One Case of Milk Fever is Just the Tip of an Iceberg

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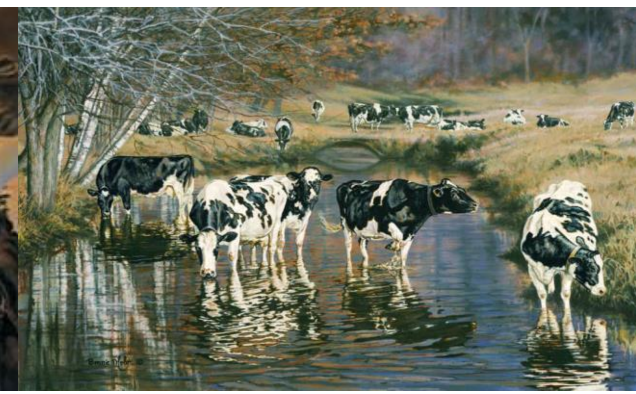


Pictures by Bonnie Mohr http://www.bonniemohr.com/

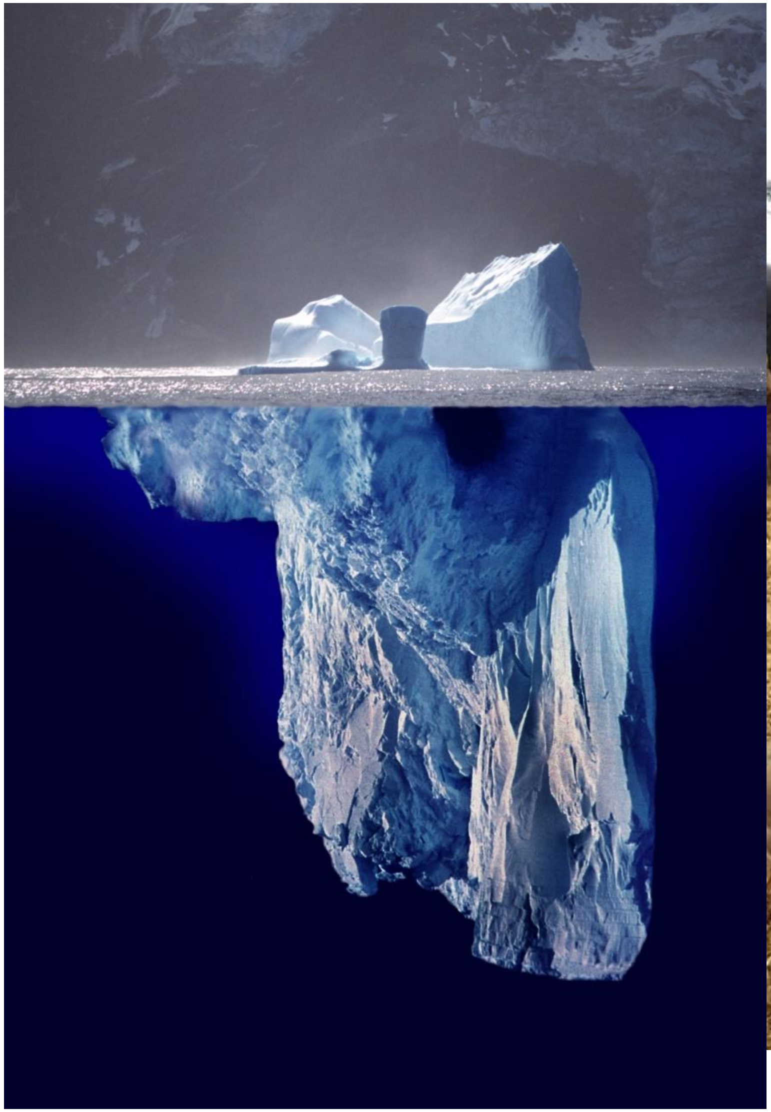
CATTLE CONGRESS 2020

February 24 and 25 at the MCH Herning Convention Center.

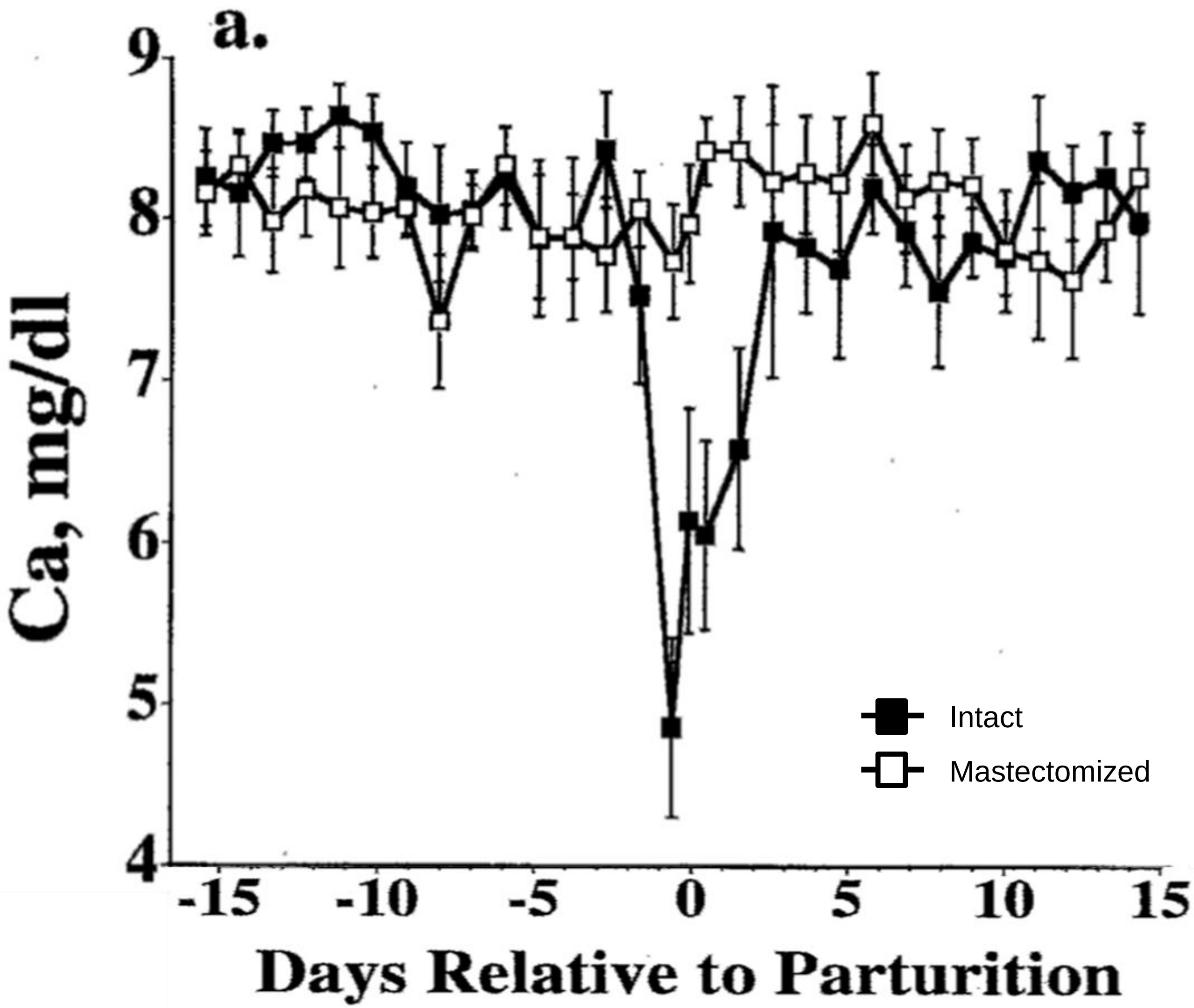
UNIVERSITY OF FLORIDA

Department of Animal Sciences

Hypocalcemia in Dairy Cows

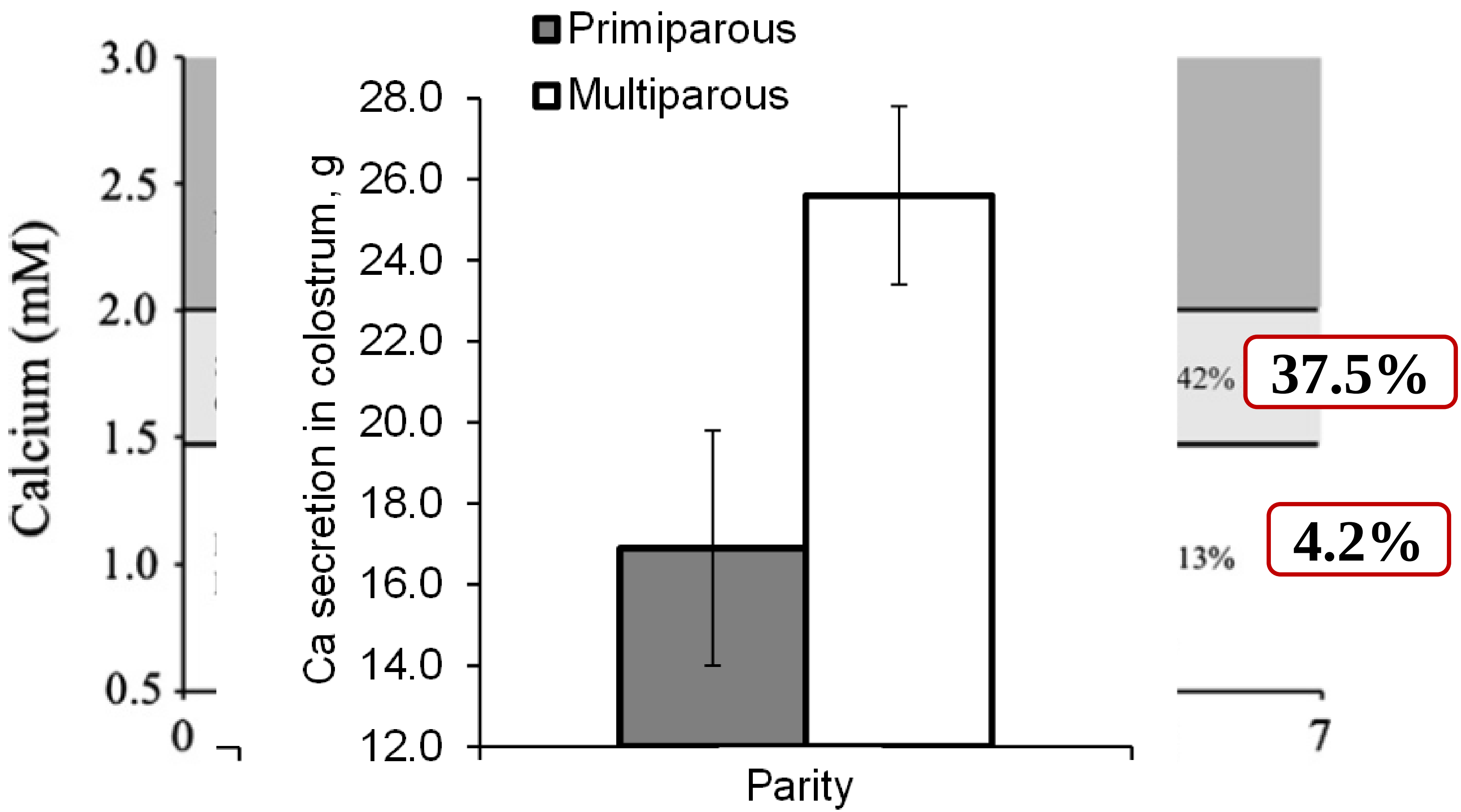


Mastectomized Cow



Goff et al. (2002) J. Dairy Sci. 85:1427-1436

Hypocalcemia in Dairy Cows



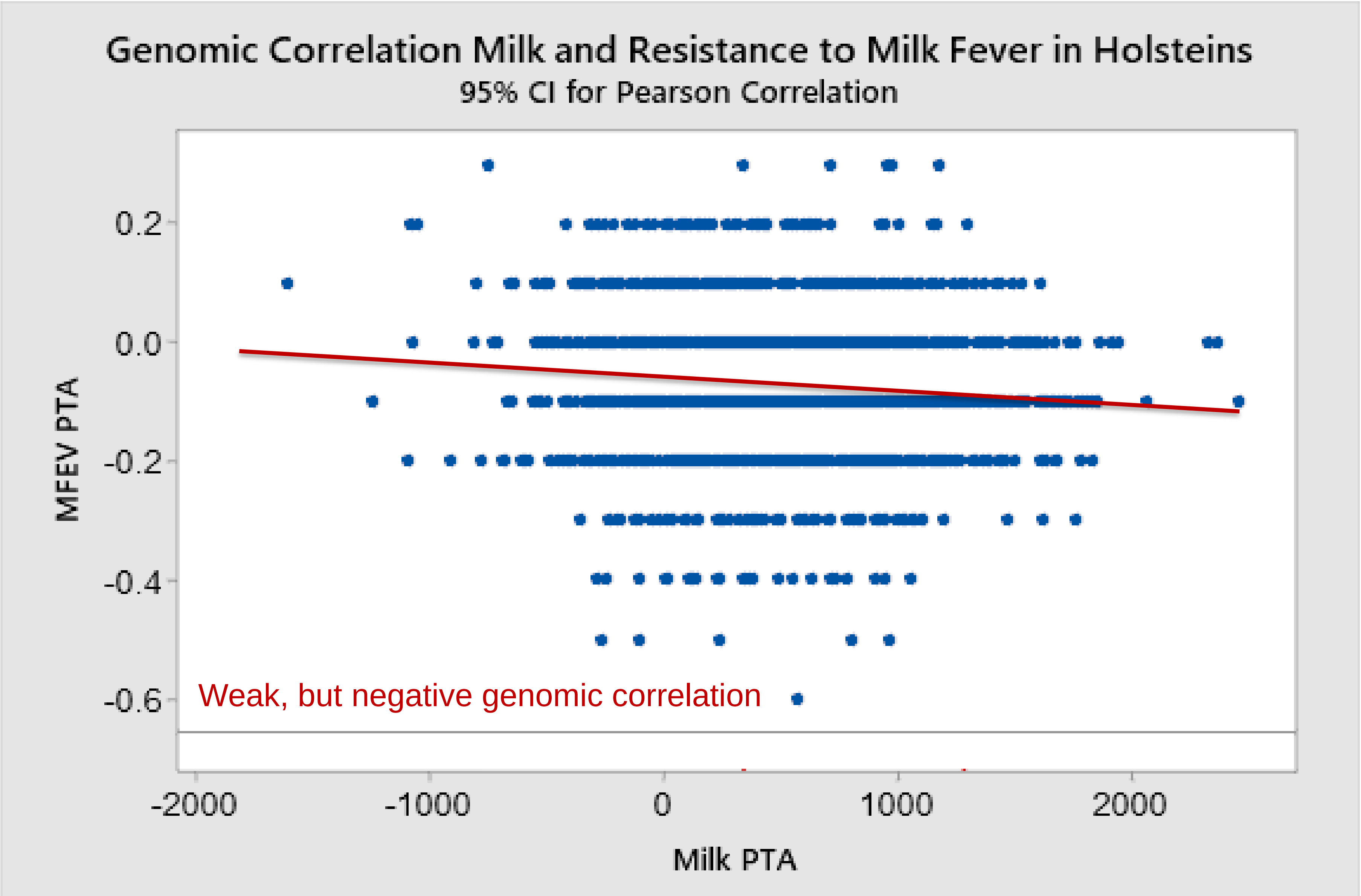
Rodney et al. (2018) J. Dairy Sci. 101: 2519–2543

1) Vet. J. 188:122-124

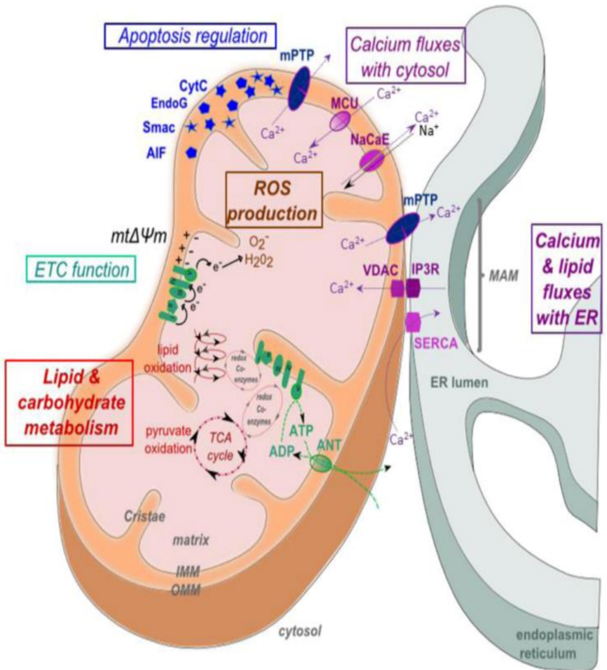
Risk Factors for Hypocalcemia

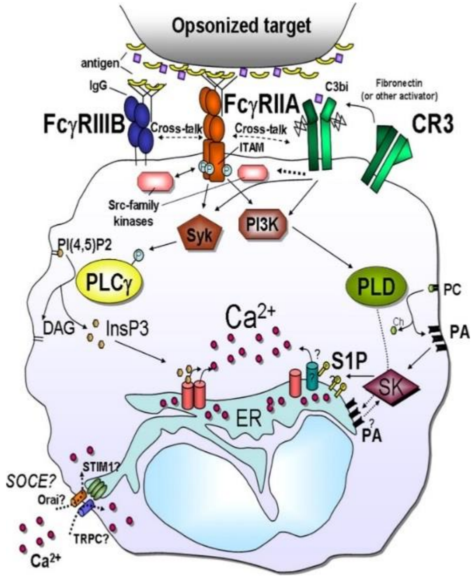
- ✓ Animal
  - ✓ Older cows (parity)
  - ✓ Jersey breed
  - ✓ Previous lactation milk yield
  - ✓ Previous case of hypocalcemia
  - ✓ Overcondition in the dry period
  - ✓ Previous dry period length
  - ✓ Genetics
- ✓ Nutritional
  - ✓ High K and Na (alkalogenic diets)
  - ✓ High P intake
  - ✓ Low dietary Mg
- ✓ Management/Environment
  - ✓ Inadequate bunk space
  - ✓ Overcrowding

Risk Factors for Hypocalcemia

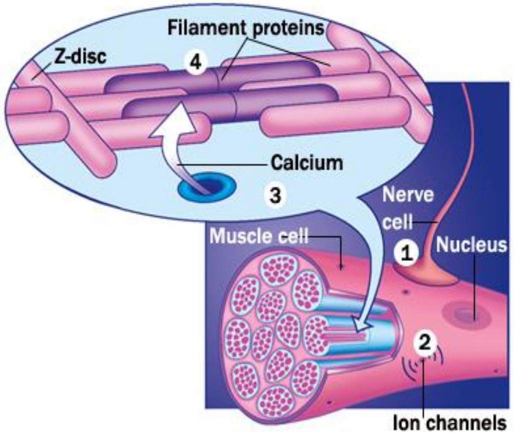


Calcium Has Numerous Roles

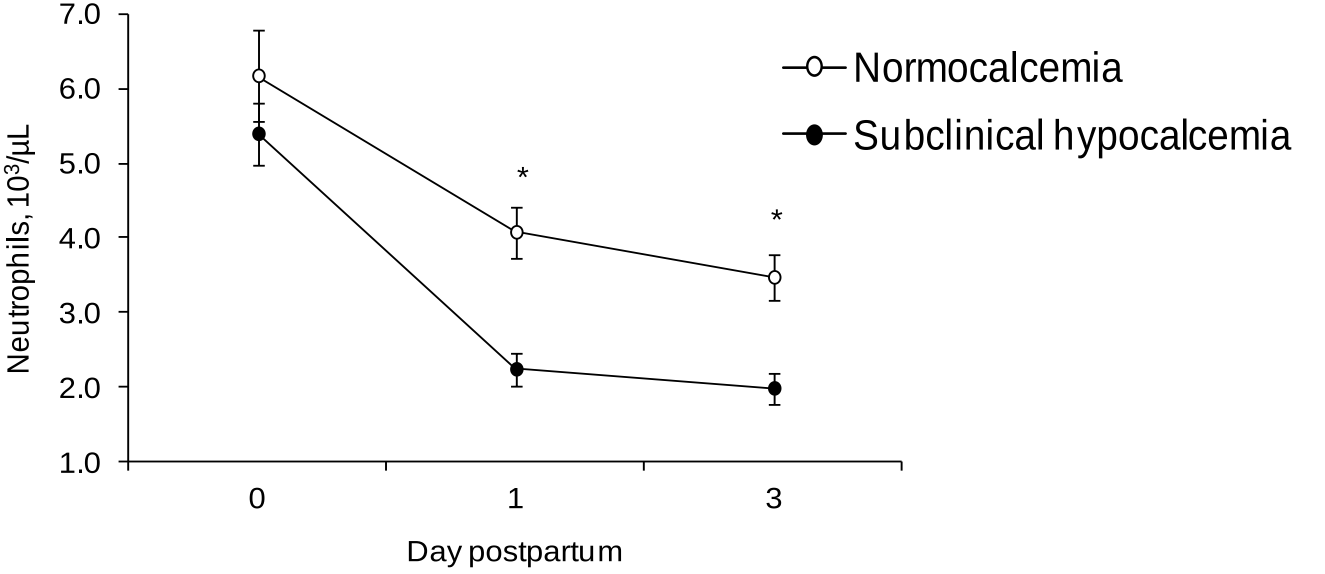




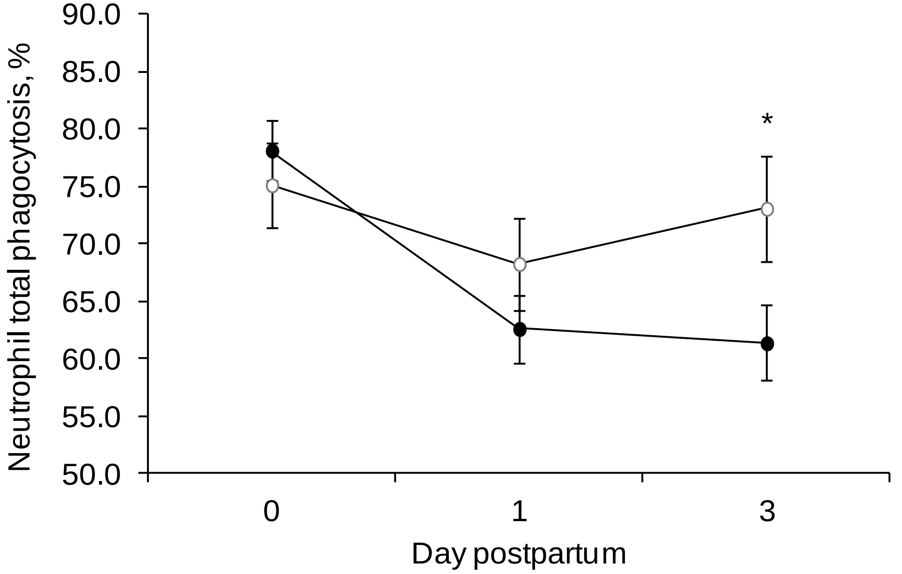
Nunes P , and Demaurex N J Leukoc Biol 2010;88:57-68

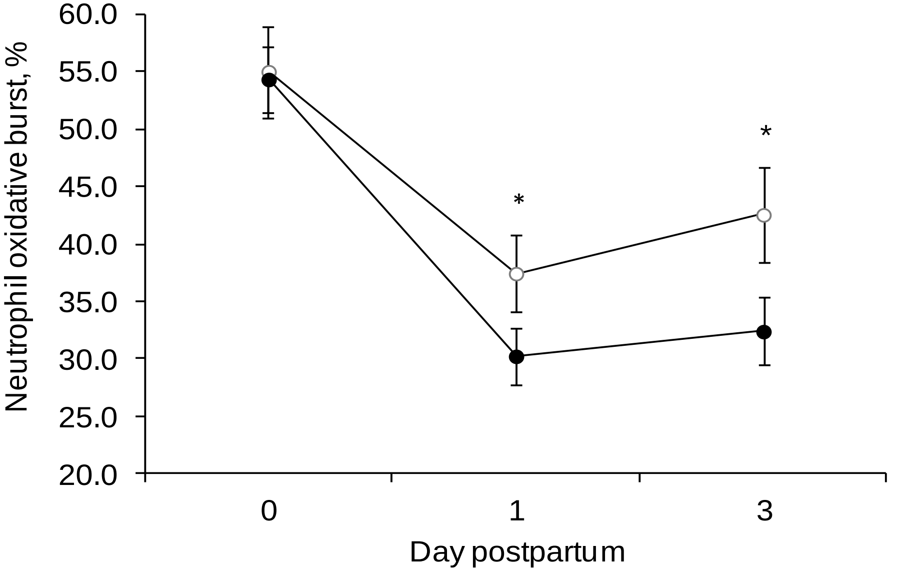


Neutrophil Function



*** Within a day, P < 0.05**





Martinez et al. (2012) J. Dairy Sci. 95:7158-7172

Subclinical Hypocalcemia and Metritis

	Subclinical hypocalcemia[1]		Normocalcemia	
	Low Risk	High Risk	Low Risk	High Risk
Metritis, % *,¶	40.7 (11/27)	77.8 (35/45)	14.3 (4/28)	20.0 (2/10)
Puerperal metritis, %*,¶	29.6 (8/27)	53.5 (24/45)	0 (0/28)	10.0 (1/10)

*Effect of hypocalcemia ($P < 0.05$),

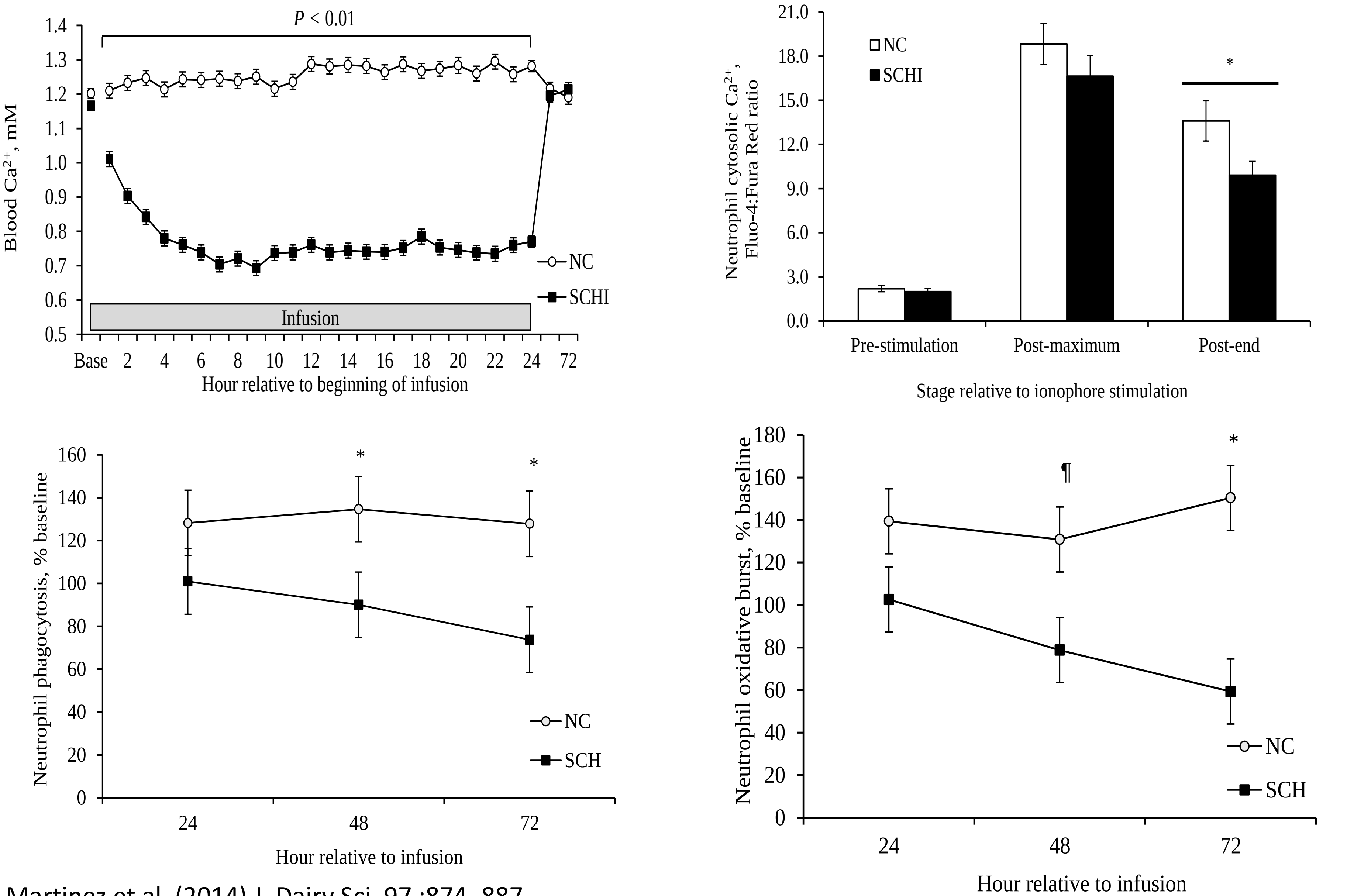
¶ Effect of metritis risk ($P < 0.05$).

[1] Serum Ca ≤ 8.59 mg/dL in the first 3 d postpartum.

[2] Puerperal metritis was defined as metritis with presence of fever (≥ 39.5°C).

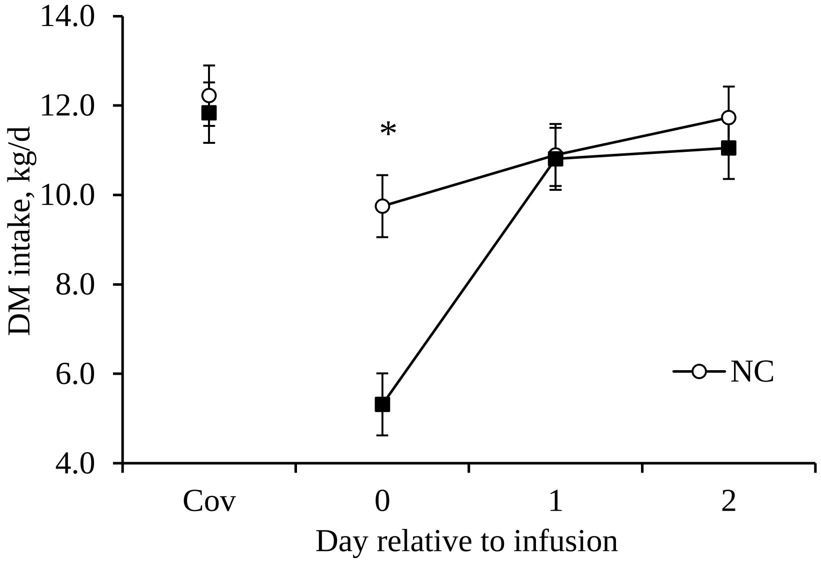
Martinez et al. (2012) J. Dairy Sci. 95:7158-7172

Induced Subclinical Hypocalcemia in Dairy Cows

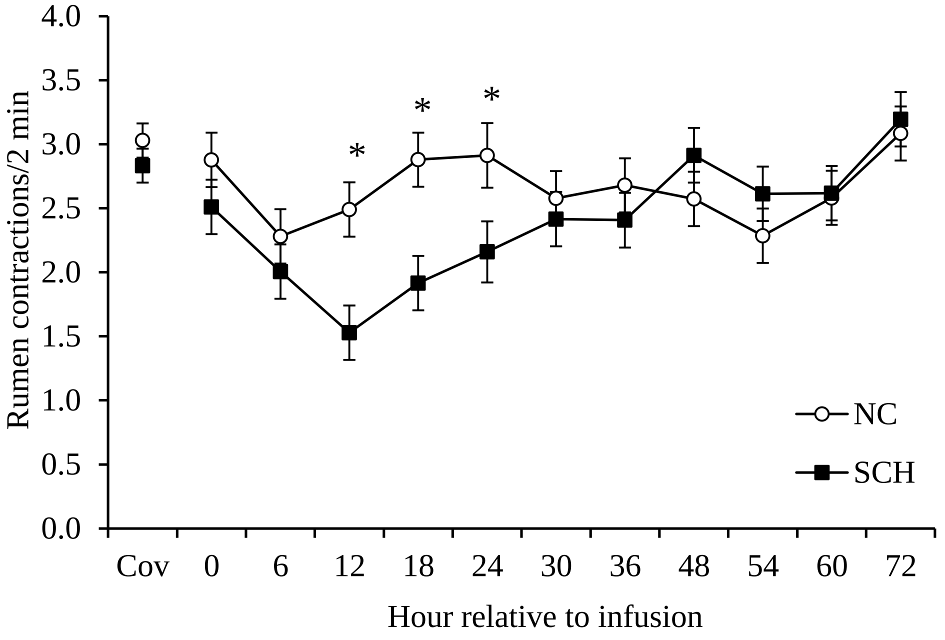


Martinez et al. (2014) J. Dairy Sci. 97 :874–887

Subclinical Hypocalcemia Reduces DM Intake and Rumen Motility in Dairy Cows



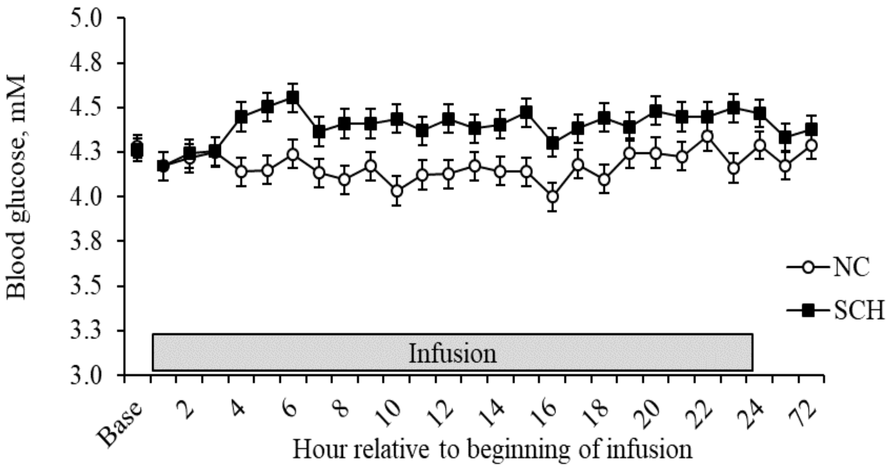
* P < 0.01



Martinez et al. (2014) J. Dairy Sci. 97 :874–887

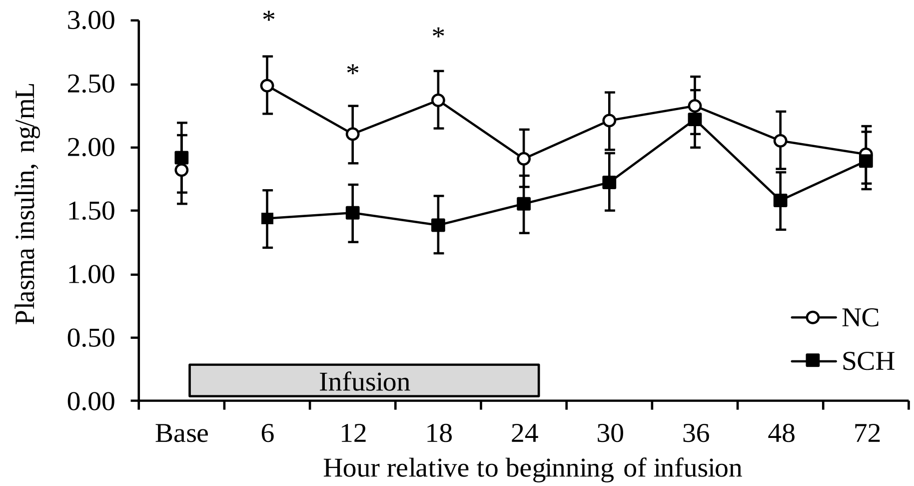
Glucose

Trt, *P* = 0.01
Hour, *P* = 0.11
Trt x Hour, *P* = 0.25



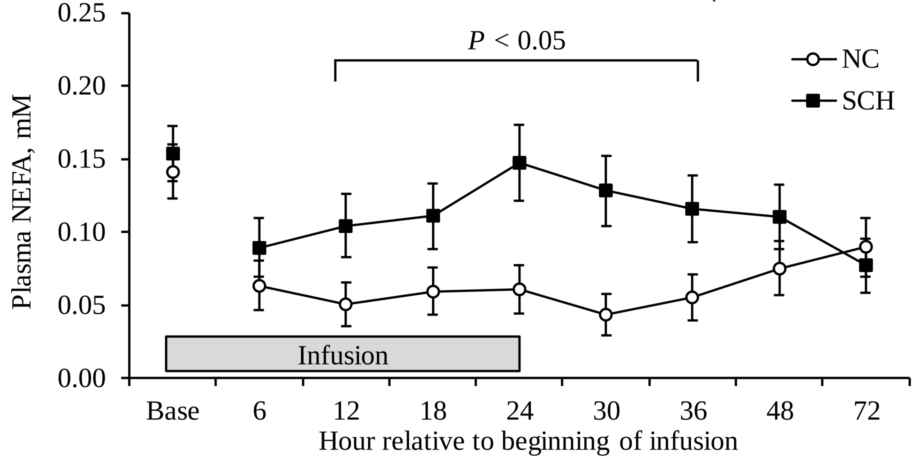
Insulin

Trt, *P* = 0.07
Hour, *P* = 0.05
Trt x Hour, *P* = 0.02



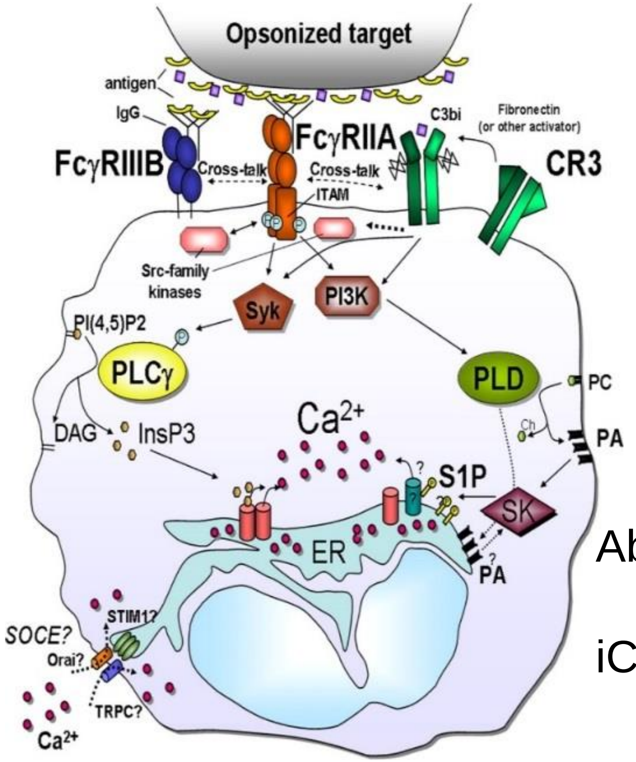
NEFA

Trt, *P* = 0.02
Hour, *P* = 0.75
Trt x Hour, *P* = 0.11



Martinez et al. (2014) J. Dairy Sci. 97 :874–887

Does Activation of Immune Cells Affect [iCa]?



Nunes P , and Demaurex N J Leukoc Biol 2010;88:57-68

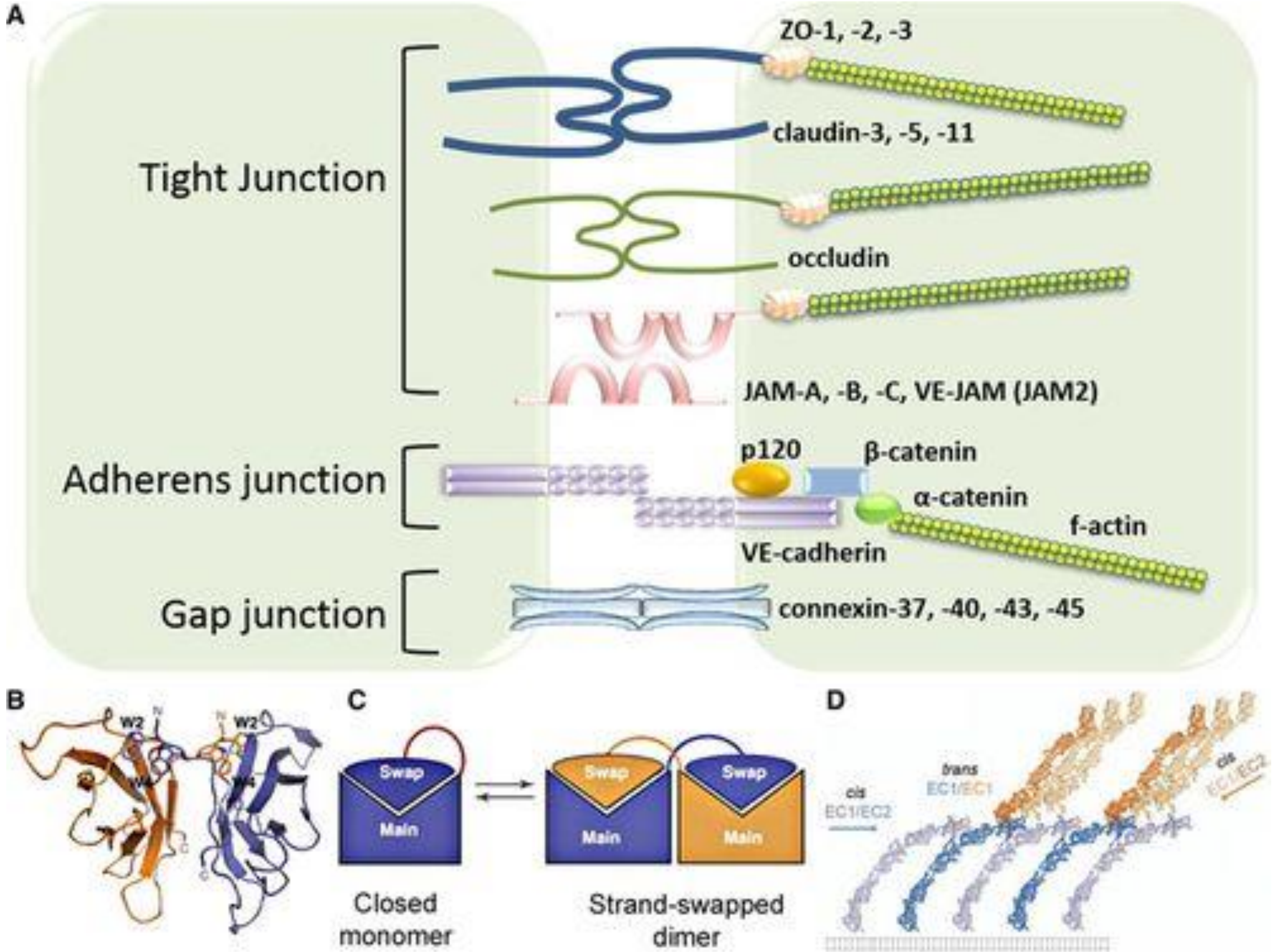
Blood [iCa]	1.2 m*M*
Neutrophil [iCa] at resting	85 n*M*
Neutrophil [iCa] at activation	400 n*M*
Neutrophils in 1mL of blood	3×10^6

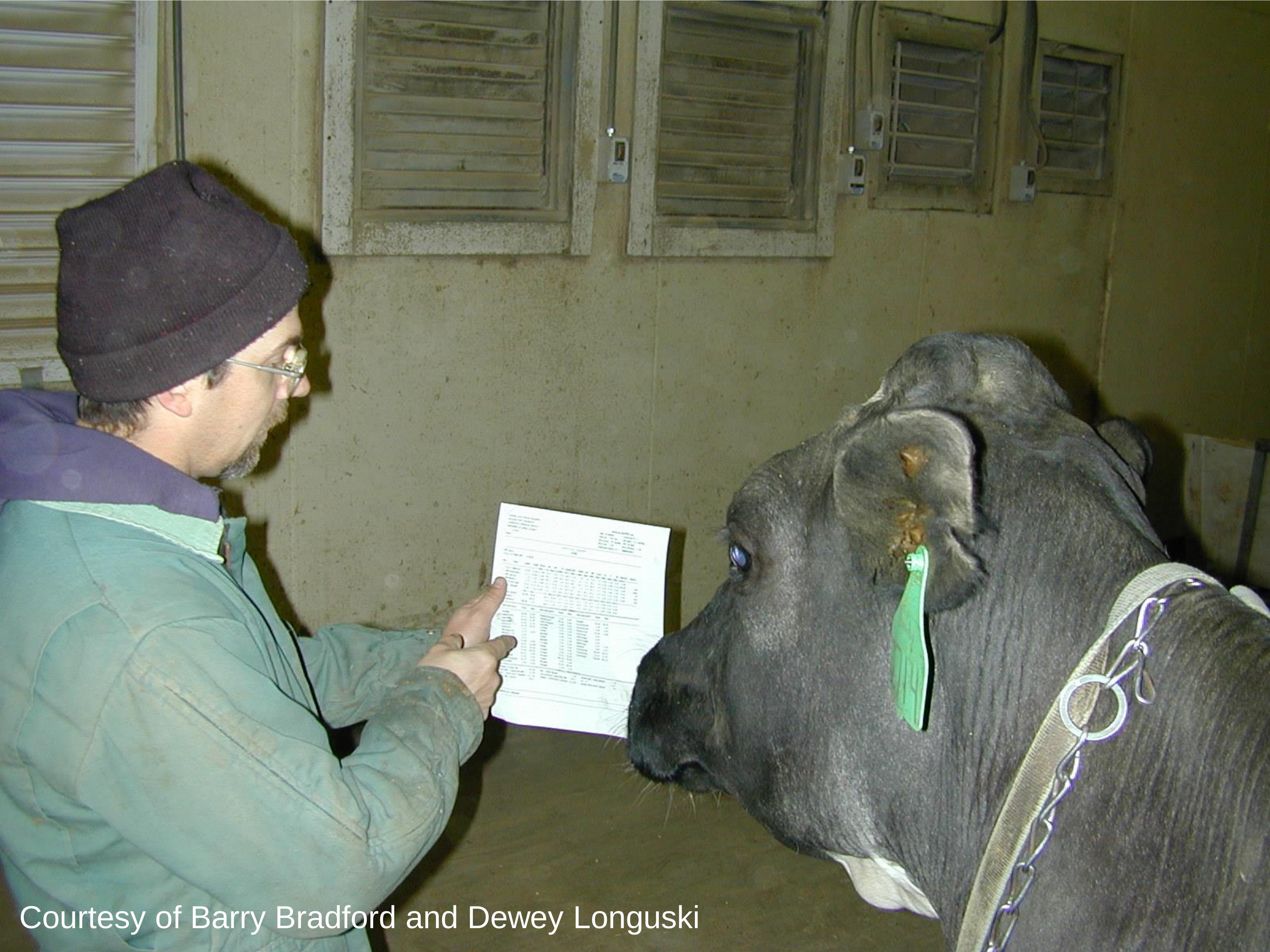
Absolute iCa in 1 mL blood	48,000.00 ng
iCa used by neutrophil activation in 1 mL blood	0.03 ng

Proportion of iCa used upon activation of neutrophils **0.0000695%** of the plasma pool

Vieira-Neto et al. (2020) J. Anim. Sci. submitted

Inflammation Activates TLR4 and Disrupts IEJs Proteins





Courtesy of Barry Bradford and Dewey Longuski

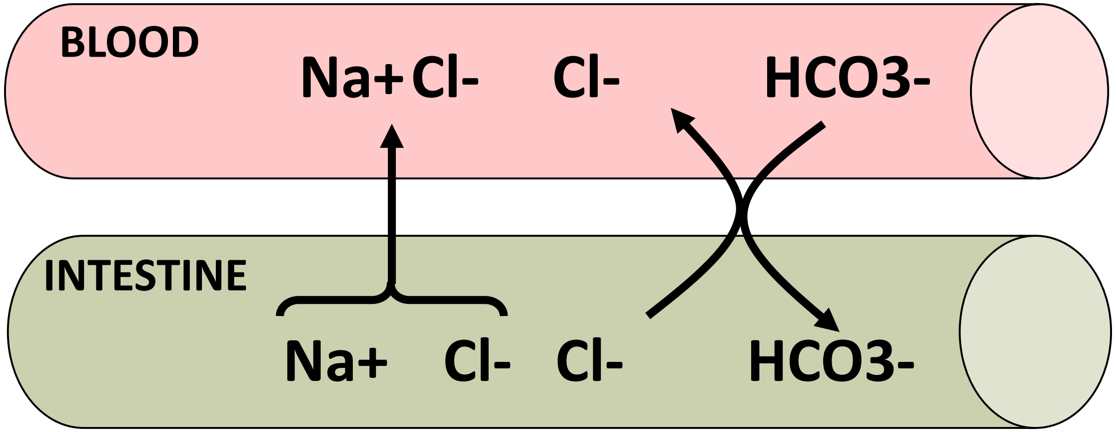
Don’t Let Her Choose

Formulate proper pre-partum diets to reduce the risk of early lactation metabolic diseases

Strategies Available to Reduce the Risk of Hypocalcemia

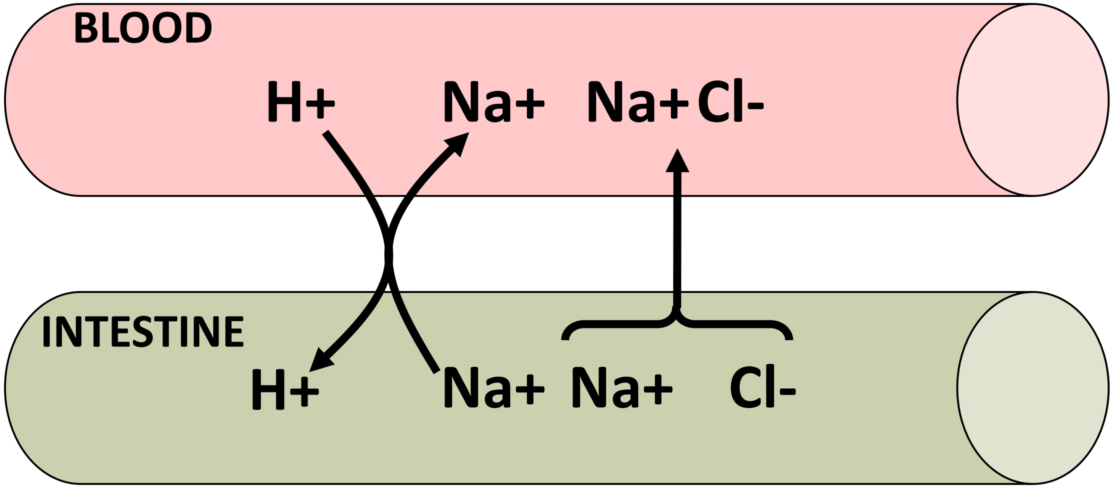
- ✓ Prepartum diets with very low Ca content
- ✓ Reduced intestinal absorption of Ca
- ✓ Altered acid-base status by dietary manipulation
- ✓ Administration of Ca at calving
- ✓ Pharmacological manipulations

How Manipulating the DCAD Affects Blood Acid-Base Chemistry



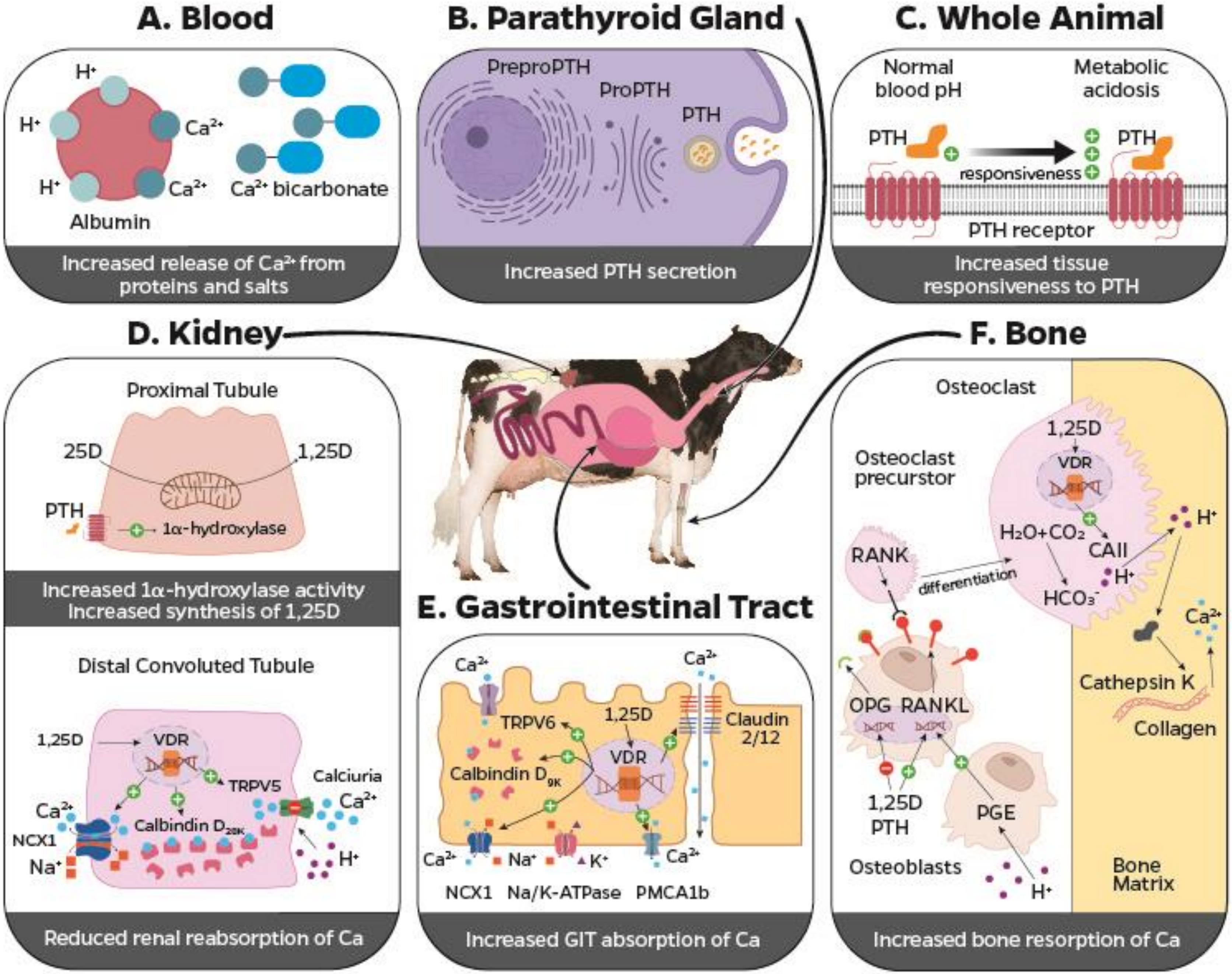
Negative DCAD with excess of strong anions relative to strong cations

HCO_3 and pH ↓



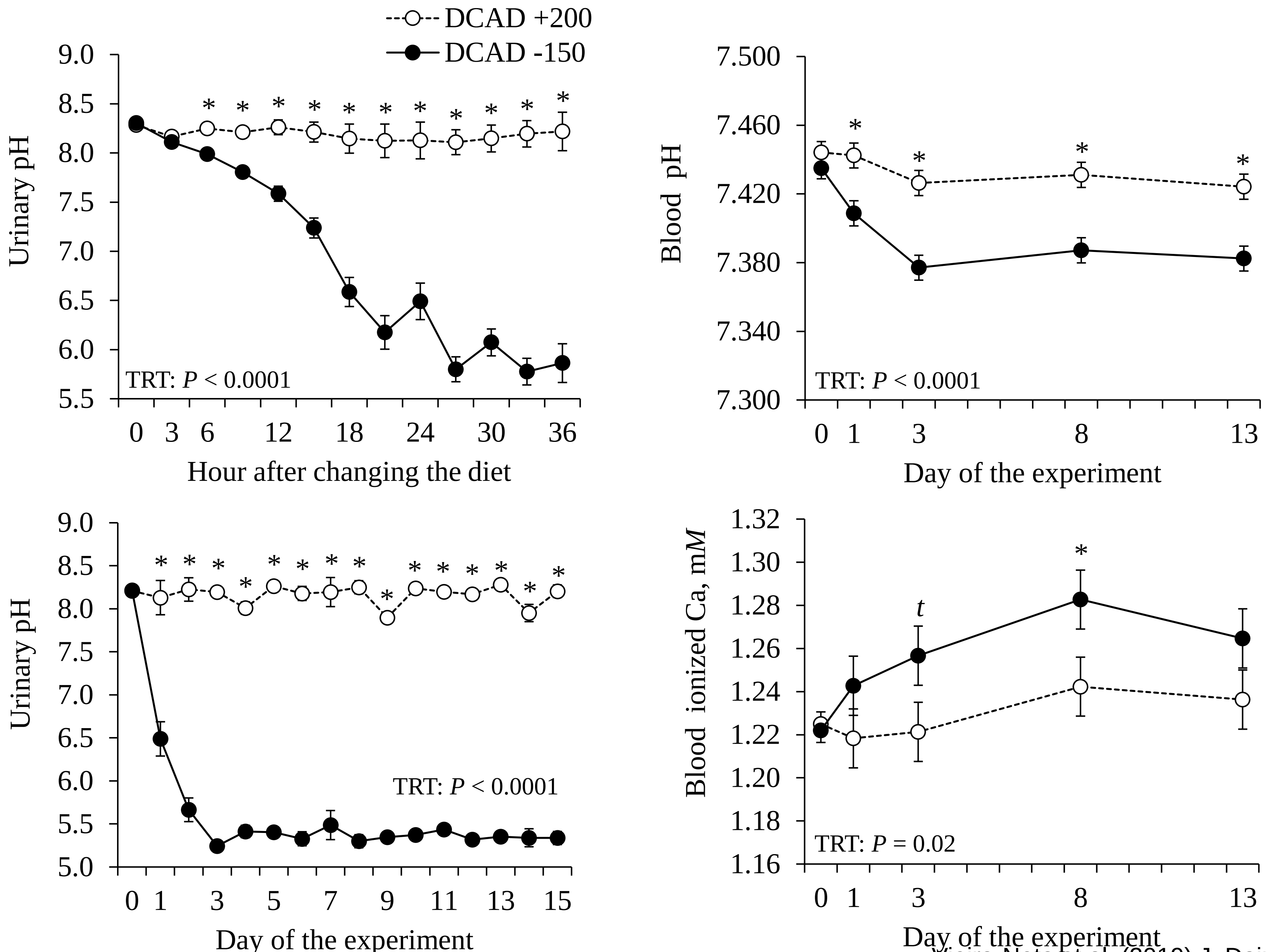
Positive DCAD with excess of strong cations relative to strong anions

HCO_3 and pH ↑



Vieira-Neto et al. (2020) J. Anim. Sci. submitted

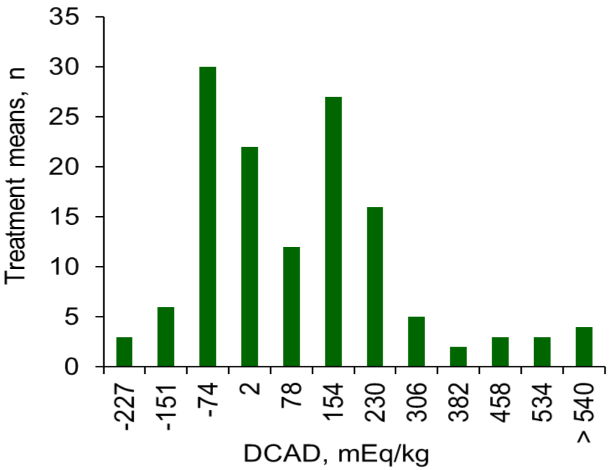
Diet effects on acid-base status

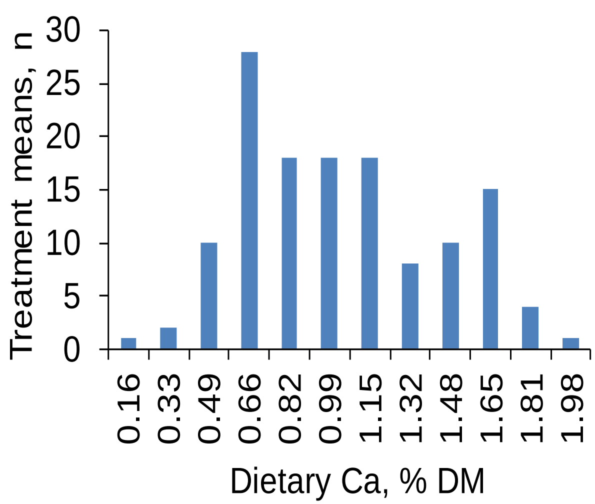


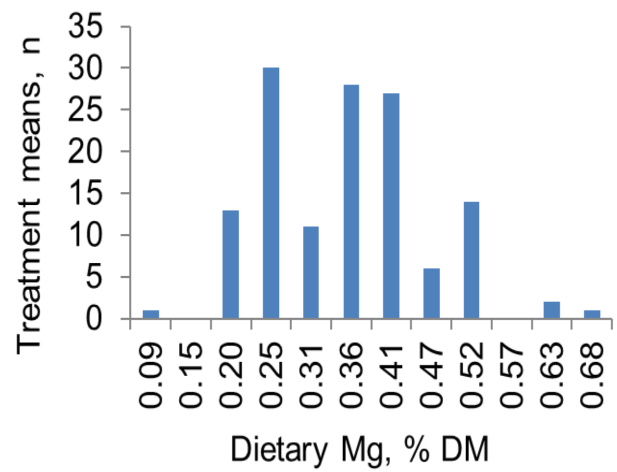
Vieira-Neto et al. (2019) J. Dairy Sci. Abstr.

Descriptive statistics of intake of minerals prepartum according to parity group

	Nulliparous		Parous	
Item	Mean ± SD	Range	Mean ± SD	Range
Intake, g/d				
Ca	99.2 ± 35.1	46.2 to 166.4	106.6 ± 54.4	9.5 to 272.2
P	35.9 ± 9.4	22.3 to 52.5	44.1 ± 16.2	10.0 to 100.1
Mg	31.7 ± 8.4	21.0 to 44.2	37.5 ± 15.7	10.0 to 87.4
K	134.5 ± 23.4	91.0 to 171.3	161.3 ± 56.2	50.1 to 372.7
Na	18.3 ± 7.1	7.4 to 30.9	20.0 ± 18.0	1.0 to 137.6
S	33.8 ± 17.7	16.4 to 84.5	36.5 ± 17.8	9.9 to 101.5
Cl	73.7 ± 31.6	18.2 to 125.0	74.9 ± 41.0	6.9 to 197.8
DCAD,[2] net Eq/d	0.1 ± 1.4	-1.5 to 2.6	0.6 ± 2.2	-2.8 to 9.4

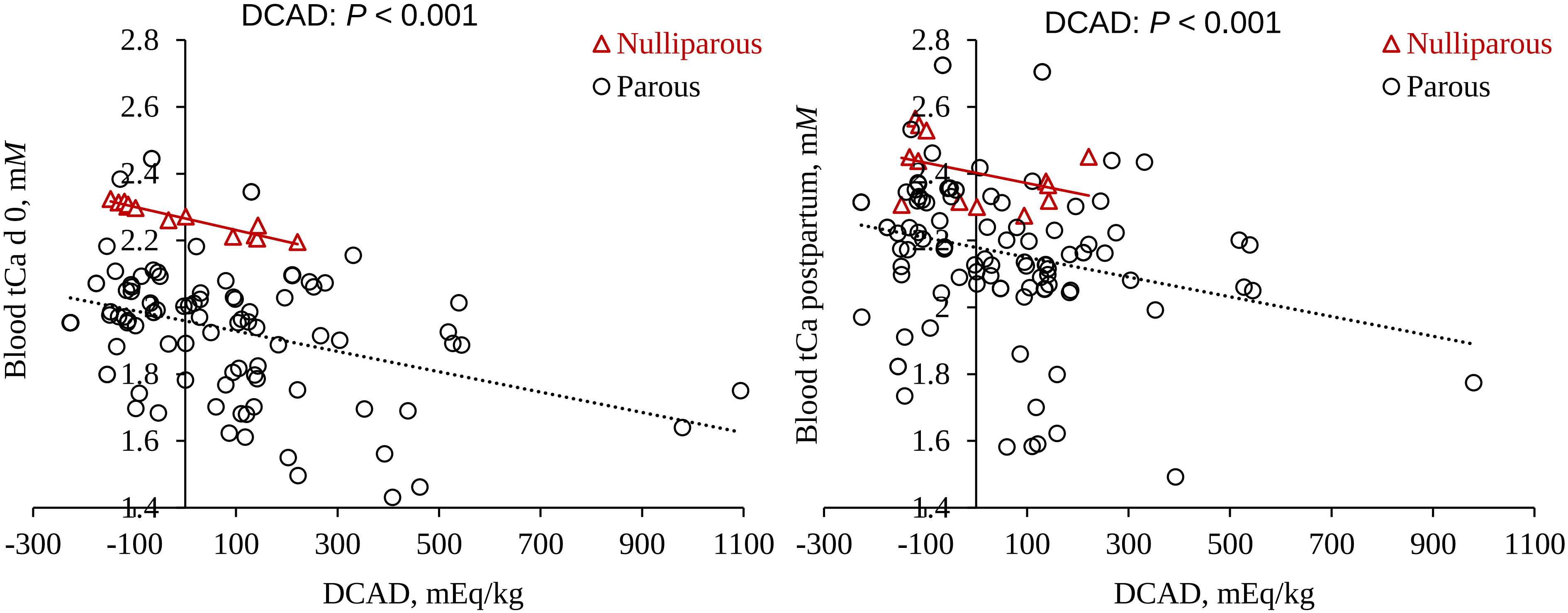






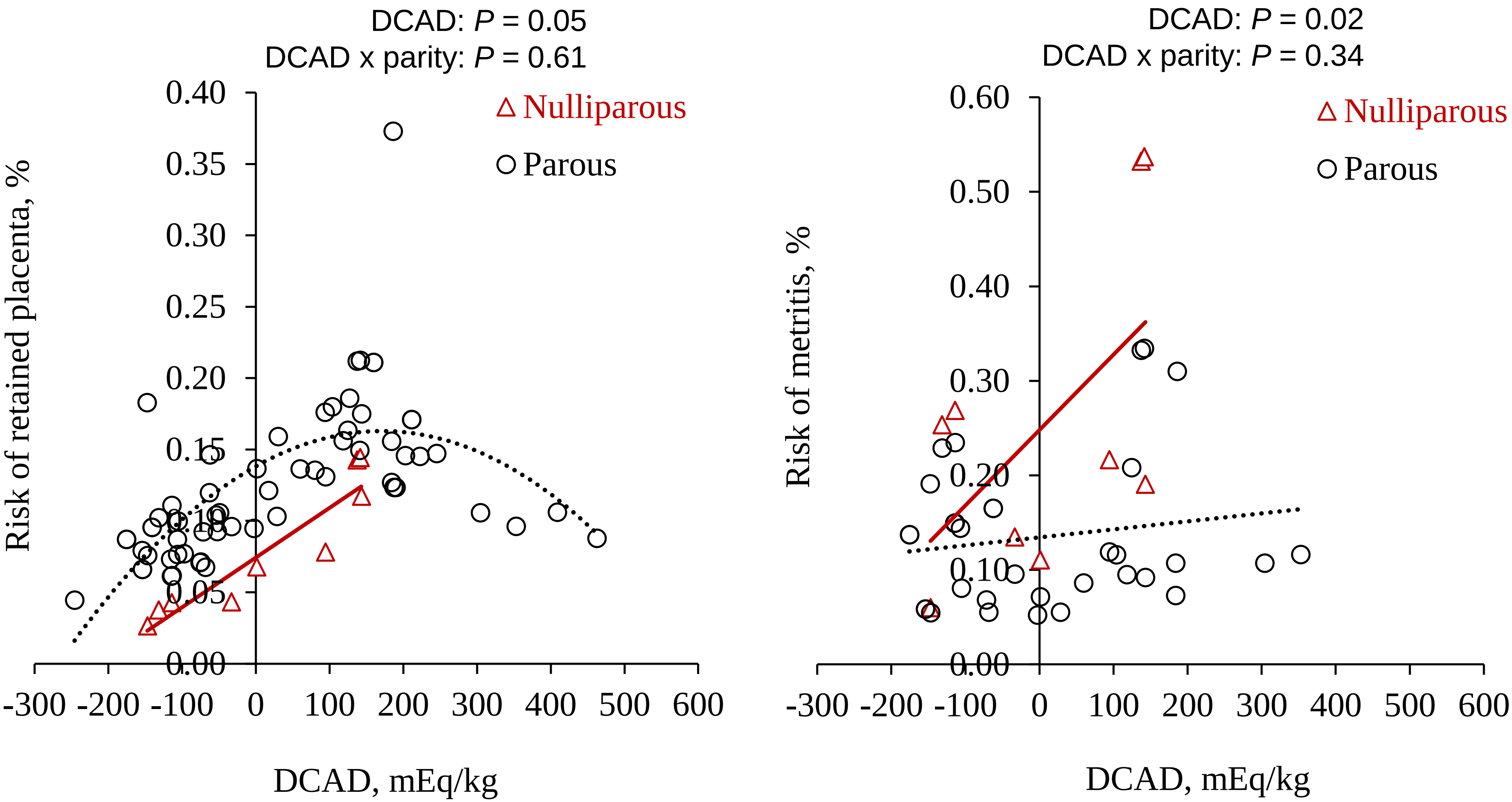
Santos et al. (2019) J. Dairy Sci. 102:2134–2154

DCAD and Blood [tCa] on the Day of Calving and Postpartum



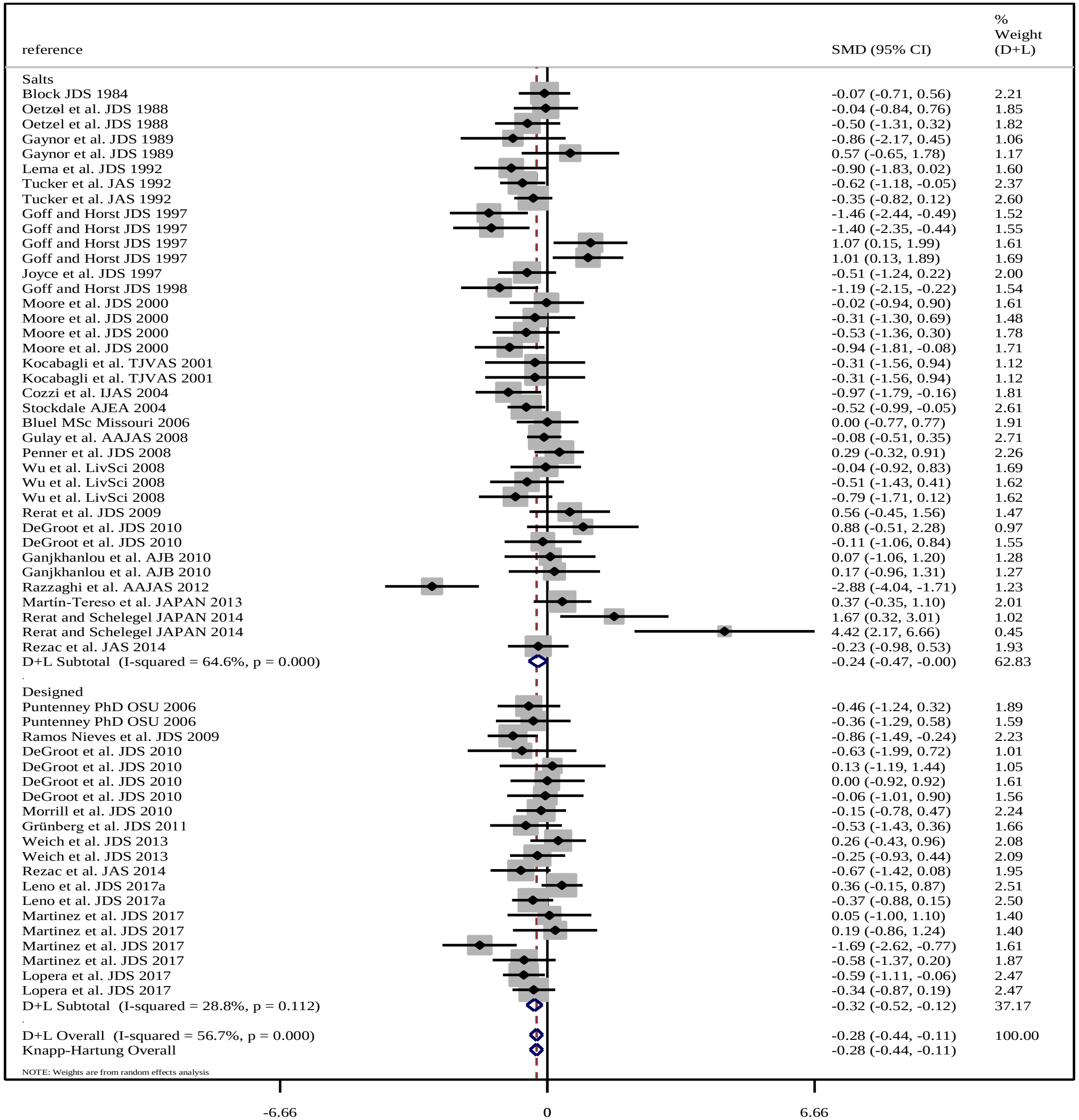
Santos et al. (2019) J. Dairy Sci. 102:2134–2154

Effect of DCAD on Risk of Retained Placenta or Metritis



Santos et al. (2019) J. Dairy Sci. 102:2134–2154

Prepartum DMI



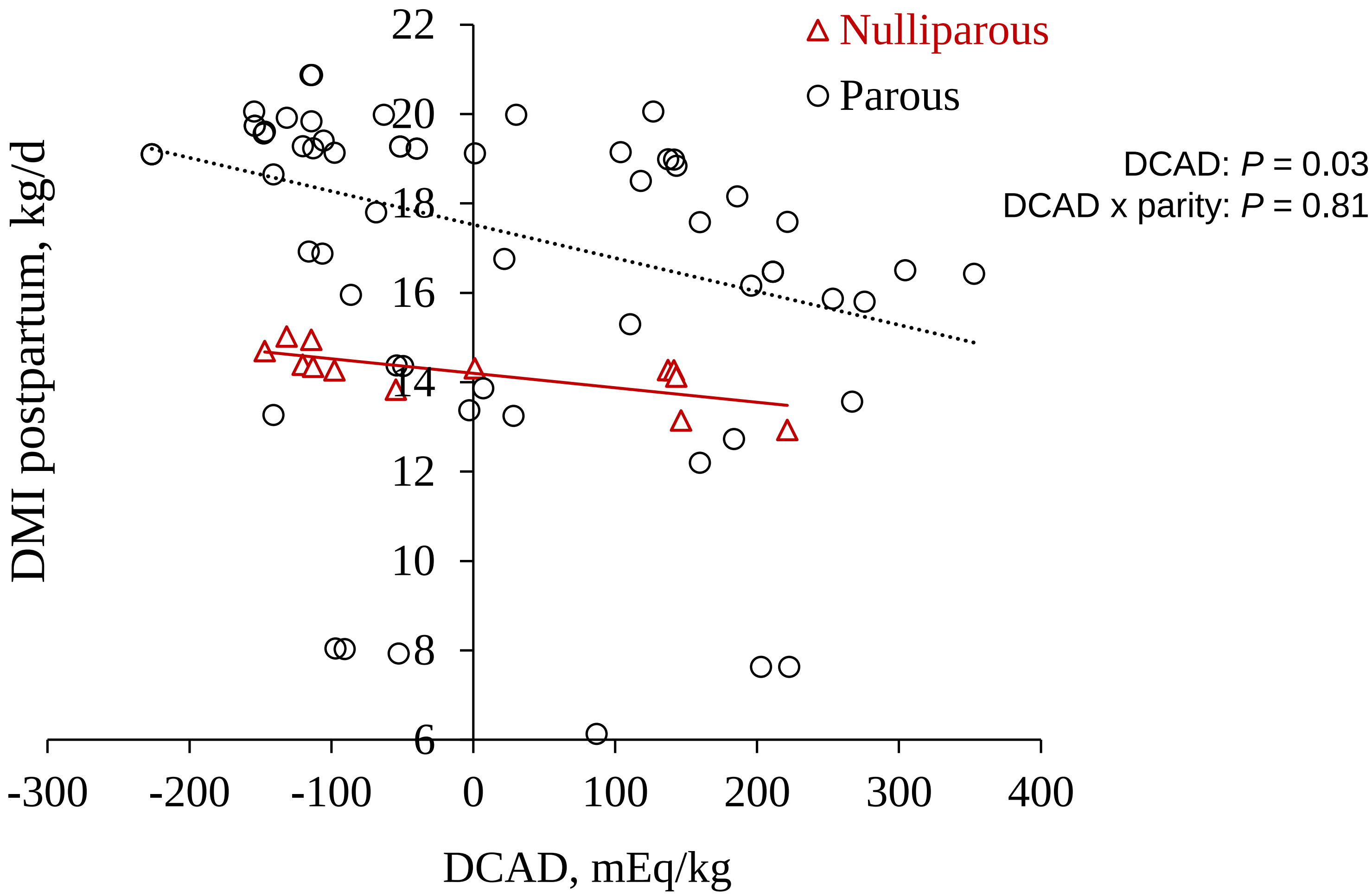
DCAD: *P* = 0.02

DCAD x type of product: *P* = 0.49

Reduction in 0.5 kg/d with use of acidogenic diets

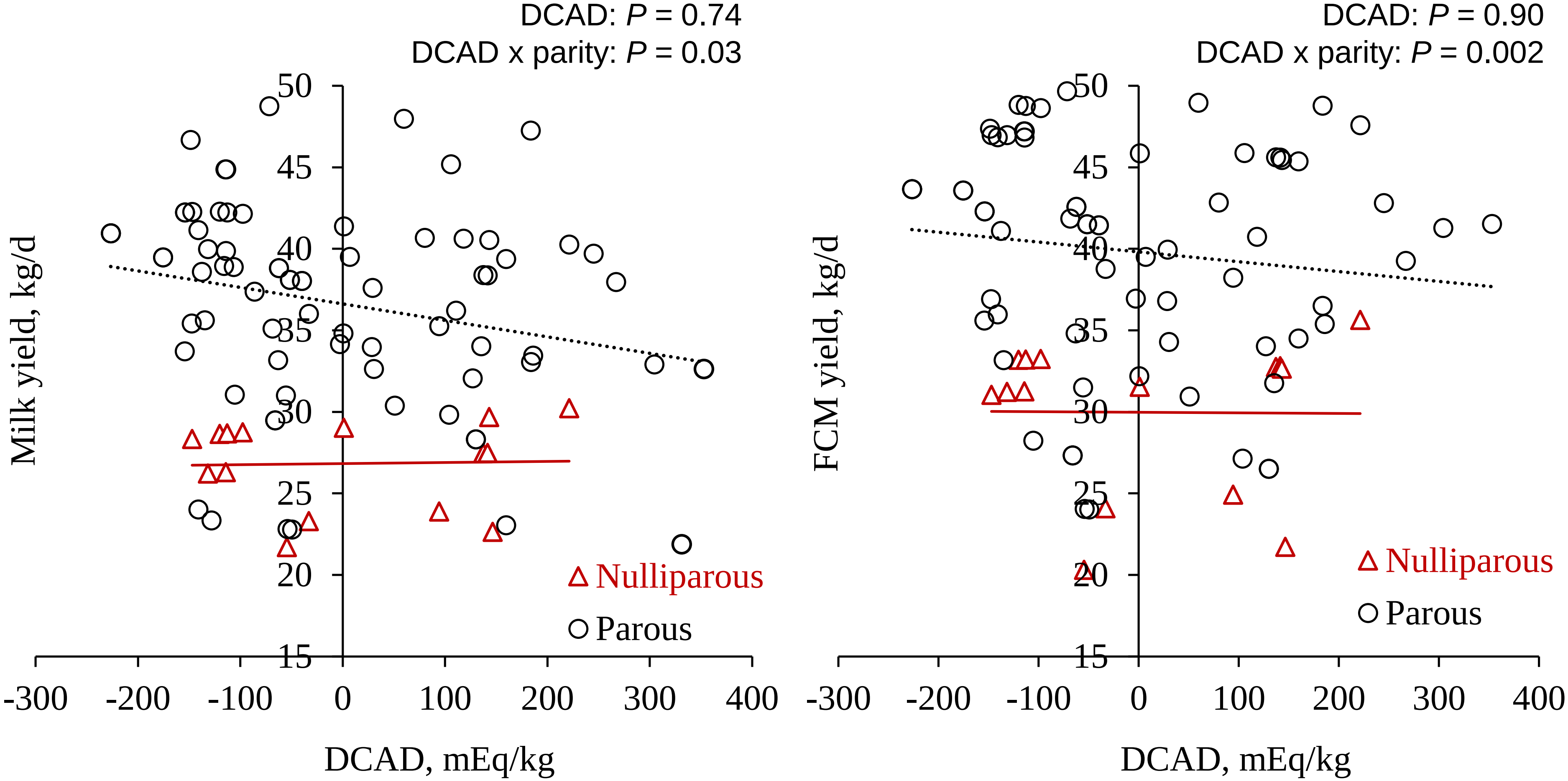
Lean et al. (2019) 2103J. Dairy Sci. 102:2103–2133

DCAD and DM Intake Postpartum



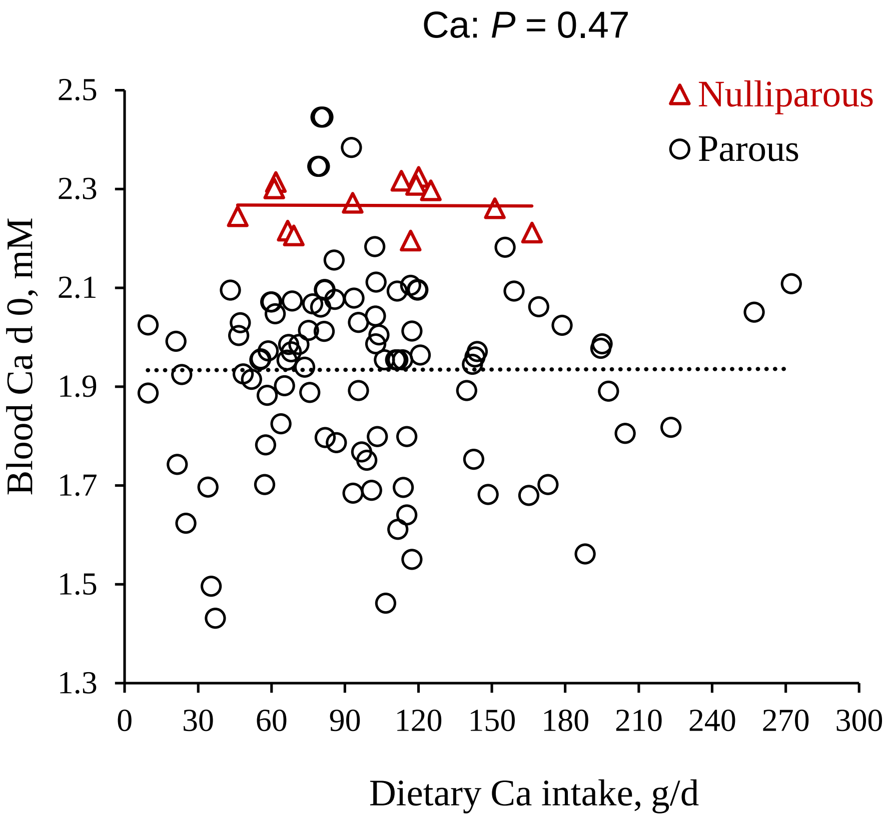
Santos et al. (2019) J. Dairy Sci. 102:2134–2154

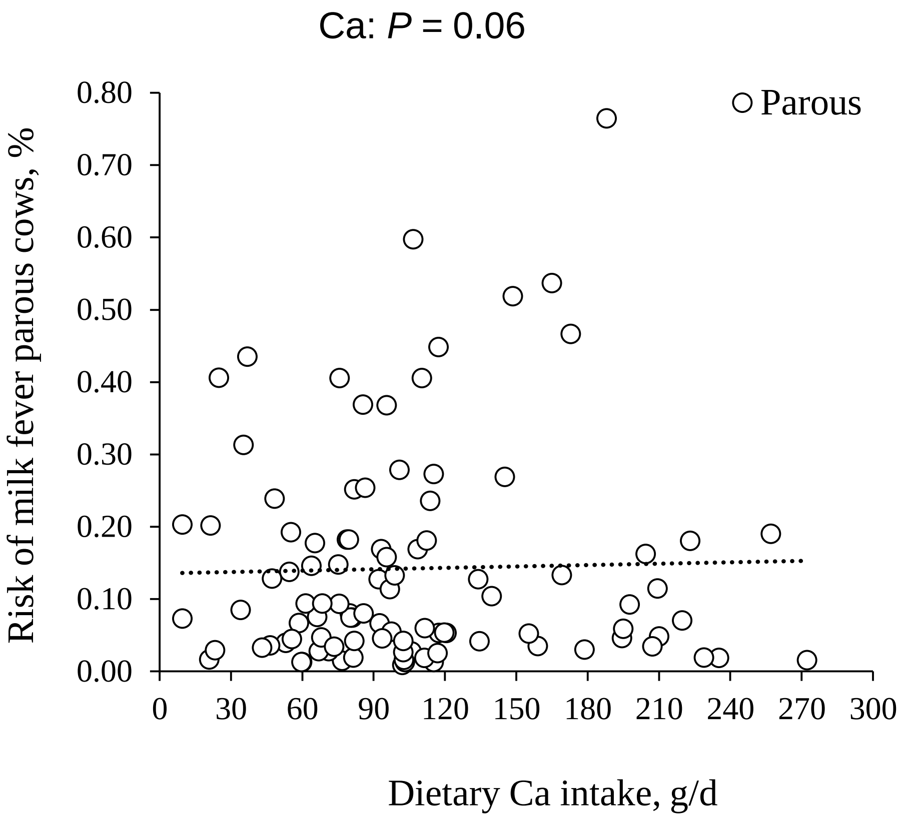
Effect of DCAD on Yields of Milk and FCM According to Parity



Santos et al. (2019) J. Dairy Sci. 102:2134–2154

What About Intake of Ca Prepartum





Concentration of Ca in prepartum diets:

- No association with production
- No association with health (tended to increase milk fever)

Santos et al. (2019) J. Dairy Sci. 102:2134–2154

Why Acidogenic Diets Depress DMI

	Treatment				
Ingredient, % DM	TRT1	TRT2	TRT3	TRT4	TRT5
Corn silage	55.0	55.0	55.0	55.0	55.0
Bermuda hay	10.0	10.0	10.0	10.0	10.0
Concentrates	34.6	32.6	24.8	27.3	25.3
Acidogenic product	---	---	7.5	7.5	7.5
Sodium chloride	---	1.0	---	---	1.0
Potassium chloride	---	1.0	---	---	1.0
Na sesquicarbonate	---	---	1.5	---	0
Potassium carbonate	---	---	1.0	---	0
Magnesium oxide	0.4	0.4	0.2	0.2	0.2
K, %	1.42 ± 0.09	1.83 ± 0.04	1.71 ± 0.04	1.29 ± 0.05	1.78 ± 0.09
S, %	0.18 ± 0.03	0.18 ± 0.03	0.37 ± 0.04	0.39 ± 0.03	0.40 ± 0.04
Na, %	0.04 ± 0.02	0.42 ± 0.05	0.54 ± 0.10	0.13 ± 0.02	0.53 ± 0.05
Cl, %	0.26 ± 0.01	1.23 ± 0.13	0.89 ± 0.07	0.91 ± 0.05	2.03 ± 0.06
DCAD,[6] mEq/kg	196 ± 20	194 ± 45	192 ± 27	-114 ± 26	-113 ± 43

Zimpel et al. (2018) J. Dairy Sci. 101:8461–8475

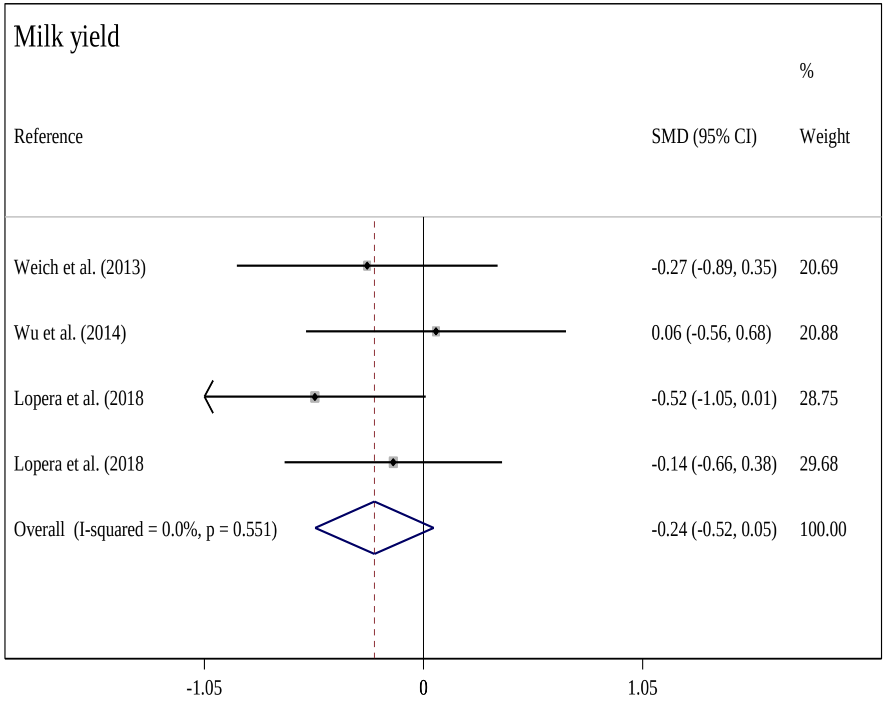
Depression in Intake Prepartum by Acidogenic Diets is Mediated by Metabolic Acidosis

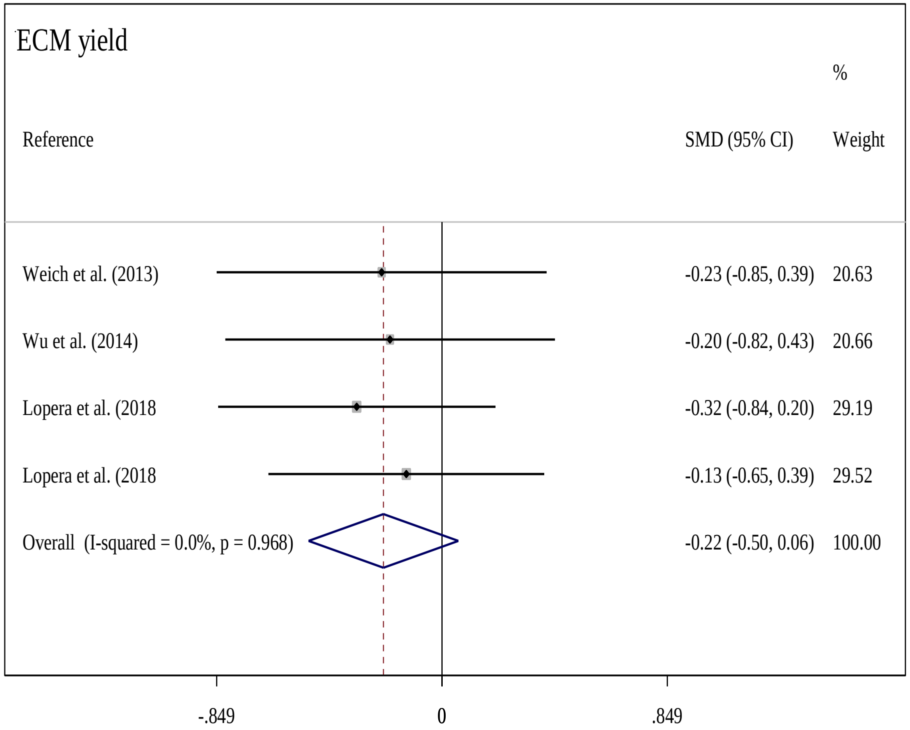
	Treatment						P-value[1]			
Item	T1	T2	T3	T4	T5	SE	AP	AB	ClAlk	ClAc
Blood pH	7.450	7.436	7.435	7.420	7.416	0.005	0.001	0.001	0.02	0.40
Base excess, mM	1.85	1.20	1.45	-0.20	-0.95	0.32	0.001	0.001	0.13	0.09
DMI, kg/d	10.3	10.2	10.2	9.7	9.5	0.2	0.02	0.003	0.60	0.30
DMI, % BW	1.76	1.75	1.74	1.68	1.64	0.03	0.03	0.003	0.63	0.14

[1] AP = contrast of effect of adding acidogenic product (T1 vs. T4); AB = contrast of acid-base status, alkalogenic vs. acidogenic diets (T2 + T3 vs. T4 + T5); ClAlk = contrast of adding Cl salts to an alkalogenic diet (T1 vs. T2); ClAc = contrast of adding Cl salts to an acidogenic diet (T4 vs. T5).

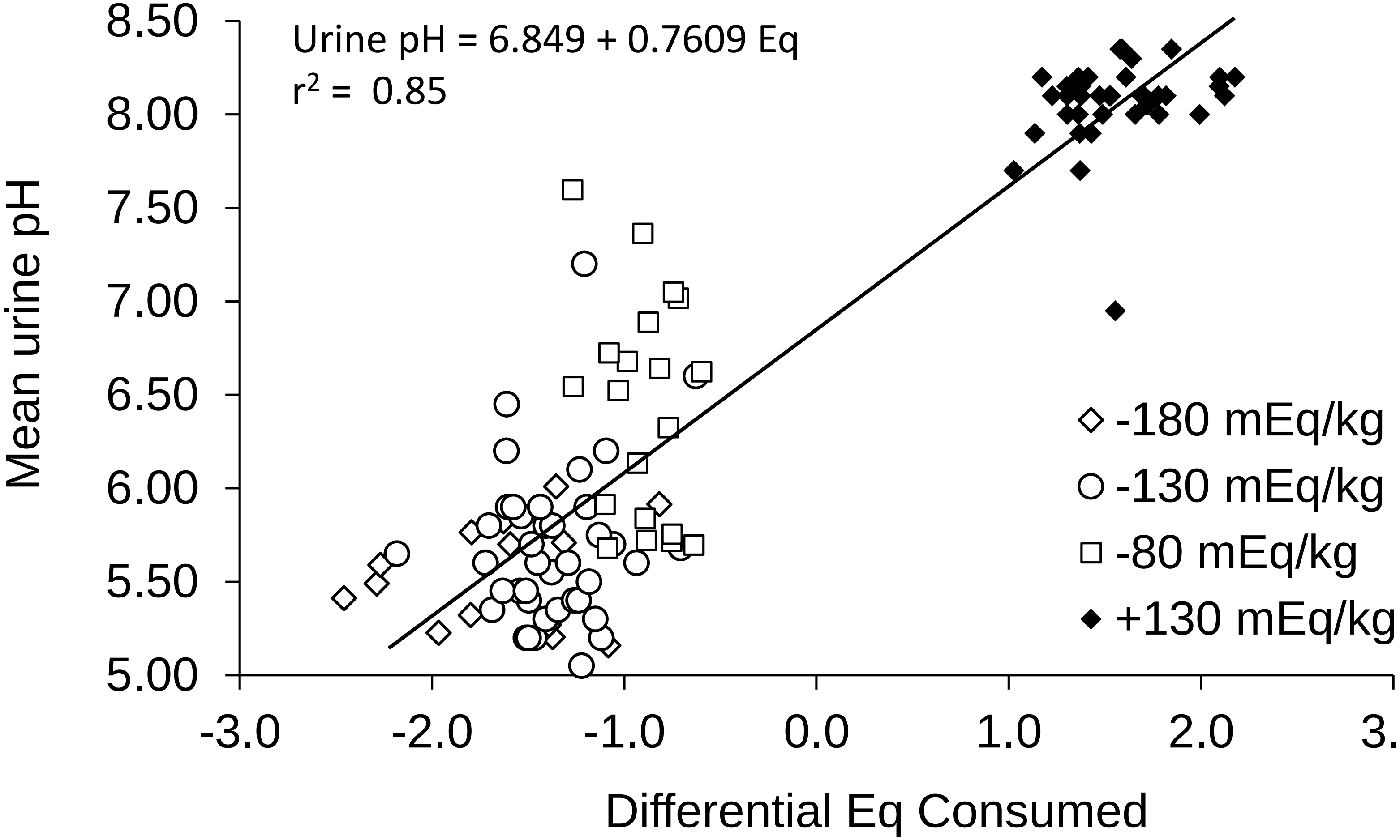
Zimpel et al. (2018) J. Dairy Sci. 101:8461–8475

Feeding Acidogenic Diets During the Entire Dry Period





Urine pH is Affected by the Differential Eq Consumed, not just the Calculated DCAD



Santos et al. (2016) FL Ruminant Nutrition Symposium

Conclusions

- ✓ Hypocalcemia is a gateway disease linked to increased risk of several other diseases in dairy cows

  – Best strategy is **prevention**

- ✓ Acidogenic diets have benefits beyond prevention of milk fever
  - ✓ Improved concentrations of Ca and P on the day of calving and Ca postpartum
  - ✓ Improved yields of milk, FCM, fat and protein in parous cows
  - ✓ Reduced incidence of milk fever, retained placenta, and metritis

- ✓ Little or no evidence that manipulating dietary Ca concentration or intake affects postpartum responses to acidogenic diets

- ✓ Limited evidence that increasing Mg to 0.3-0.4% of diet DM reduced milk fever and no evidence of a benefit to performance or risk of other diseases

- ✓ The ideal prepartum DCAD remains undetermined, but most likely around -100 mEq/kg

Thank you

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