Jockey Club College of Veterinary Medicine and Life Sciences
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In collaboration with Cornell University

Low prepartum calcium or anionic diets? The dilemma of urine pH

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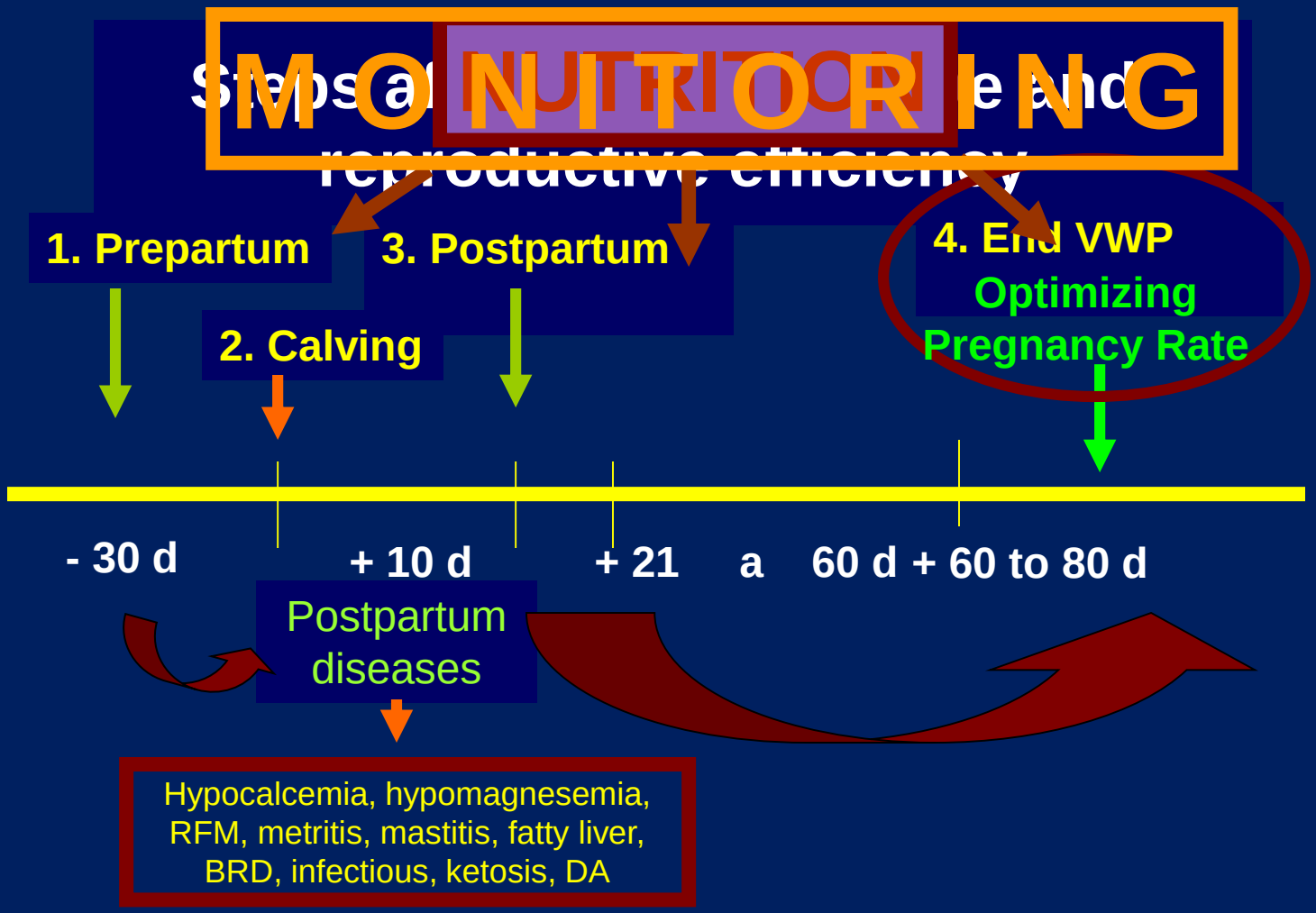
MONITORING
1. Prepartum
2. Calving
3. Postpartum
4. End VWP
Optimizing
Pregnancy Rate
- 30 d
+ 10 d
+ 21
a
60 d + 60 to 80 d
Postpartum
diseases
Hypocalcemia, hypomagnesemia,
RFM, metritis, mastitis, fatty liver,
BRD, infectious, ketosis, DA

Cost of Diseases (Liang et al., JDS 2017)

Item	Primiparous	Multiparous
Mastitis	$ 325 ± 71	$ 426 ± 80
Lameness	$ 185 ± 64	$ 333 ± 68
Metritis	$ 171 ± 47	$ 262 ± 56
RFM	$ 150 ± 51	$ 313 ± 64
LDA	$ 432 ± 101	$ 639 ± 114
Ketosis	$ 77 ± 24	$ 180 ± 63
Hypocalcemia	-	$ 246 ± 52

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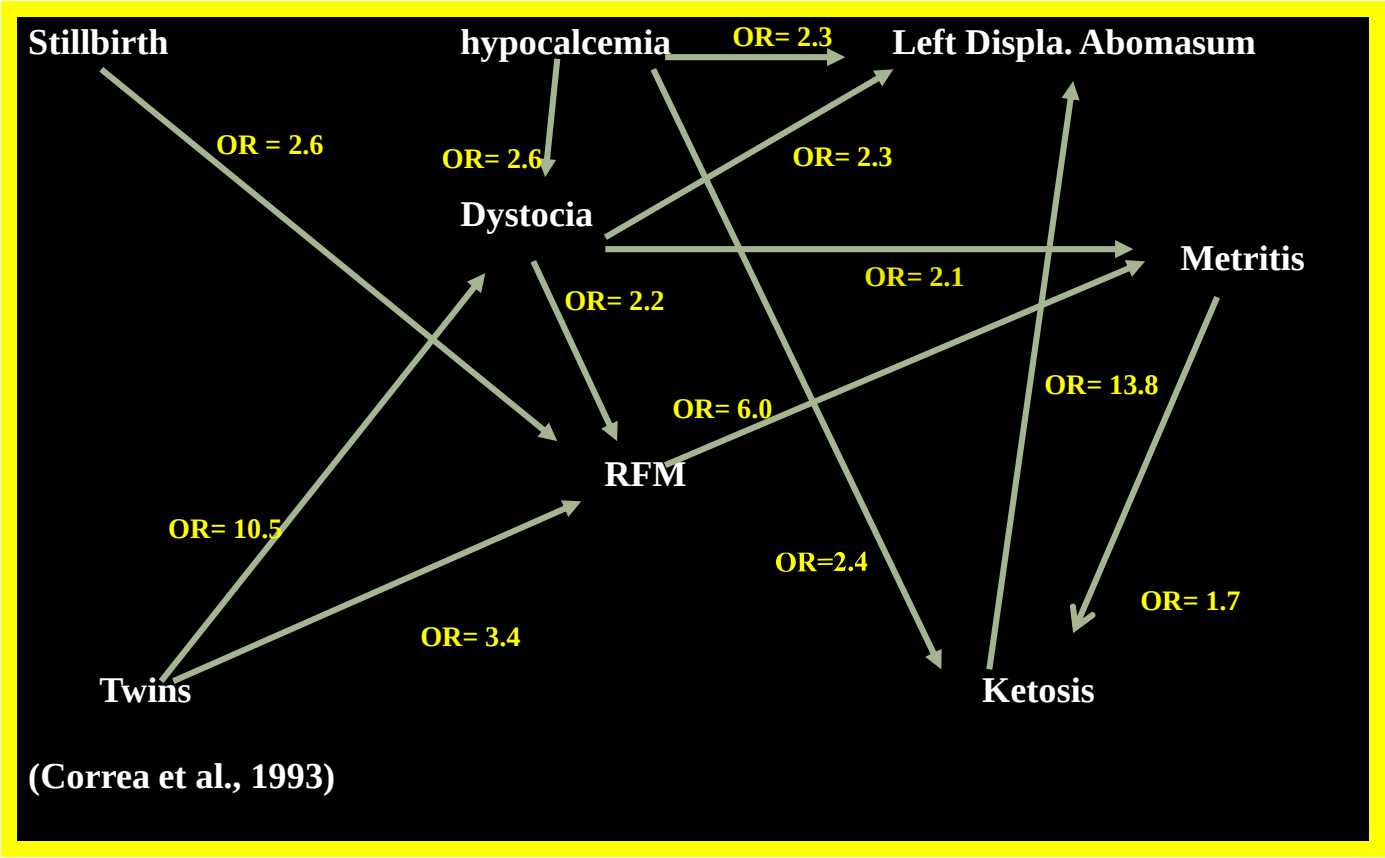
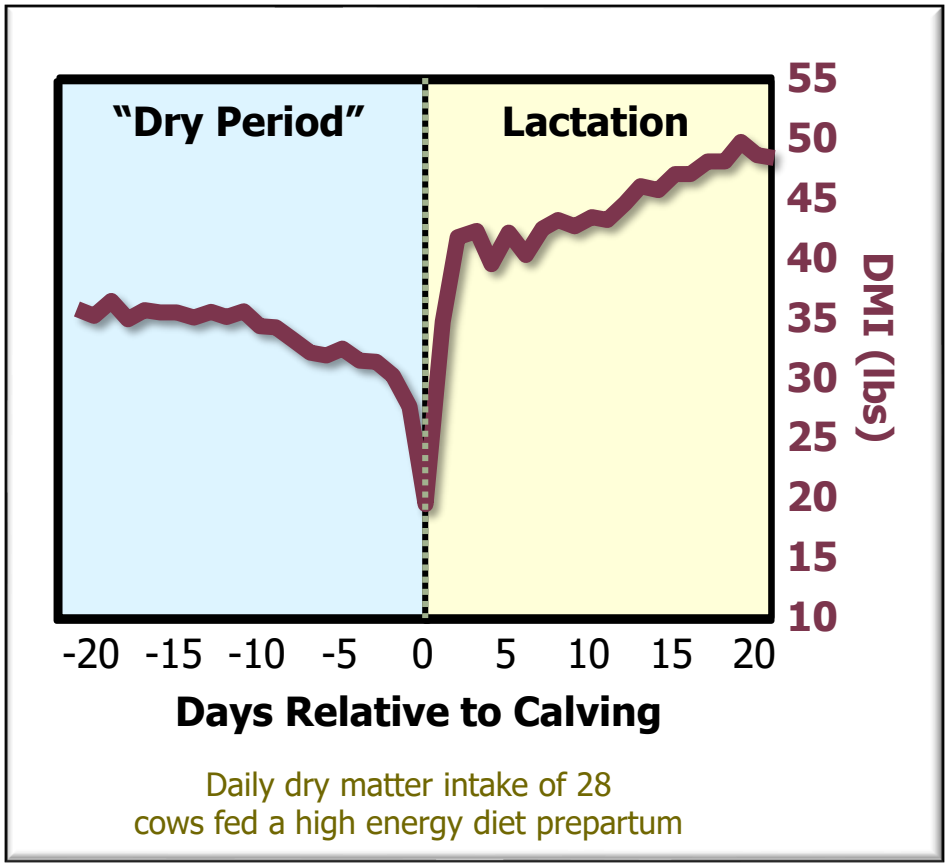
Path Analysis & Odd Ratios



“Preventing Diseases”

The Key

Dry Matter Intake



Source picture: www.pgbovine.net

Challenges Facing the Transition Cow

1. Negative Energy Balance (mobilization of fat)
2. Mineral Imbalances (Ca, Mg, Se,…)
3. Negative Protein Balance (protein breakdown)
4. Social Pressures (stock density, heat stress, cow comfort)
5. Reduce oxidative stress (high metabolic rate)

Metabolic disease ↔ **Immune dysregulation**

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Goals prepartum period

- Reduce severity of hypocalcemia
- Prevent weight losses and ketosis
- Adapt rumen to avoid acidosis
- Feed sufficient fiber (forage NDF)
- Not overfeed energy
- Provide adequate vitamins and minerals

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HYPOCALCEMIA

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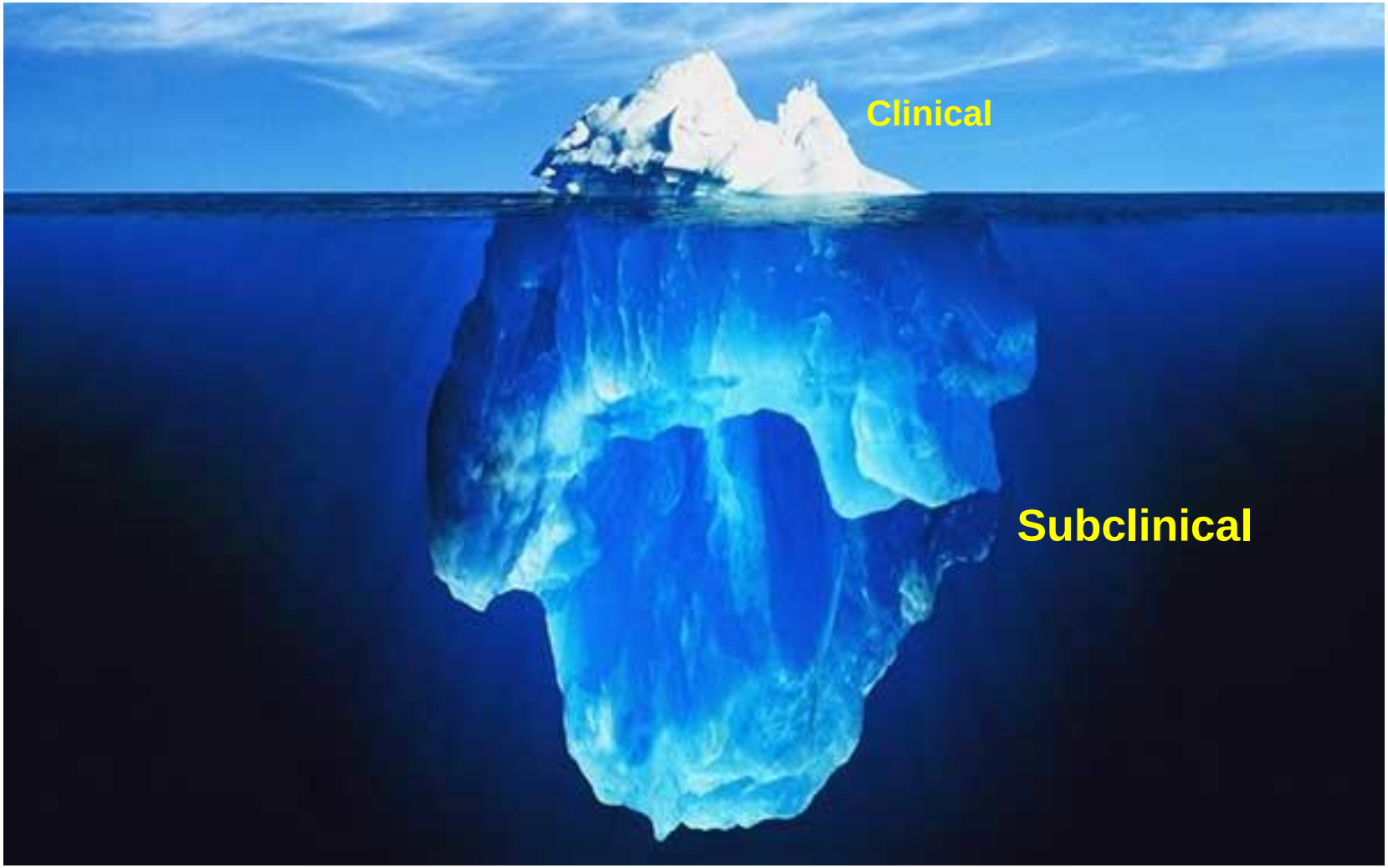

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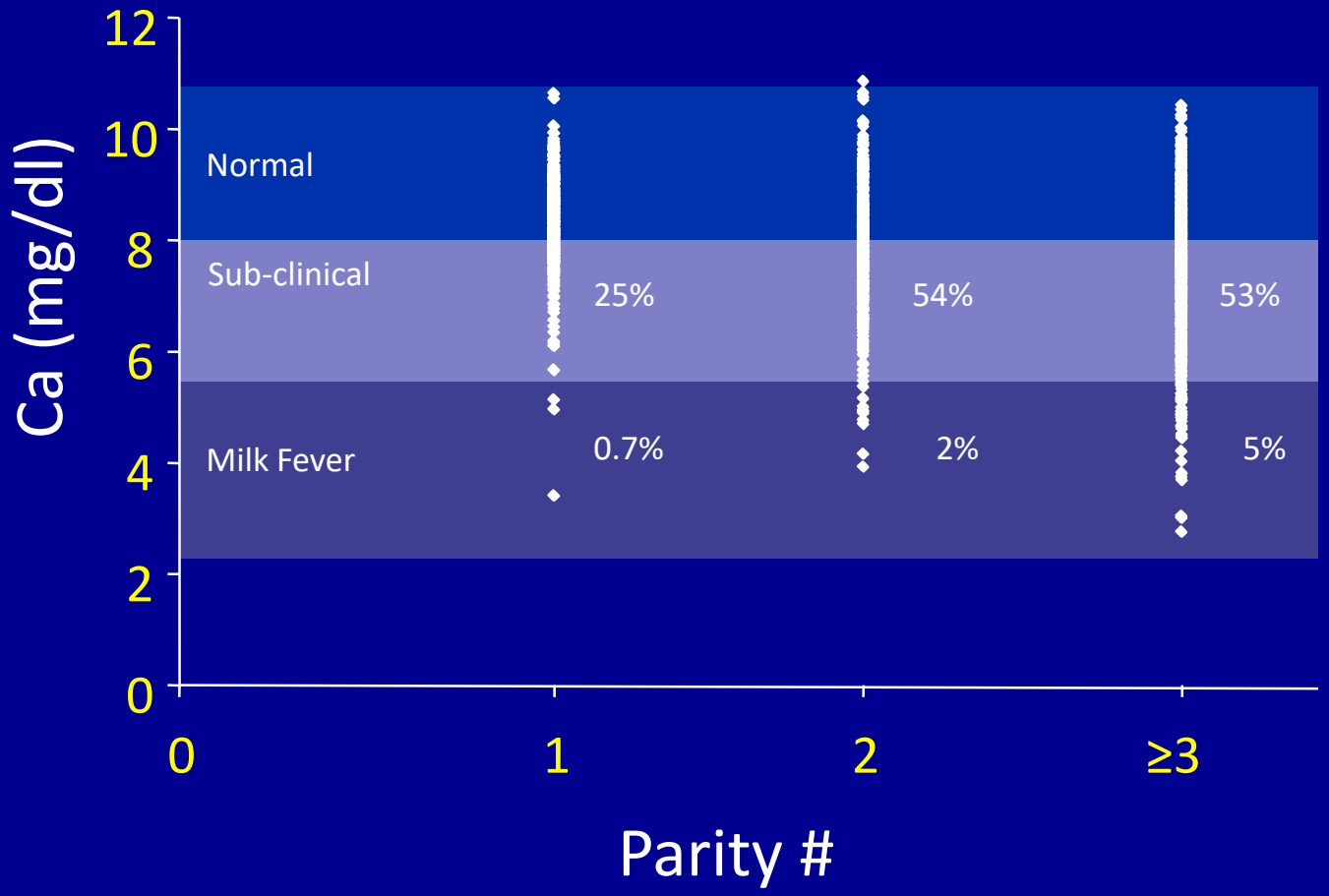
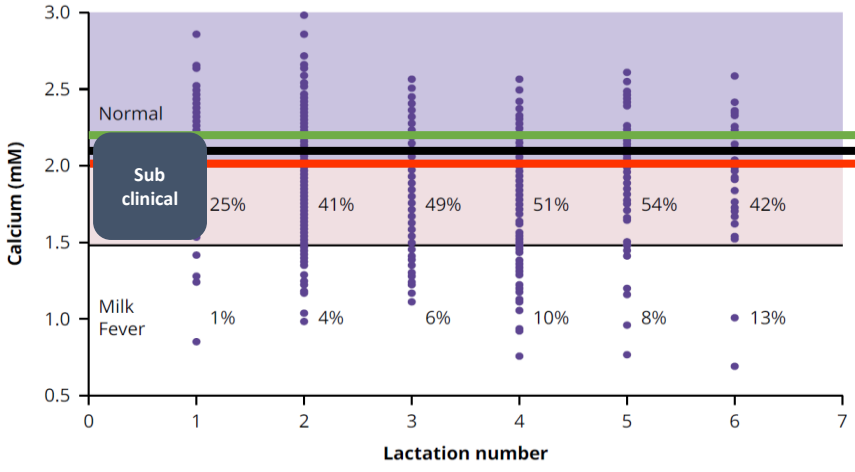
Incidence of hypocalcemia in USA dairies



(Reinhardt et al., 2011)

Hypocalcemia : 1 out of every 2 cows has subclinical hypocalcemia



2.2 mM

67.5%

53.0%

2.1 mM

40.7%

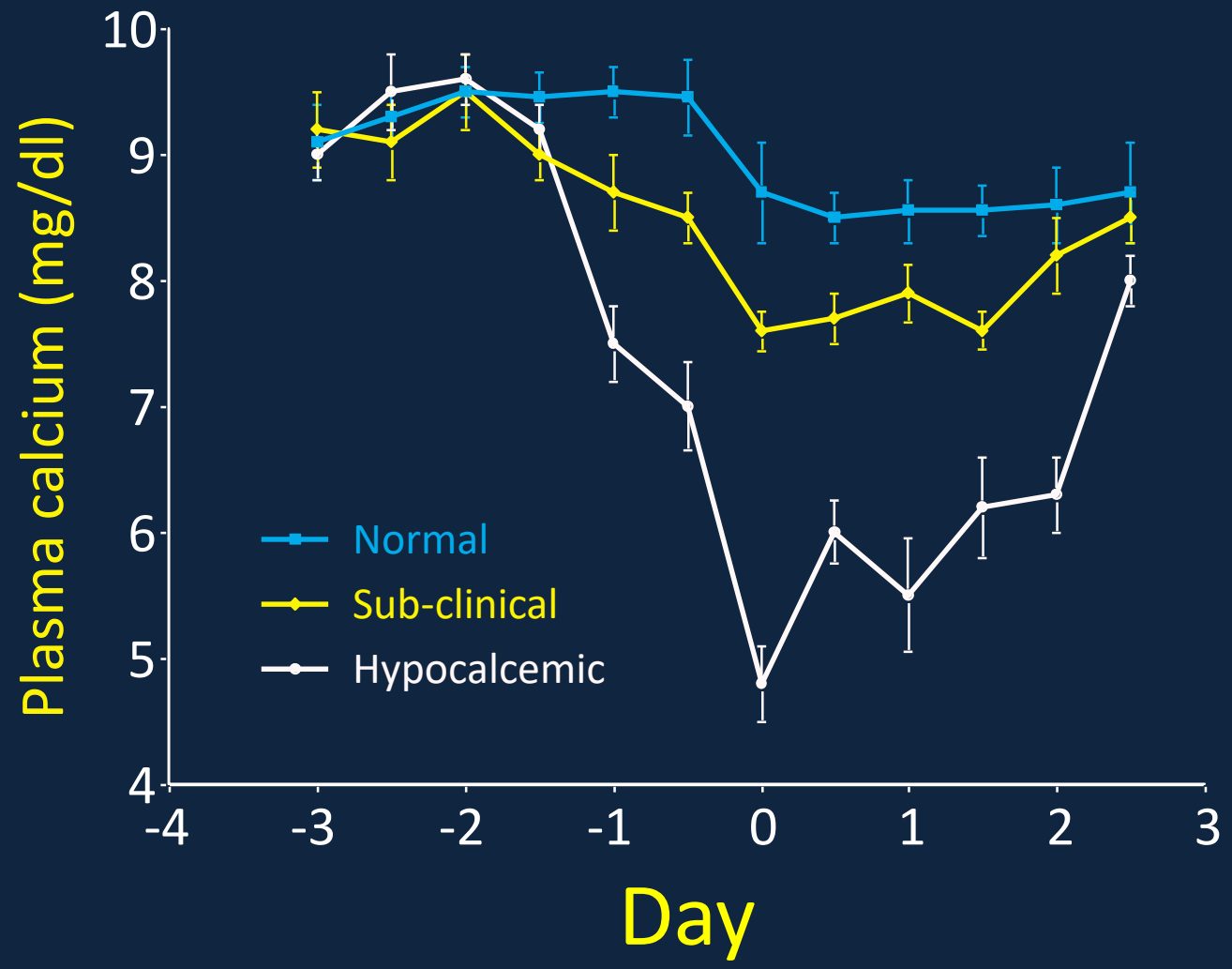
2 mM

115 commercial German dairy herds

Need to reset the threshold level of calcium for sub clinical hypocalcemia

Reinhardt et al. (2011) → **Venjakob et al., (2017)**

Hypocalcemia or Poor Management?


Plasma calcium (mg/dl)
10
9
8
7
6
5
4
-4
-3
-2
-1
0
1
2
3
Day
Normal
Sub-clinical
Hypocalcemic

Risk factors !!!

- Lactation (older cows)
- Milk yield
- Dystocia (calving difficulties)
- Breed (Jersey)
- Prepartum management
- BCS during dry period

Subclinical Hypocalcemia

- Transient: first 24-48 h pp
- Permanent: up to 7-10 d pp
- Delayed: from 3-4 d pp and beyond

(Neves et al 2018; McArt & Neves 2020)

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journal homepage: www.elsevier.com/locate/vas

Plasma ionized calcium and magnesium concentrations and prevalence of subclinical hypocalcemia and hypomagnesemia in postpartum grazing Holstein cows from southern Chile

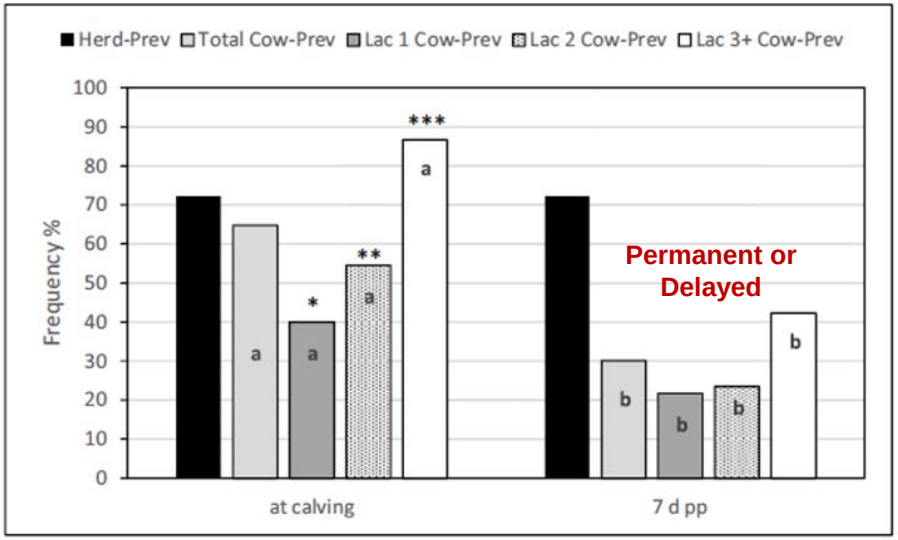
Pedro Melendez [a,*], Francisca Lopez [b], Jorge Lama [c], Bernardita Leon [c], Pablo Pinedo [d]

Table 1
Ionized calcium and magnesium plasma concentrations (mmol/L) at calving and at 7 d postpartum (pp), total and by lactation, in grazing Holstein cows with spring parturitions in southern Chile.

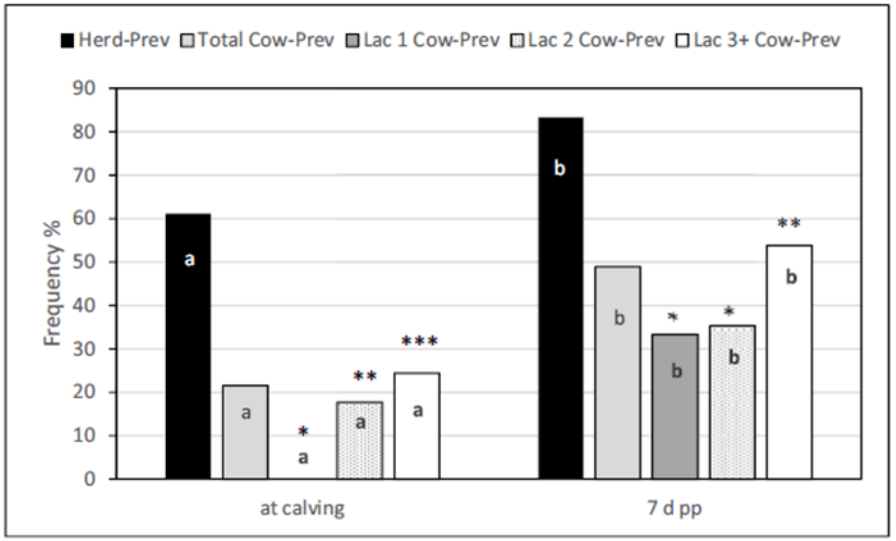
Item	Ionized Ca (mmol/L)		Ionized Mg (mmol/L)	
	At calving	7 d pp	At calving	7 d pp
Total (18 herds, n=113 at calving; n=175 at 7 d pp)				
Mean	0.99	1.01	0.58[a]	0.51[b]
SEM	0.16	0.13	0.12	0.09
Range	0.44-1.24	0.54-1.27	0.19-1.11	0.25-0.84
By lactation (11 herds, n=88 at calving and at 7 d pp)				
1 (n=30)				
Mean	1.064*	1.05	0.63[a]	0.54[b, *]
SEM	0.13	0.12	0.06	0.10
Range	0.77-1.19	0.71-1.20	0.55-0.73	0.39-0.84
2 (n=17)				
Mean	1.024*	1.04	0.60[a]	0.53[b, *]
SEM	0.13	0.10	0.07	0.09
Range	0.81-1.24	0.84-1.22	0.51-0.74	0.38-0.69
3+ (n=41)				
Mean	0.89[a, **]	1.01[b]	0.61[a]	0.50[b, **]
SEM	0.17	0.16	0.12	0.10
Range	0.54-1.18	0.54-1.27	0.32-0.89	0.30-0.75

a, b: statistical differences ($P \leq 0.05$) between days.
*, **: statistical differences ($P \leq 0.05$) within day among lactations.

Hypocalcemia



Hypomagnesemia



Prevention Milk Fever

- 2 methods (prepartum)
  - Low Calcium diets. Ca binders - Bentonites, Zeolites
  - Negative DCAD (Body ACIDIFICATION)

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Calcium Restriction

- More traditional method
- Total dietary intake Ca <20 g/d
- Calcium binders: Bentonites, Zeolites

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Etiology/Pathogenesis of Milk Fever

- Three hormones/vitamins involved:
  - PTH hormone (+): ↑ Ca in blood
  - Thyrocalcitonin (-)
  - Vitamin D (+): ↑ digestive Ca absorption

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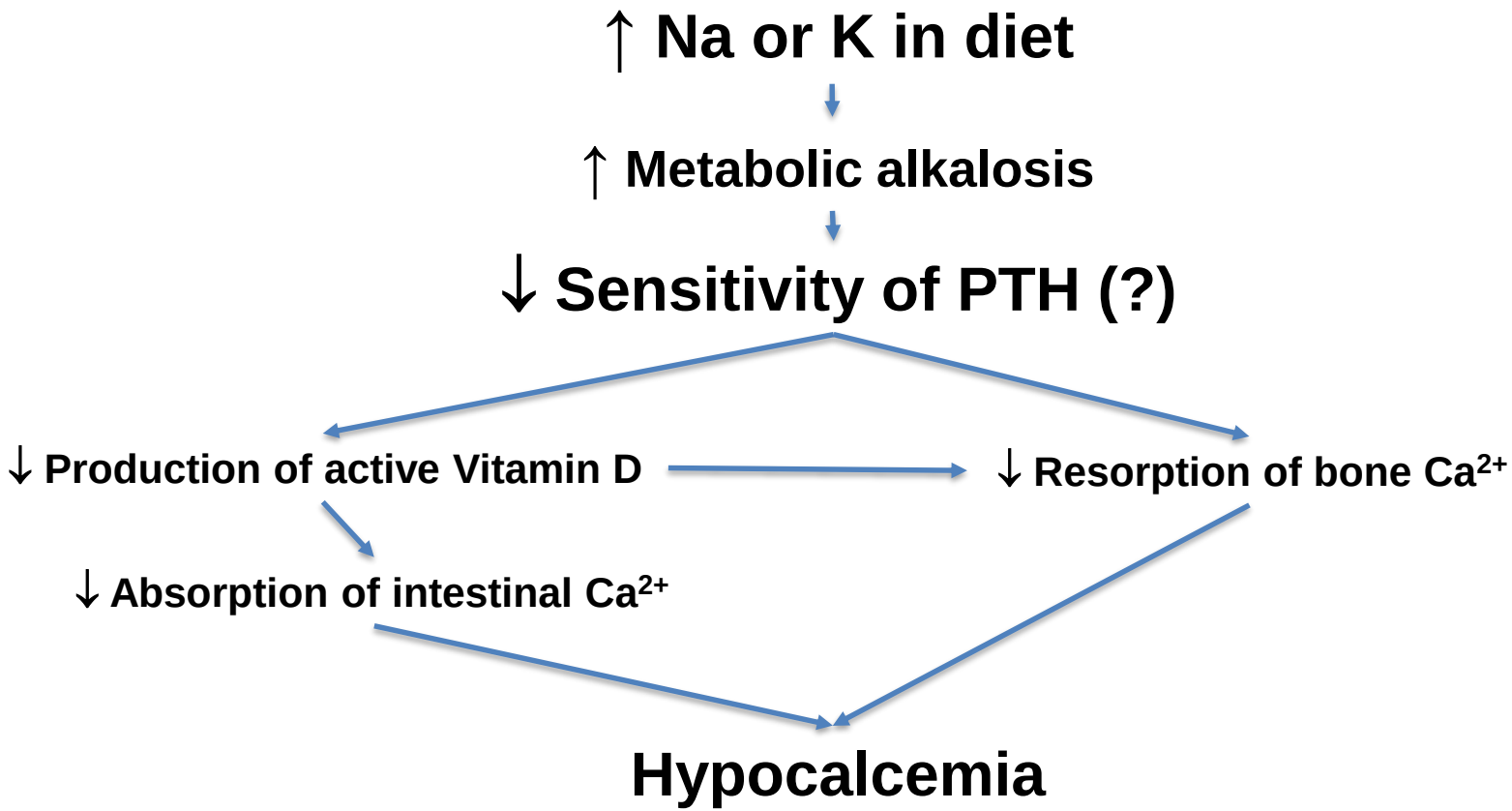
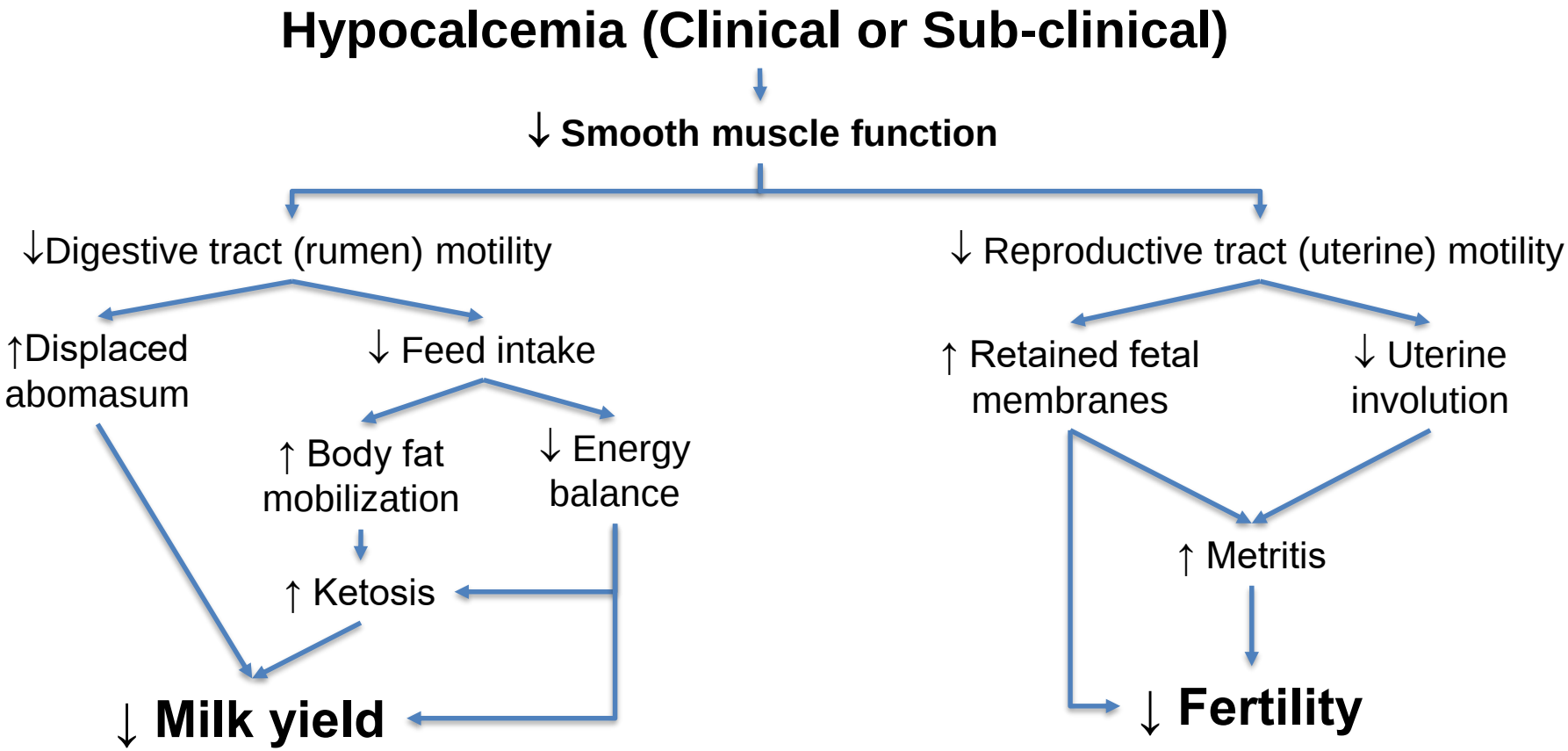
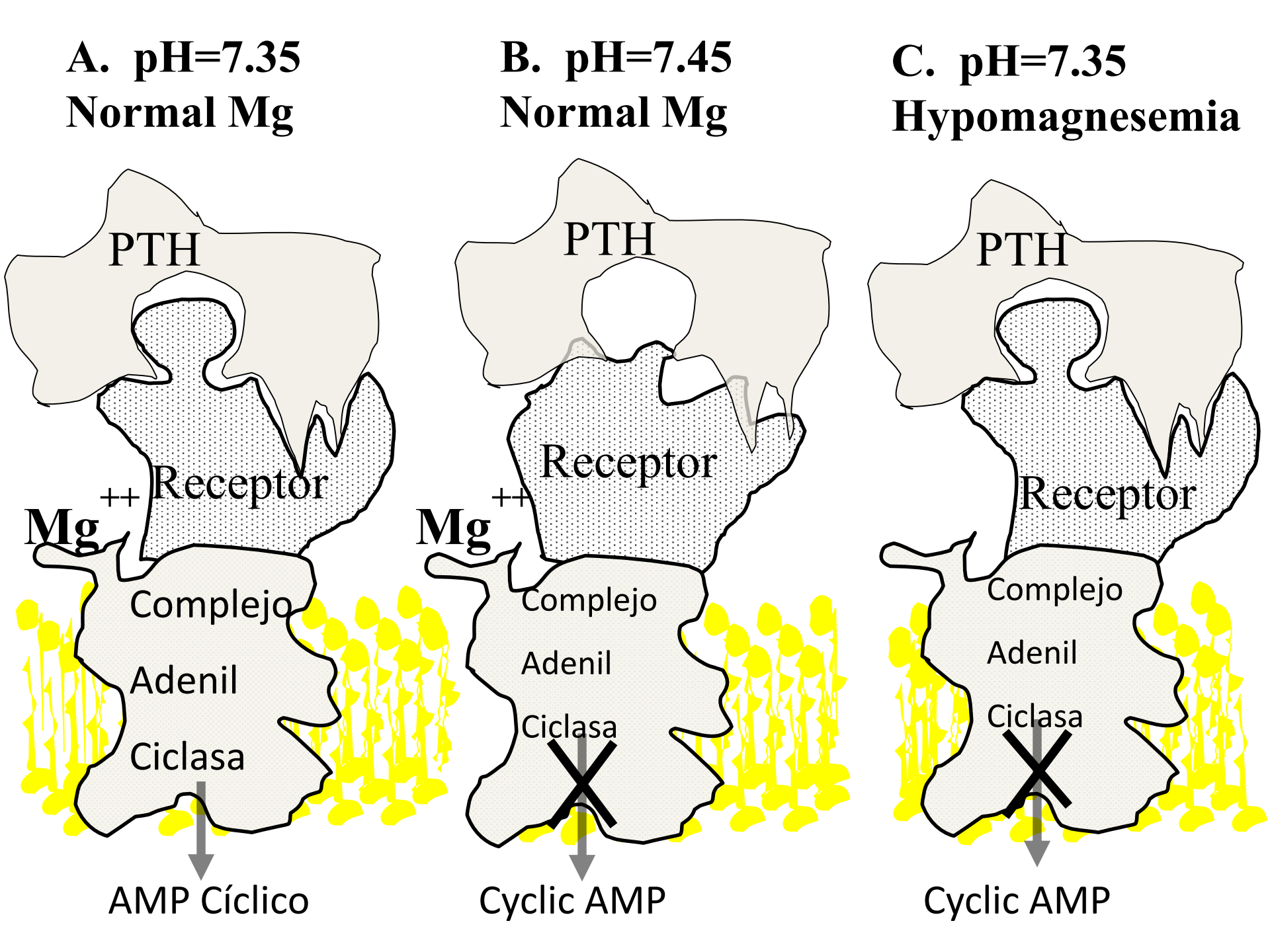
Etiology/Pathogenesis of Milk Fever



Hypocalcemia: Pathophysiological effects




A. pH=7.35
Normal Mg
B. pH=7.45
Normal Mg
C. pH=7.35
Hypomagnesemia
PTH
Receptor
++
Mg
Complejo
Adenil
Ciclasa
AMP Cíclico
Cyclic AMP
Cyclic AMP

Anionic Compounds

$(K^+ + Na^+)$ minus $(Cl^- + S^-)$

Cations Anions

Dietary Cation-Anion Difference (DCAD)

DCAD + 100

DCAD - 100

Diets prepartum

- Diets high in K (lush pastures, molasses) (DCAD positive) induce body alkalosis **more hypocalcemia**

- Diets high in Cl and S (anionic compounds) (DCAD negative) induce body acidosis **less hypocalcemia**

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Make the diet “Acidogenic”

Ingredients	Dry matter, %	As fed, kg	Dry matter intake, kg
Soybean hulls ground	90.2	0.200	0.180
Corn grain 73 % starch	87.5	0.300	0.263
Canola mealsolv. extr.	91.9	0.850	0.781
Soybean meal solv. 47%	90.0	0.925	0.833
DCAD status is + 100 to +150 mEq/kg diet			
Sugarcane molasses 49%	73.3	0.060	0.044
Min + Vit Dry Cow	93.6	0.042	0.039
Sodium Chloride	99.8	0.006	0.006
Calcium carbonate	99.2	0.005	0.005
Ryegrass silage	31.9	13.500	4.307
Corn Silage	34.1	5.000	1.705
Barley Straw	87.8	5.500	4.829
Total			**13.171**

Meta-analysis of 42 randomized experiments: Santos et al., 2019

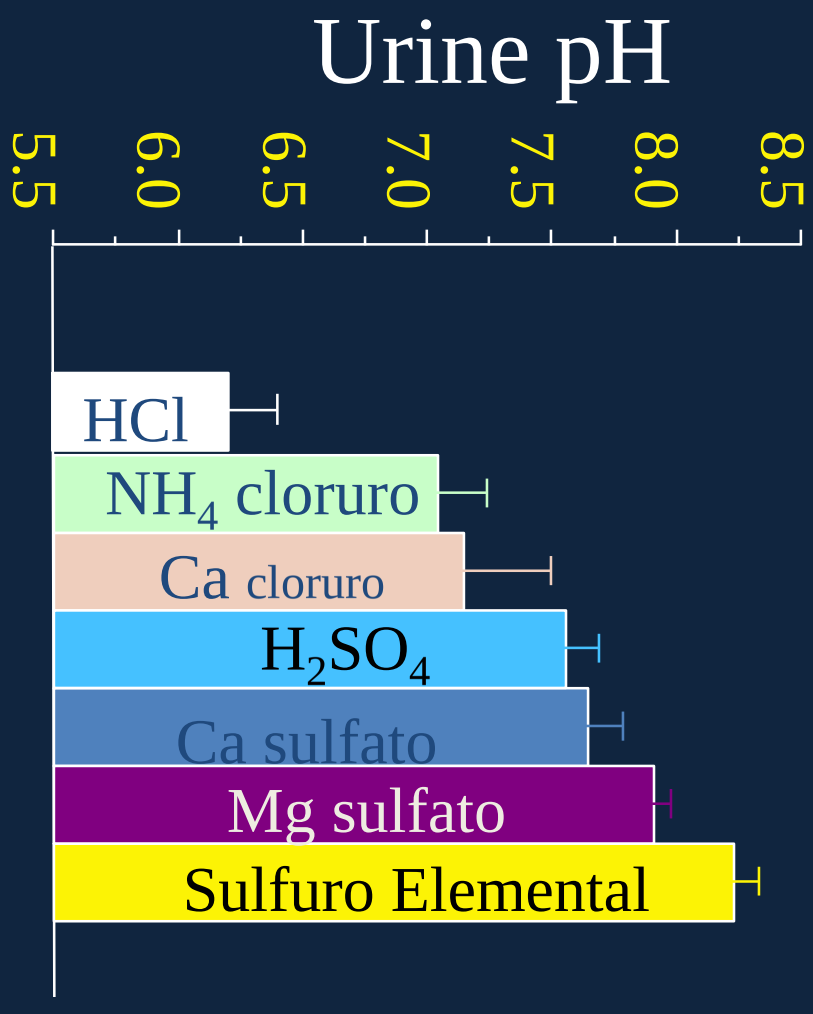
Parameters	DCAB, mEq/kg diet		Difference
	+200	-100	
DMI, kg/d	17.7	18.7	**1.0**
Milk, kg/d	36.2	37.9	**1.7**
FCM, kg/d	38.8	39.9	**1.1**
Milk fat, kg/d	1.438	1.512	**0.074**
Milk proetin, kg/d	1.115	1.139	**0.024**
Body weight, kg	616.3	663.0	**46.7**

How Acid?
Effectiveness of Anionic Compounds

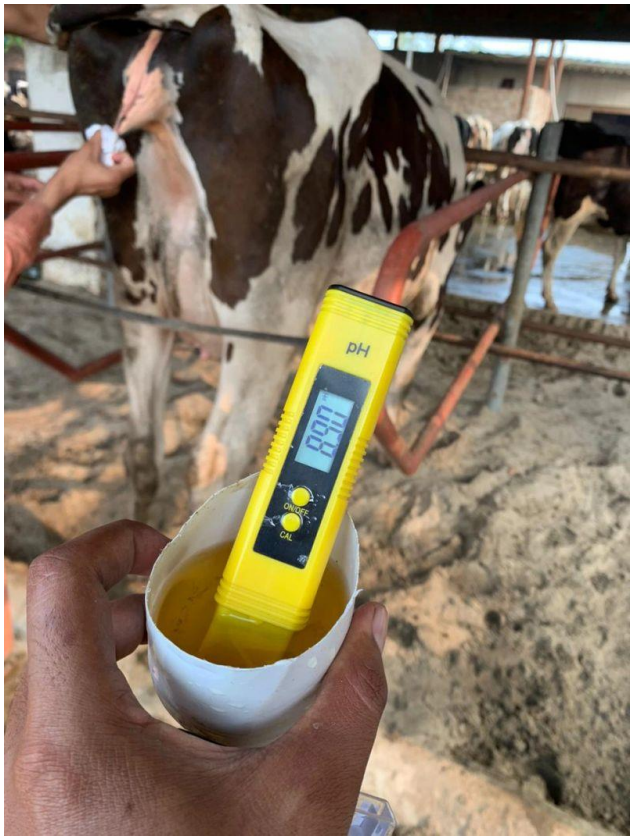
- Urine pH

- No anionic diets (more K)
  - Urine pH 8.0-9.0

- Anionic diets (more Cl & S)
  - Urine pH 6.0-7.0


Urine pH
5.5
6.0
6.5
7.0
7.5
8.0
8.5
HCl
NH4 cloruro
Ca cloruro
H2SO4
Ca sulfato
Mg sulfato
Sulfuro Elemental


Collection of Urine
Sample In Cows

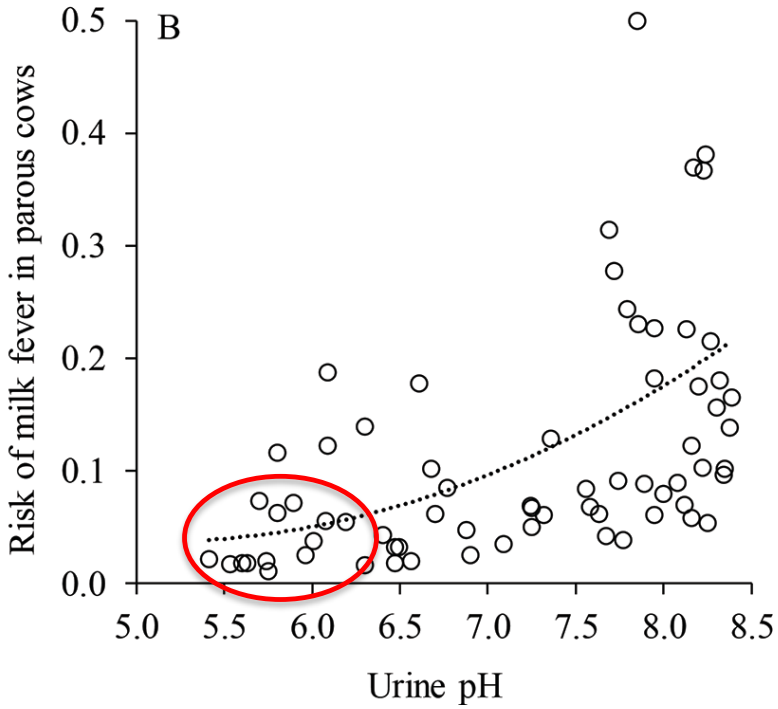

pH

What does urine pH mean?

- pH scale is logarithmic

- 8.5 to 7.5------- 10x
- 8.5 to 6.5-------10*10 = 100x
- 8.5 to 5.5-------10*10*10 =1,000x

Charbonneau et al., 2006



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Melendez et al., 2021

Animal. 2021 Mar;15(3):100148. doi: 10.1016/j.animal.2020.100148

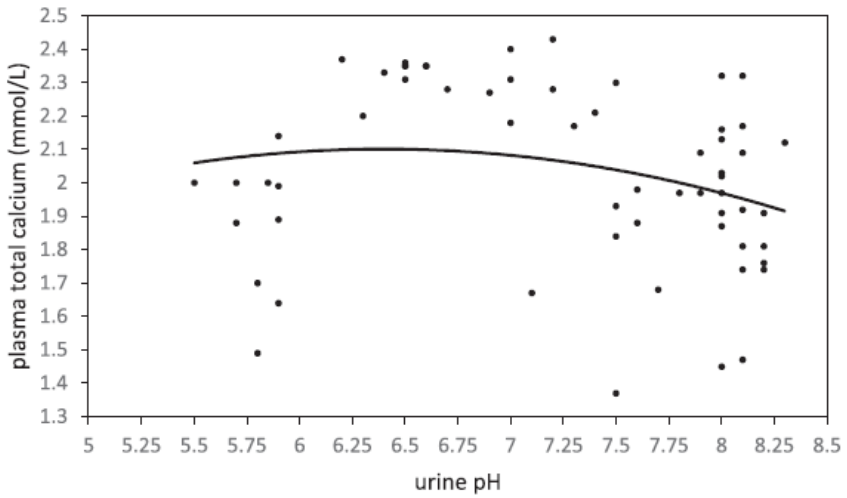

Table 5

Percentage and number of cases (n/total) c

Urine pH	Stillborn %
<6.0 ($n = 22$)	13.6[a] (3/22)
6.0–7.0 ($n = 46$)	8.7[ab] (4/46)
>7.0 ($n = 135$)	4.4[b] (6/135)
Comparison urine pH	
<6.0 vs >7.0	
AOR	2.39
(95% CI)	(1.06–5.40)
P-value	0.035

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(-) DCAD & pH Urinario

6.0 a 6.8 Holstein

5.8 a 6.2 Jersey

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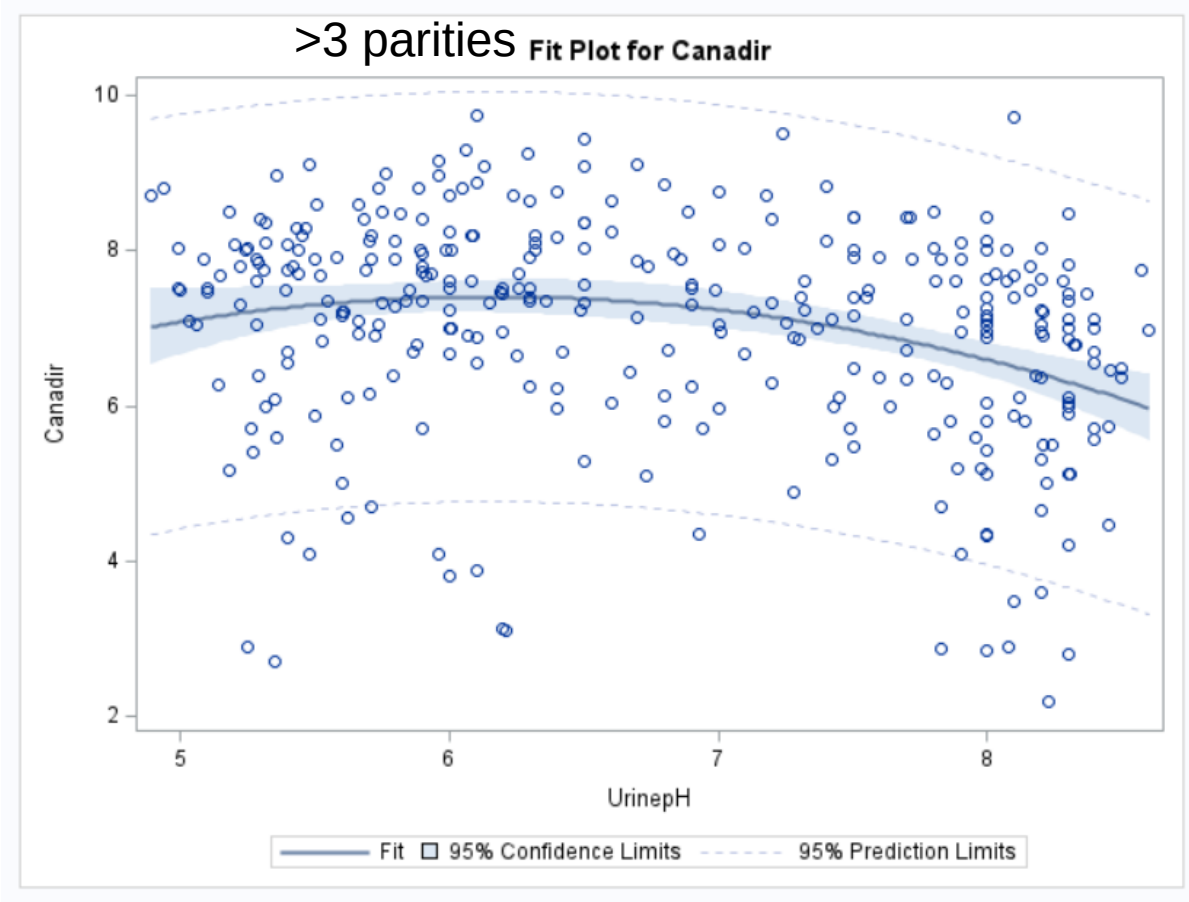
Goff et al., unpublished data



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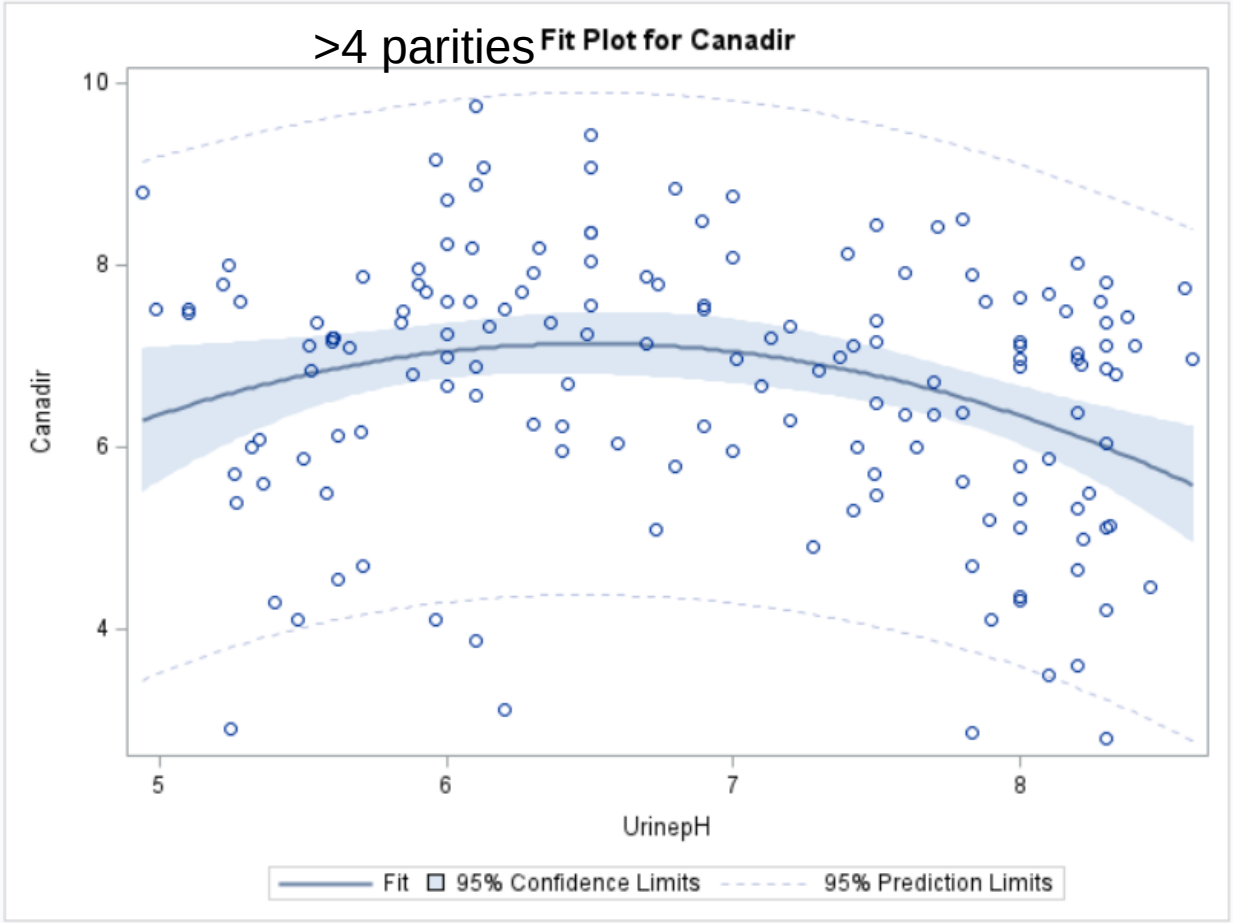
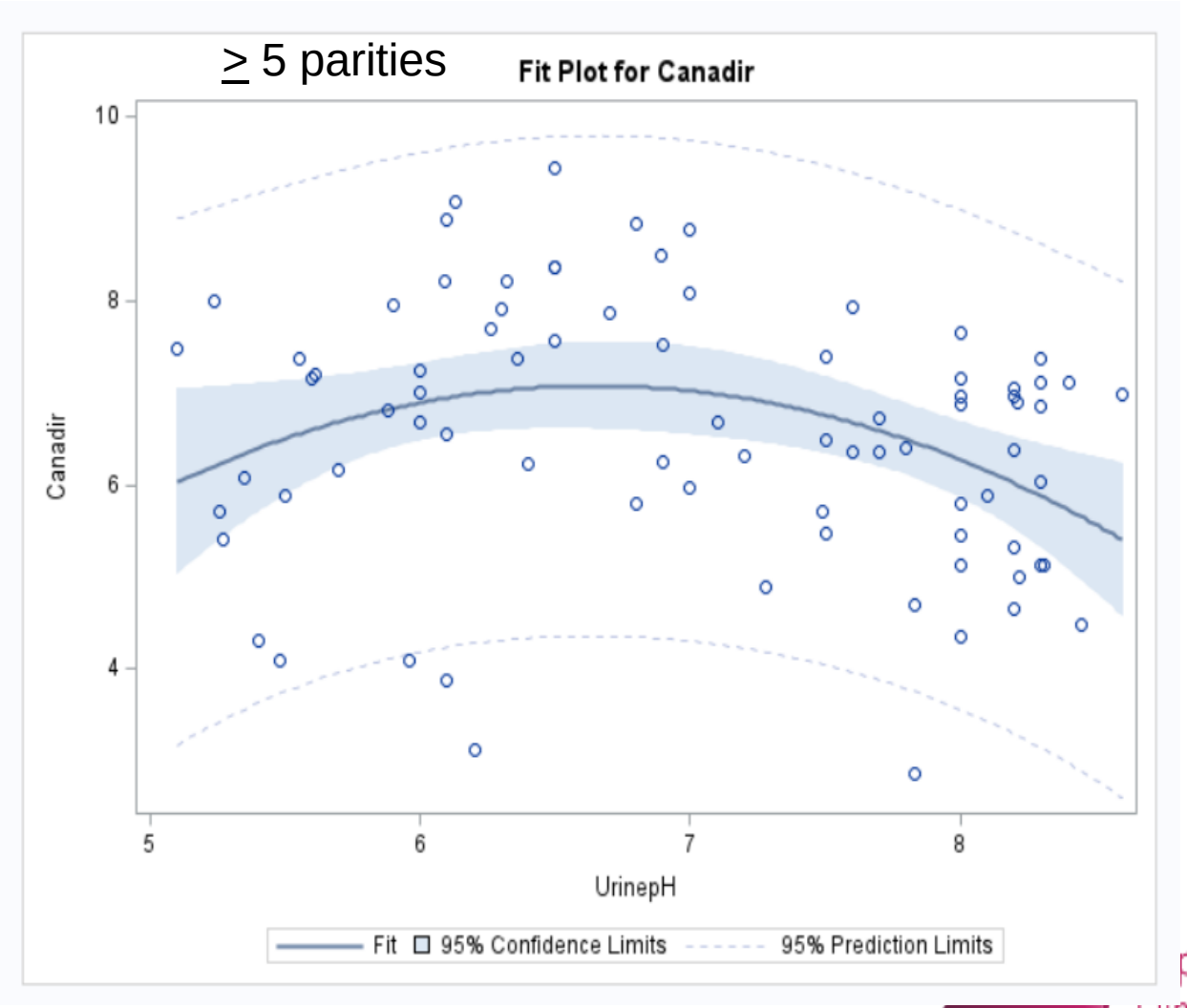
Goff et al., unpublished data



Goff et al., unpublished data



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Cow ID	Parity	Calving date	Gestation length	Days in prepartum	BCS	Type of calving	Liters first milking	Liters second milking	Day 1	Day 2	Day 3	Day 4	Day 5
9680	1	11/4/2024	277	34	-	Normal	4	3	11.5	22.6	22.8	16.1	8.4
8931	2	11/4/2024	276	27	3.75	Normal	0	0	0.2	0.3	0	0	0
9810	1	11/4/2024	281	34	-	Normal	4	5	22.6	26.4	8.6	18.8	10.3
7425	4	11/4/2024	275	27	3.25	Normal	2	0	16.5	24.9	27.5	21.9	10.2
8682	2	11/4/2024	283	35	3.75	Normal	4	2	3.5	14	20.1	17.8	9.1
8983	2	11/4/2024	283	34	3.5	Normal	2	2	7.6	22.2	24.4	17.9	9.5
9012	2	11/5/2024	273	26	3.25	Normal	2	2	15.3	22	17.7	10.4	32.4
4902	7	11/6/2024	284	37	3.5	Normal	3	0.5	4.8	30.8	20.1	11.2	48.4
8335	3	11/6/2024	275	27	3.75	Normal	3.5	0.5	1.2	15.7	9.4	8.6	37.1
8205	3	11/6/2024	278	29	3.5	Dystocia	3.5	0.5	1.5	19.1	19.9	10.6	38.1
8274	3	11/6/2024	277	29	3.5	Normal	1	1	0.5	4.6	10.2	5.2	34.7
7364	4	11/6/2024	275	27	3.75	Normal	1	0.5	1.2	14	18.3	11.2	47.6
5763	6	11/7/2024	279	30	3.75	Normal	1	2	1.1	15.1	8.5	38	39.3
6331	5	11/7/2024	278	30	4	Normal	0.5	0	0	0	2.6	24.7	22.5
7120	4	11/7/2024	275	28	3.5	Normal	4		13.2	7.2	38.1	39.2	43.7
7230	4	11/7/2024	282	35	3.5	Normal	4	0	2.9	20.7	43.1	44.3	43.5
9757	1	11/7/2024	281	38	-	Normal	1	2	10.5	8.1	18	24.5	27.4
9860	1	11/8/2024	269	29	-	Normal	0.5	5	1.9	3.6	19.8	20.7	22.7
8253	3	11/8/2024	279	30	3.75	Dystocia	6	0.5	0.9	2.1	29.9	22.1	37.7
9772	1	11/8/2024	272	30	-	Normal	4	2	23.8	26.4	18.4	29.6	32.2
9790	1	11/9/2024	274	34	-	Normal	4	2	21.6	23.9	14.2	25.1	26.8
6389	2	11/19/2024	284	27	3.5	Normal	0	0.5	0.9	15.3	7.9	-	-
9048	2	11/19/2024	276	27	3.5	Normal	0	0	0.5	0.5	-	-	-

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Birth weight (BW) of female calves born from December 10, 2024, to January 14, 2025. Q1-Q4 (quartile 1 and 4)

Item	Calvings	Birth Weight	Q1-Q4	Gestation length	Q1-Q4	Comment
Females Herd Case	97	35.9±4.5	34-45	274.5±4.0	272-287	51.5% of calves weighed ≤ 36 kg
Normal BW for Holsteins*	5,253	39.4 ±4.4	36-42	274.4±4.8	273-278	

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Item	Amount (% as Dry Matter)
Dry Matter %	57
Crude Protein %	11.6
Soluble Protein %	4.4
N-Ammonia %	1.37
FDIP %	1.01
NDIP %	1.92
ADF %	20.4
NDF %	33.5
Lignin %	4.34
NDF dig 24 h	12.4
NDF dig 240 h	21.0
uNDF 240 h	12.5
Ethanol soluble sugars	5.8
Water soluble sugars	8.4
Starch %	33.7
Total Fat %	3.38
Total Fatty Acids %	2.36
Ash %	7.41
Ca %	0.75
P %	0.3
Mg %	0.33
K %	1.04
S %	0.29
Na %	0.12
Cl %	1.2
DCAD (mEq/kg DM)	-200.4

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Urine pH
20 cows

4.5 to 5.5

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Changes

- Increased CP to 15.5%
- Reduced starch to 18%
- Improved DCAD
- Urine pH 5.8 to 6.5
- Colostrum production 15 liters

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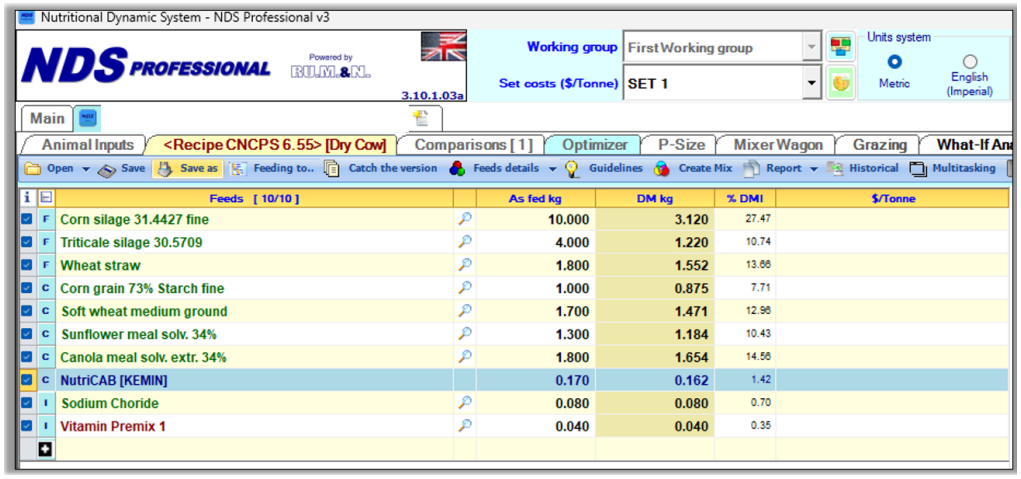
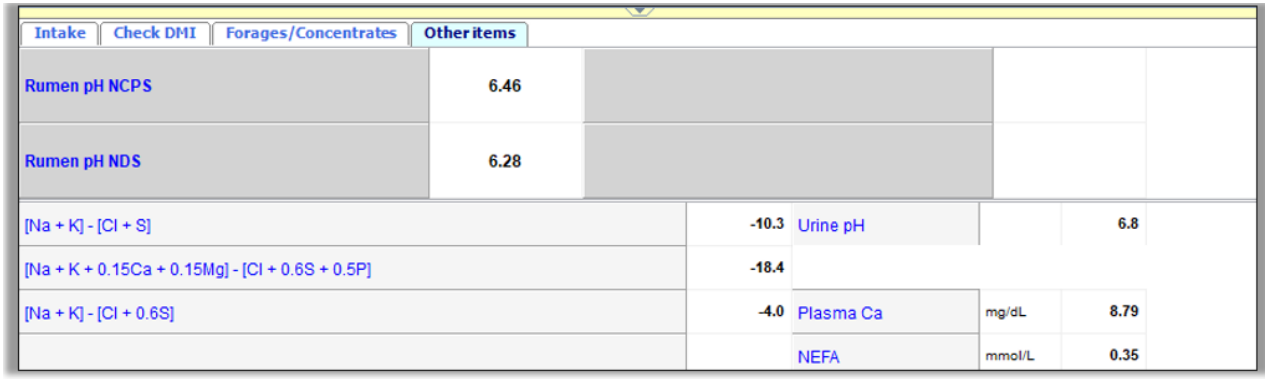
Balancing Cations and Anions in the diet





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Take-Home Message

- Ca binders are expensive and reduce Ca absorption too much (P ???, Mg ???)

- Anionic compounds are highly effective in controlling milk fever

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Take-Home Message

- DCAD prepartum: -100 to -200 mEq/kg DM
- Target: Urine pH 6.0 to 6.8
- Measure urine pH once a week in 5-10 cows

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Thank you very much !!!