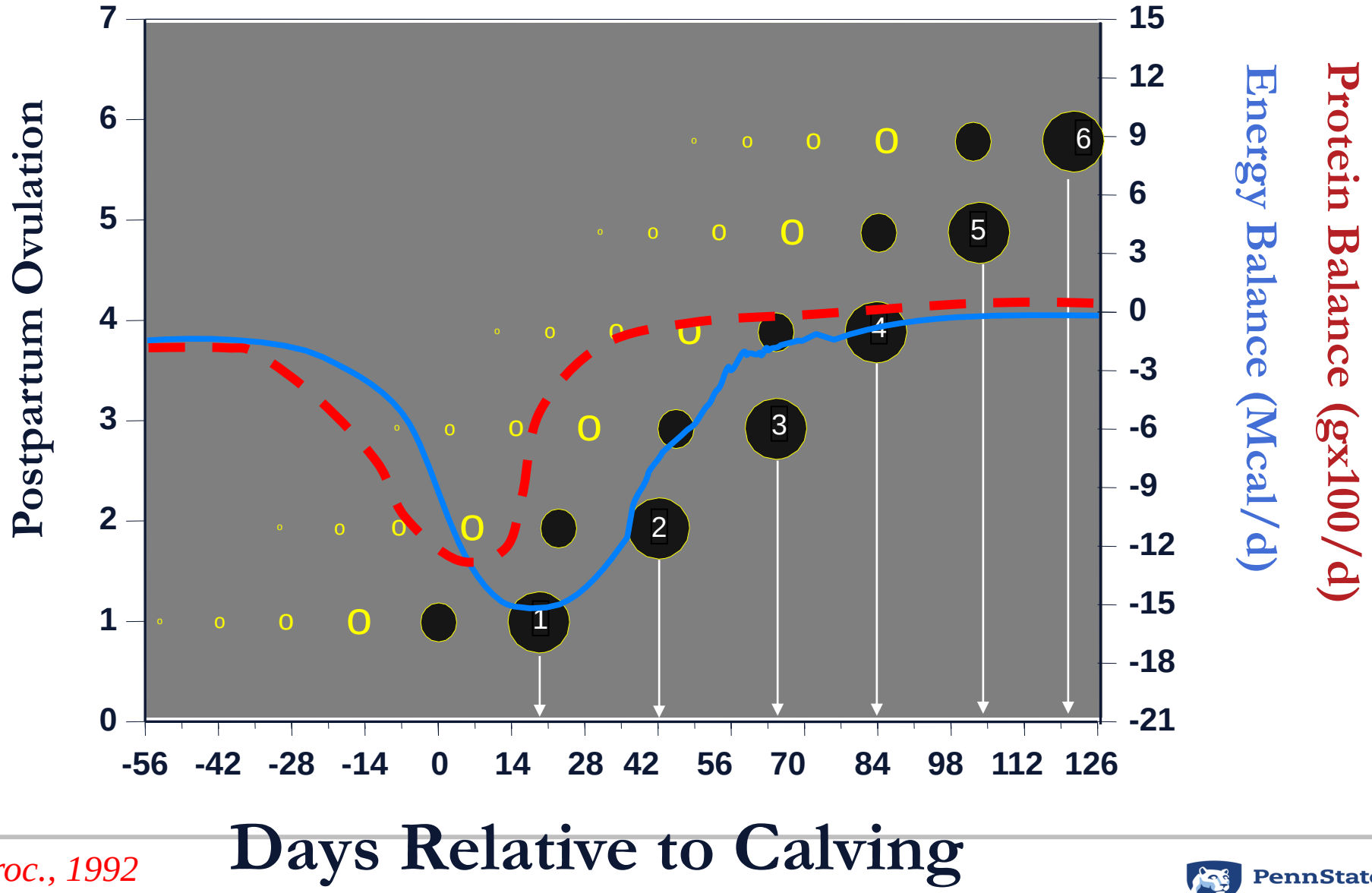
Bradford et al., JDS 2015

Transition Cows Experiencing Stressors

- Decreased dry matter intake and milk
- Increased body fat mobilization and wasting of muscle tissue
- Divert nutrients from milk to stress response/immune system
- Potential mechanism
  - Release of pro-inflammatory cytokines (TNFα, IL-1β, IL-6) and stress hormones (glucocorticoids, epinephrine, cortisol)

Drackley et al., 2005

Follicular Memory Hypothesis



Britt, Bovine Proc., 1992

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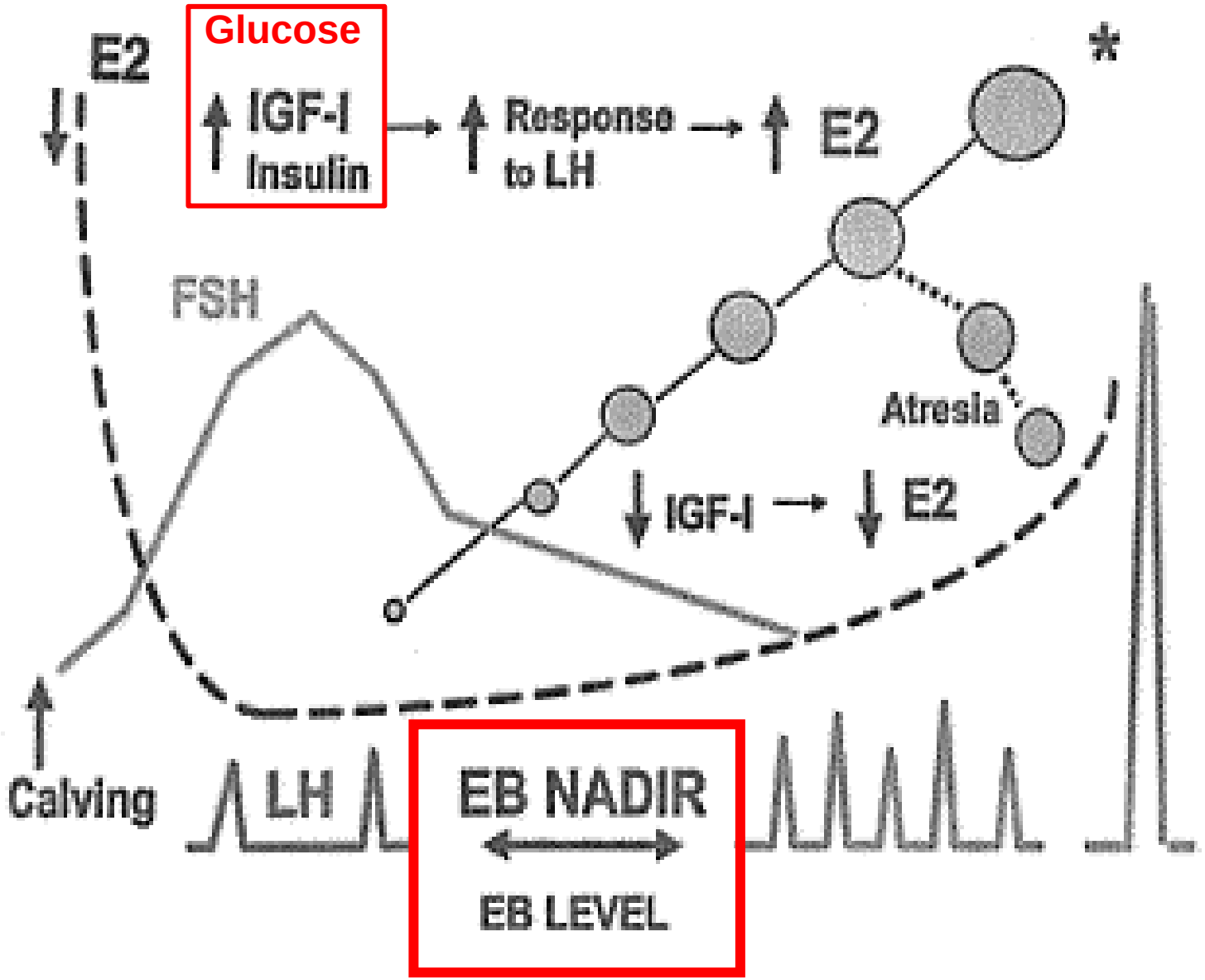
Initiating First Ovulation



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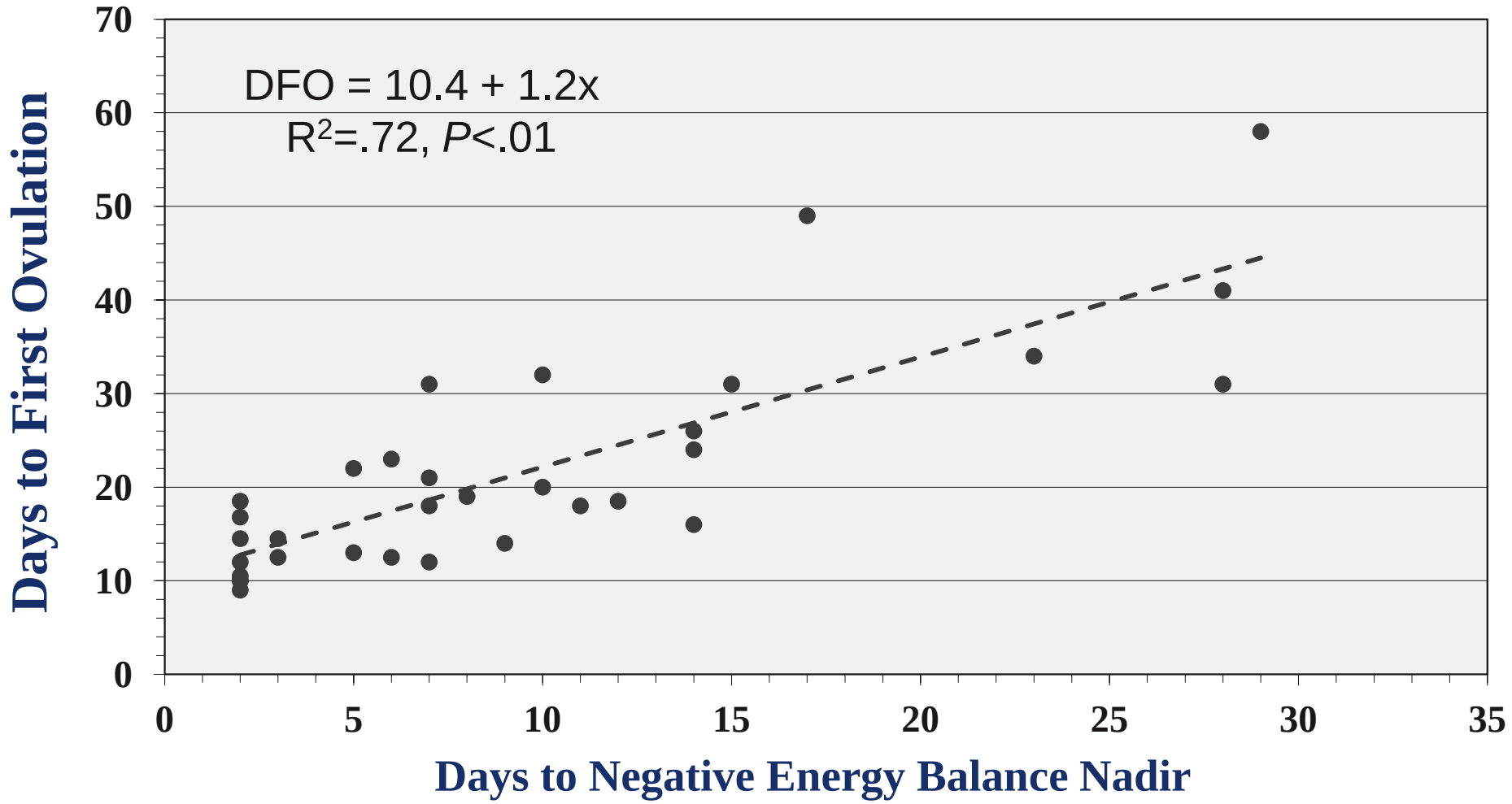
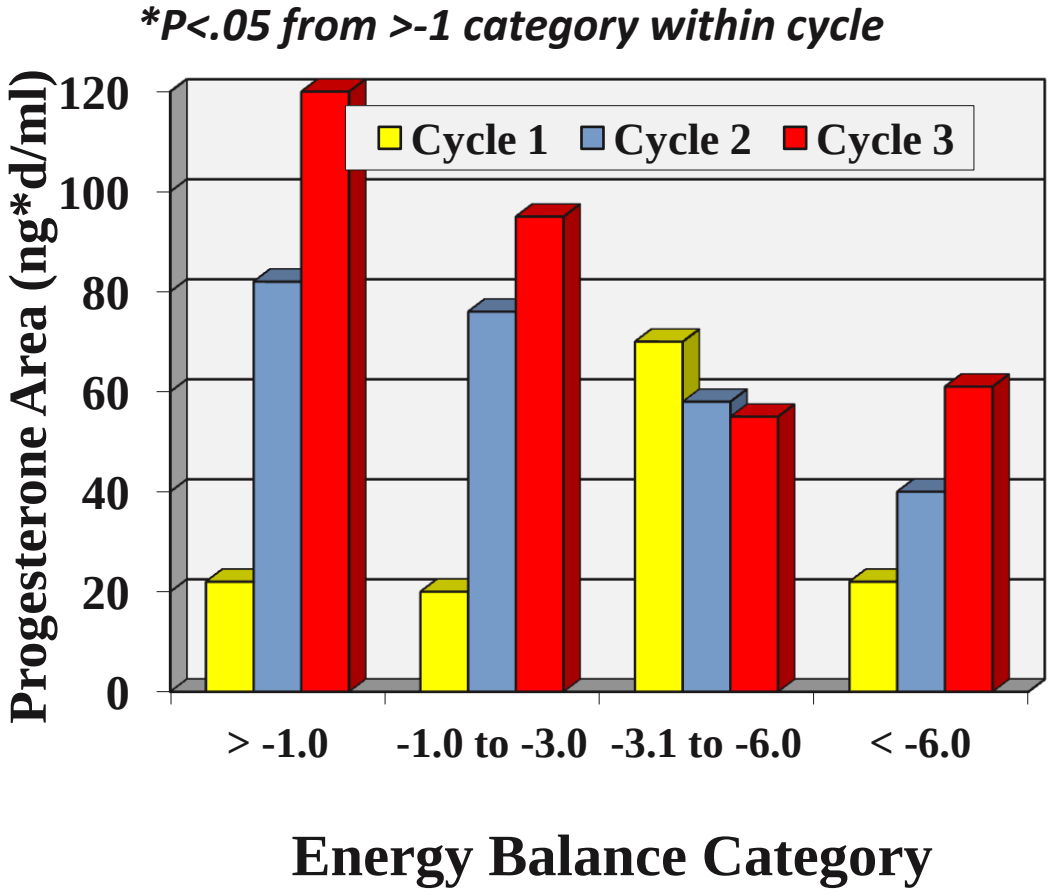
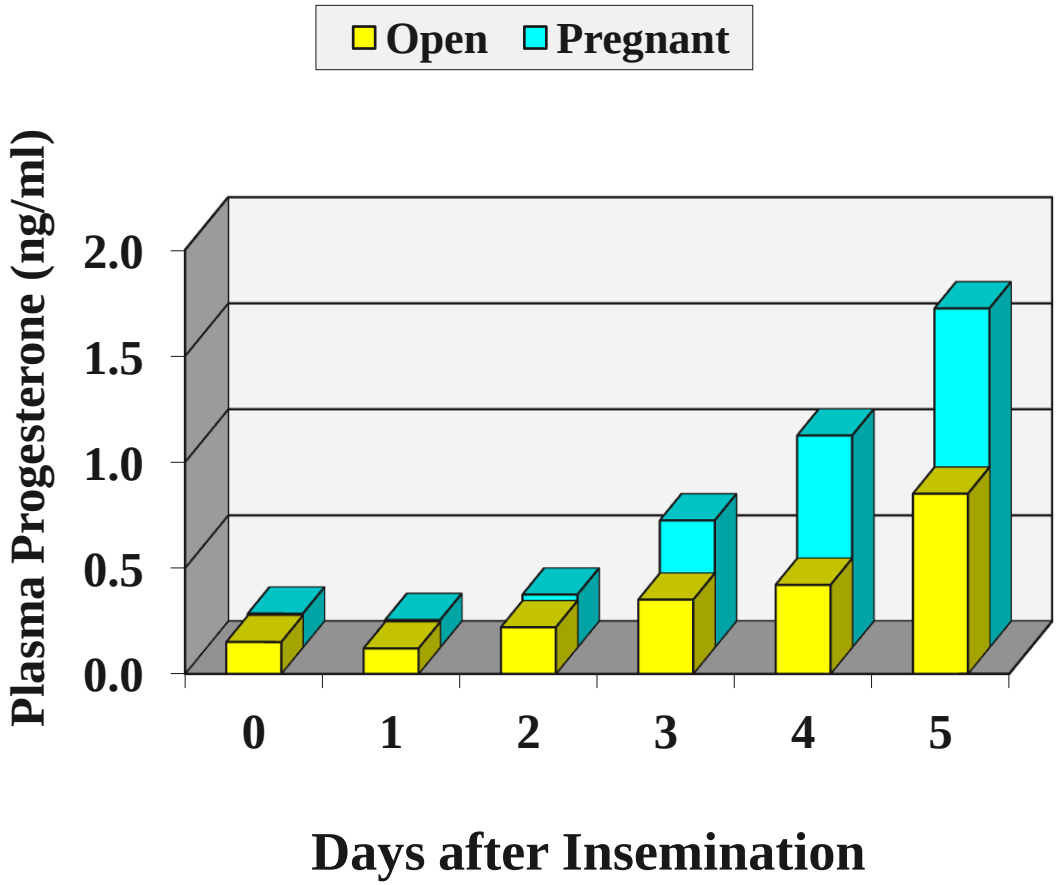
Energy Balance Effects on First Ovulation



Canfield and Butler, J Anim Sci 1991

Energy Balance Effect on Progesterone

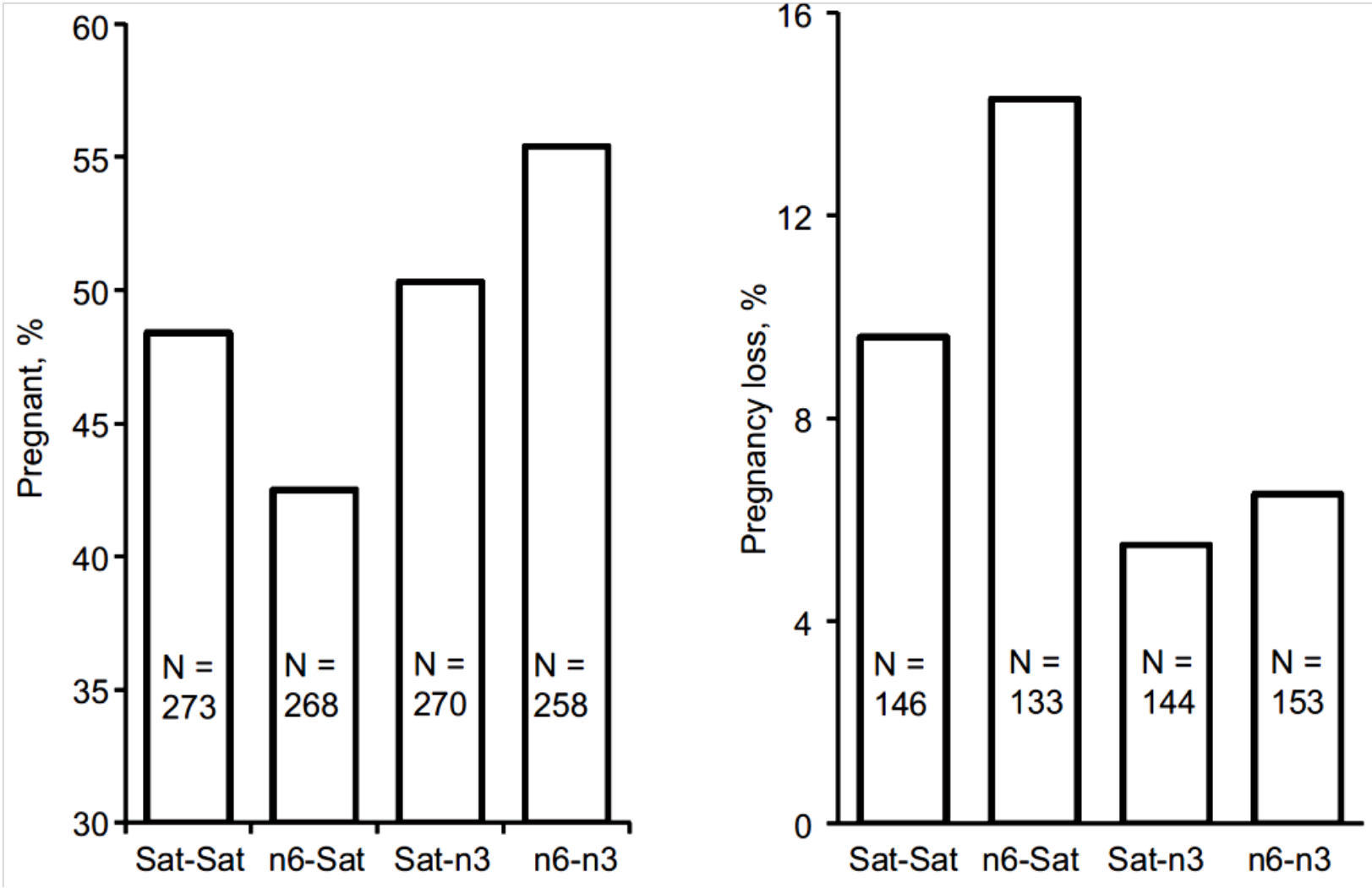




Villa-Goodoy et al, JDS 1988

Butler et al., 1996

Fatty Acid Source Effects

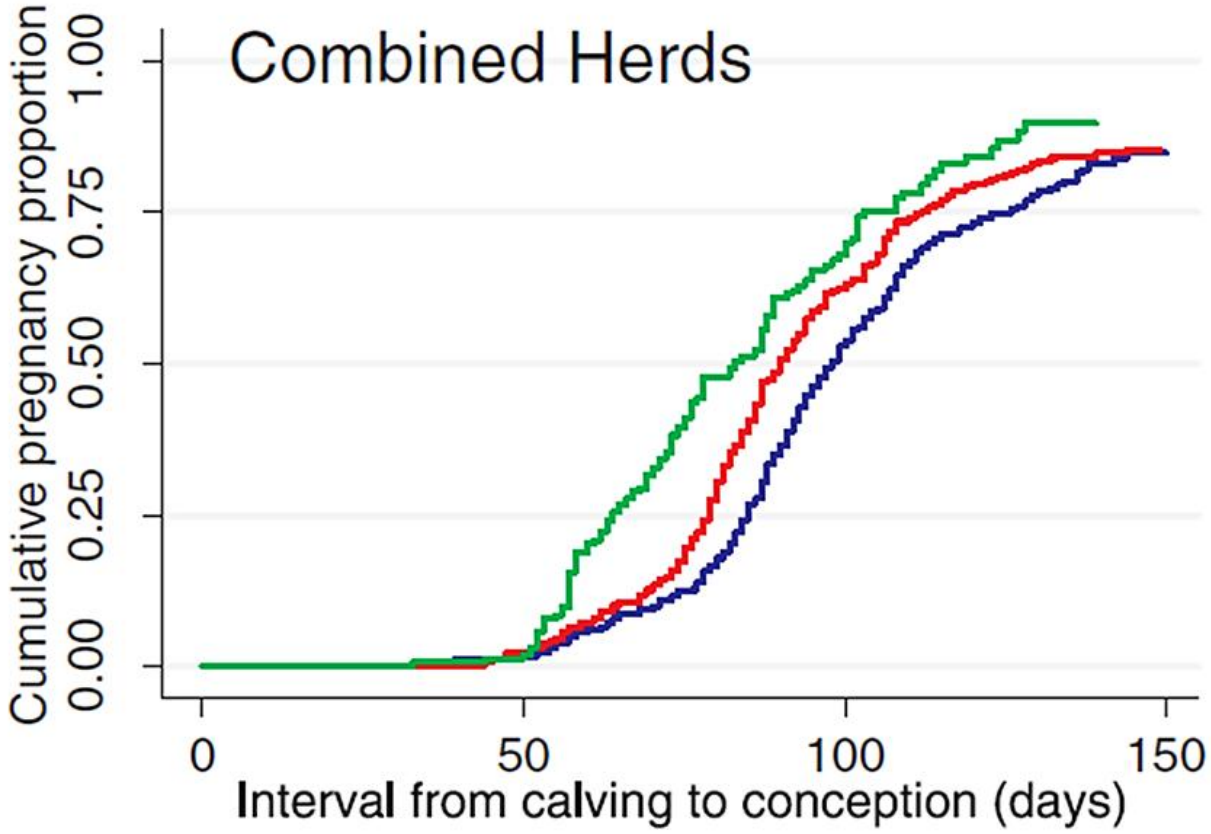


Effect of feeding Ca salts of either mostly saturated (Sat), mostly omega 6 (n6) or mostly omega 3 (n3) fatty acids during the transition (-30 to 30 days postpartum) or the breeding periods (31 to 160 days postpartum) on pregnancy on day 60 after the first and second AI or pregnancy loss between 32 and 60 days of gestation. Treatments are depicted according to the sequence of fat fed during the transition and breeding periods. Cows fed n3 had greater 52.9 vs. 45.5%, P < 0.01 pregnancy per AI than those fed Sat primarily as a result of reduced 6.1 vs. 11.8%, P < 0.01 pregnancy loss (Silvestre et al., 2010a).

Santos et al., Reprod Domes Anim 2010

Prepartum Diet Exposure

- Prepartum diets averaged +286 g/d MP
- Improved health performance
- Reduced culling
- Risk of pregnancy increased 2.1 and 2.2x in herds with +MP balance

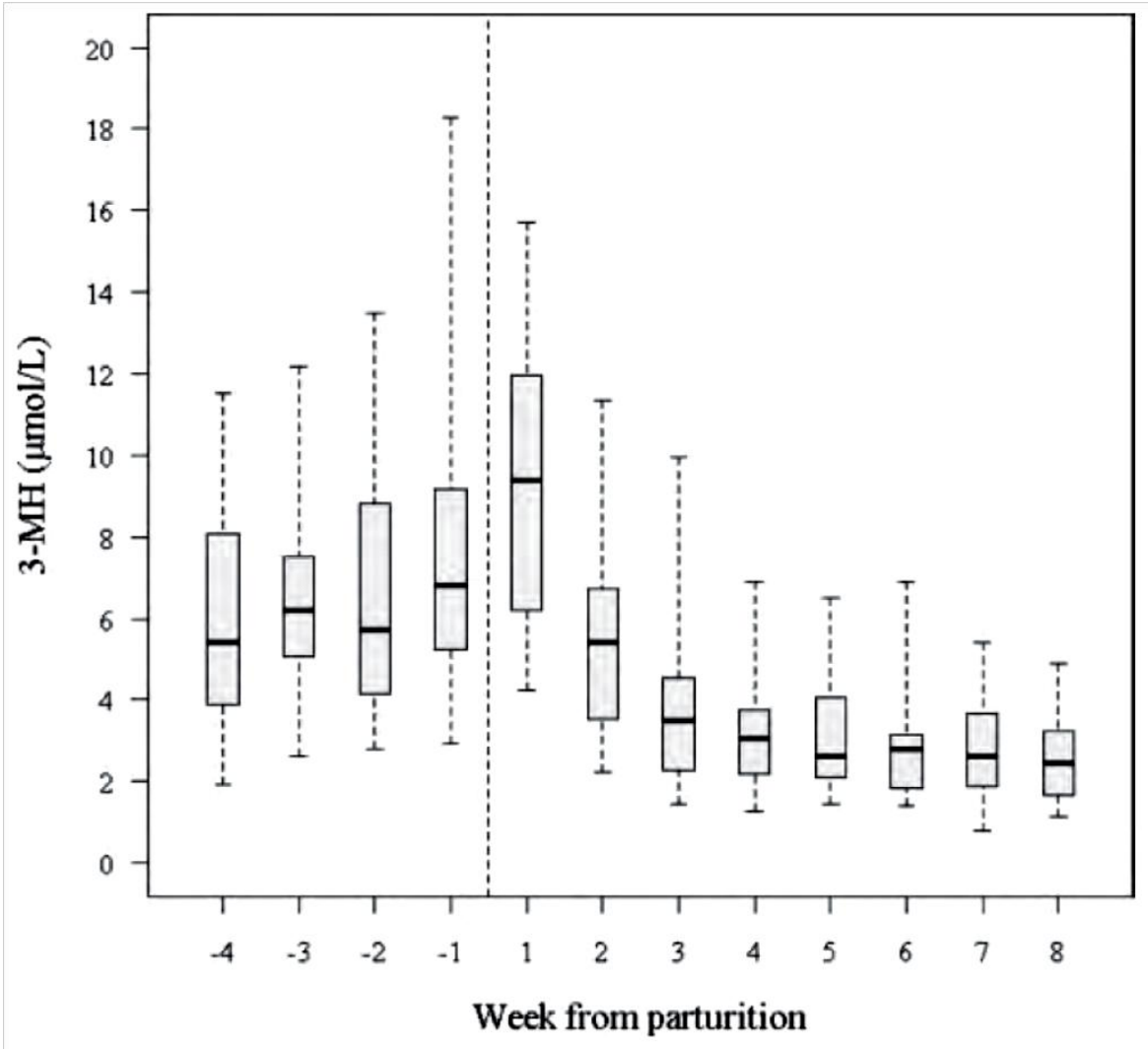


Blue: 0-10 days
Red: 11-20 days
Green: >20 days

DeGaris et al., Aust Vet J 2010

Protein Mobilization

- 3-methyl Histidine is a marker for skeletal muscle breakdown
- Protein mobilization occurs prior to parturition and before fat mobilization
- Cows unable to mobilize protein had higher BHB
- Hyperketonemia associated with severe protein/fat mobilization

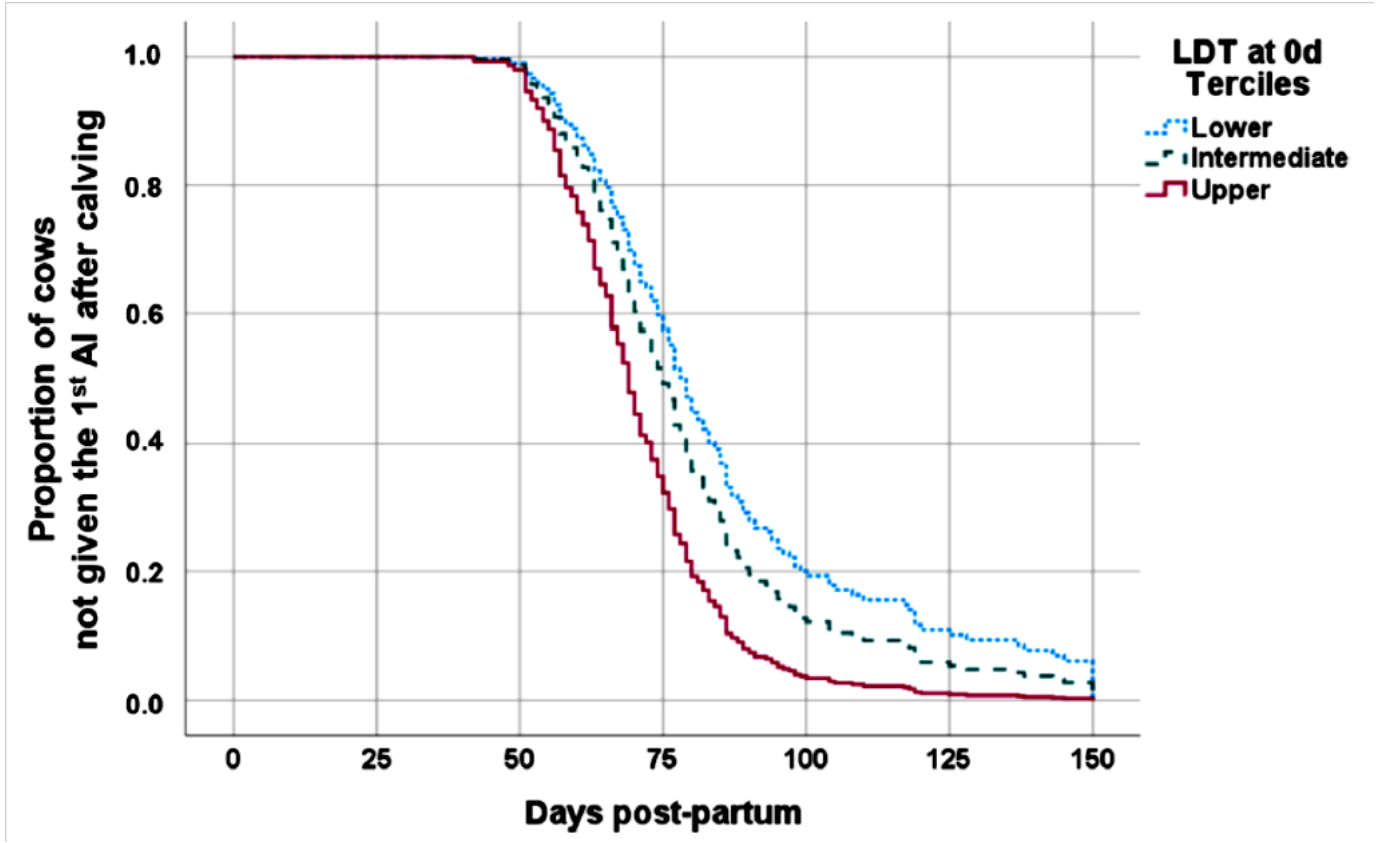


van der Drift et al., JDS 2012;95:4911-4920

Protein Mobilization and Reproduction

- Longissimus dorsi thickness (LDT) terciles represent protein mobilization
- Cows in upper tercile were 2.05 times more likely to have 1st AI by 150 DIM than lower tercile
- Backfat thickness effects were inconclusive

Longissimus dorsi thickness at Calving



Siachos et al., Animal 2022

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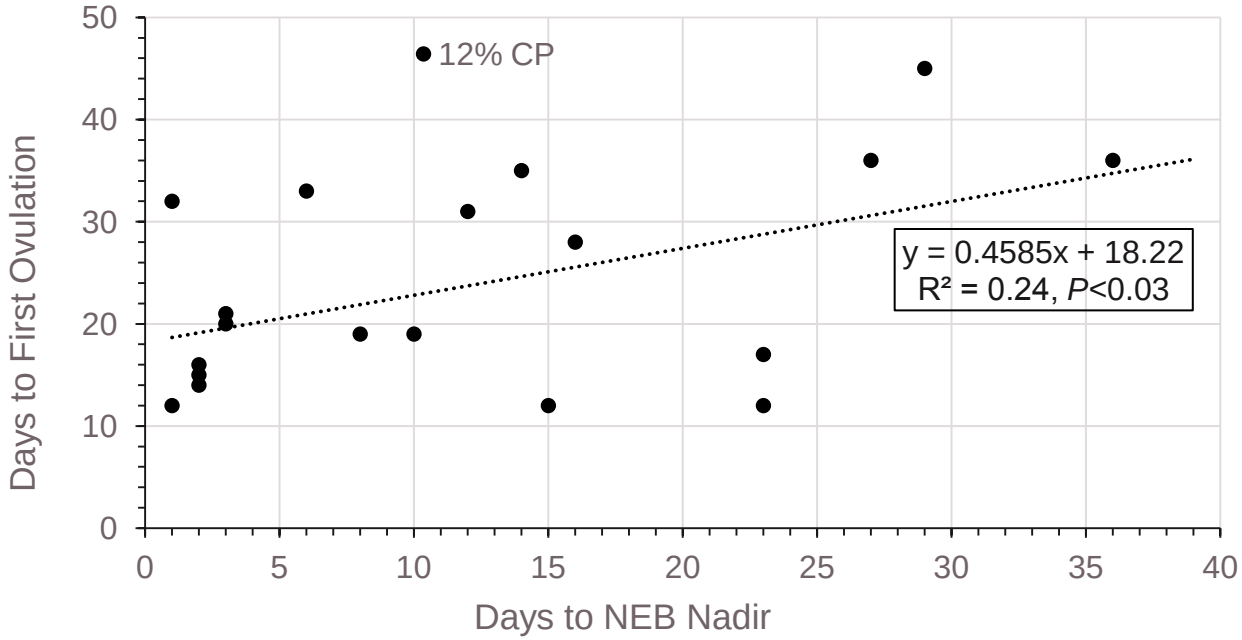
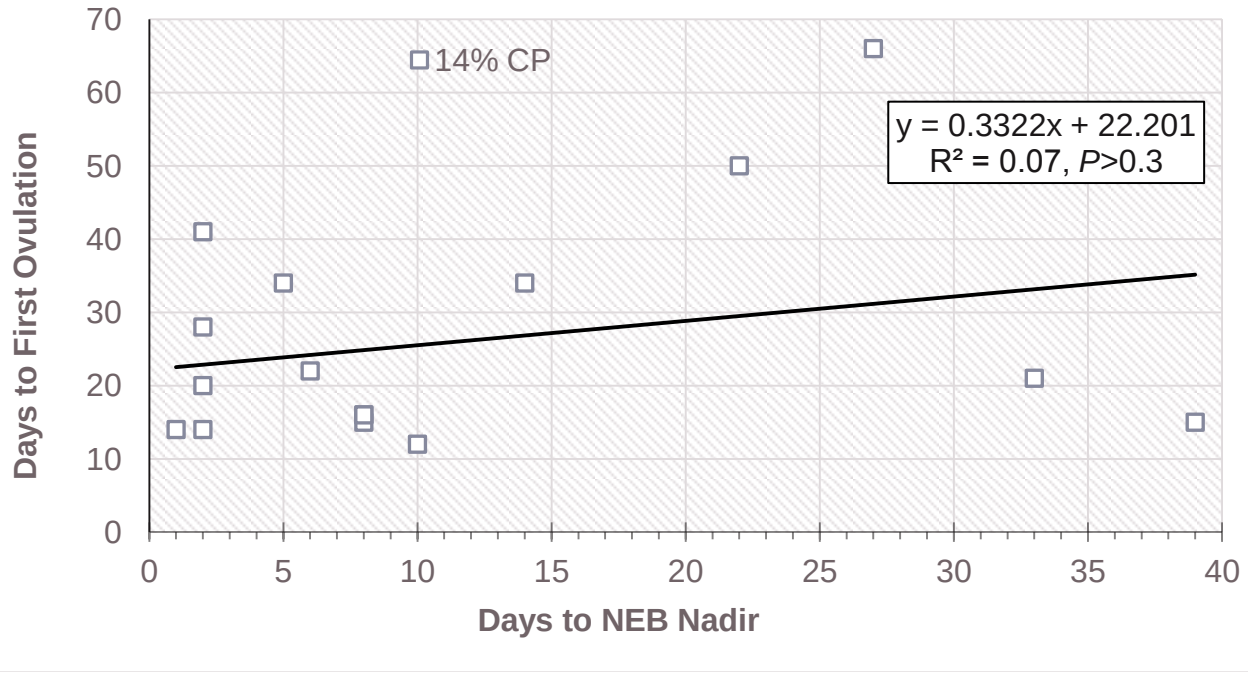
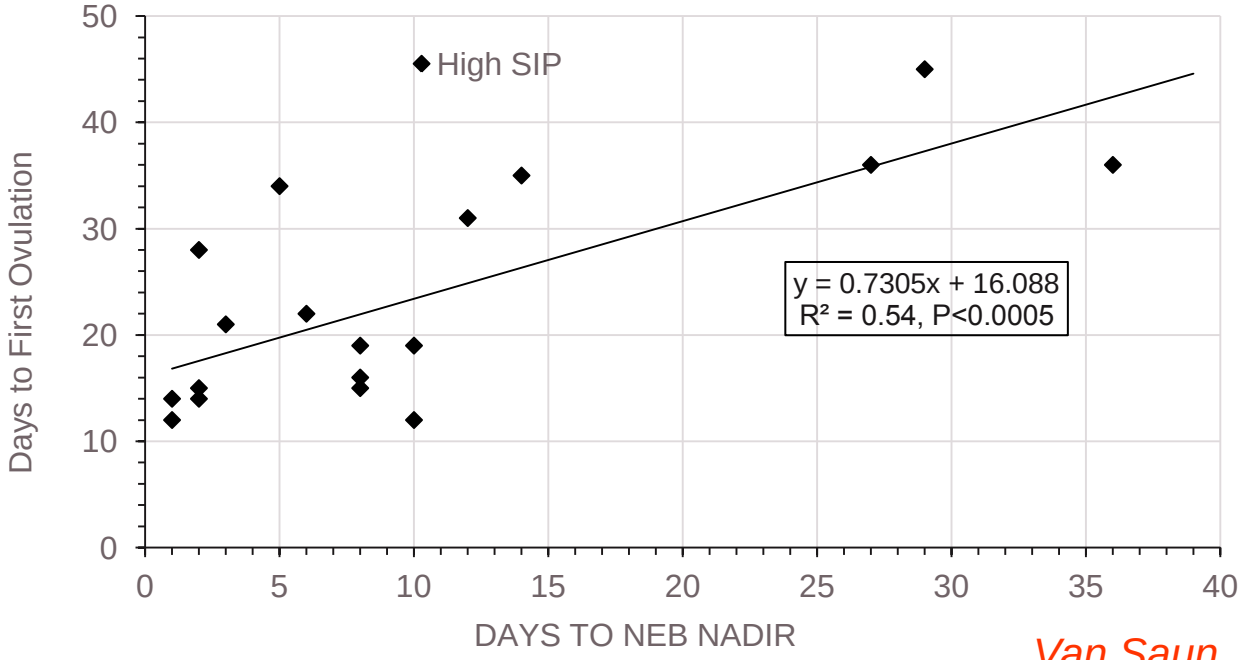
Prepartum Protein Effects on Reproduction

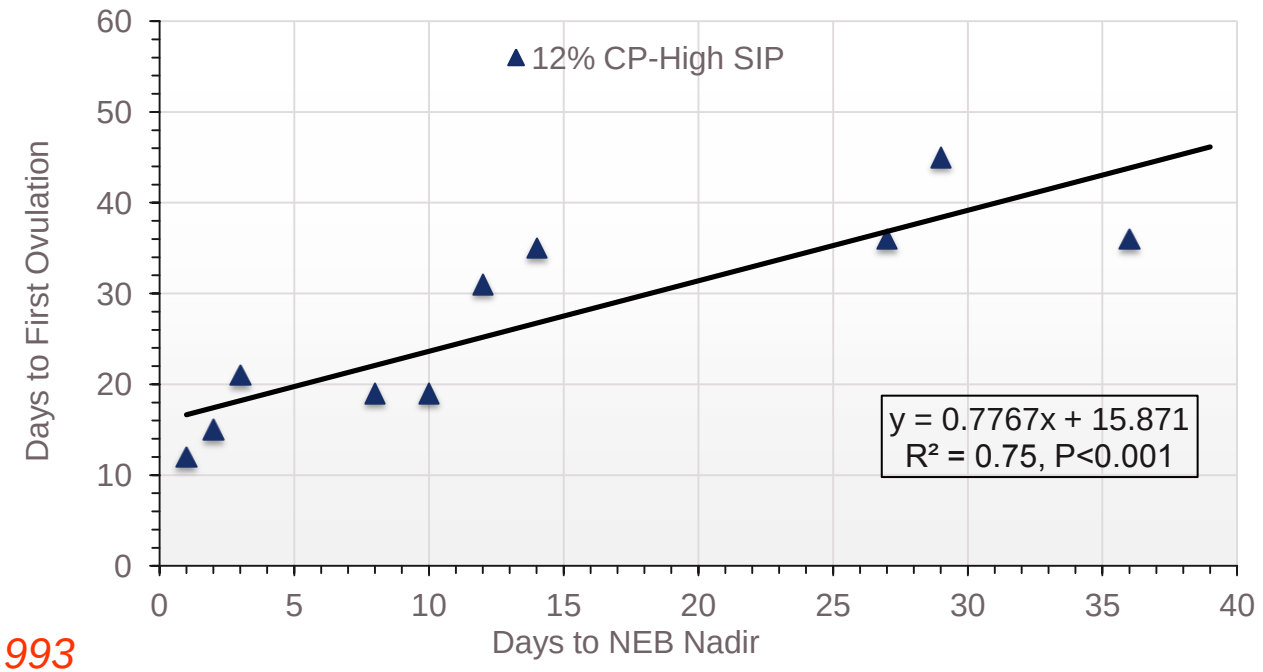
Parameter	Low RUP		High RUP	
	High SIP	Low SIP	High SIP	Low SIP
DFO, days	24.5	17.4	22.6	39.6
DFS, days	64.6	69.8	68.4	65.0
Days Open	93.3	92.7	74.8	58.5
Pregnancy Rate:				
First Service	44.4	55.6	50.0	83.3
Overall	88.9	77.8	87.5	83.3
Clinical Ketosis	31.6% (6/19)		0 % (0/19)	
BCS @ calving	3.91		3.99	

Van Saun and Sniffen, 1995









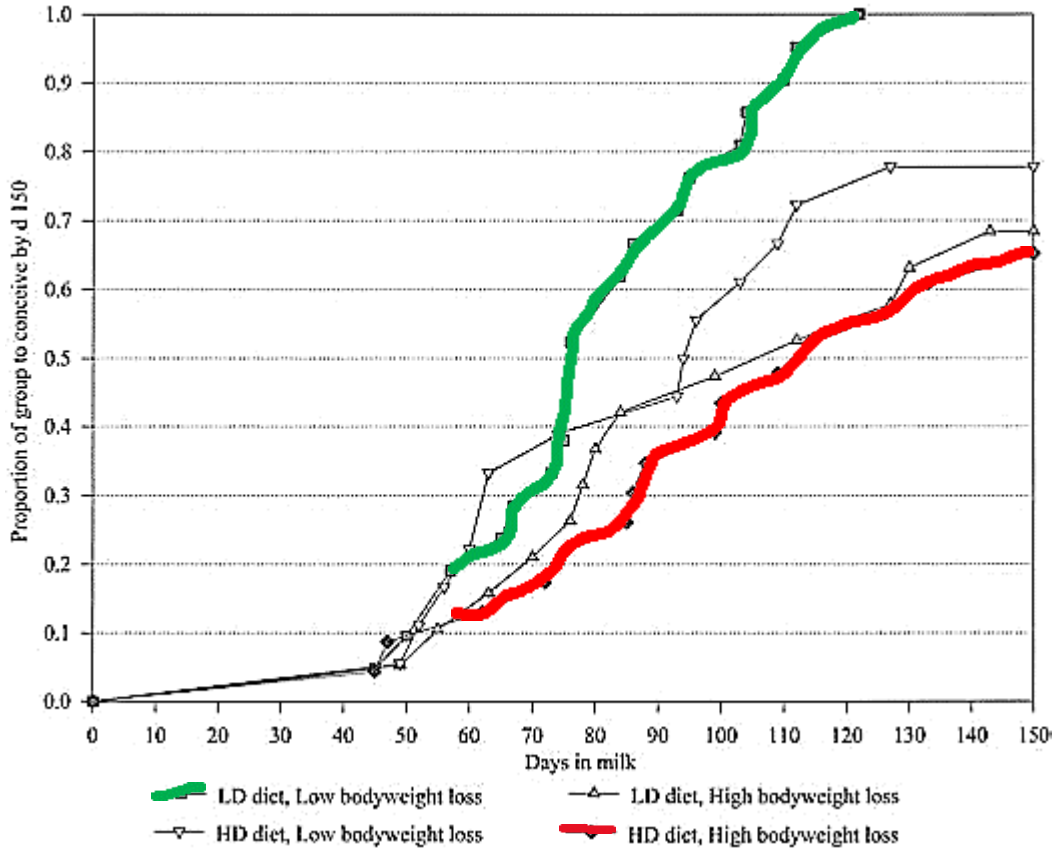
Van Saun, 1993

Body Weight Loss and Protein Degradability

Factors affecting probability of conception to first service

Variable	BW Chg	Prot Degrad
Relative Risk		
Favorable	1.76	1.00
Unfavorable	0.48	0.31
OR	3.69	0.31
P	.003	.022

Favorable characteristics: change in BW during first 6 wk of lactation >−51 kg; low-degradable (LD) diet.
Unfavorable characteristics: change in BW during first 6 wk of lactation <−109 kg; highly-degradable (HD) diet.



Interval from calving to initial conception for cows fed low-degradable (LD) or high-degradable (HD) diets and losing greater or less than 76 kg during early lactation.

Westwood et al., J. Dairy Sci. 2002; 85:3225–3237

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Rumen-Protected Methionine

Table 2. Effect of feeding rumen-protected Met (RPM) diet or a control diet (CON) pre- and postpartum on pregnancies per timed AI (TAI) and pregnancy loss after first-service TAI[1]

	All cows inseminated[2]				Synchronized cows only[3]			
Item	CON	RPM	Trt	Farm	CON	RPM	Trt	Farm
Pregnancy per TAI	CP = 14.6-15.9%							
25 d after TAI	57.8 ± 4.1	58.9 ± 4.0	0.43	0.41	64.0 ± 3.9	64.7 ± 3.9	0.45	0.30
29 d after TAI	54.7 ± 3.6	56.7 ± 3.6	0.36	0.18	61.0 ± 3.3	62.9 ± 3.4	0.35	0.14
32 d after TAI	48.8 ± 3.3	49.1 ± 3.3	0.48	0.53	54.3 ± 3.2	55.1 ± 3.3	0.43	0.49
39 d after TAI	47.1 ± 3.1	48.7 ± 3.1	0.37	0.37	52.3 ± 3.0	54.4 ± 3.1	0.32	0.32
67 d after TAI	43.3 ± 4.3	45.9 ± 3.4	0.30	0.28	48.3 ± 3.5	51.3 ± 3.6	0.28	0.27
Pregnancy loss								
25 to 29 d after TAI	5.9 ± 2.1	1.1 ± 1.8	0.17	0.23	5.6 ± 2.2	0.7 ± 1.5	0.16	0.39
29 to 32 d after TAI	10.9 ± 2.7	12.9 ± 2.8	0.31	0.16	10.9 ± 2.9	11.7 ± 3.1	0.43	0.32
32 to 39 d after TAI	3.4 ± 1.9	0.4 ± 0.9	0.19	0.39	3.6 ± 2.1	0.4 ± 1.0	0.19	0.41
39 to 67 d after TAI	7.0 ± 2.9	5.4 ± 2.5	0.34	0.47	6.2 ± 3.0	5.7 ± 2.9	0.46	0.72
Total 25 to 67 d after TAI	23.8 ± 3.9	21.1 ± 3.7	0.31	0.41	22.6 ± 3.9	19.2 ± 3.7	0.28	0.54

[1]Trt = treatment effect. One-sided tests for the effect of treatment. For all variables, Trt by farm $P > 0.10$. Values are presented as LSM ± SEM.

[2]All cows enrolled in the experiment that had a pregnancy outcome at first-service TAI.

[3]Only cows considered synchronized by the Double-Ovsynch protocol included (P4 >1.0 ng/mL at the first PGF of Breeding-Ovsynch, P4 ≤0.5 ng/mL 48 h after the first PGF of Breeding-Ovsynch, and P4 >1.0 ng/mL 8 d after TAI). P4 = progesterone.

Stangaferro et al., JDS 2021

Identified Nutritional Control Points in Managing Transition Success

- Minimize drop in prepartum DMI
  - Improved postpartum DMI
  - Minimize increase in NEFA
- Adequate dietary supply of ME and MP
  - Based on observed intake and accounts for variation
- Minimize risk of hypocalcemia
  - Hypocalcemia gateway disease
  - Compromises immune cell function
- Maintain the immune response and minimize inflammation

Summary

- Impact of transition diet is mediated through inappropriate metabolic adaptations:
  - Negative energy balance and metabolic diseases of energy (protein) metabolism
  - Immune dysfunction and excessive inflammation predisposing to infectious disease conditions
  - Metabolic diseases associated with mineral deficiencies
- Stressors will exacerbate metabolic adaptations leading to greater disease risk *(Horst et al., JDS 2021)*

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Thank You for Your Attention!

Questions?

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