Creating the cash cow

Factors influencing preweaning morbidity and mortality

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VVMA
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Overview

1. Host factors
    - In utero factors
    - Colostrum: day 1 and beyond
    - Nutrition
    - Vaccination
2. Environment
3. Wrap up

Why calves?

- Raising heifers is the second largest expense on a dairy farm
- Less illness/disease means better daily gains
- Better daily gains mean:
    - Earlier first breeding
    - Better lactation yields
- Fewer deaths = fewer heifers needed as replacements

Donovan et al. 1986; Soberon and Van Amburgh, 2013; Gelsinger et al. 2016; Abuelo et al., 2021

Birth to the beginning of puberty: fastest growth and best feed efficiency

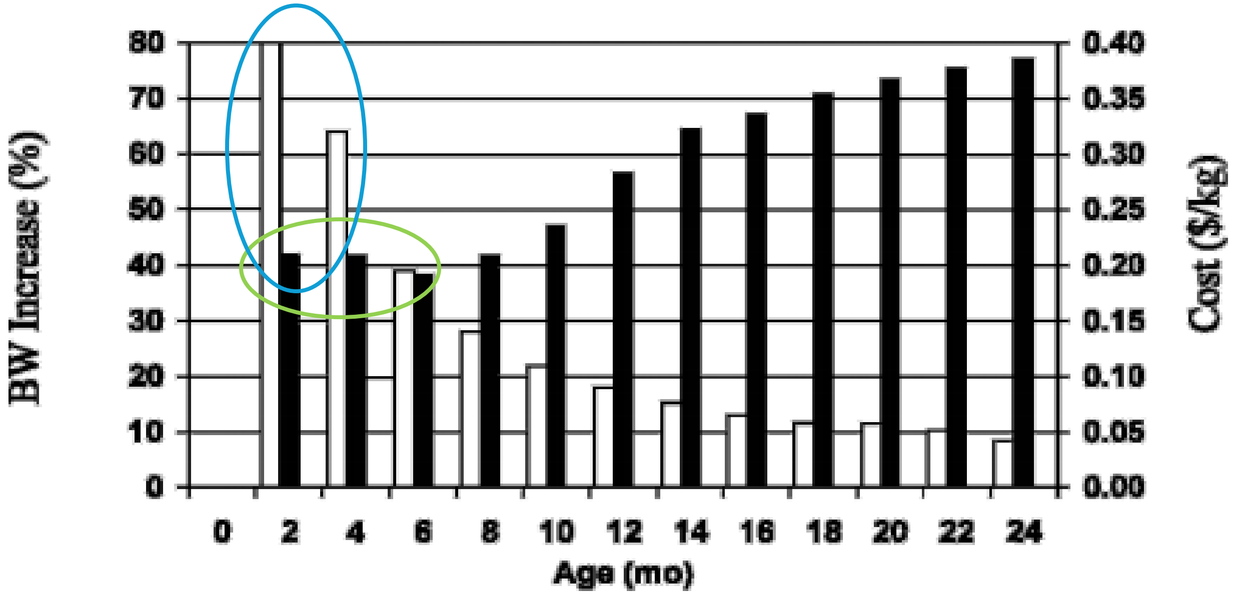
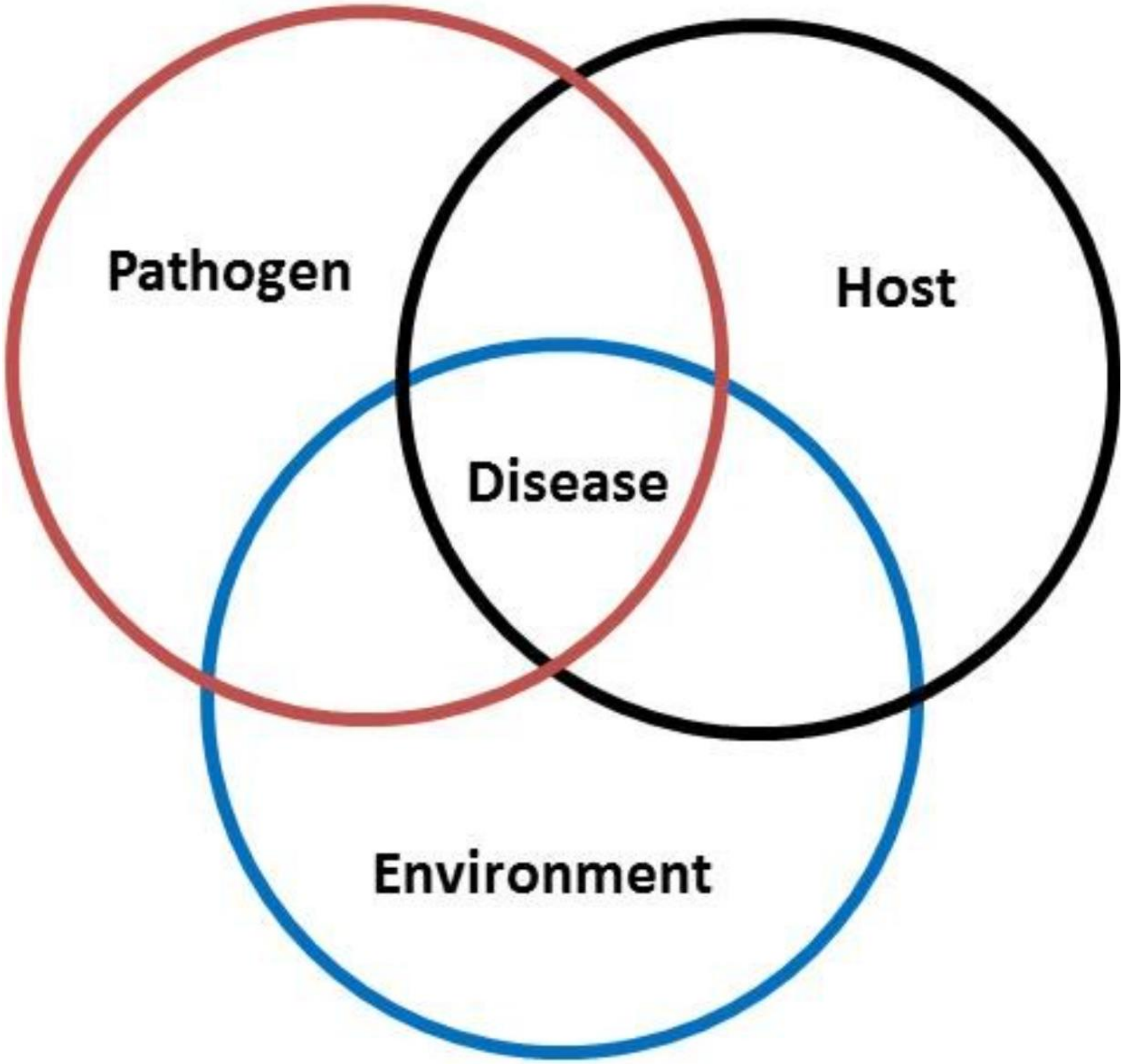


Figure 2. Percentage BW increase (open bar) relative to the previous 2-mo period and feed costs per kilogram of BW gain per 2-mo phase (closed bar) for Holsteins from birth through 24 mo of age.

Open bars = body weight increase

Dark bars = cost per kg gain


Pathogen
Host
Disease
Environment

Host

How do we improve host (calf) immunity and resistance?

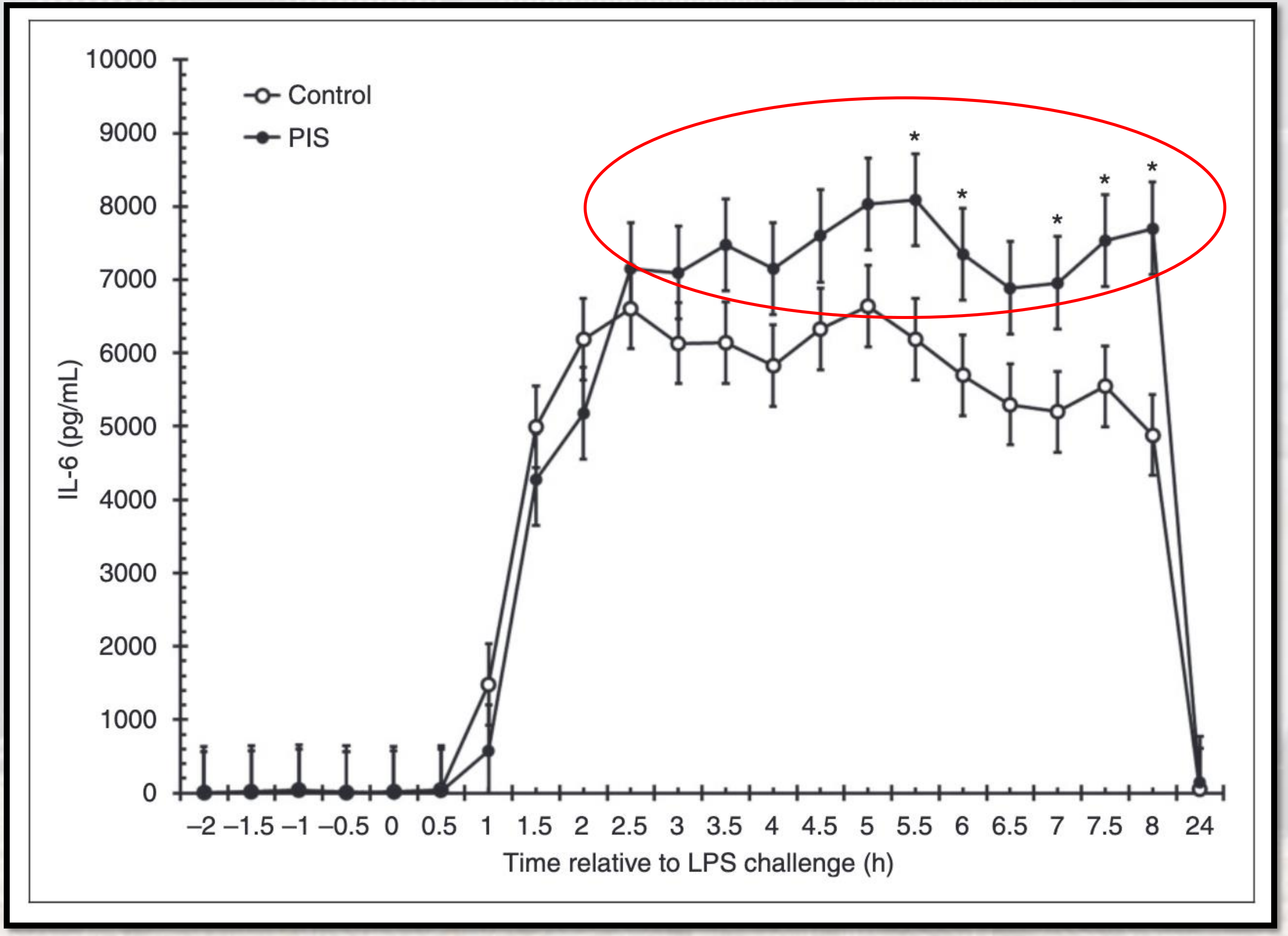
Prenatal Factors

Prenatal Factors

What happens in the prenatal period has long lasting effects

- ➢Lasting immunological and physiological effects from in utero endotoxin exposure as demonstrated by Carroll et al. (2017):
- ➢Administered LPS or saline to pregnant cows (233 d gestation)
- ➢LPS challenged their heifer calves after weaning

Carroll et al. 2017, *Innate Immunity,* 23:97-108



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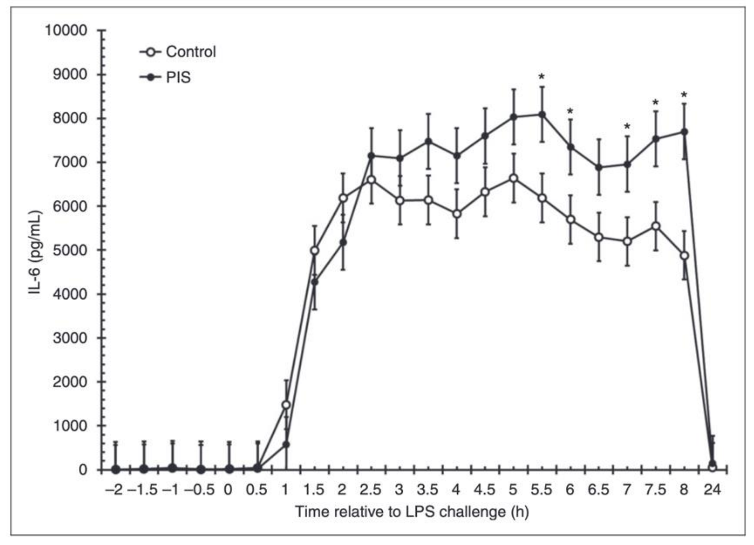

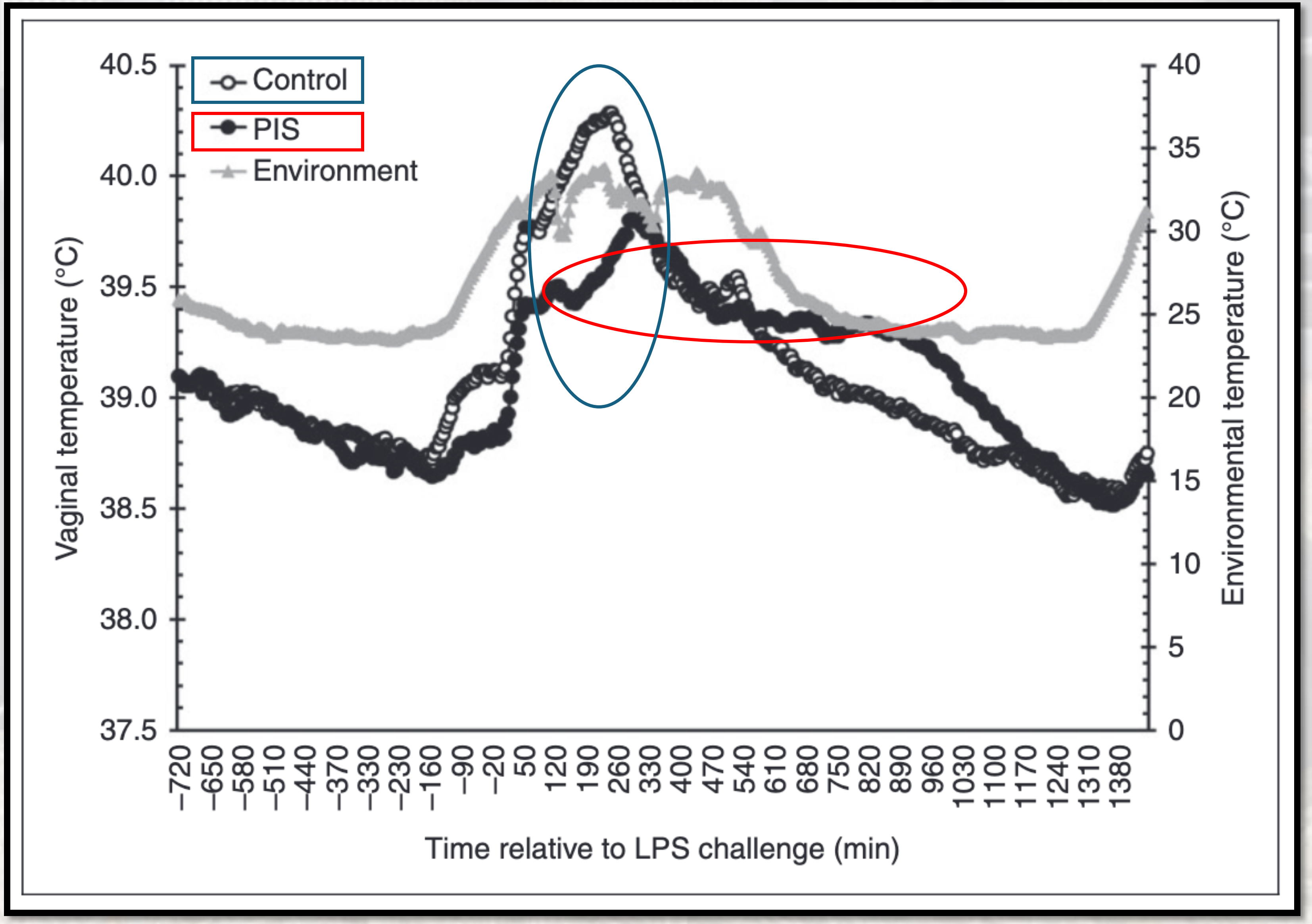

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Prenatal Factors

Late gestation nutrition impacts calf:

- Mortality
- Morbidity
- Immune response

Table 1
Summary of research investigating the consequences of prenatal malnutrition on offspring health parameters (mentioned in this article)

Reference	Species	Nutritional Insult	Period of Insult	Health Consequences
Corah et al,[20] 1975	Beef cows	65% energy requirements	Last 100 d of gestation	Increased neonatal mortality

Cooke et al. 2019, *Vet Clin Food Anim* 35:331–341

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Stalker et al,[30] 2006	Beef cows	Body reserve loss	Last trimester of gestation	Increased calf death from birth to weaning
Berry et al,[40] 2008	Dairy cows	Negative energy balance	Most of lactation	Reduced survival to second parity and increased milk somatic cell count
Larson et al,[32] 2009	Beef cows	Body reserve loss	Last trimester of gestation	Increased incidence of BRD and gastrointestinal diseases in the feedlot
Hammer et al,[24] 2011	Ewes	60% energy requirements	Mid and late gestation	Increased efficiency in extracting colostrum nutrients
Gonzalez-Recio et al,[41] 2012	Dairy cows	Negative energy balance	Most of lactation	Lived 16 d shorter and reduced metabolic efficiency
Moriel et al,[31] 2016	Beef cows	70% of energy requirements	Last 40 d of gestation	Impaired humoral and physiologic responses to vaccination against BRD pathogens

Cooke et al. 2019, *Vet Clin Food Anim* 35:331–341

Prenatal Factors

- Possible causes for undersupply:
    - Overstocking/overcrowding
    - Predicted vs. actual dry matter intake (DMI)
    - Ration formulation – ME, MP, vitamins and minerals
    - Chop lengths, peNDF
    - Forage quality
    - Feed availability
    - Inaccurate mature cow bodyweights
    - Heifers vs. mature cows

Prenatal Factors

Heat stress

↑ speed of gut closure

↓ IgG efficiency of absorption

↓ growth to puberty

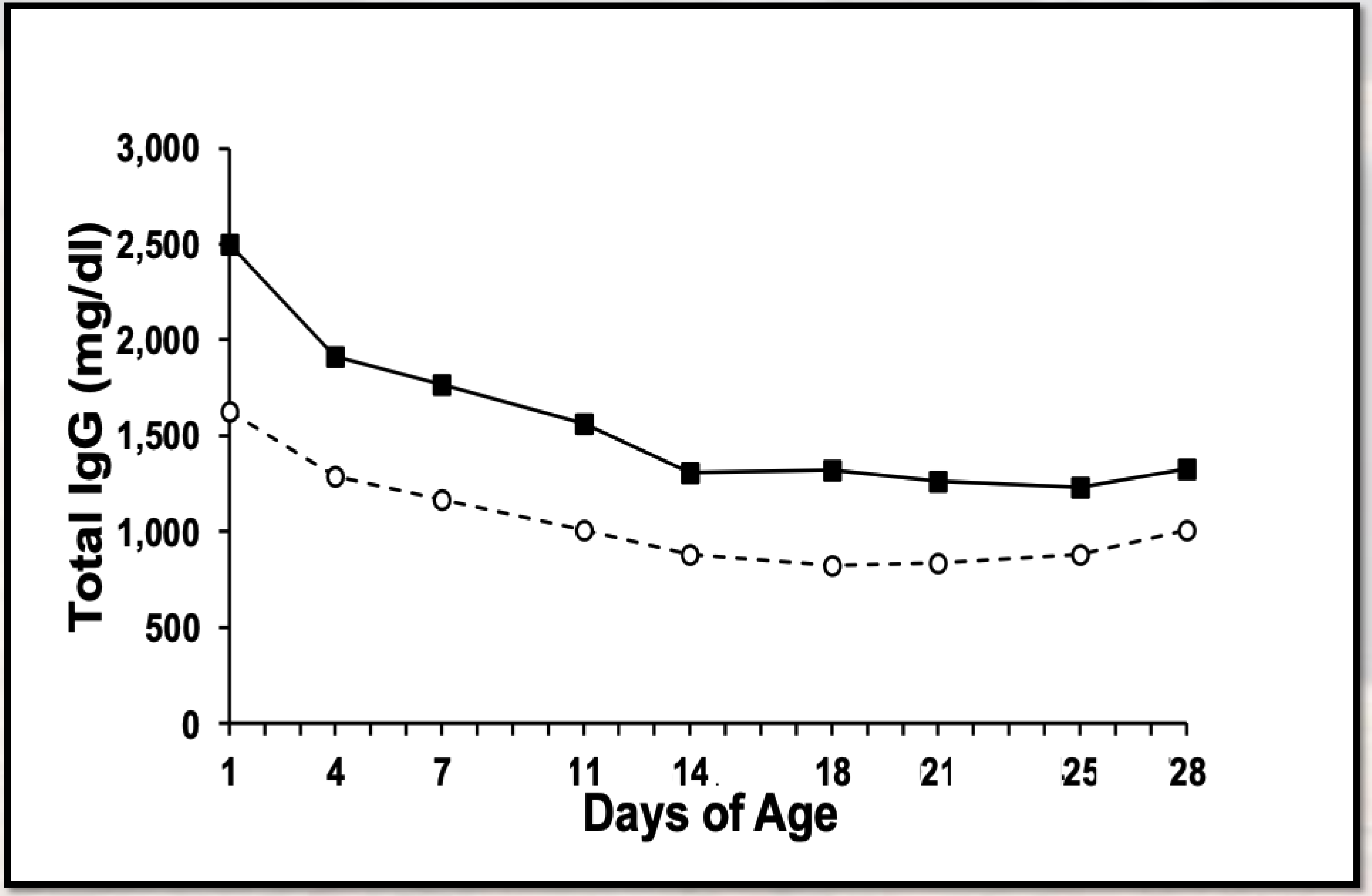
↓ calf survival

↓ IgG production

↓ reproduction and milk production

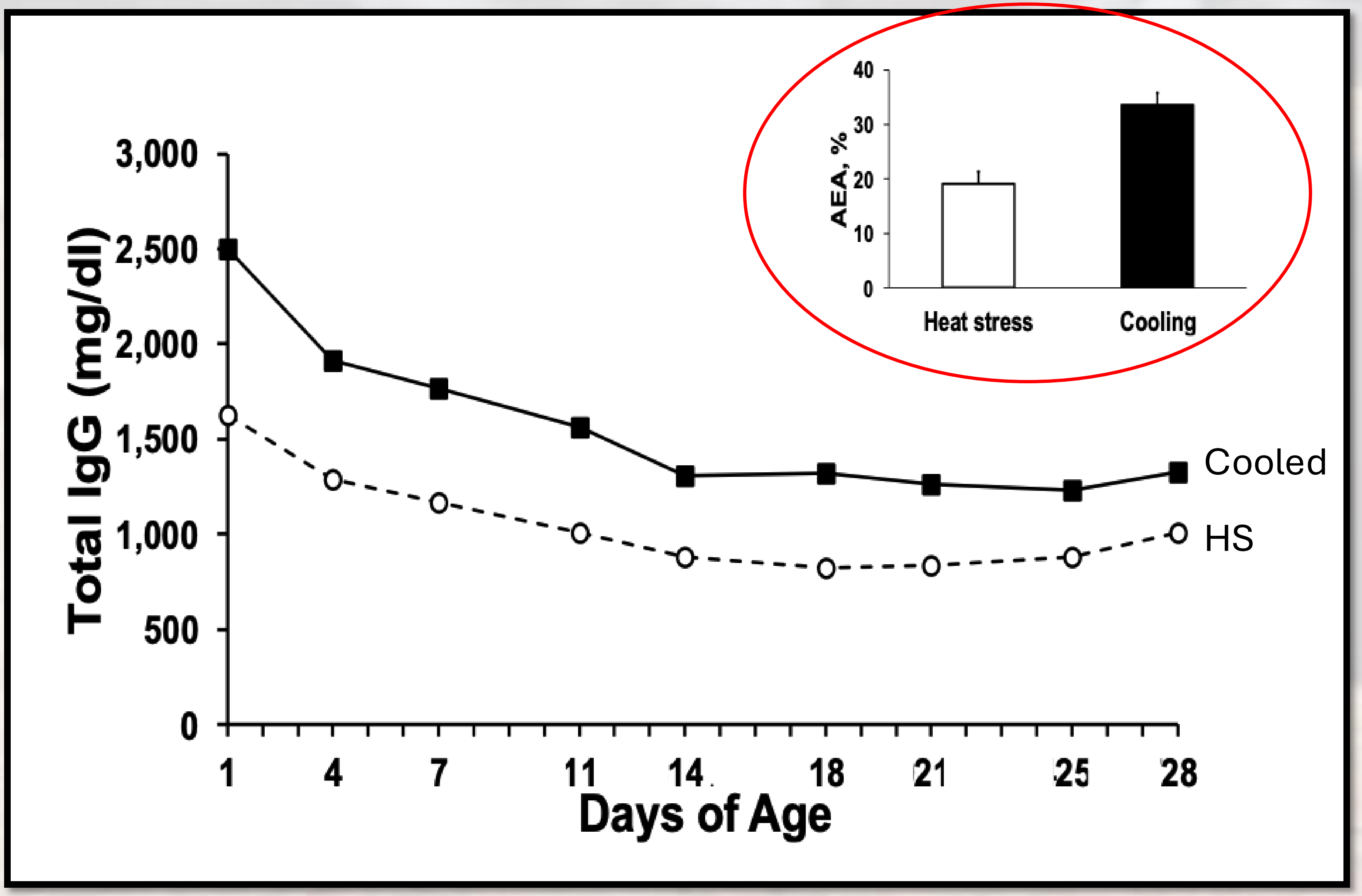
Tao et al., 2012; Monteiro et al., 2016; Ahmed et al., 2021

Prenatal Factors



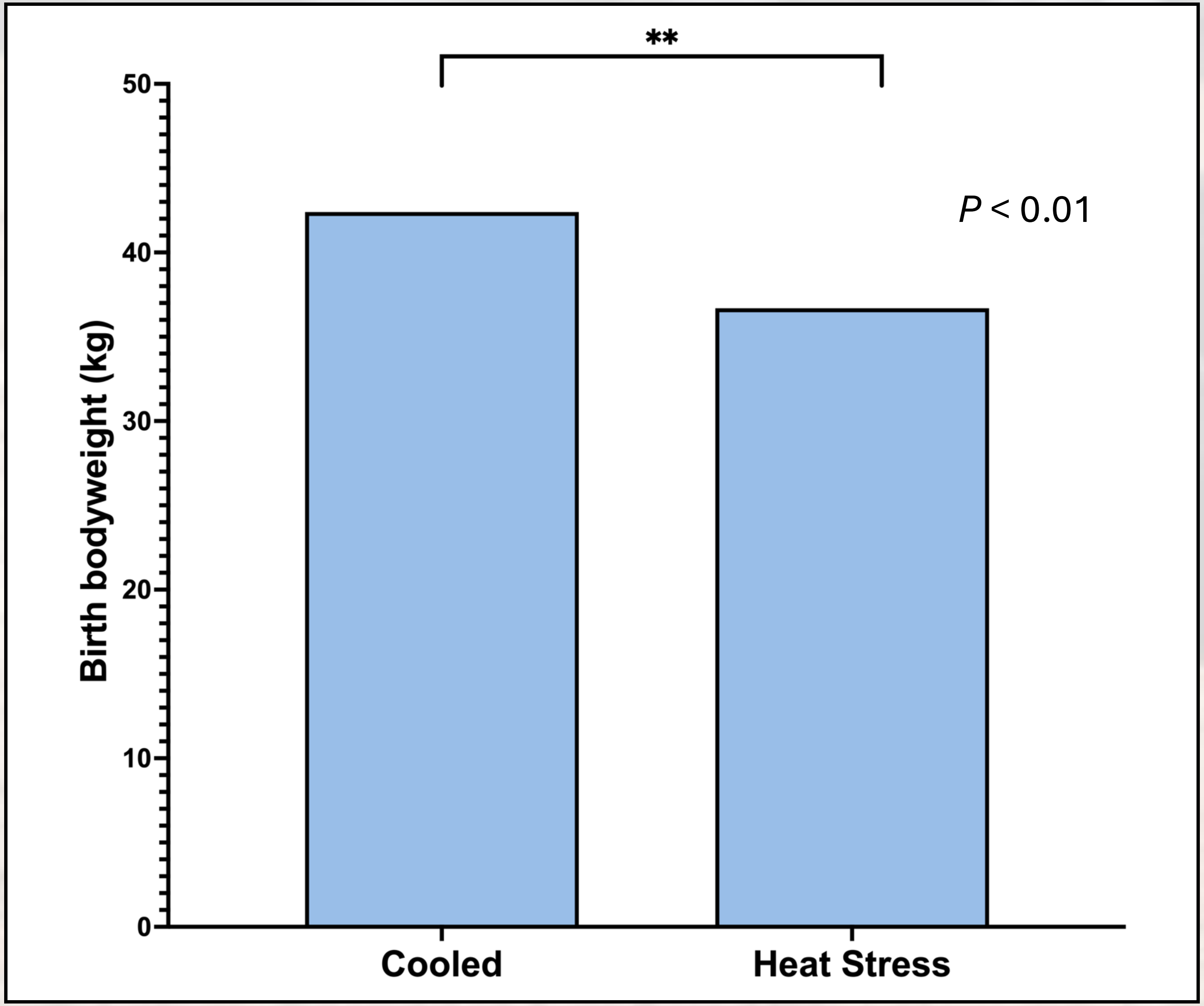
Tao et al., 2012

Prenatal Factors



Tao et al., 2012

Prenatal Factors



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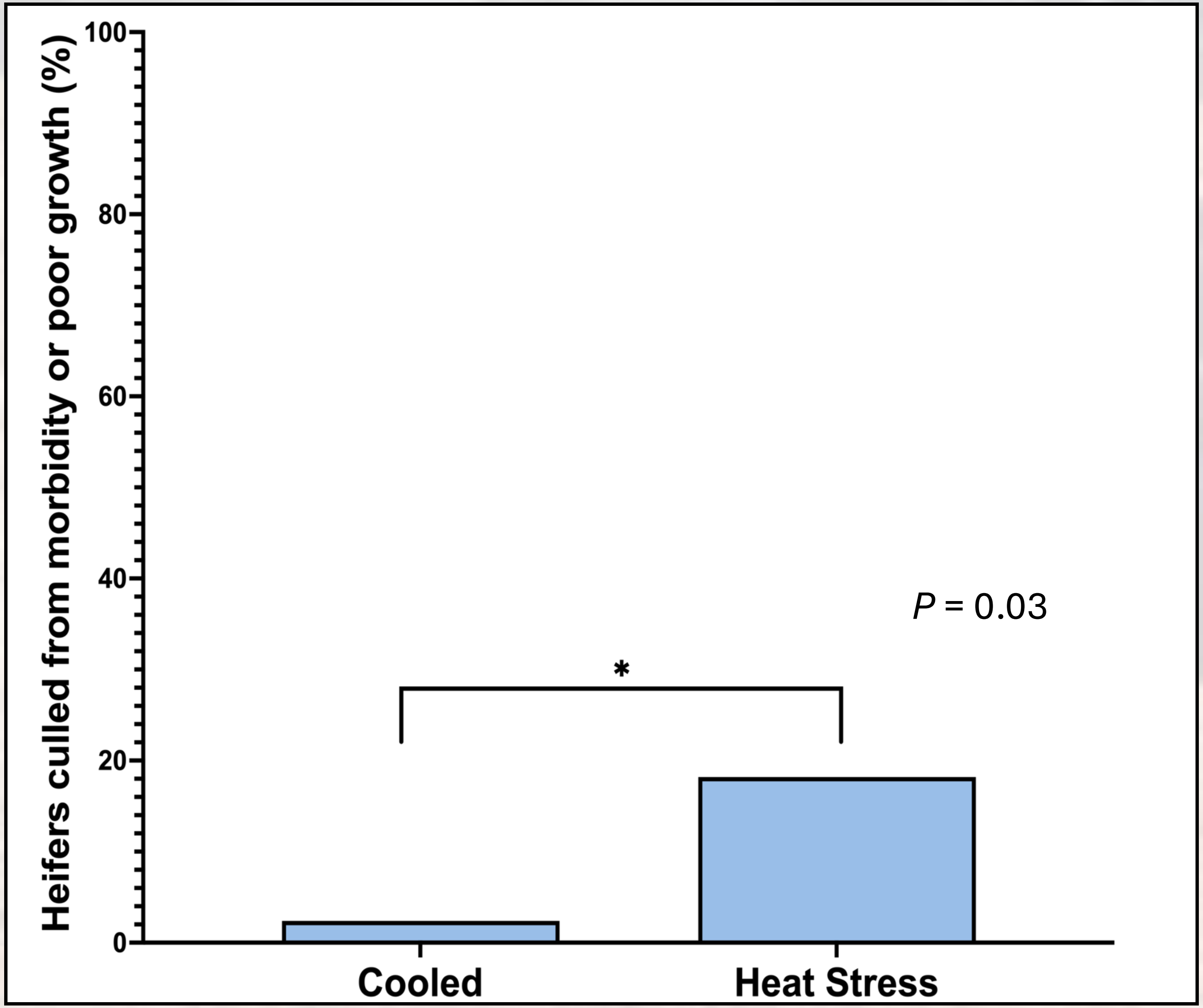
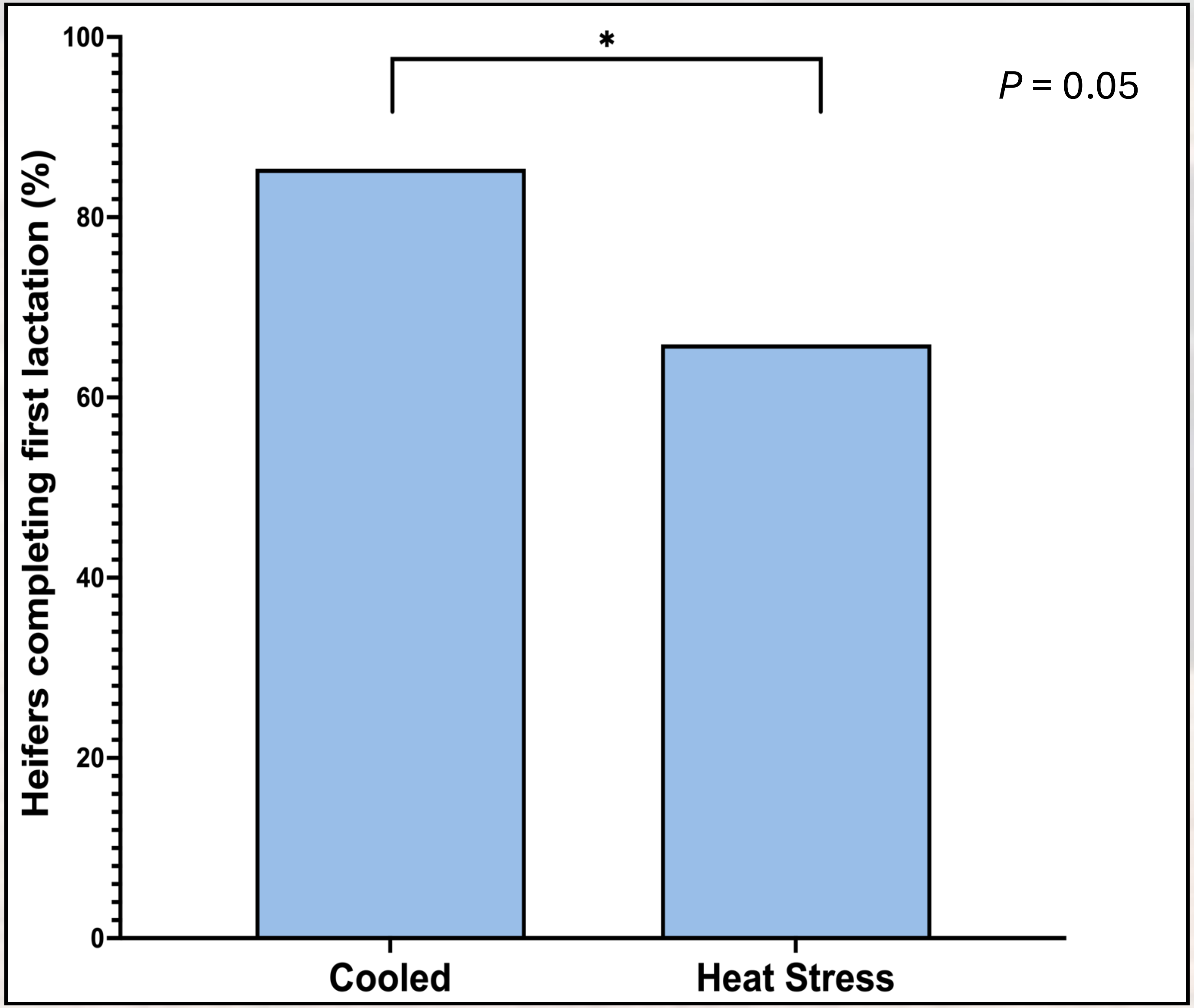


Monteiro et al., 2016

Prenatal Factors



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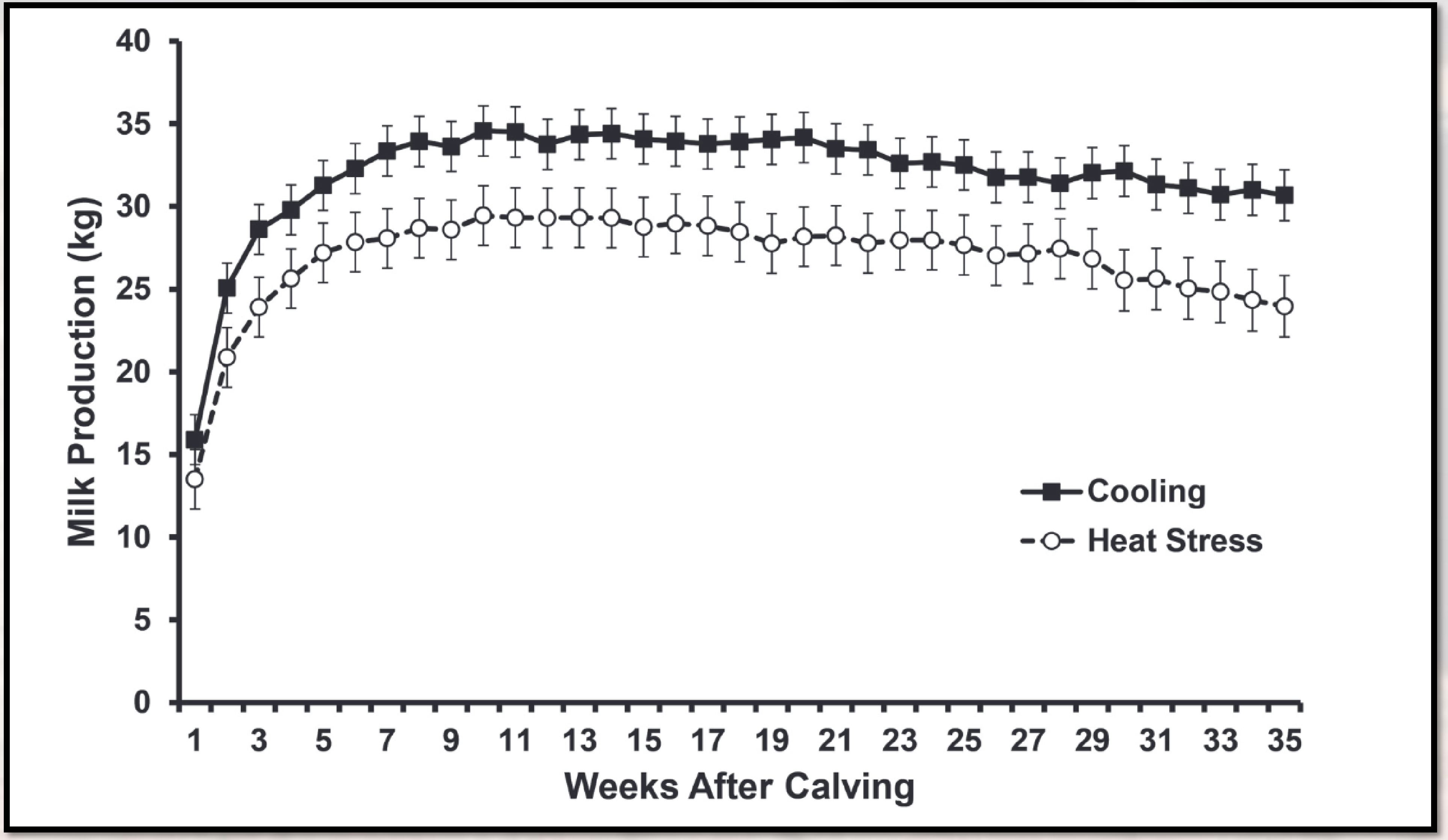


Monteiro et al., 2016

Prenatal Factors

Calves born to **thermoneutral dams** were fed colostrum from heat (HT) stressed dams or cooled (C) dams

Variable	HT	C	*P*-value
AEA (%)	27.5	27.6	0.95
ADG (g/d)	470	400	0.12
Weaning weight (kg)	66	62	0.12
Weaning withers height (cm)	83.6	83.0	0.30

Monteiro et al., 2014

Prenatal Factors

- Respiration rates > 60 breaths per minute = heat stress
- Dry cow barn:
  - Fans
    - Type? → Axial better than high volume low speed
    - Size? → Every ft diameter = 6 - 8 feet of air
    - Air speeds? → Want 320 - 450 ft/min
  - Sprinklers
    - Large droplets that penetrate hair
  - Space per cow
    - 120 ft^2 for close-ups

Don’t forget about maternity pen cleanliness!

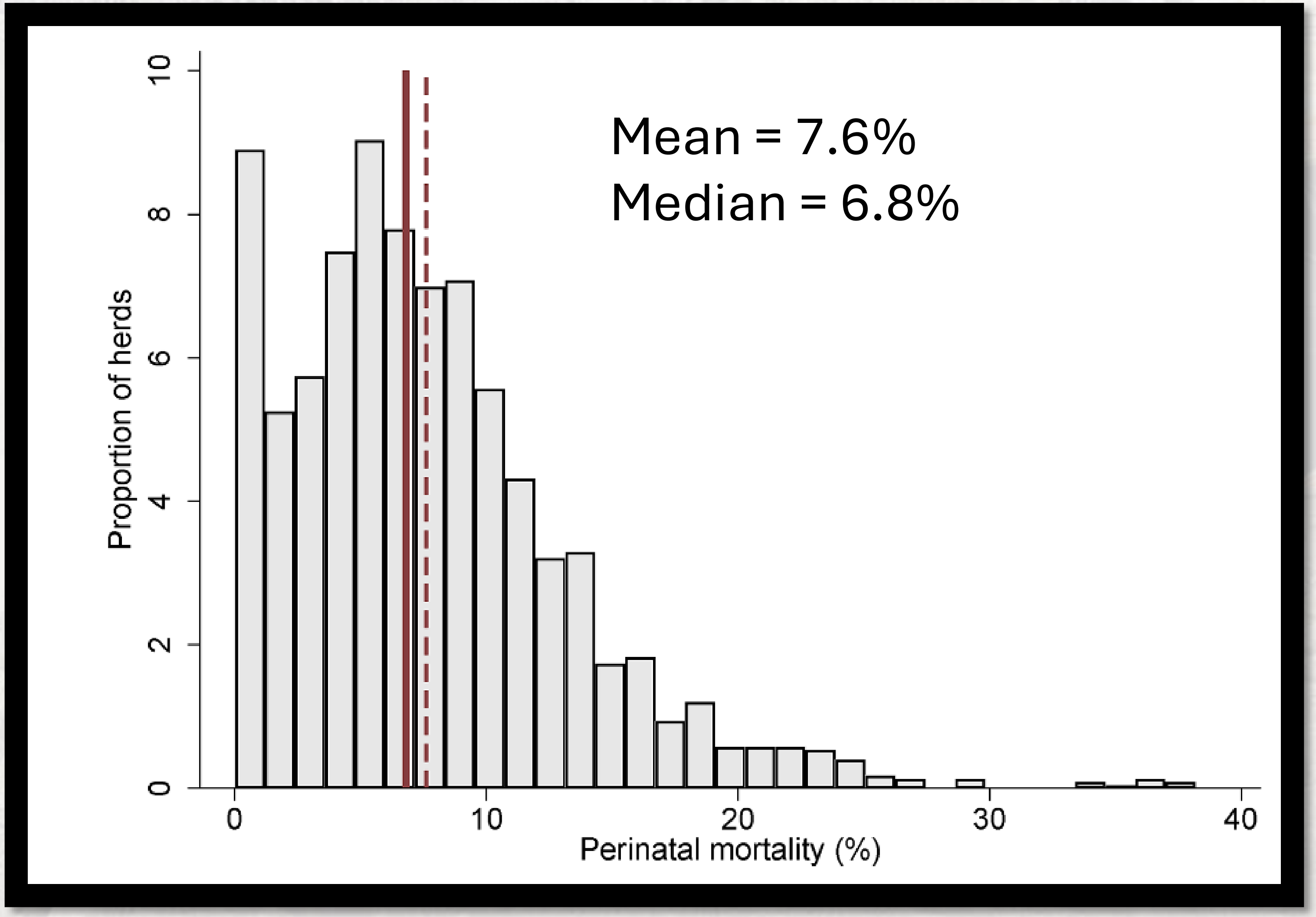
Cows increase fecal coliform counts by 10^4 to 10^7 cfu/g around parturition

Maternity pen hygiene is associated with Johne’s transmission

Pelan-Mattocks et al., 2000

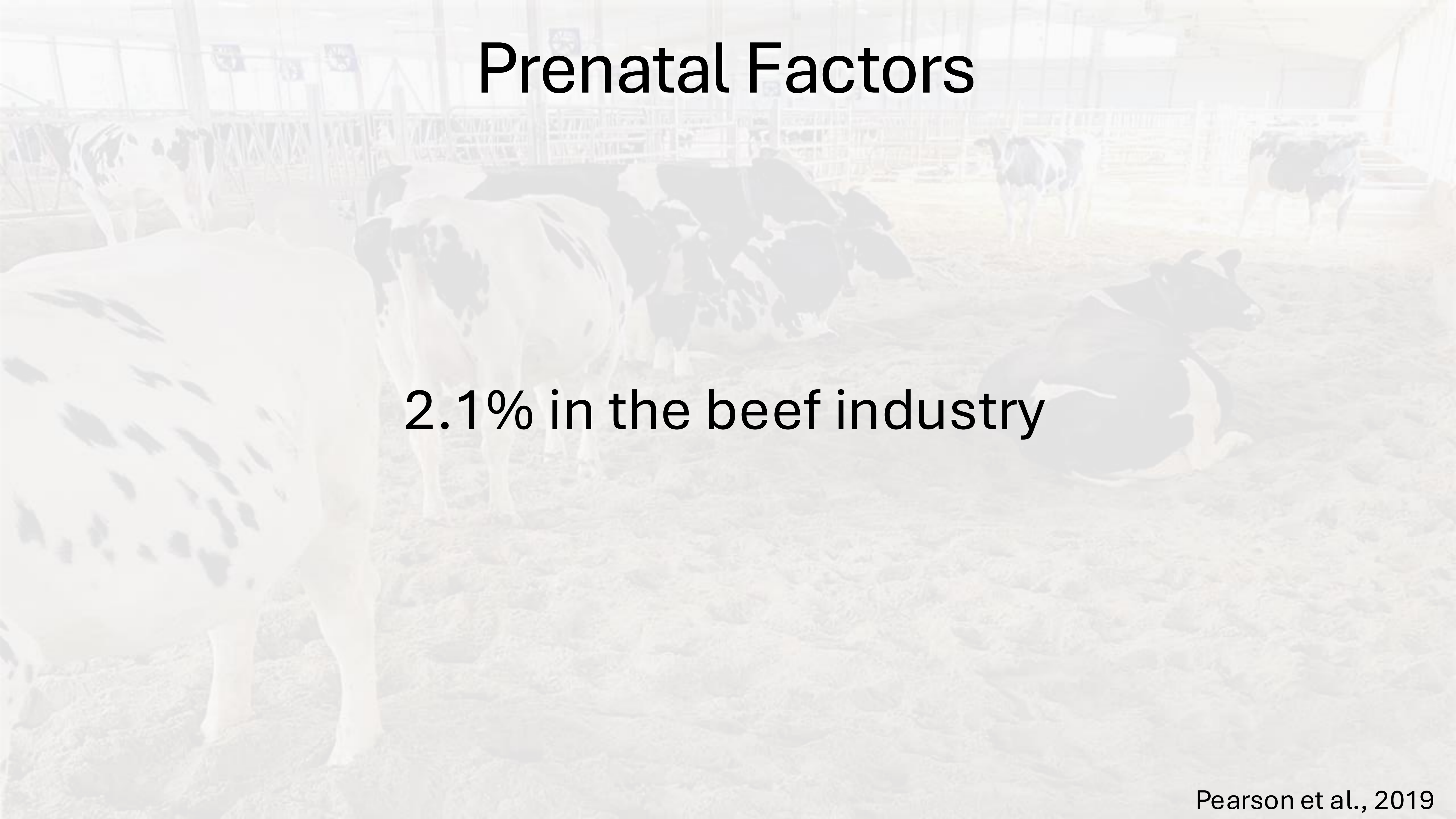
Donat et al., 2016

Prenatal Factors



Umaña Sedó et al., 2024 JDS

Prenatal Factors



2.1% in the beef industry

Pearson et al., 2019

Prenatal Factors

Calf report for the last year

Month	Fresh	None	Twins	%T	Male	Female	%F	Alive	Dead	%D	M:Dead	%M	F:Dead	%F	Sold	DCC
Mar17	5	0	0	0	3	2	40	4	1	20	1	33	0	0	2	0
Apr17	19	0	1	5	13	7	35	19	1	5	1	8	0	0	13	1
May17	12	0	0	0	6	6	50	11	1	8	1	17	0	0	5	0
Jun17	8	0	2	25	6	2	25	6	2	25	1	17	1	50	5	1
Jul17	16	0	0	0	6	10	62	15	1	6	1	17	0	0	5	0
Aug17	27	0	1	4	12	15	56	25	2	7	1	8	1	7	9	0
Sep17	18	0	2	11	12	7	37	18	1	5	0	0	1	14	0	0
Oct17	14	0	0	0	4	8	67	12	0	0	0	0	0	0	0	0
Nov17	15	0	1	7	6	9	60	12	3	20	1	17	2	22	0	0
Dec17	17	0	1	6	8	9	53	14	3	18	2	25	1	11	0	1
Jan18	17	0	1	6	12	5	29	15	2	12	2	17	0	0	0	0
Feb18	12	0	1	8	4	9	69	13	0	0	0	0	0	0	0	1
Mar18	18	0	0	0	10	8	44	16	2	11	1	10	1	12	0	3
=====	=====	====	======	==	======	======	==	======	======	==	======	==	======	==	======	======
TOTAL	198	0	10	5	102	97	49	180	19	10	12	12	7	7	39	7

Goal <5%

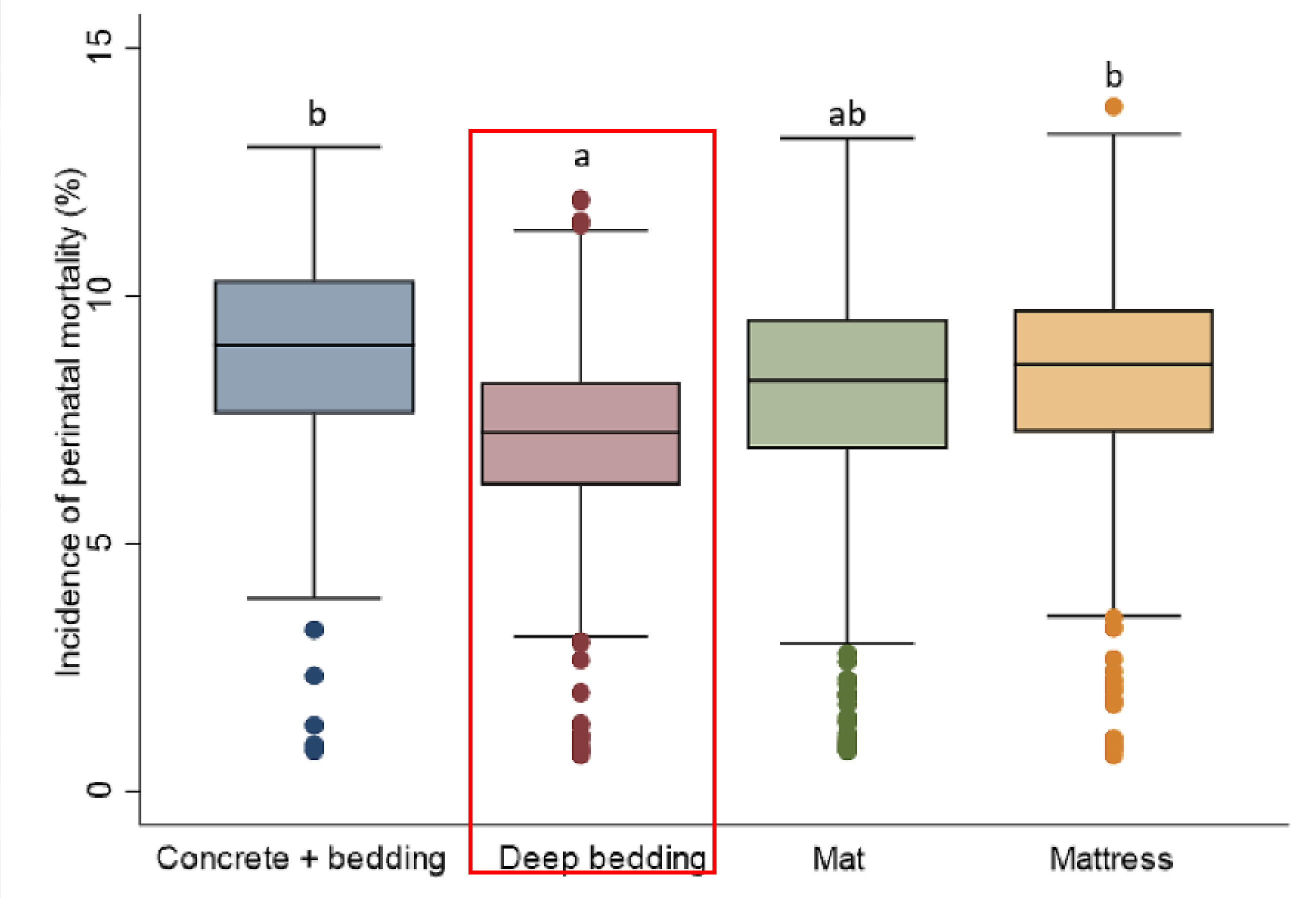
DairyComp (events\3), DHIA, or written records

How can we reduce perinatal mortality?

- Lying surface types
- Timing of moving dry cows
- Increased calving intervention
- Calving blinds?
- Reduce dystocia

How can we reduce perinatal mortality?

Lying surface types



Umaña Sedó et al., 2024 JDS

How can we reduce perinatal mortality?

- Moving dry cows at stage 1 of parturition:
  - Longer duration of calving
  - Higher risk of dystocia
  - High levels of assistance
  - Higher risk of perinatal mortality
- Good opportunity to ensure all farms have calving protocols outlining stages of parturition

Proudfoot et al., 2013

TaviVets Dairy Digest

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Calving Process and Assistance

Calving marks the start of a new lactation for the dairy cow, and the life of her calf. The successful beginning of both these events starts with managing calving successfully. It is important to have a good understanding of the process of calving.

Parturition is initiated by hormonal and physical changes at the end of gestation, approximately 280 days in dairy cattle. A dairy cow will gradually progress through three stages to deliver her calf.

Stage 1 (4-24 hours duration) – dilation of the cervix

The calf moves into position as the cervix and birth canal begin to dilate. Signs that may or may not be noticeable include *restless behavior, frequent transition from laying to standing, raised tail head, vocalization, increased urination and defecation, full udder, and mucus discharge*.

Stage 2 (30 min - 1 hour duration)

The cow or heifer has a fully dilated cervix, and the calf moves through the birth canal. The appearance of the water bag (amniotic sac) and abdominal contractions are evident as the calf's legs become visible.

Stage 3 (up to 12 hours)

Expulsion of the fetal membranes (placenta) occurs 8-12 hours post calving. If it takes longer than 24 hours, it is considered retained membranes or placenta. Dystocia, twinning, induction, hypocalcemia (milk fever) and abnormally long or short pregnancies increase the incidence of retained placenta.


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- Early intervention is best
- Odds of stillbirth increase if stage 2 is > 2 hours
- Assisting cows without progress 80 min after onset of stage 2 reduces risk of stillbirth
- Every additional hour in stage 2 increases odds of stillbirth by 30%

Gundelach et al., 2009; Scheunemann et al., 2011; Mee et al., 2014

Calving blinds

High stocking density + blind

104.4 ft^2/cow

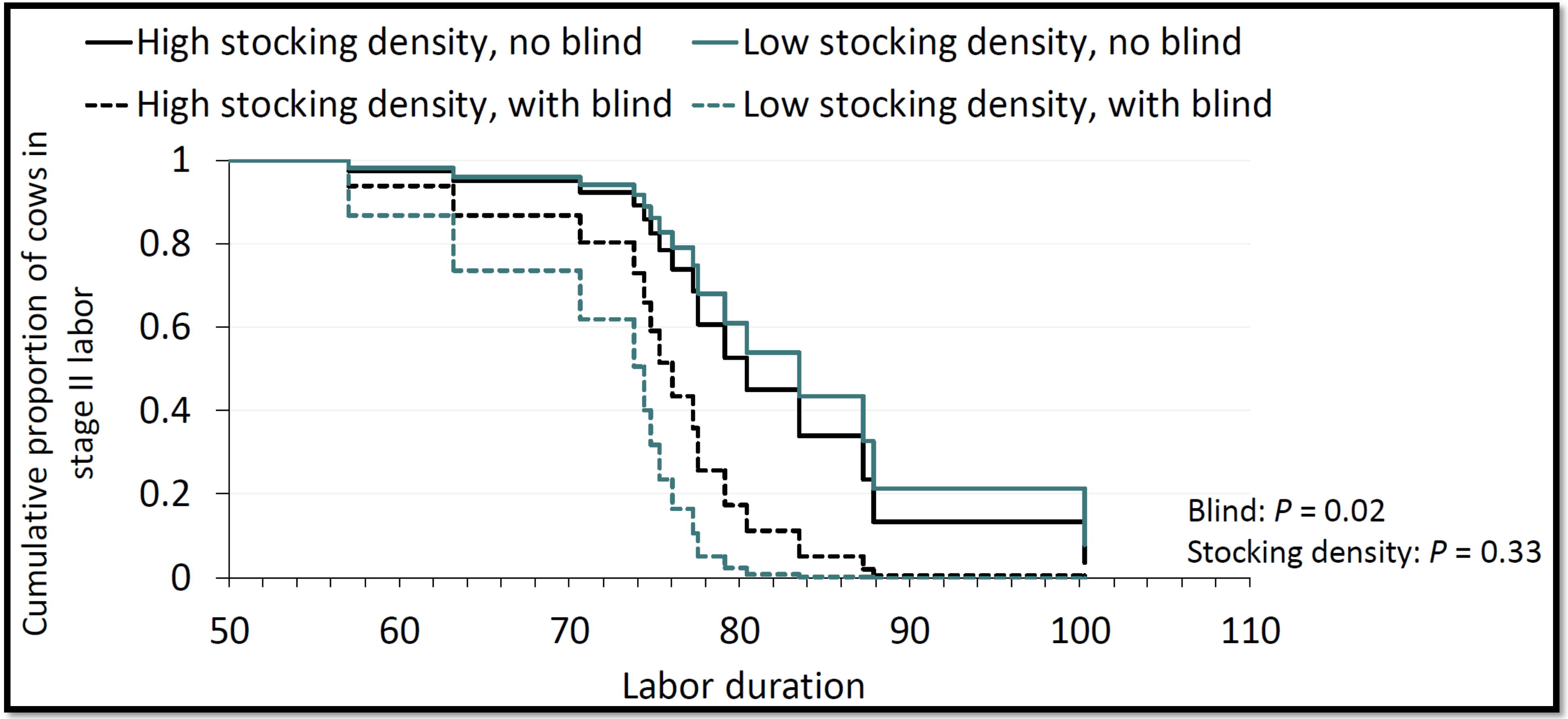
Low stocking density + blind

208.8 ft^2/cow

Creutzinger et al., 2021

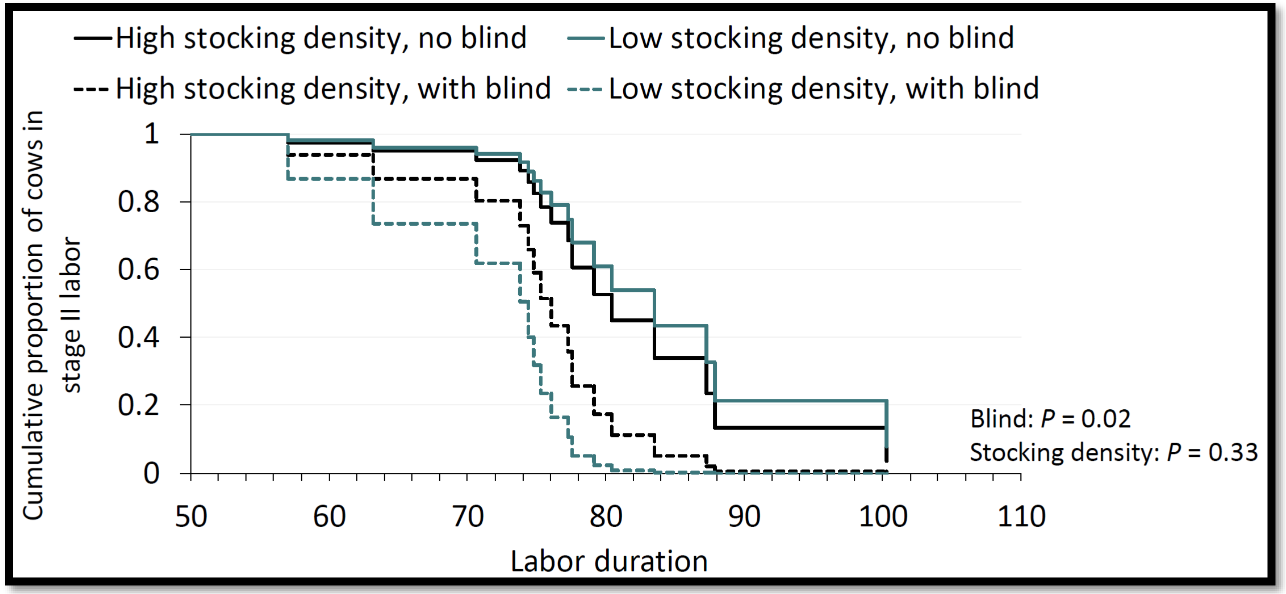
Calving blinds

- **Calving blinds reduced calving time** for both stocking density groups
- Calving time was not affected by stocking density alone



Creutzinger et al., 2021

Calving blinds

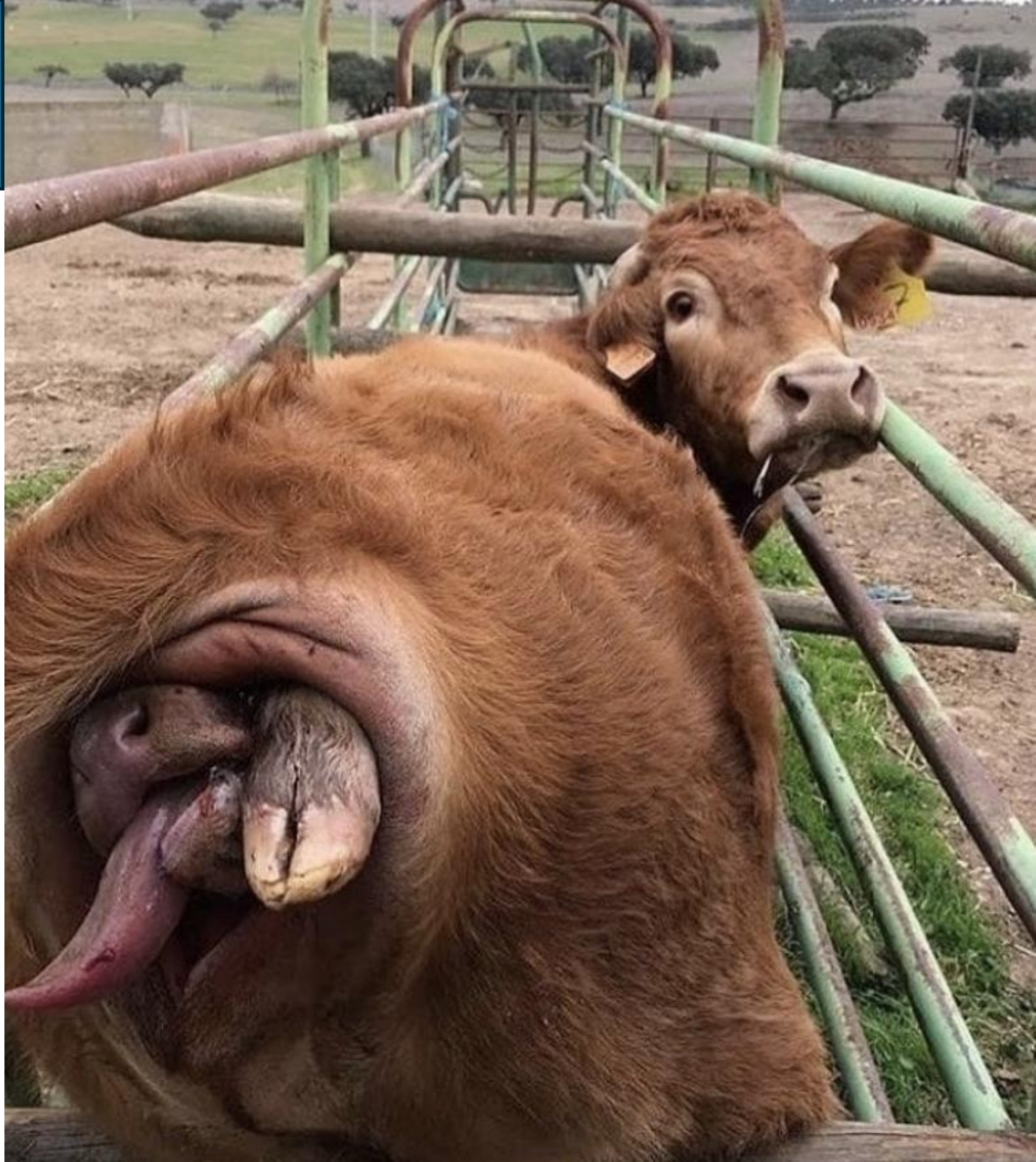


Reducing the amount of time animals are in stage 2 may benefit the cow and calf as prolonged labor is associated with dystocia

Creutzinger et al., 2021

Dystocia

- 50% of perinatal mortality is from dystocia
- 2-15 X increased risk for perinatal mortality
- First calf heifers are at highest risk
  - Right size, right body composition

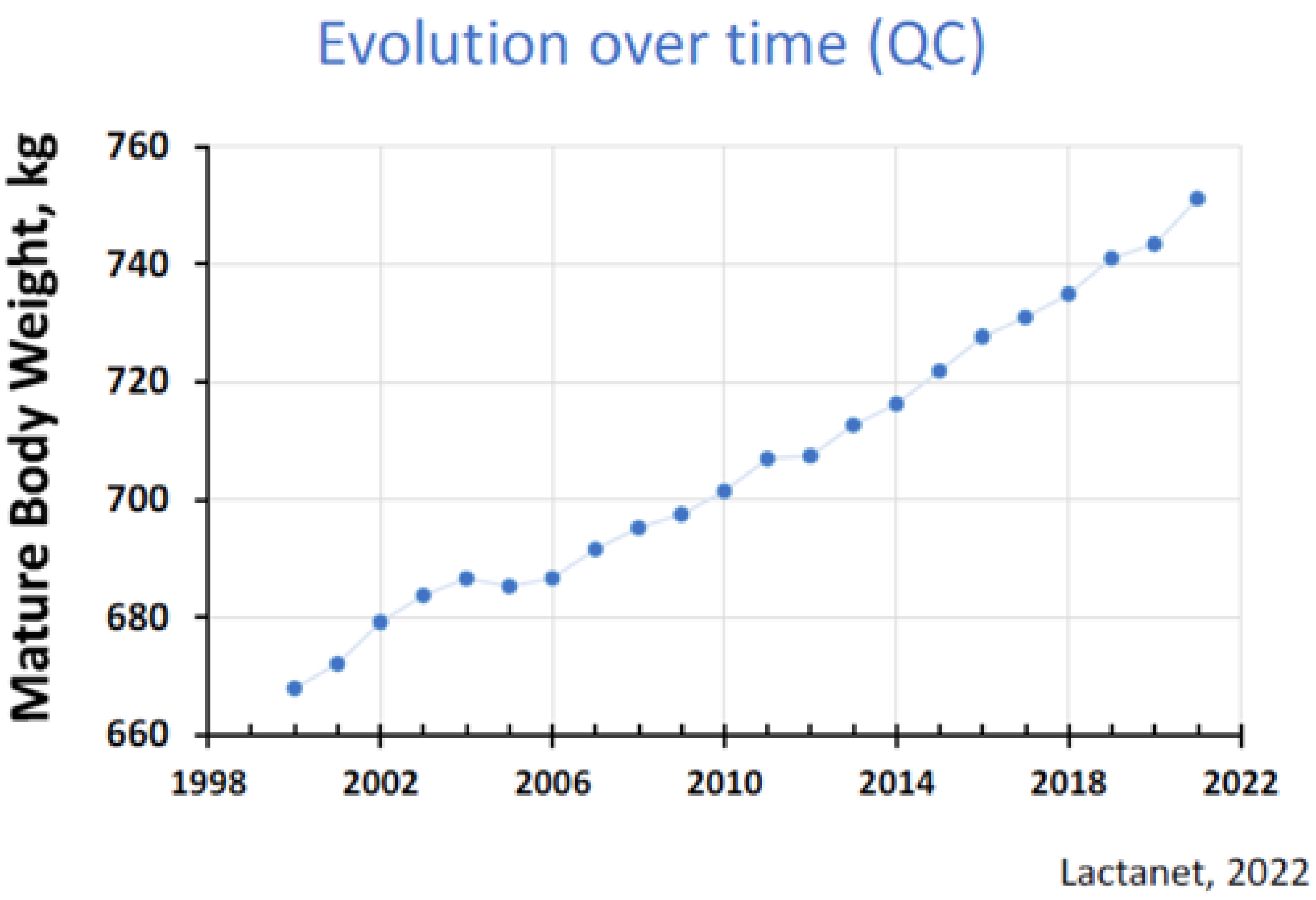


Lombard et al., 2007

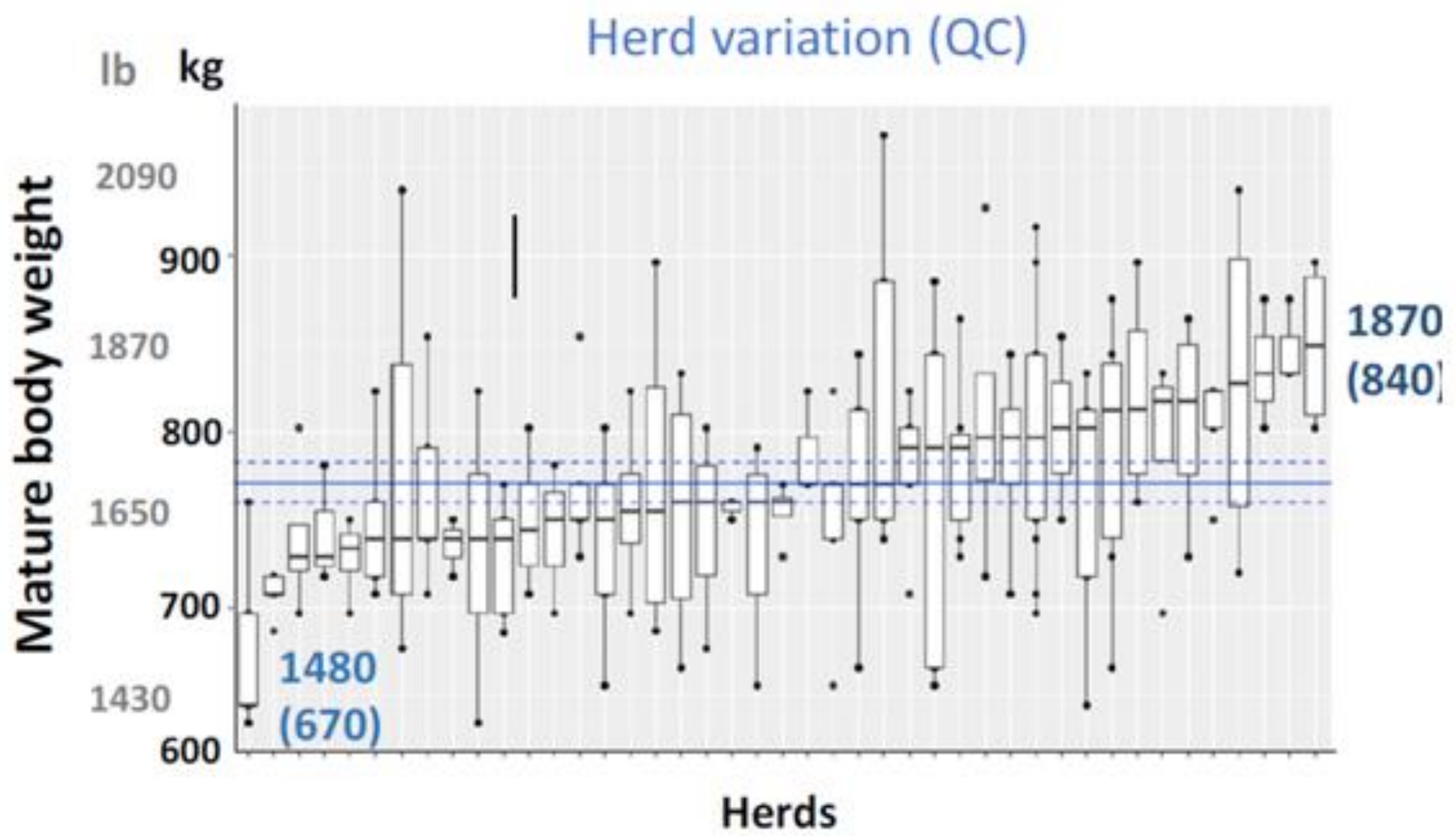
Growth targets are dependent on the **herd's mature cow bodyweight (MBW)**

Breed at 55-60% MBW
Calve at 83-85% MBW

Mature Body Weight



Mature Body Weight



Lactanet, unpublished

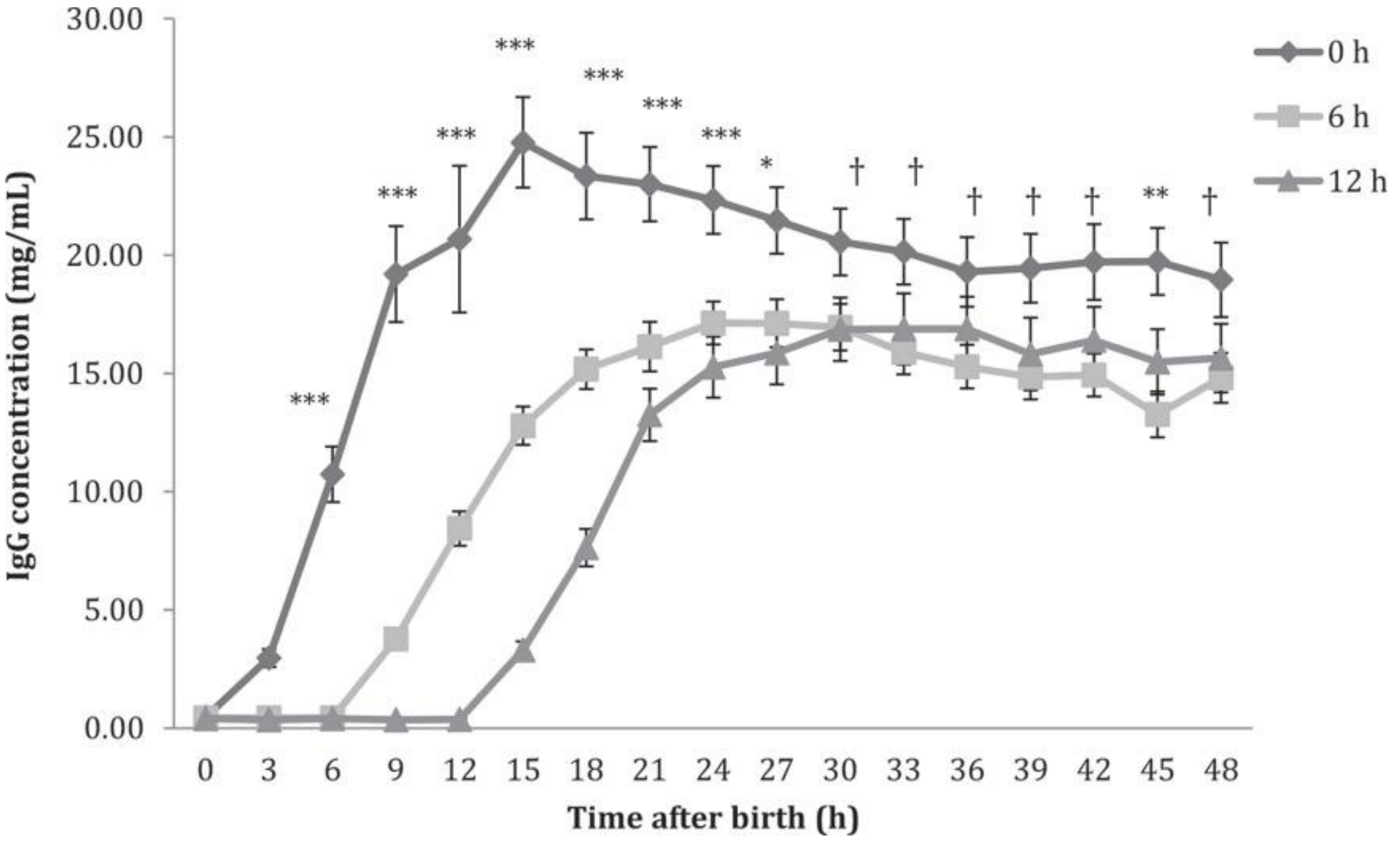

COLOSTRUM

Colostrum – 5 Q's

1) **Q**uick
2) s**Q**ueeky clean
3) **Q**uantity
4) **Q**uality
5) **Q**uantify

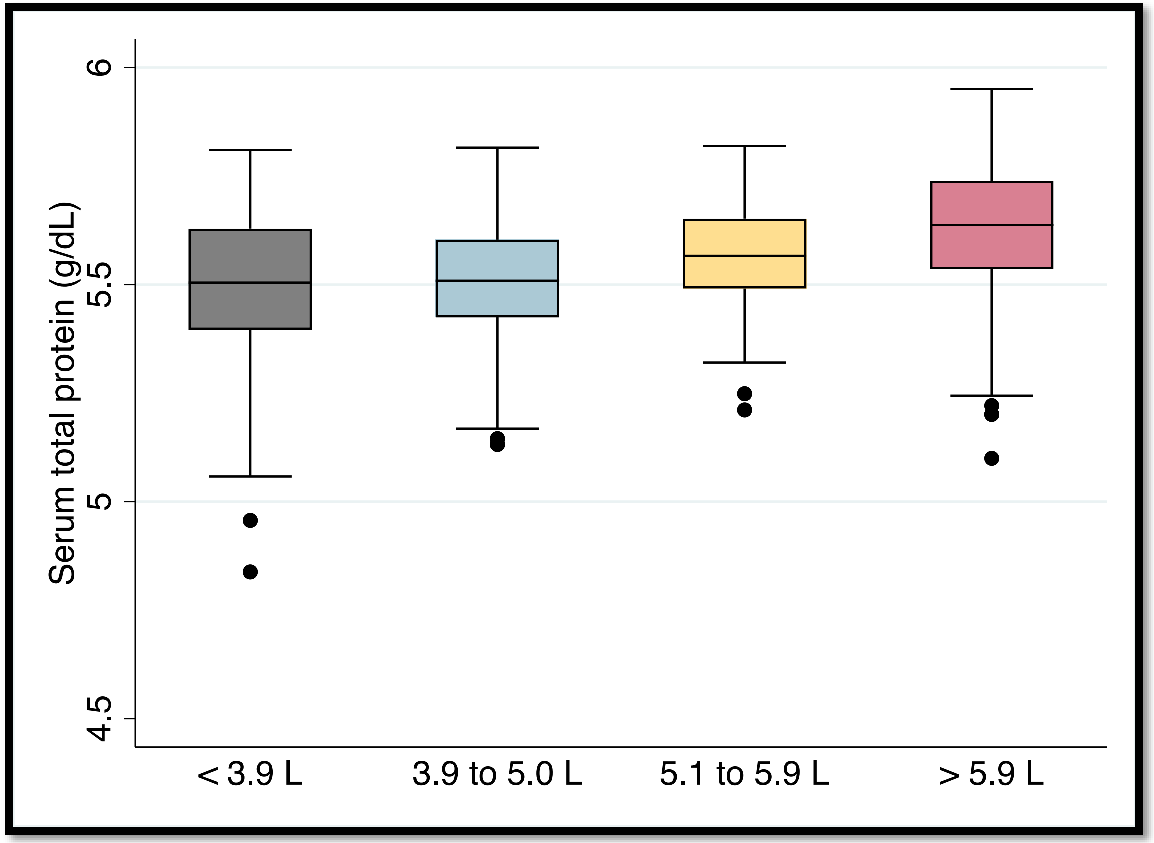
Colostrum – Quick

As quickly as possible, ideally within 1 hour of life



Fisher et al. 2018

Colostrum - Quantity



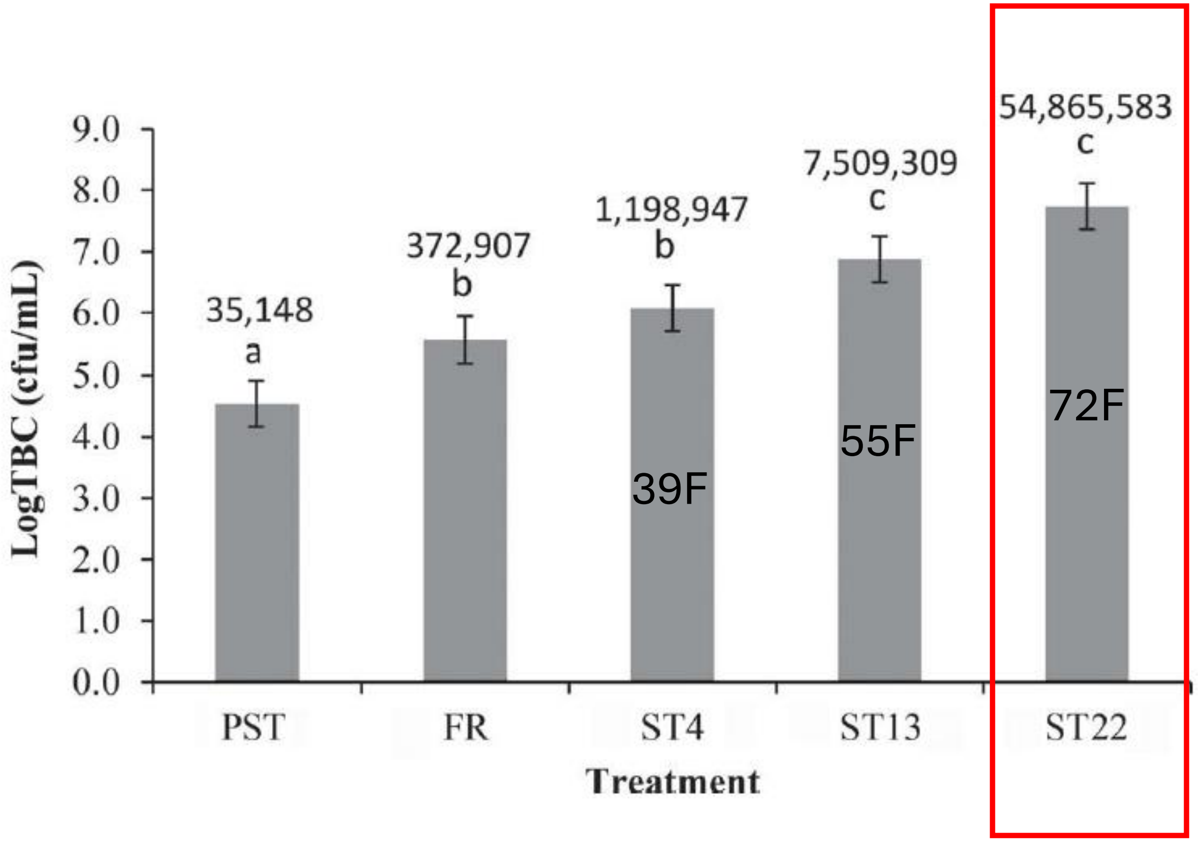
Renaud et al., 2020

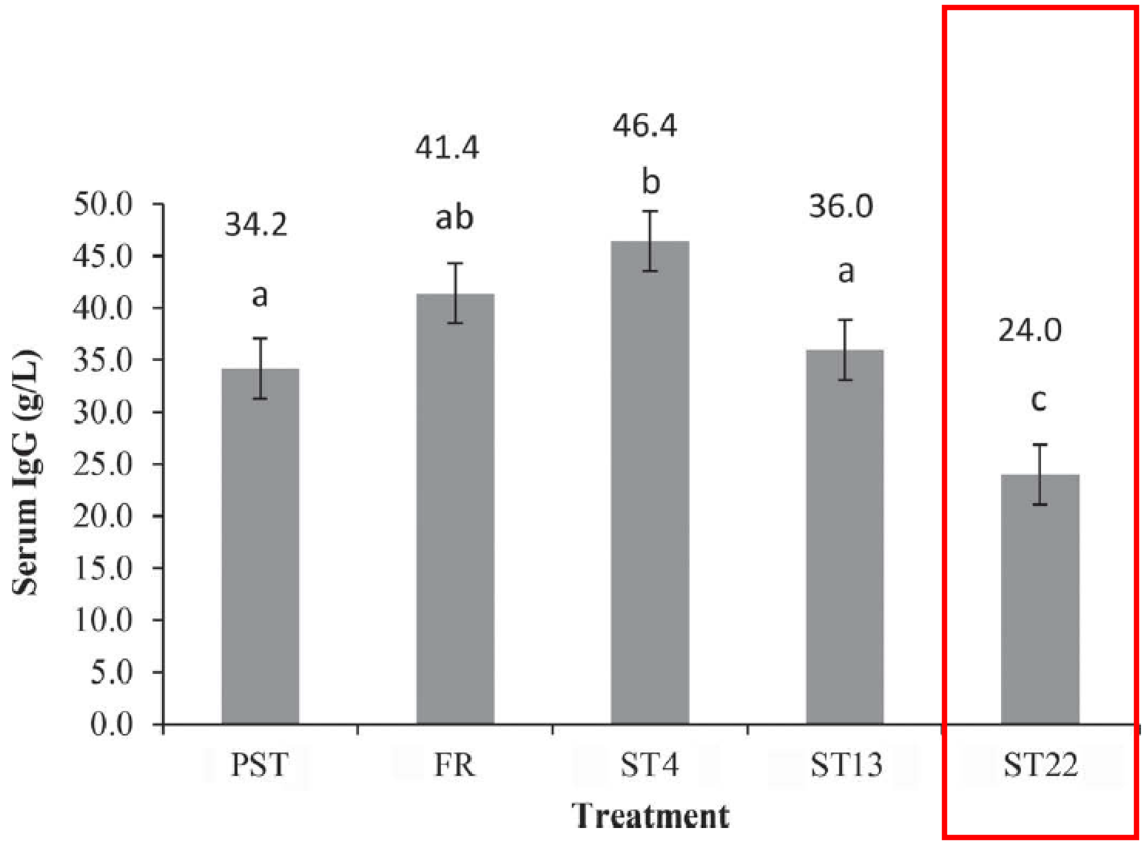
8.5% to 10% of body weight at first feeding

- 3 L Jerseys
- 4 L Holsteins

≥ 6 L in first 24 hours

Colostrum – sQueeky Clean





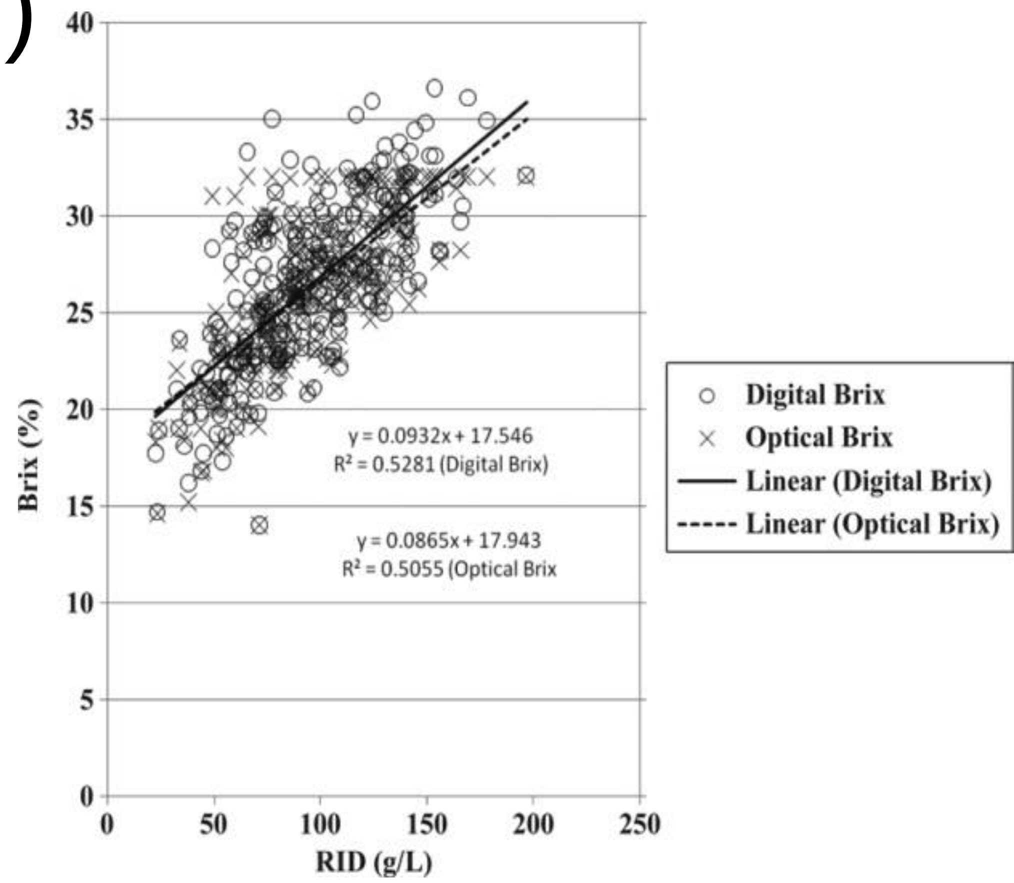
Under 100,000 cfu/ml total bacteria count

Godden et al., 2008
Cummins et al. 2017

Colostrum - Quality

22% Brix or greater (ideally ≥ 24%)

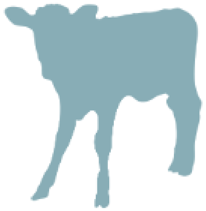
≥ 50 g/L of IgG



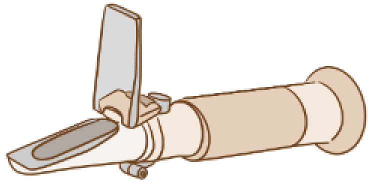
Bielmann et al., 2010; Shively et al., 2018

Colostrum - Quality

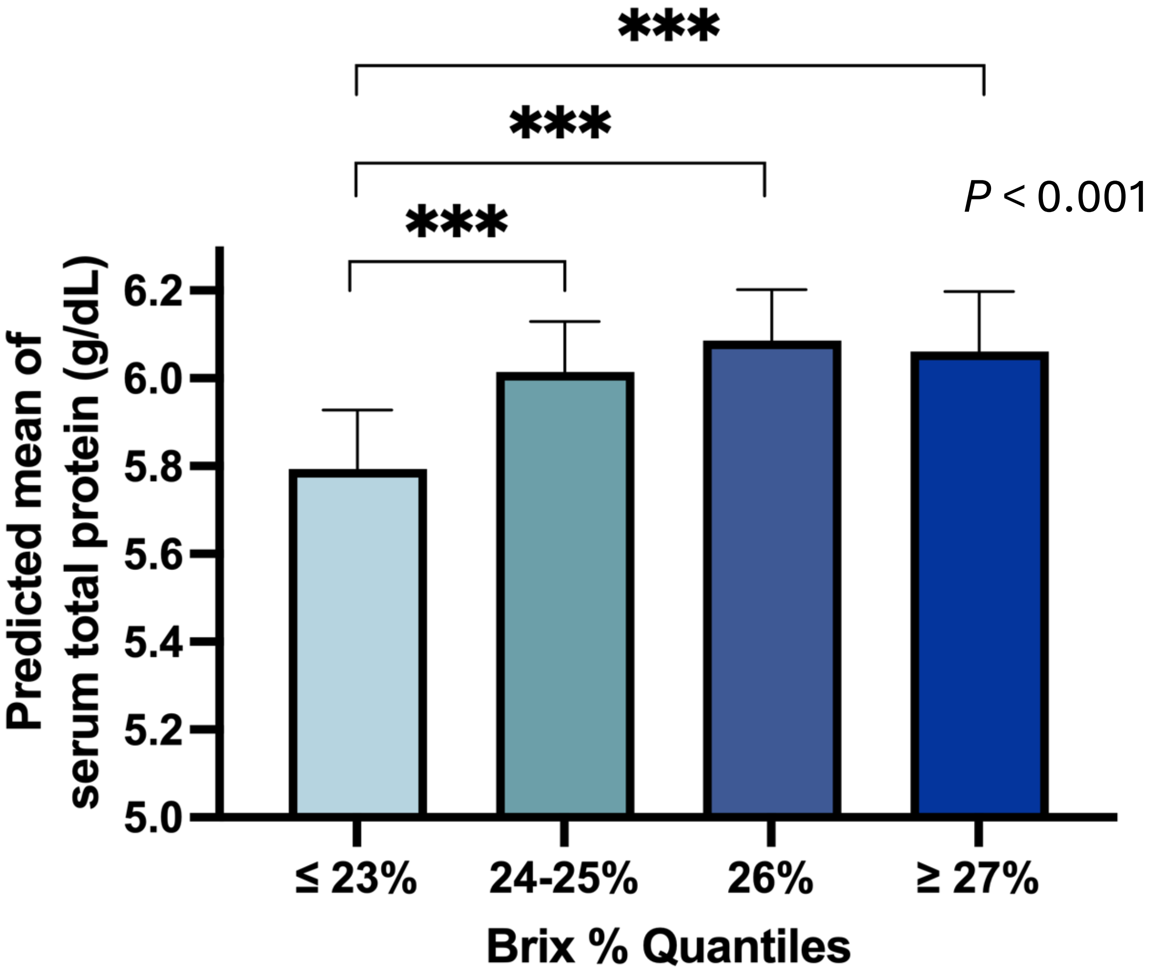
Calf health records
2,022 calves, 11 dairies



Whole blood was collected at 1–7 d old for serum total protein (STP)

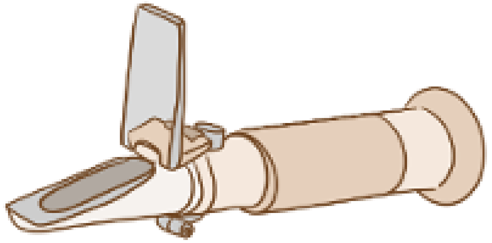


Serum analysis using an optical refractometer



Edwards et al., *in prep*

Can we make poor Brix colostrum better?



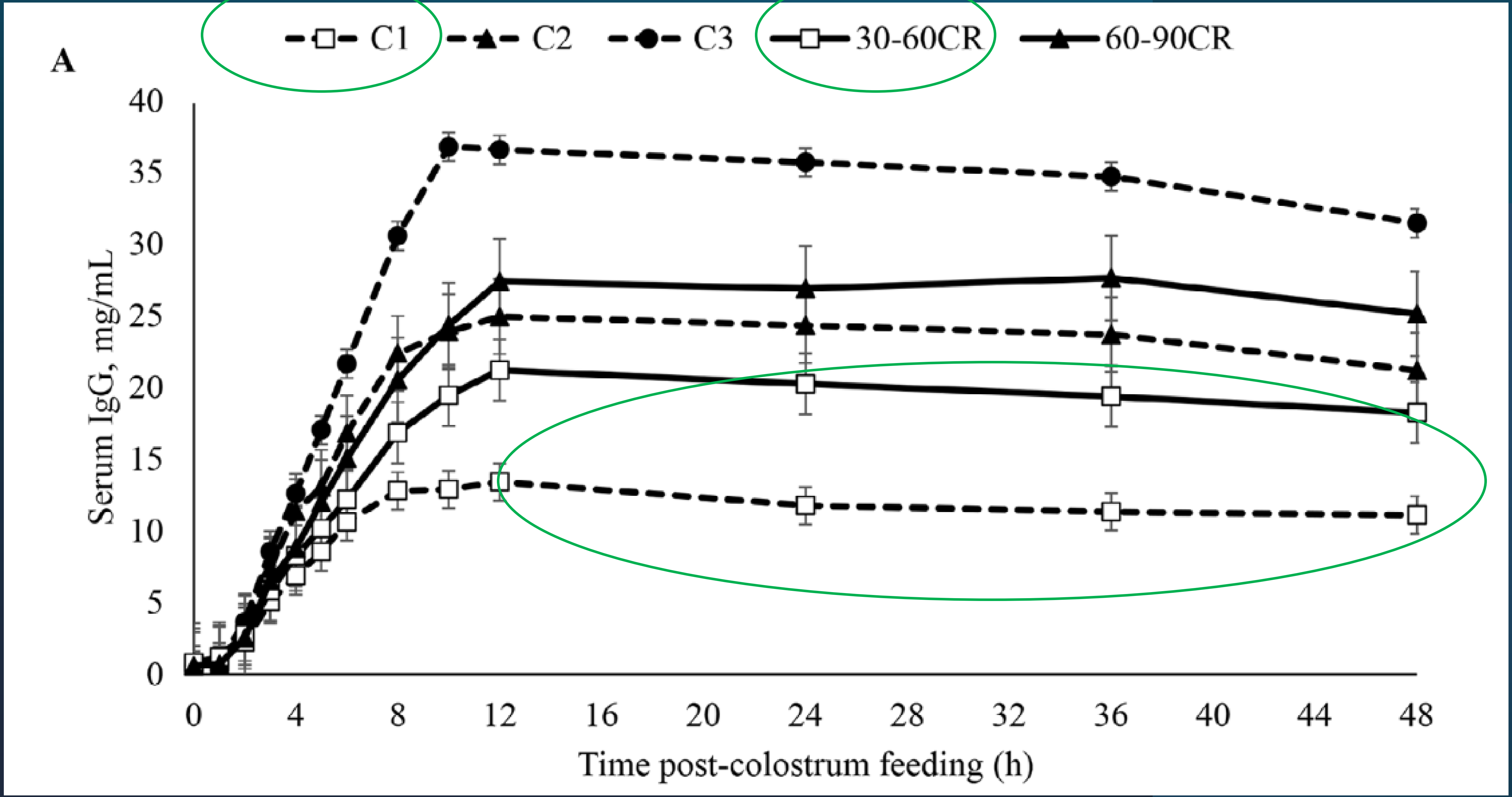
48 hr

3.8 L of:

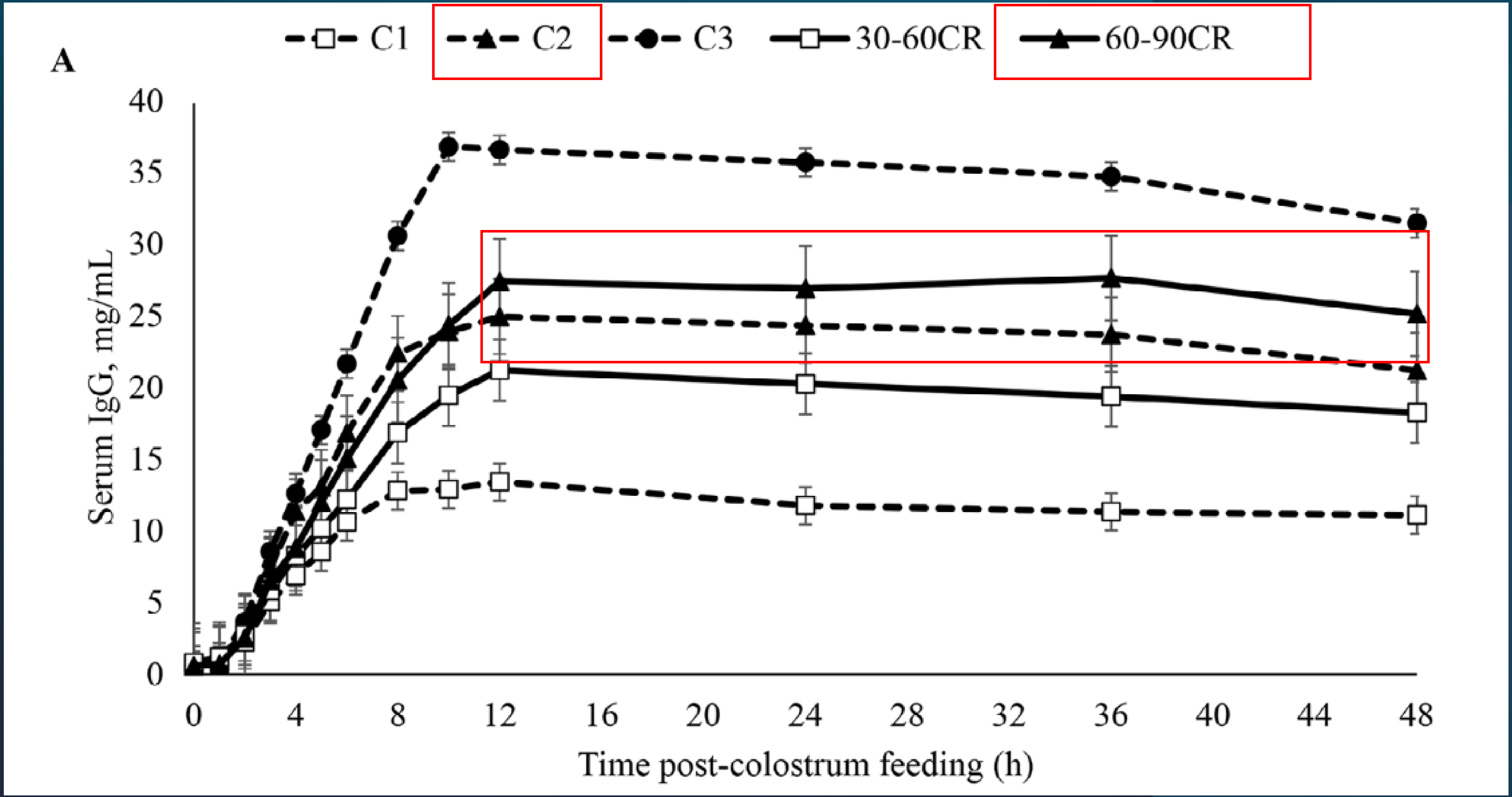
1) 30 g/L IgG MC (C1)
2) 60 g/L IgG MC (C2)
3) 90 g/L IgG MC (C3)

4) C1 + 551g CR → 60 g/L IgG "30-60"
5) C2 + 620g CR → 90 g/L IgG "60-90"

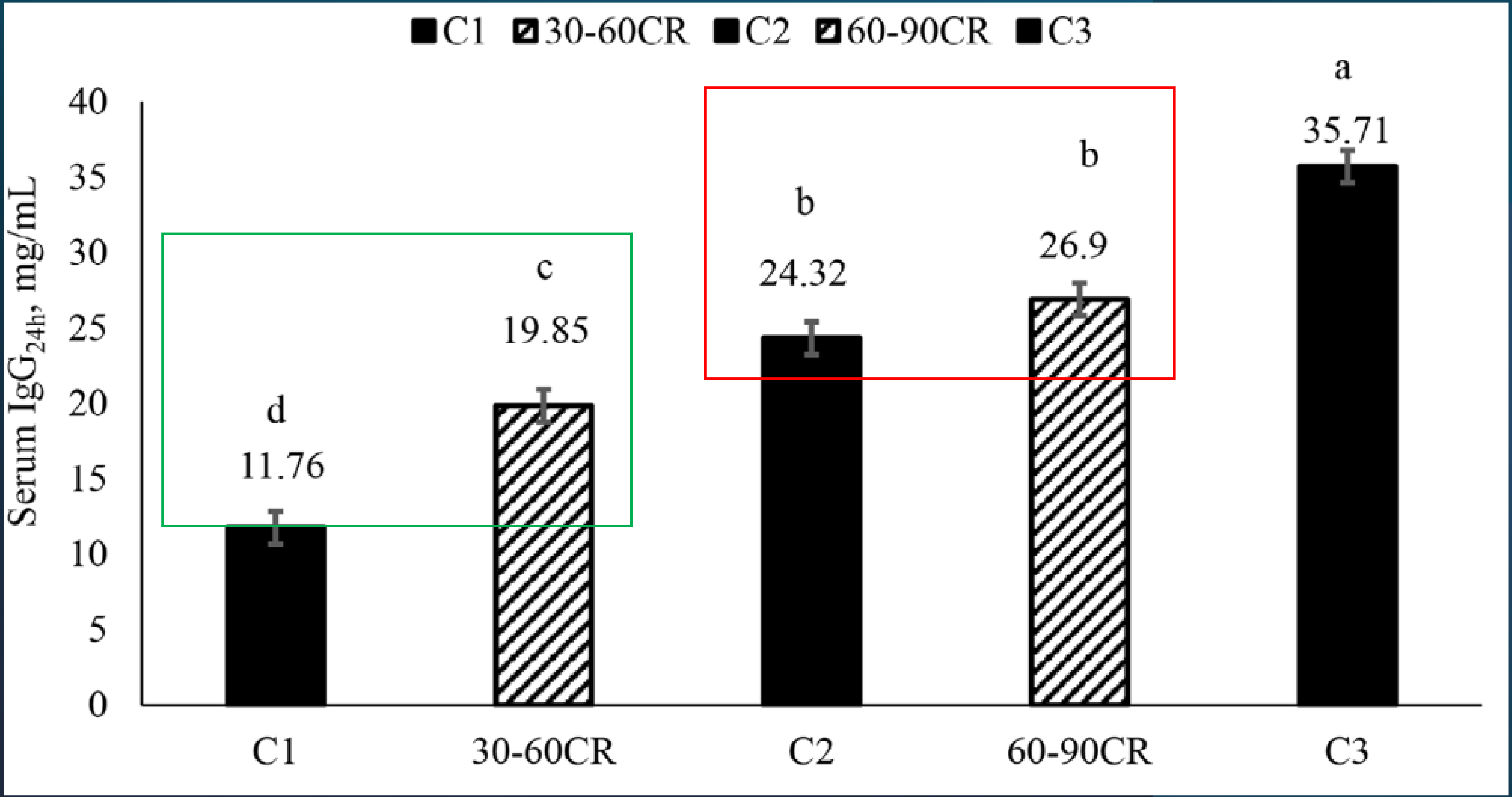
Lopez et al., 2023



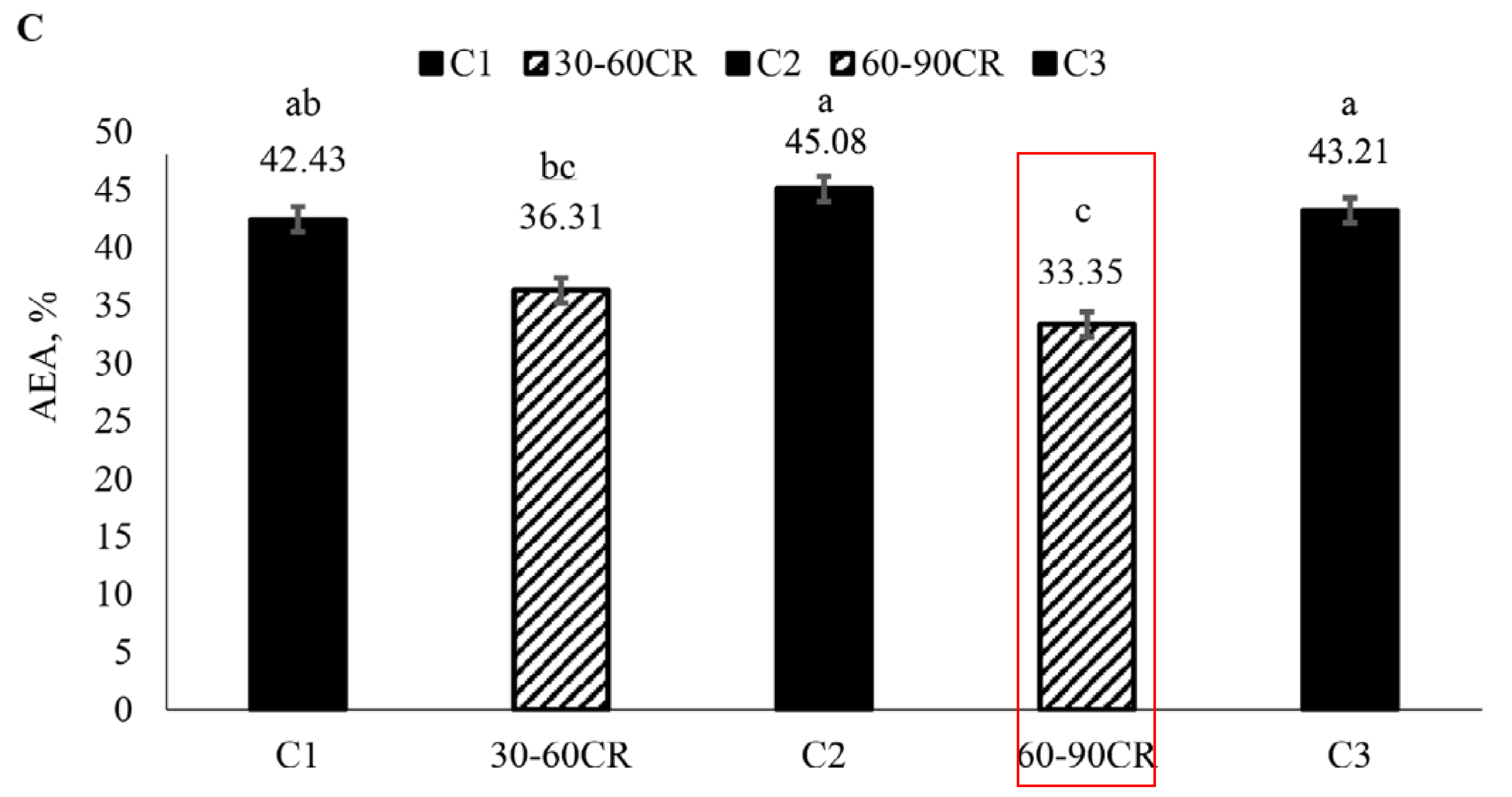
Lopez et al., 2023



Lopez et al., 2023



Lopez et al., 2023

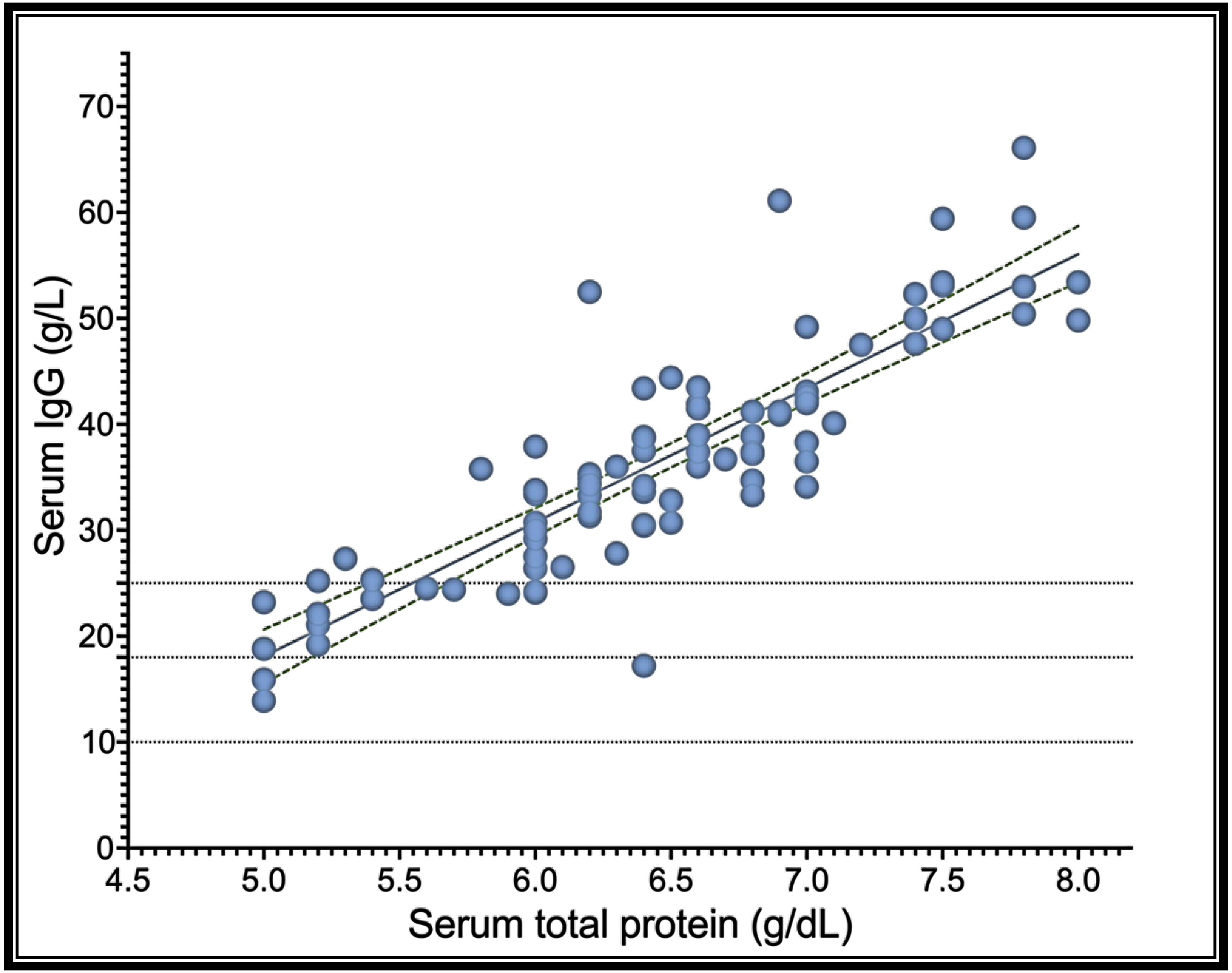


Lopez et al., 2023

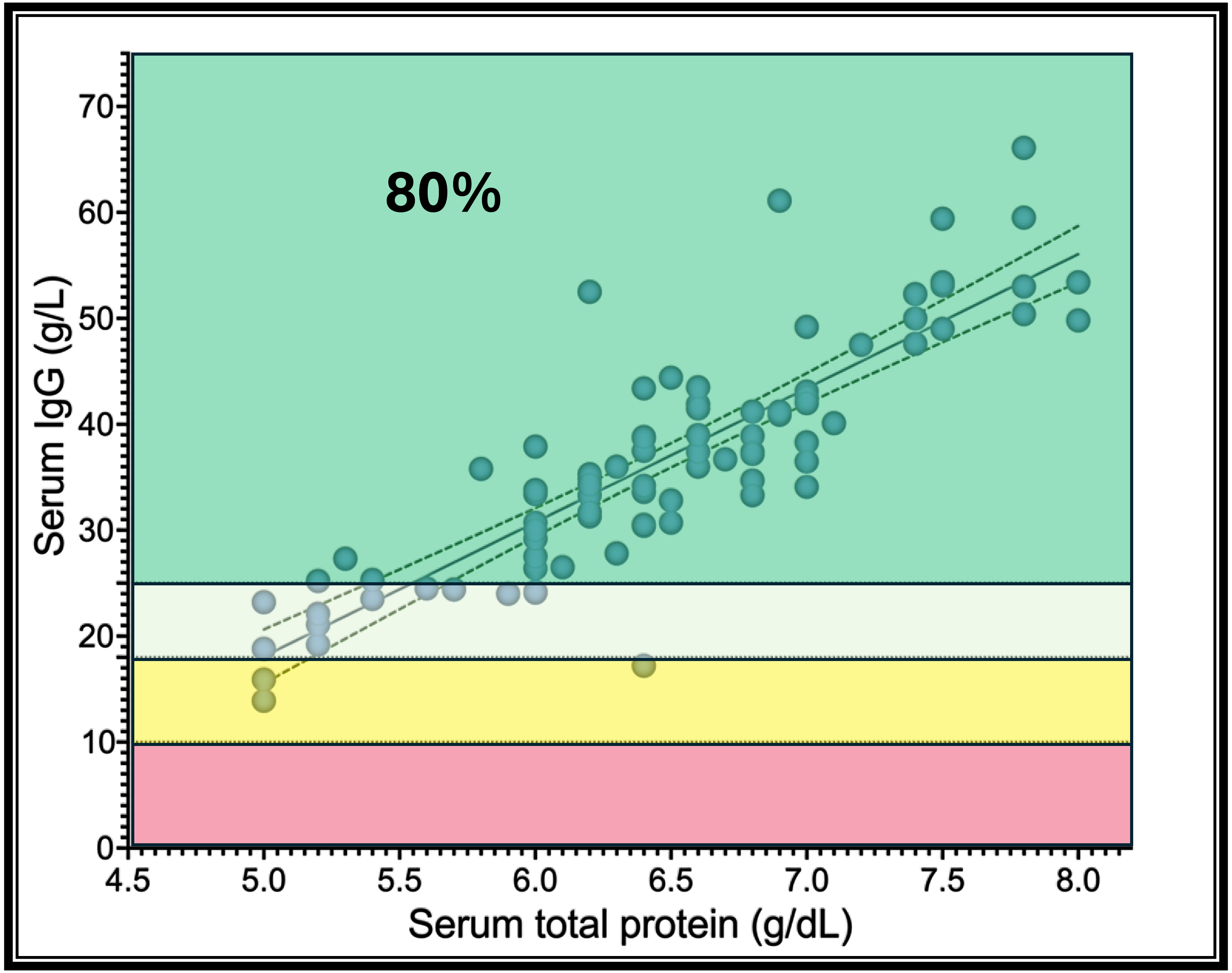
Colostrum – Quantify

Category	Serum IgG (g/L)	Total protein (g/dL)	Target (% calves)
Excellent	> 24.9	> 6.1	> 40
Good	18.0 to 24.9	5.8 to 6.1	~ 30
Fair	10.0 to 17.9	5.1 to 5.7	~ 20
Poor	< 10.0	< 5.1	< 10

Lombard et al., 2020



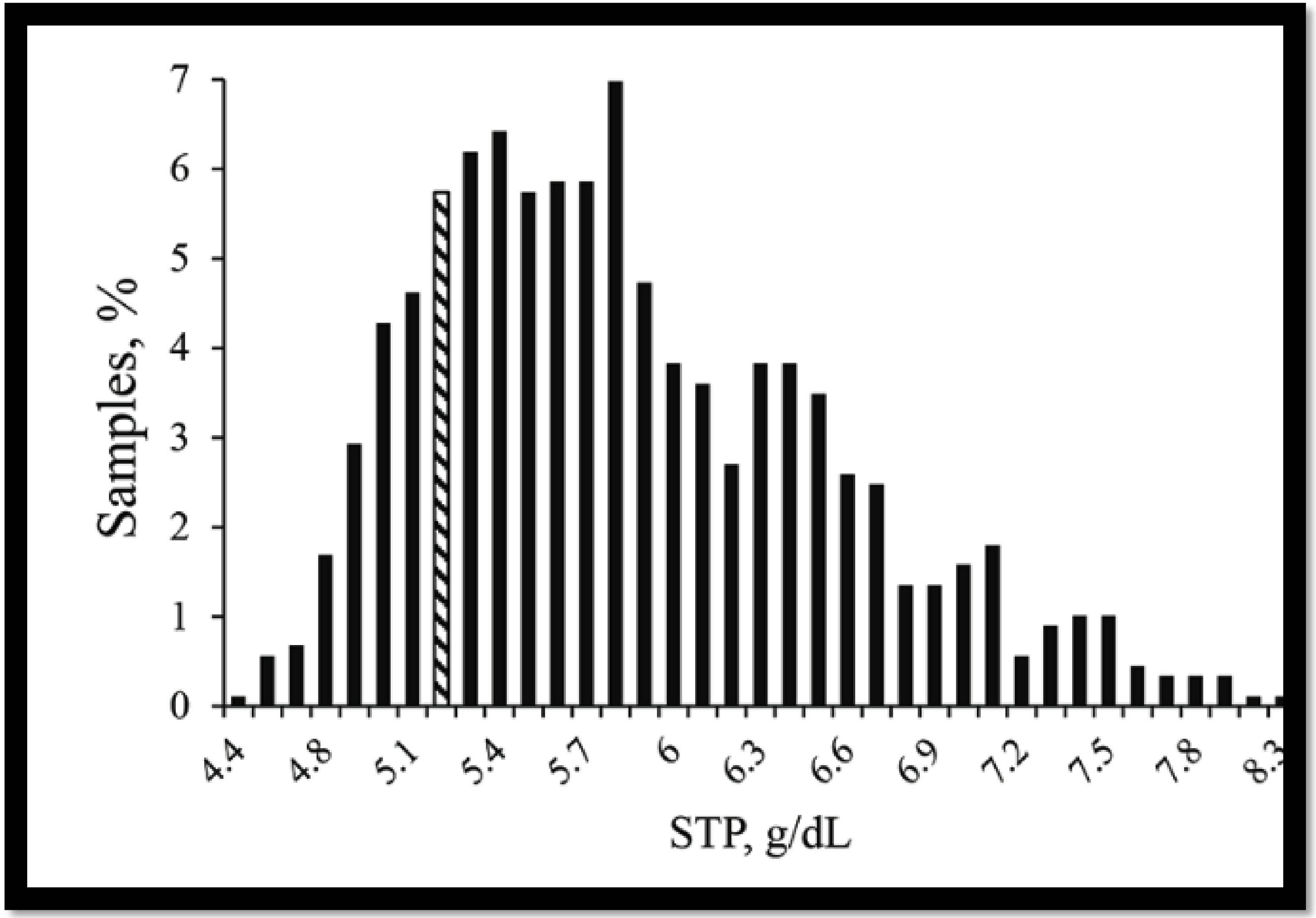
$R^2 = 0.75$
Mean = 36.5 g/L



$R^2 = 0.75$
Mean = 36.5 g/L

Target (% calves)
> 40
~ 30
~ 20
< 10

But what about colostrum powder?



Lopez et al., 2021

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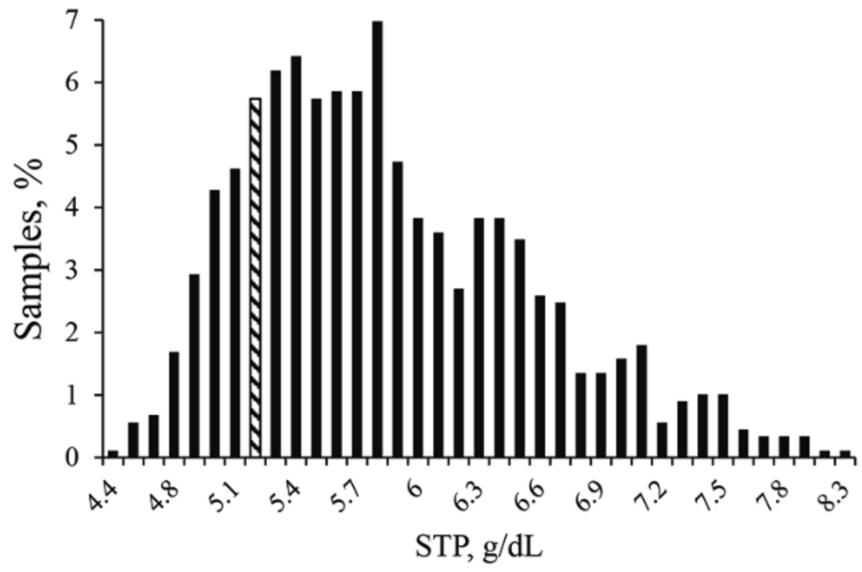
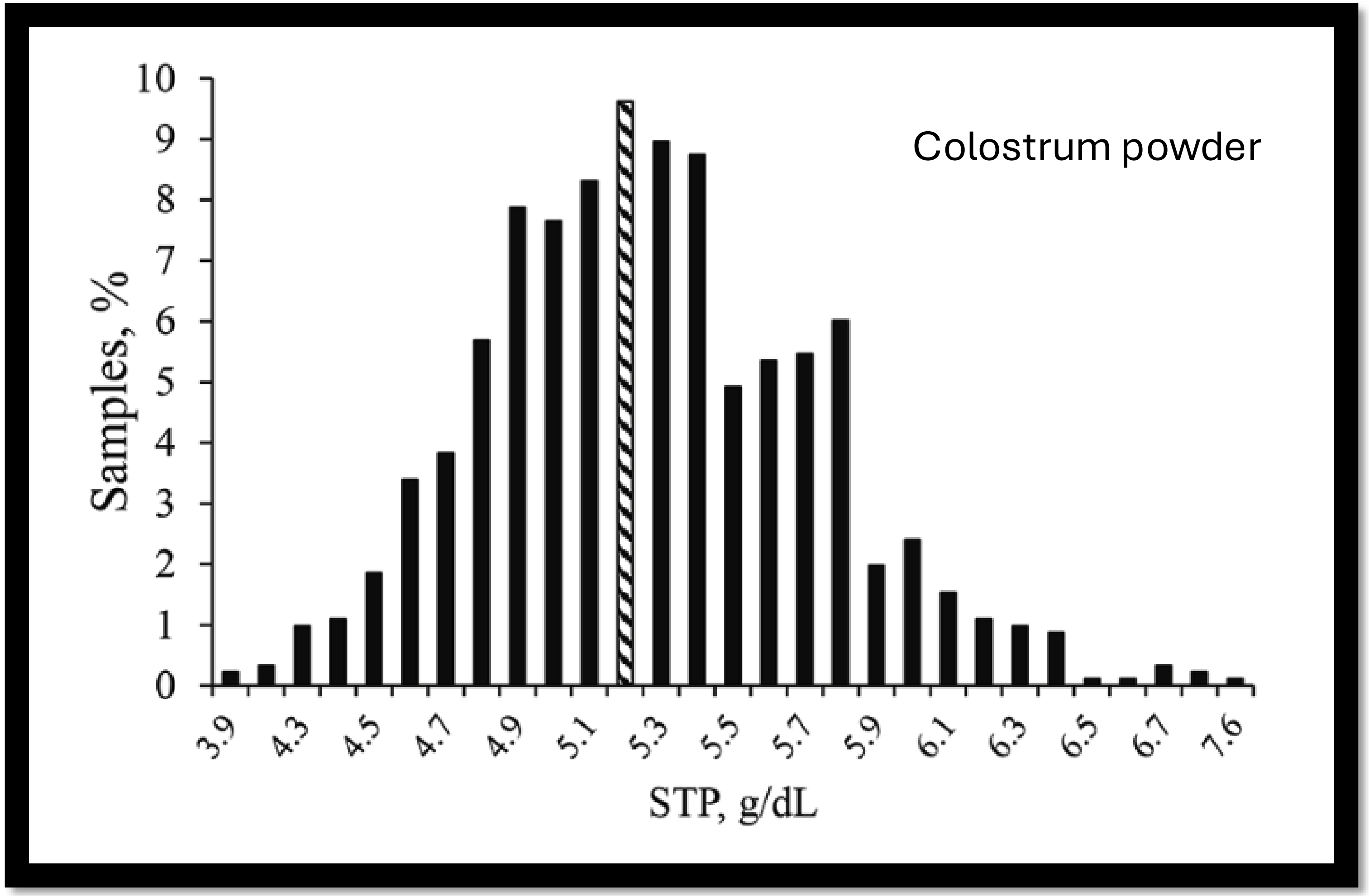
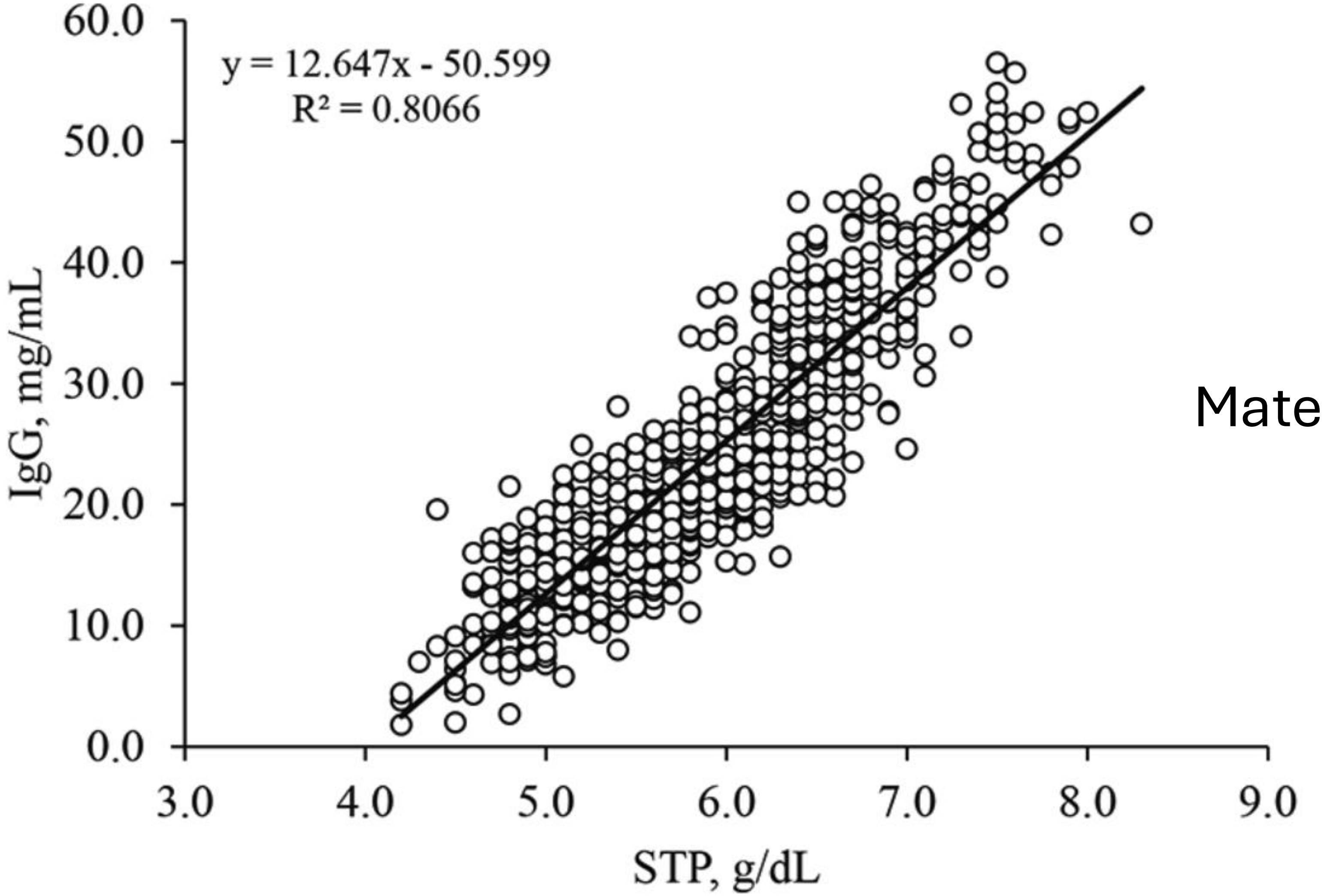




Lopez et al., 2021

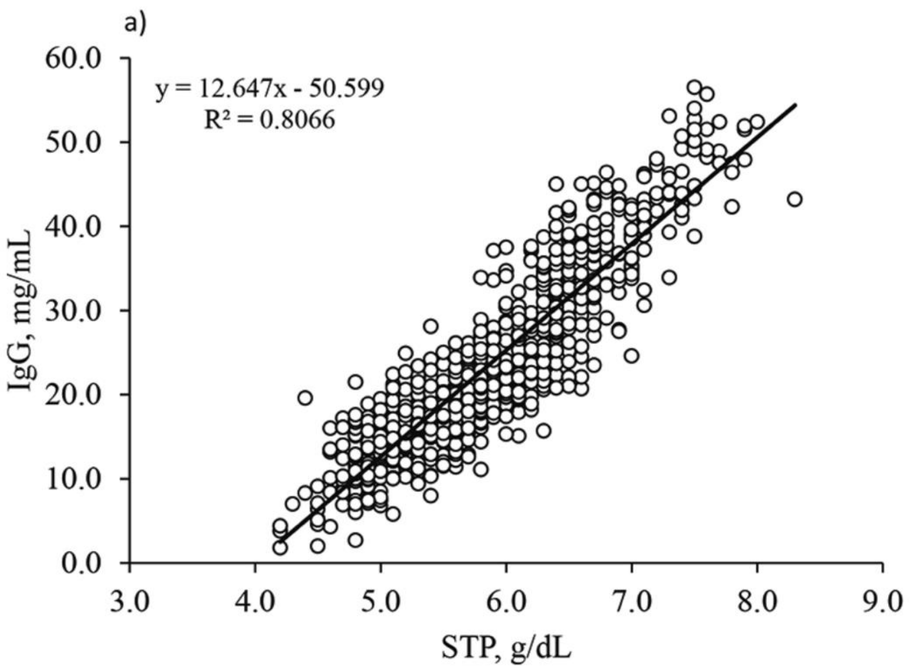
But what about colostrum powder?



Maternal colostrum

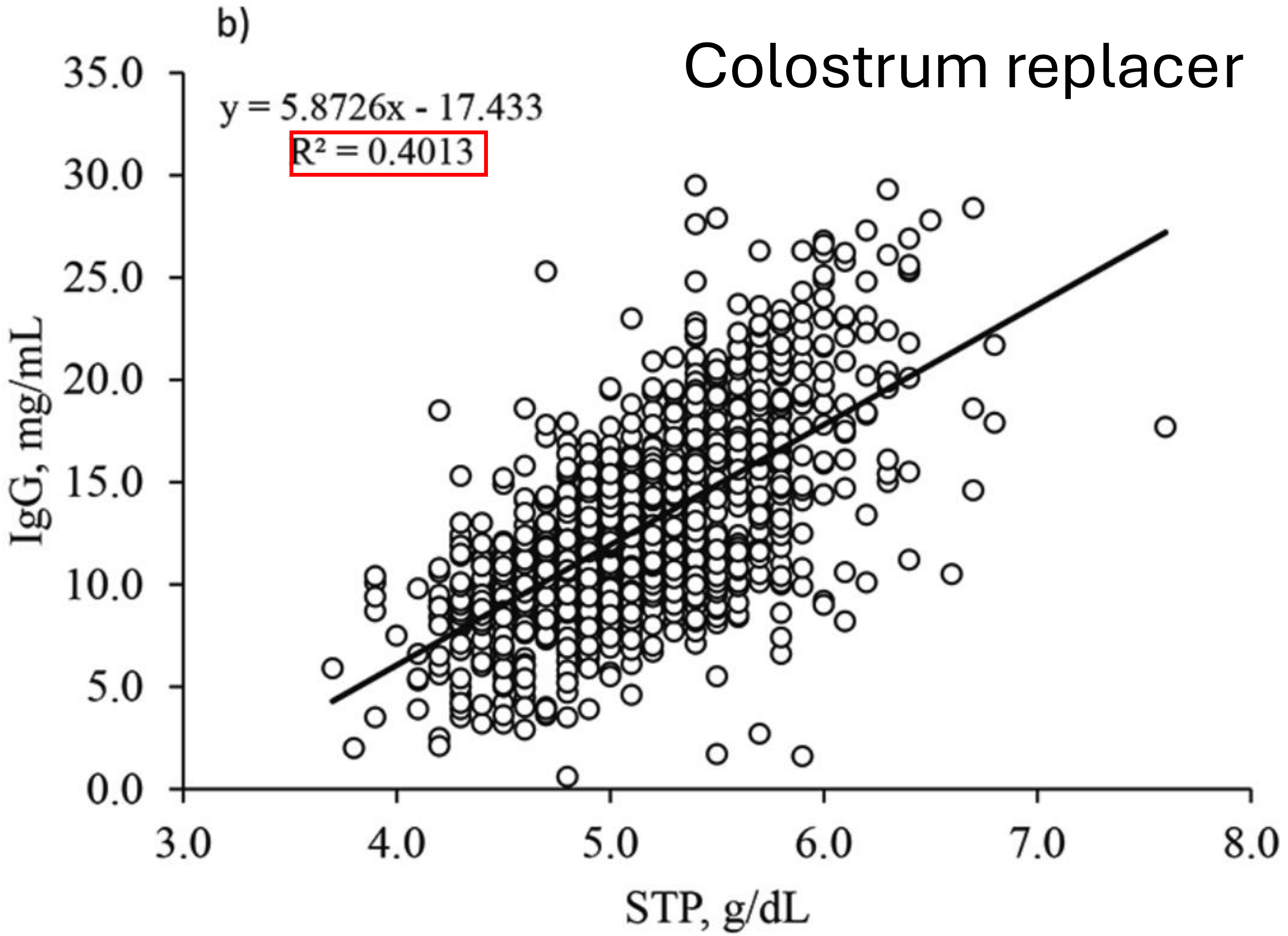
Lopez et al., 2021

But what about colostrum powder?



4.9 g/dL?

Colostrum replacer



Lopez et al., 2021


COLOSTRUM
DAY 1 AND BEYOND

Colostrum and Health

Failed transfer of passive immunity results in:

1.5X increased risk for diarrhea

1.75X increased risk for respiratory disease

2X increased risk for mortality

Raboisson et al., 2016

Colostrum and Growth

Improved colostrum management = better ADG

	Control		Intensified	
Variable	Poor	Good	Poor	Good
n	21	20	17	25
IgG, mg/dL	558	1793	609	2036
ADG, kg/d	0.53	0.50	0.63[a]	0.74[b]

[a,b] $P < 0.05$. Interaction, $P < 0.07$

Osorio et al., 2009 (unpublished)

Colostrum and Growth

Improved colostrum management = better long-term performance

Variable	2 L	4 L
Pre-pubertal daily gain (kg/d)	0.8 kg/d	1 kg/d
Age at conception (months)	14.0	13.5
Survival through 2nd Lactation	75%	87%
Milk yield through 2nd Lactation (kg)	16,045	17,071

Faber et al., 2005

Colostrum and Transition Milk

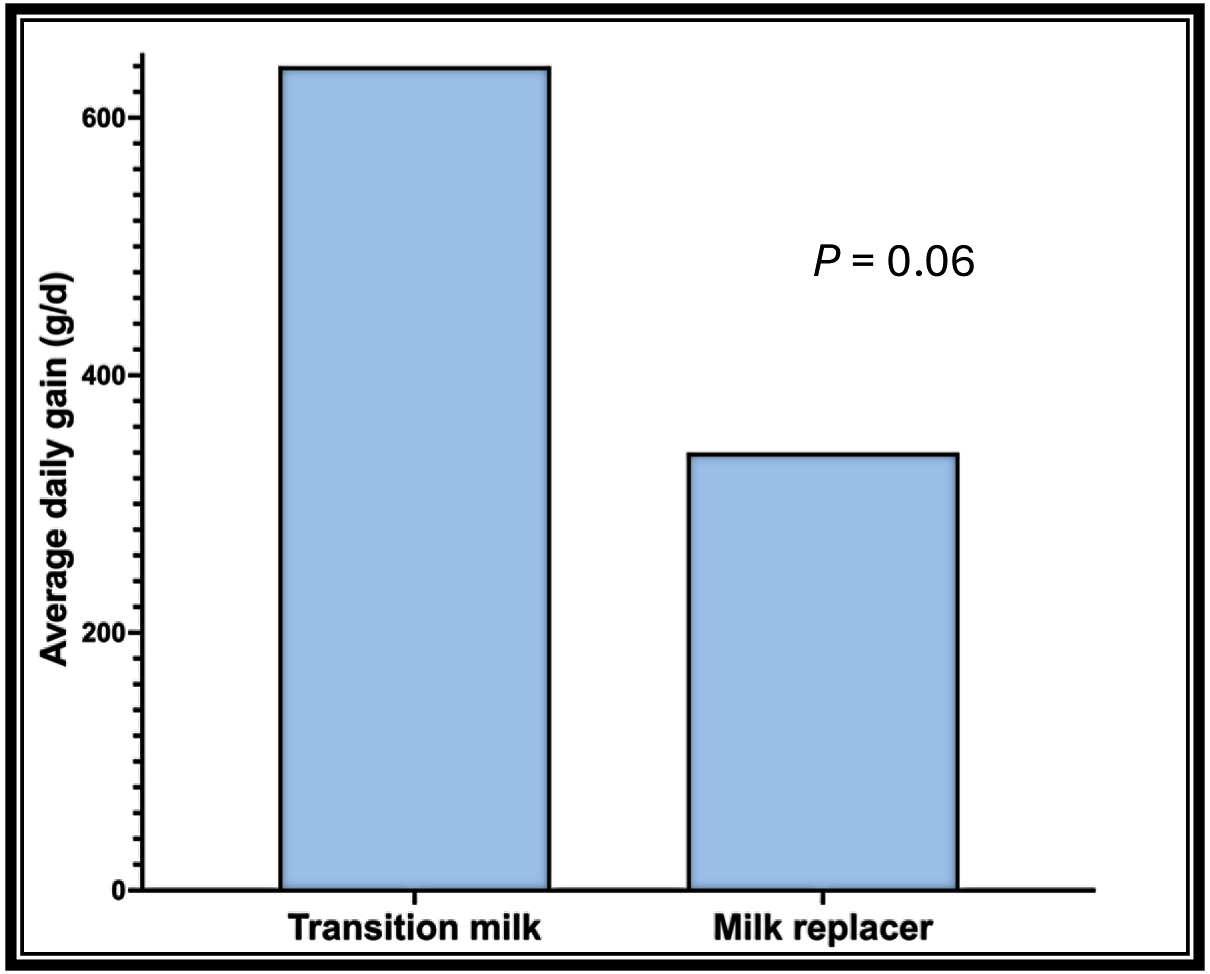
Transition milk is milkings 2-6 after calving

Variable	1	2	3	4	5/6	Mature
Fat (g/L)	64	56	46	50	50	39
Protein (g/L)	133	85	62	54	48	32
Lactose %	2.69	3.04	3.52	3.82	4.15	4.54
IgG (g/L)	81	58	17	12	ND	<2
Insulin (ug/L)	65	35	16	8	7	1
Growth hormone (ug/L)	1.4	0.5	< 1	< 1	<1	<1
IGF-1 (ug/L)	150	ND	ND	ND	ND	ND

Blum and Hammon, 2000; Tsioulpas et al., 2007

Colostrum and Transition Milk

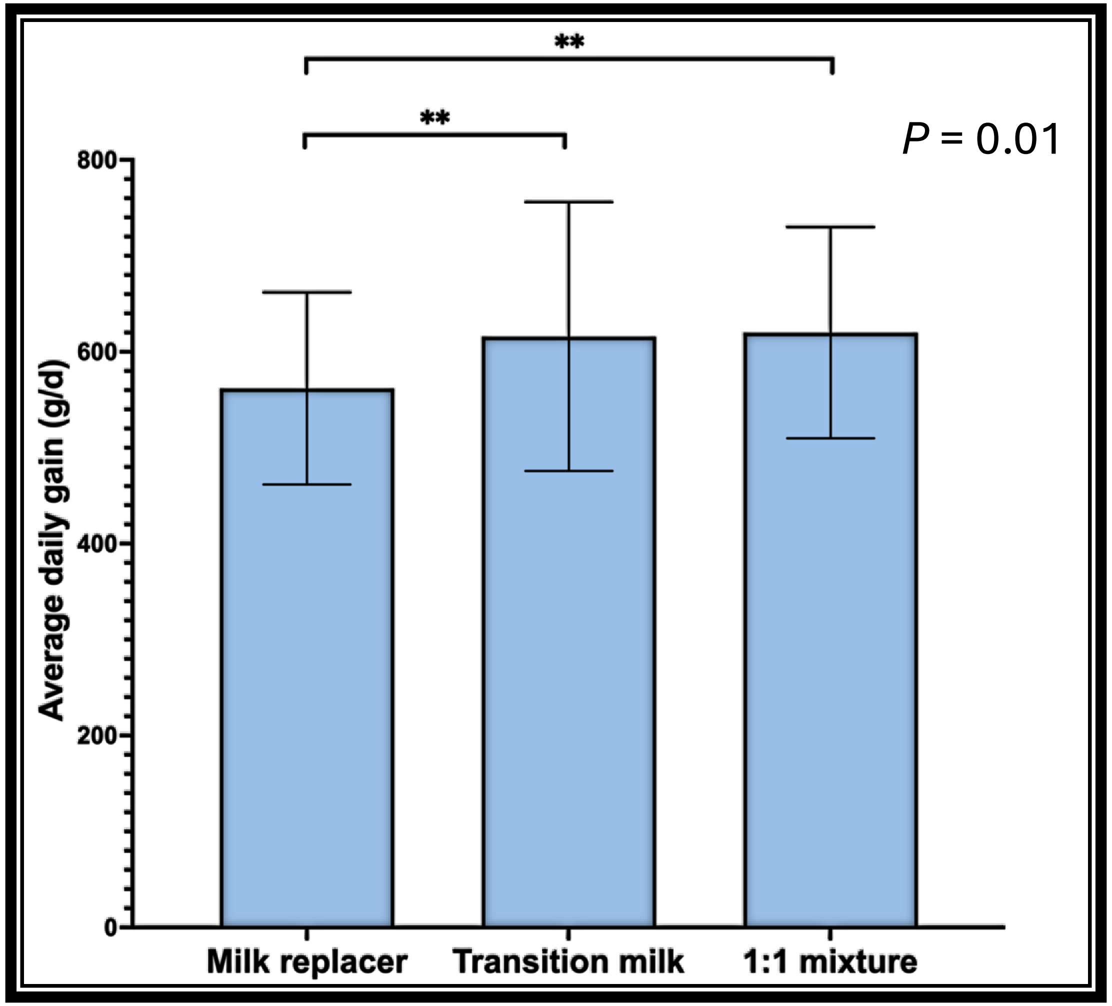
Improved growth 300 g/d in first 5 days of life



Van Soest et al., 2022

Colostrum and Transition Milk

Grow 10% faster for the entire preweaning period when fed for first 3 days



Van Soest et al., 2020

Colostrum and Transition Milk

- Improved health
- Fewer treated calves

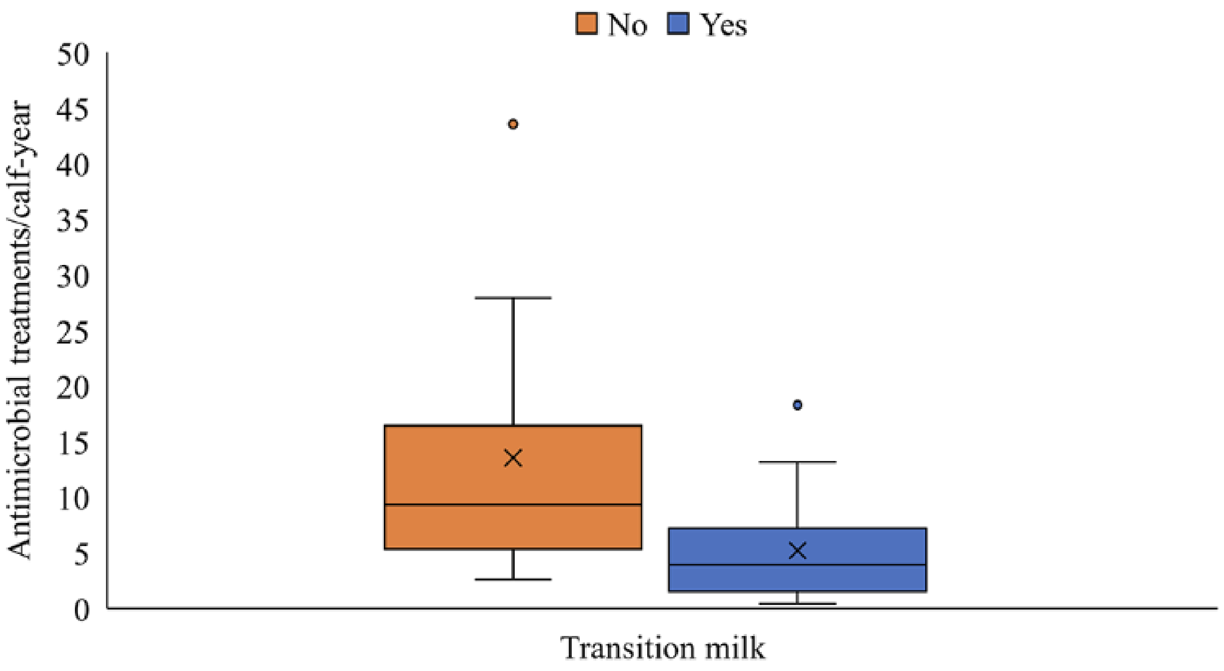


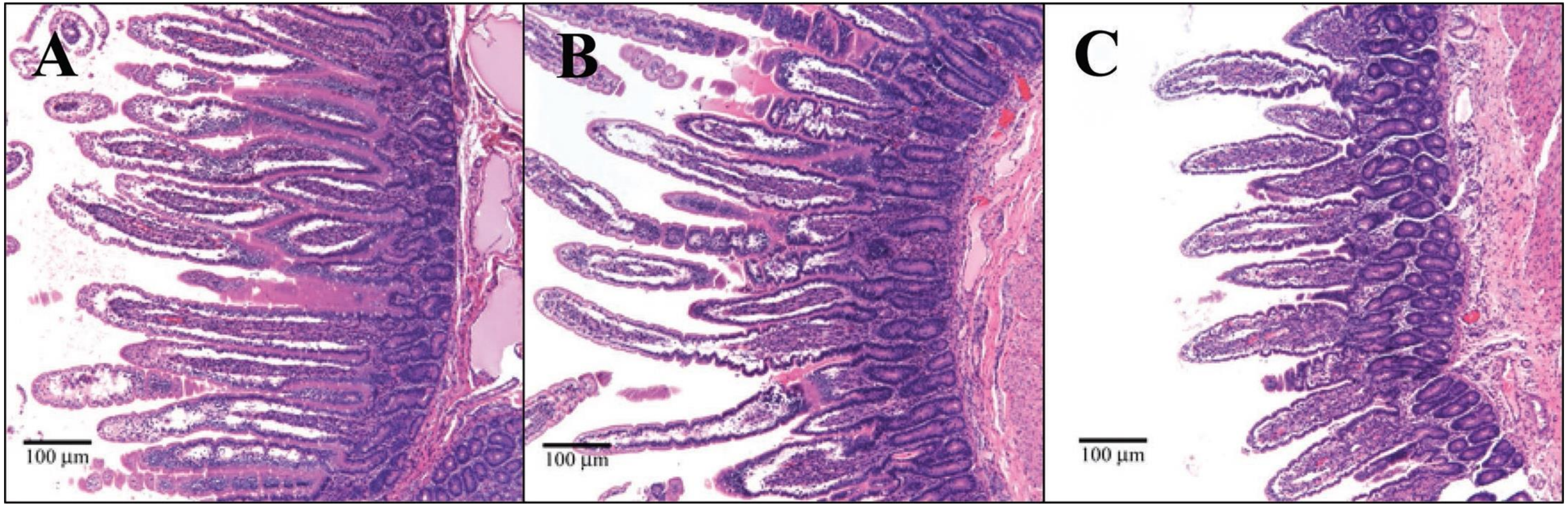
Figure 5. Box plot showing the predicted back-transformed number of antimicrobial treatments per calf-year between farms with survey response on feeding transition milk to calves (n = 74). Upper edges of boxes: 75th percentile; lower edges of boxes: 25th percentile; midlines: median; whiskers: 95th and 5th percentiles; X: mean; dots: outliers.

Uyama et al., 2022

Colostrum and Transition Milk

Greater villus height = improved gut development
More intestinal T and B cells → improved immunity?

C 1:1 WM



Pyo et al., 2012

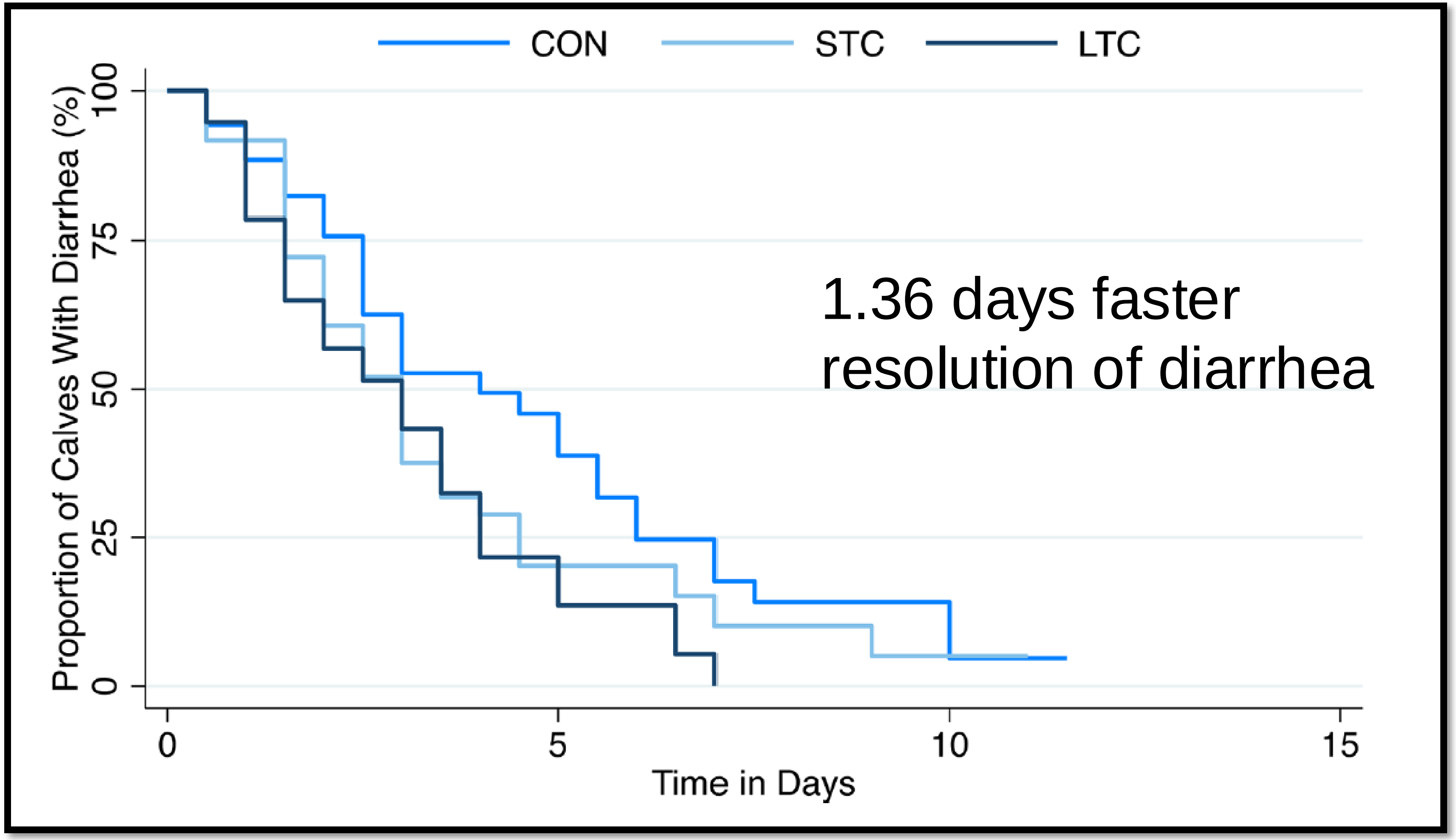
Can we use colostrum to prevent or treat disease?

Diarrhea treatment

- Calves with a fecal score of 2 or 3 (positive for diarrhea)
- Fed a of a blend of milk replacer and colostrum replacer “LTC”
  - 65 g/L colostrum replacer + 65 g/L milk replacer fed as a 2.5 L feeding
    - Total of 163 g of each per feeding
  - Fed twice daily for 4 days (8 total feedings)

Carter et al., 2022

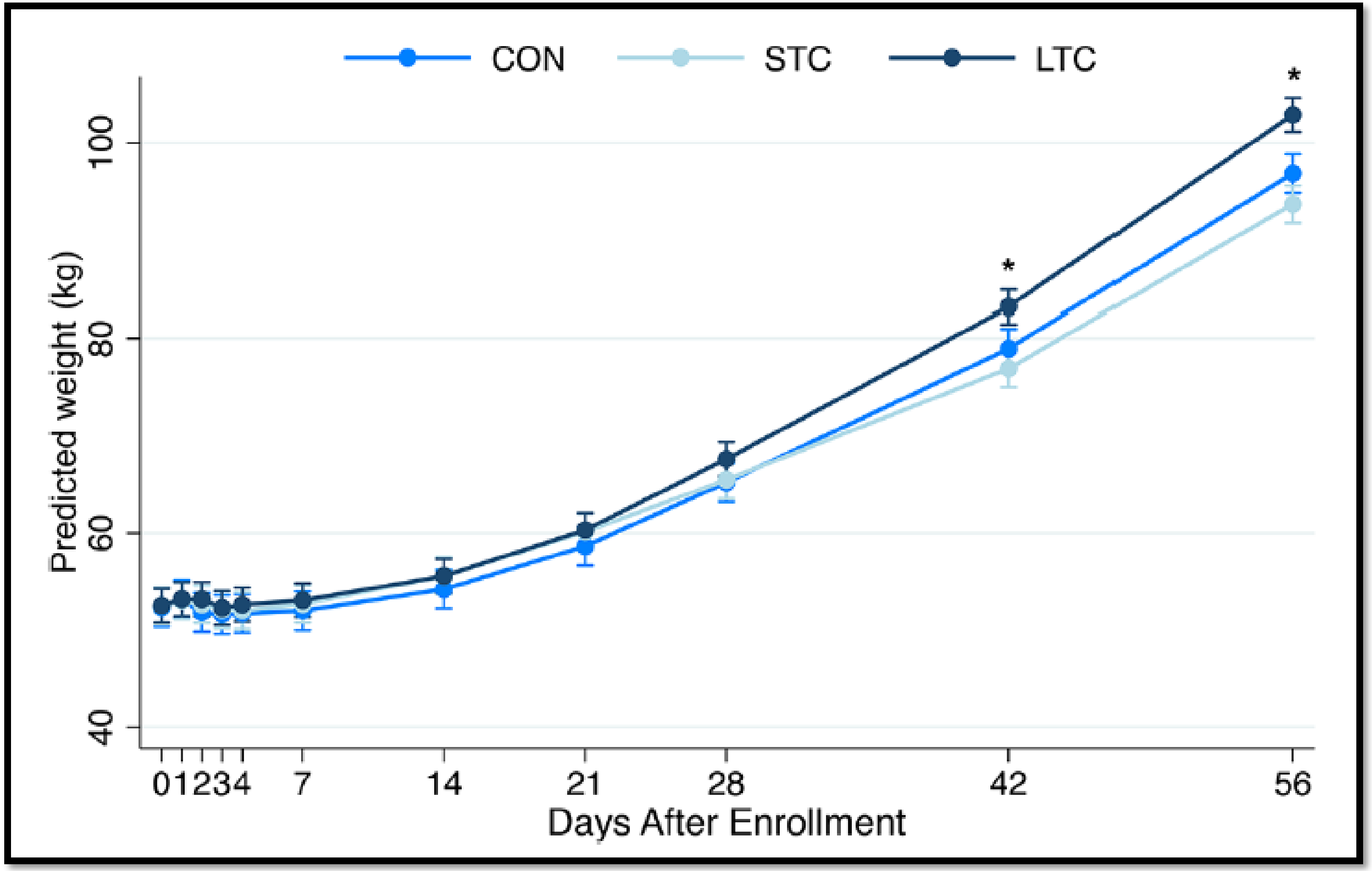
Diarrhea treatment



1.36 days faster resolution of diarrhea

Carter et al., 2022

Diarrhea treatment



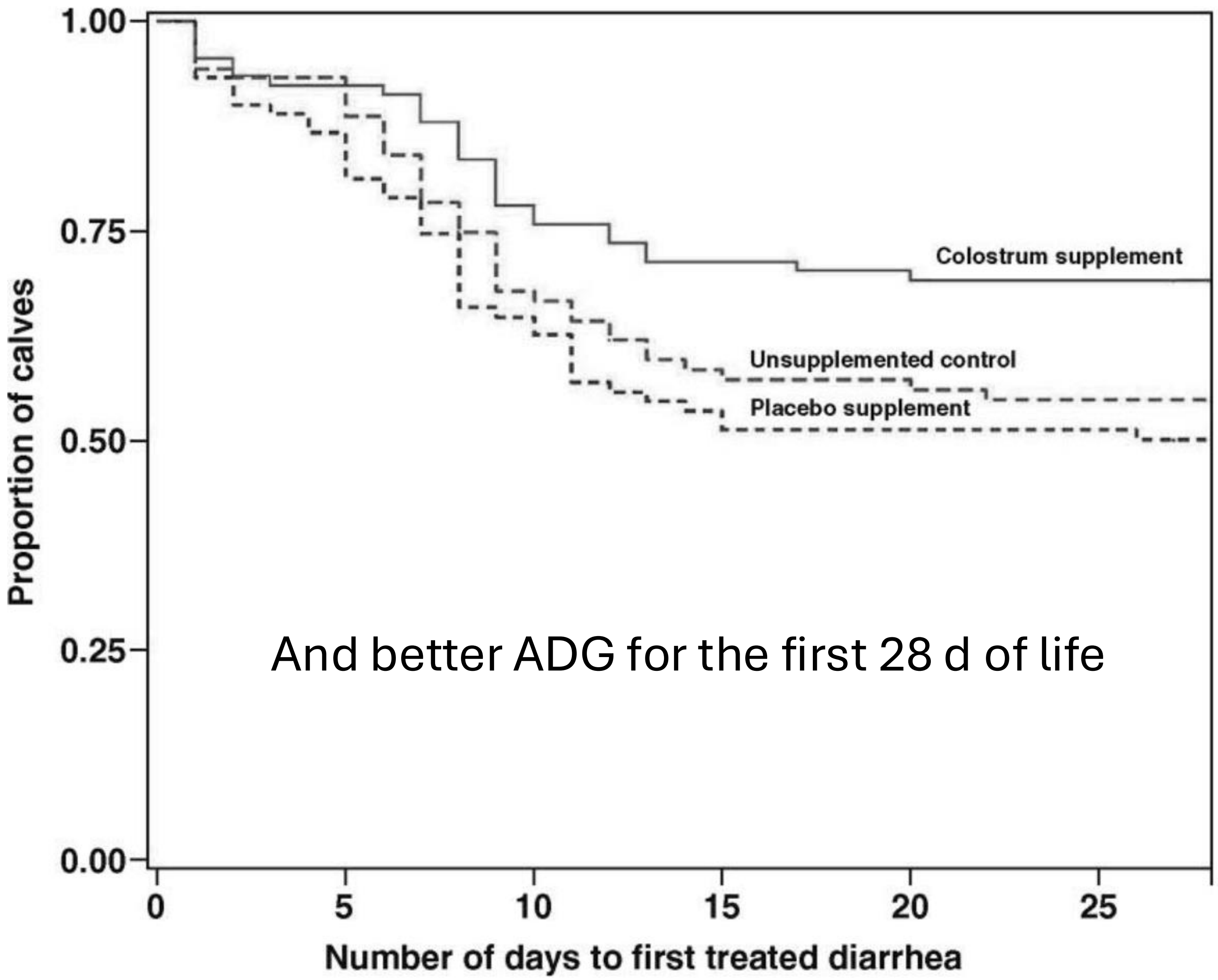
98 g/d improved ADG

Carter et al., 2022

Diarrhea prevention

- Enrolled 90 calves into 1 of 3 treatment groups fed 2X/d:
  - CS: 70 g colostrum powder in the milk twice daily for 14 days
  - PS: 70 g placebo equal in nutritional value to CS but without IgG
  - UC: unsupplemented control (70 g milk replacer)

Berge et al., 2009



And better ADG for the first 28 d of life

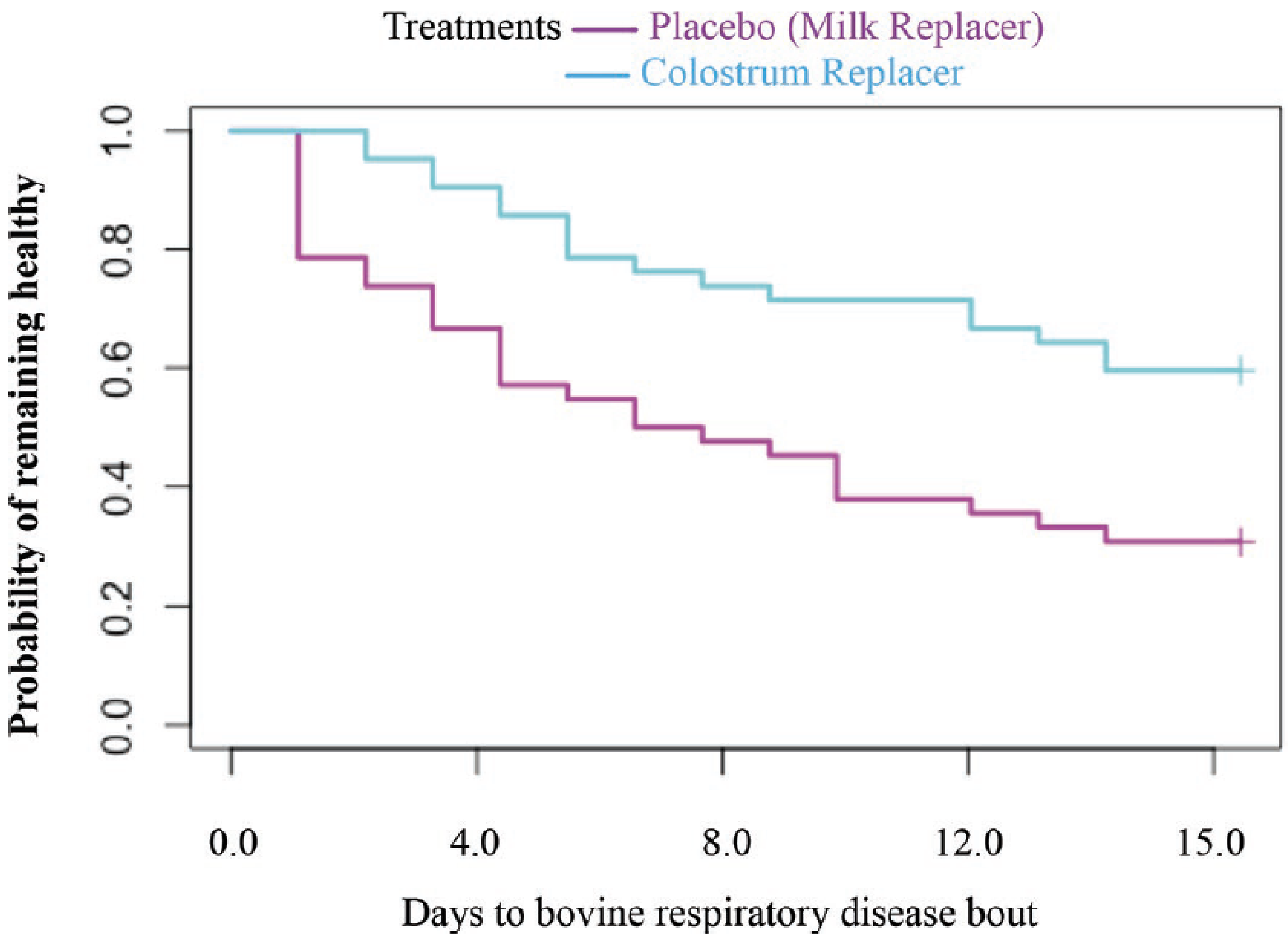
Berge et al., 2009

Respiratory disease prevention

- Calves enrolled if they triggered alarm on automated calf feeder (based on 12-d rolling average)
  - Negative deviations of milk intake (20% reduction)
  - Decreased drinking speed (30% reduction)
- Once daily intervention of milk replacer for 3 days (placebo)
  - 125 g/d as a 1 L feeding
- Once daily intervention of colostrum replacer for 3 days
  - 125 g/d as a 1 L feeding

Cantor et al., 2021

Respiratory disease prevention



1.64 times greater odds for BRD if not given colostrum replacer

Cantor et al., 2021

Can we use colostrum to assist weaning?

65 calves were housed individually from birth until 70 d of age

Edwards et al., 2024

Can we use colostrum to assist weaning?

65 calves were housed individually from birth until 70 d of age

Fed milk replacer (150 g/L) 3 times daily up to 12 L/d until 56 d

Edwards et al., 2024

Can we use colostrum to assist weaning?

Weaned over 8 days from day 57-64

Twice daily feeding from d 57-60 (7.6 L total)

Once daily feeding from d 61-64 (3.8 L total)

Edwards et al., 2024

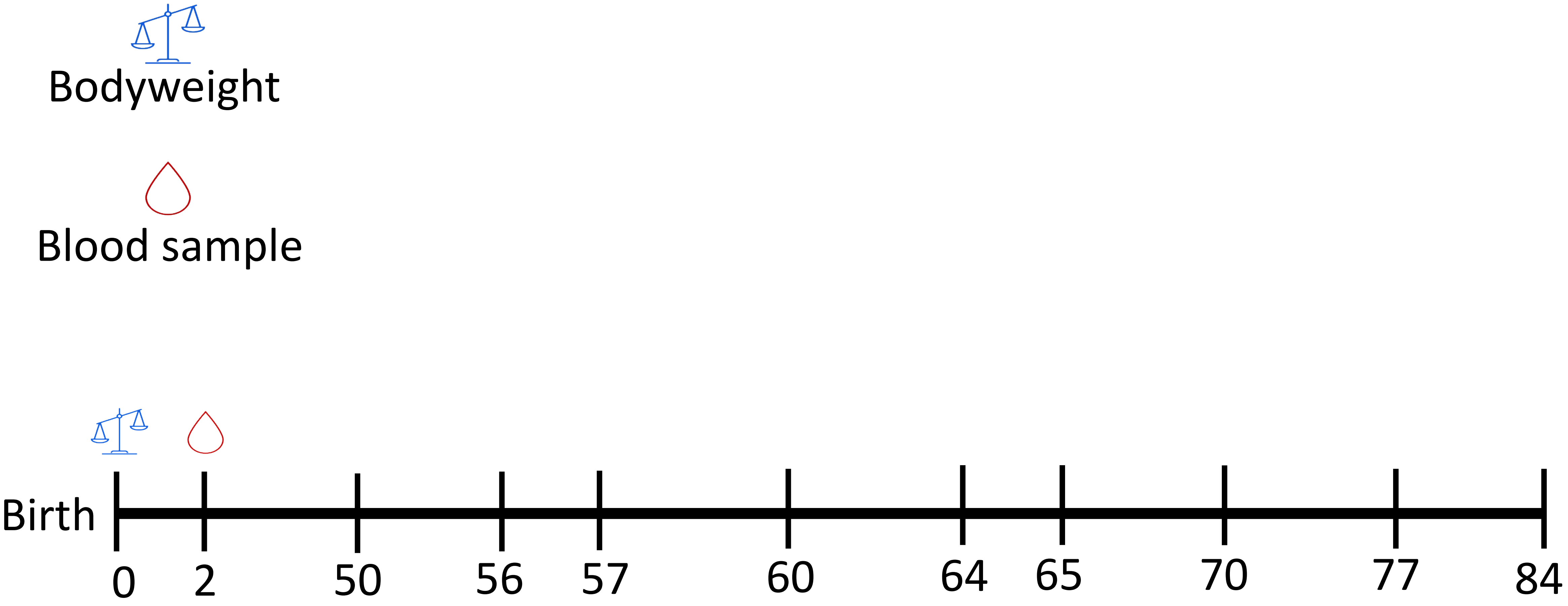
At 57 d, calves were blocked by birth weight and enrolled in 1 of 2 treatments equal in ME and fed once daily d 57-64:

Control (n = 31): 3.8 L milk replacer (150 g/L concentration)

Colostrum supplementation (n = 34): 3.8 L mixture of 0.95 L bovine colostrum replacer (125 g/L) and 2.85 L milk replacer (150 g/L)

Edwards et al., 2024

Can we use colostrum to assist weaning?



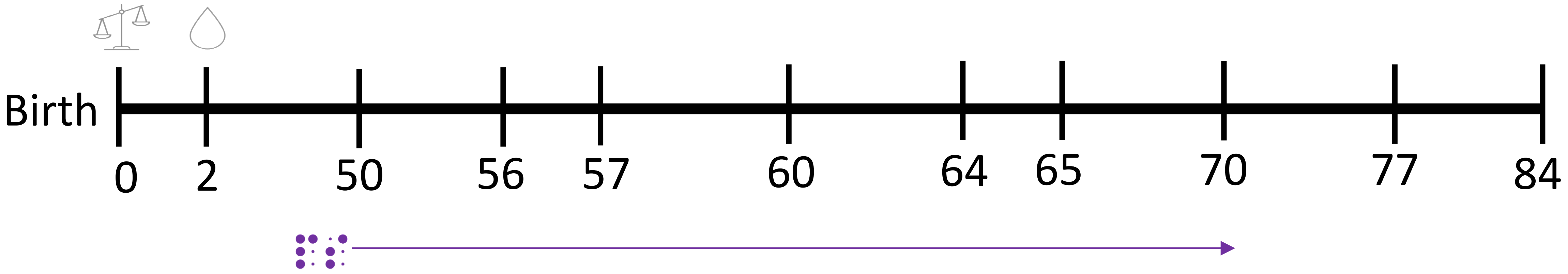
Edwards et al., 2024

Can we use colostrum to assist weaning?

Bodyweight

Starter intake

Blood sample



Edwards et al., 2024

Can we use colostrum to assist weaning?

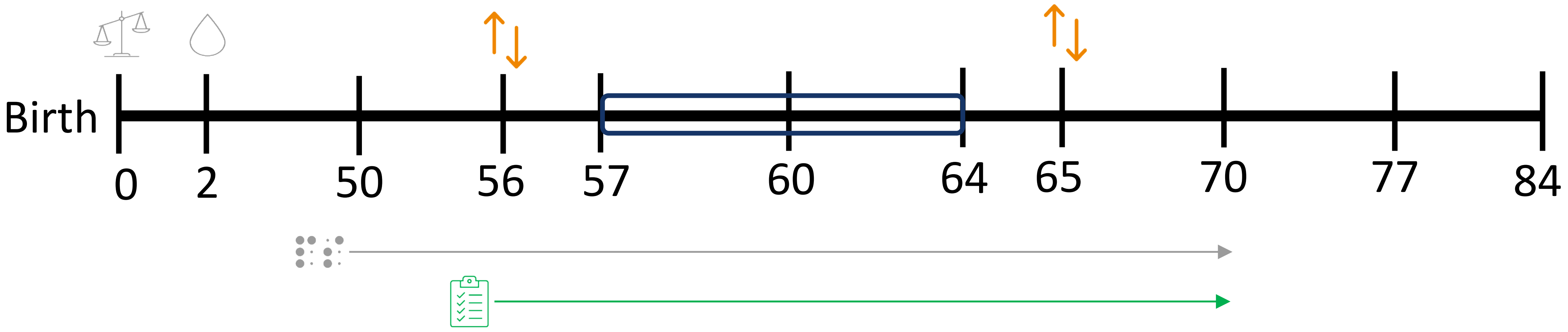
Bodyweight

Starter intake

Blood sample

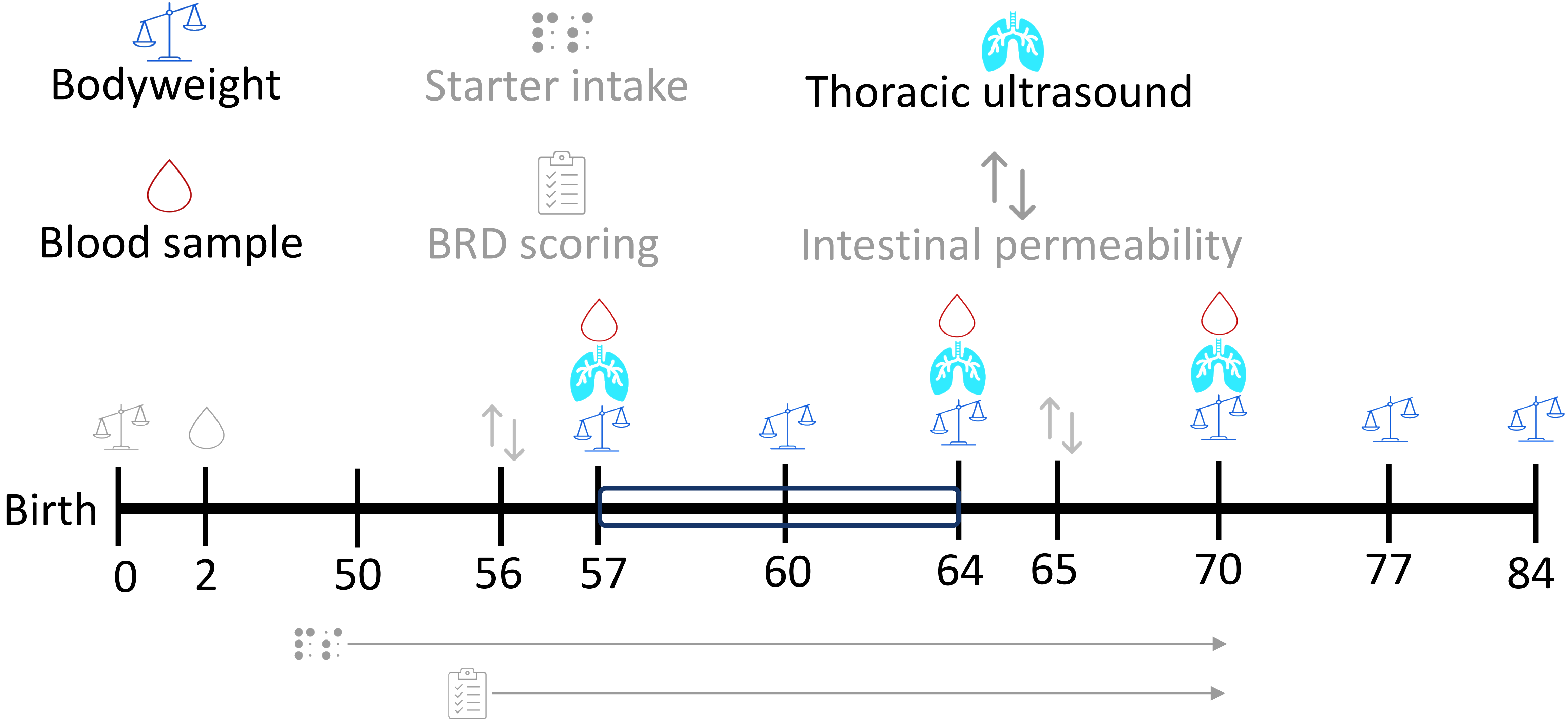
BRD scoring

Intestinal permeability



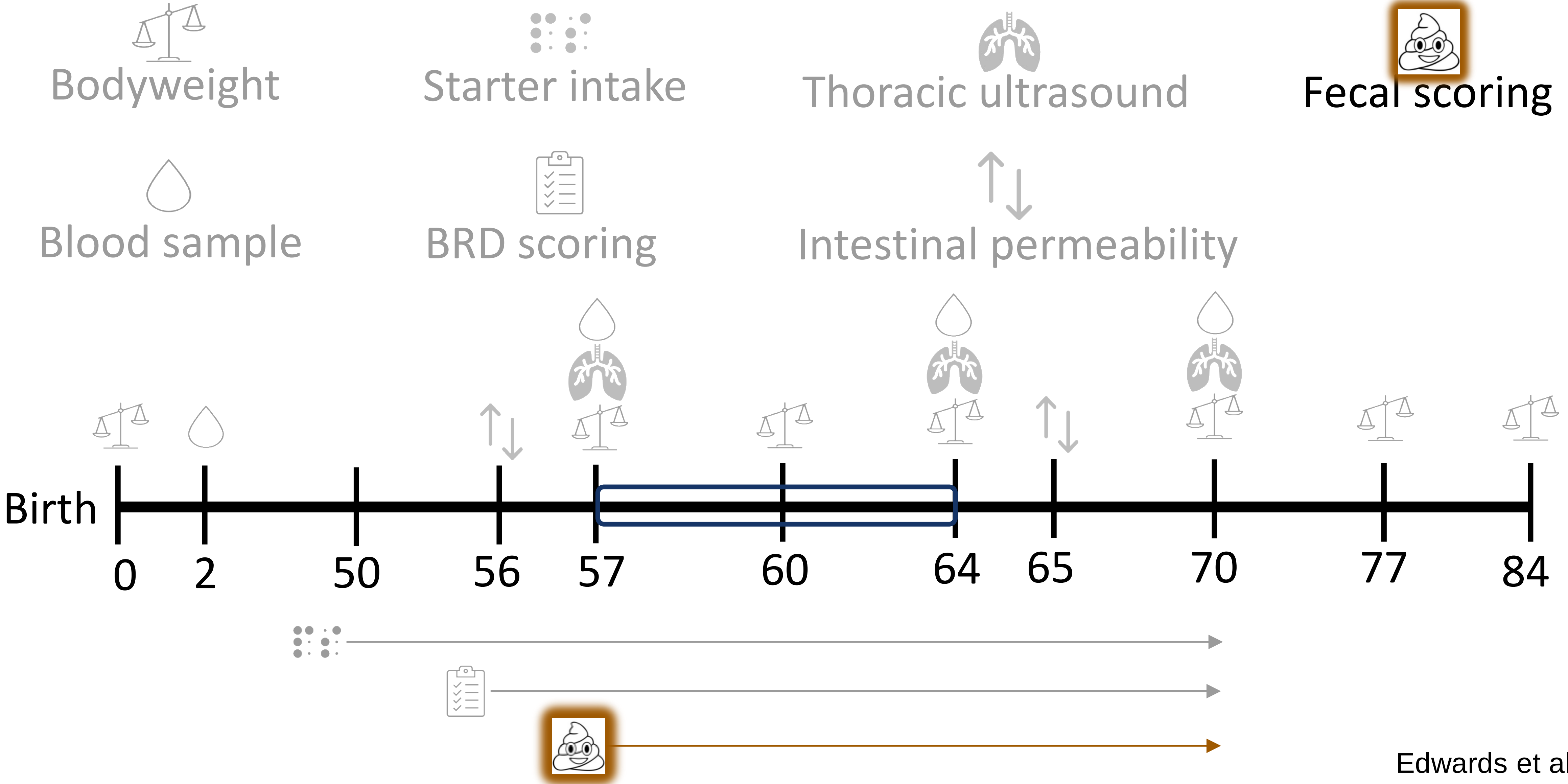
Edwards et al., 2024

Can we use colostrum to assist weaning?



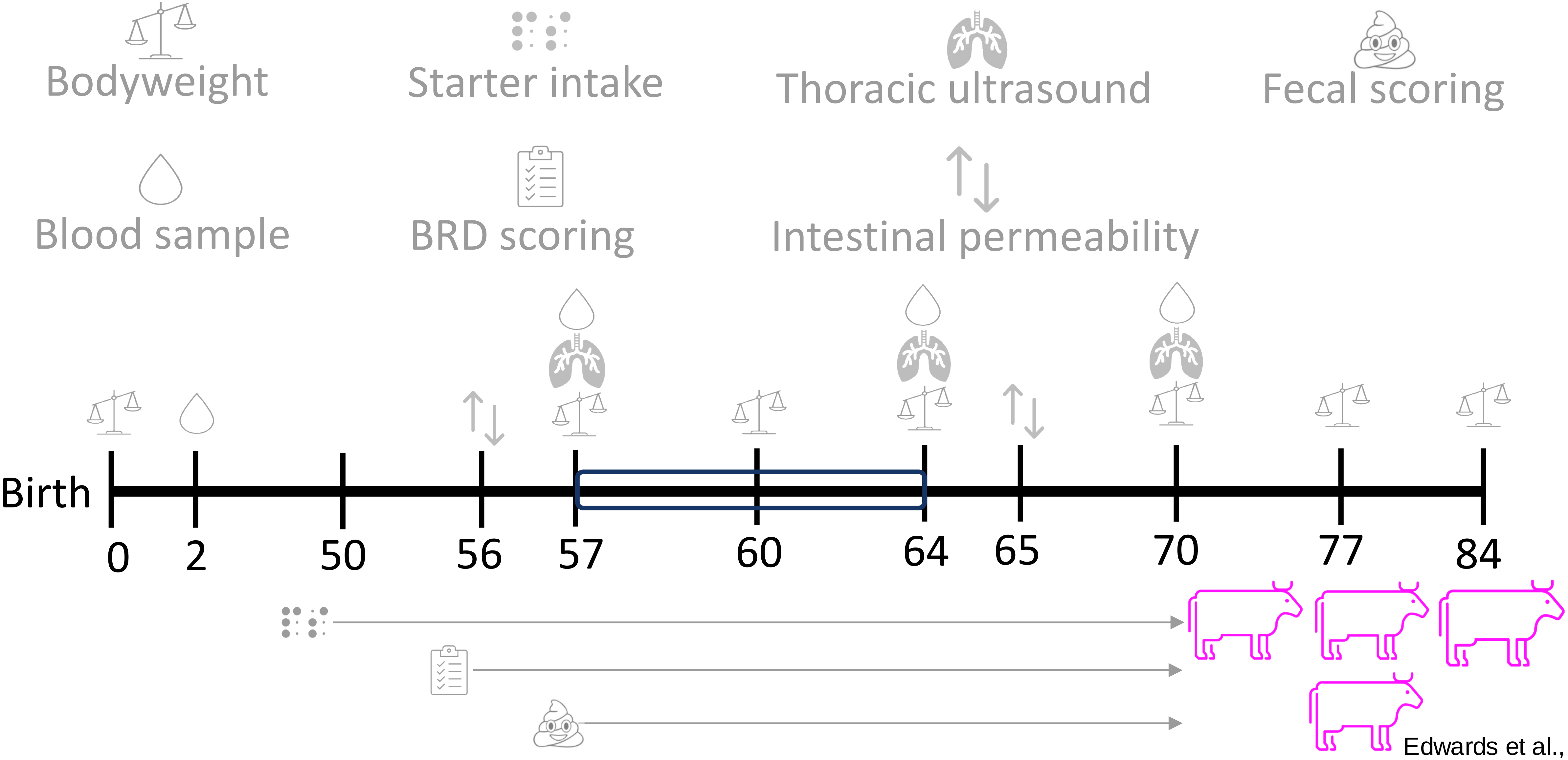
Edwards et al., 2024

Can we use colostrum to assist weaning?



Edwards et al., 2024

Can we use colostrum to assist weaning?



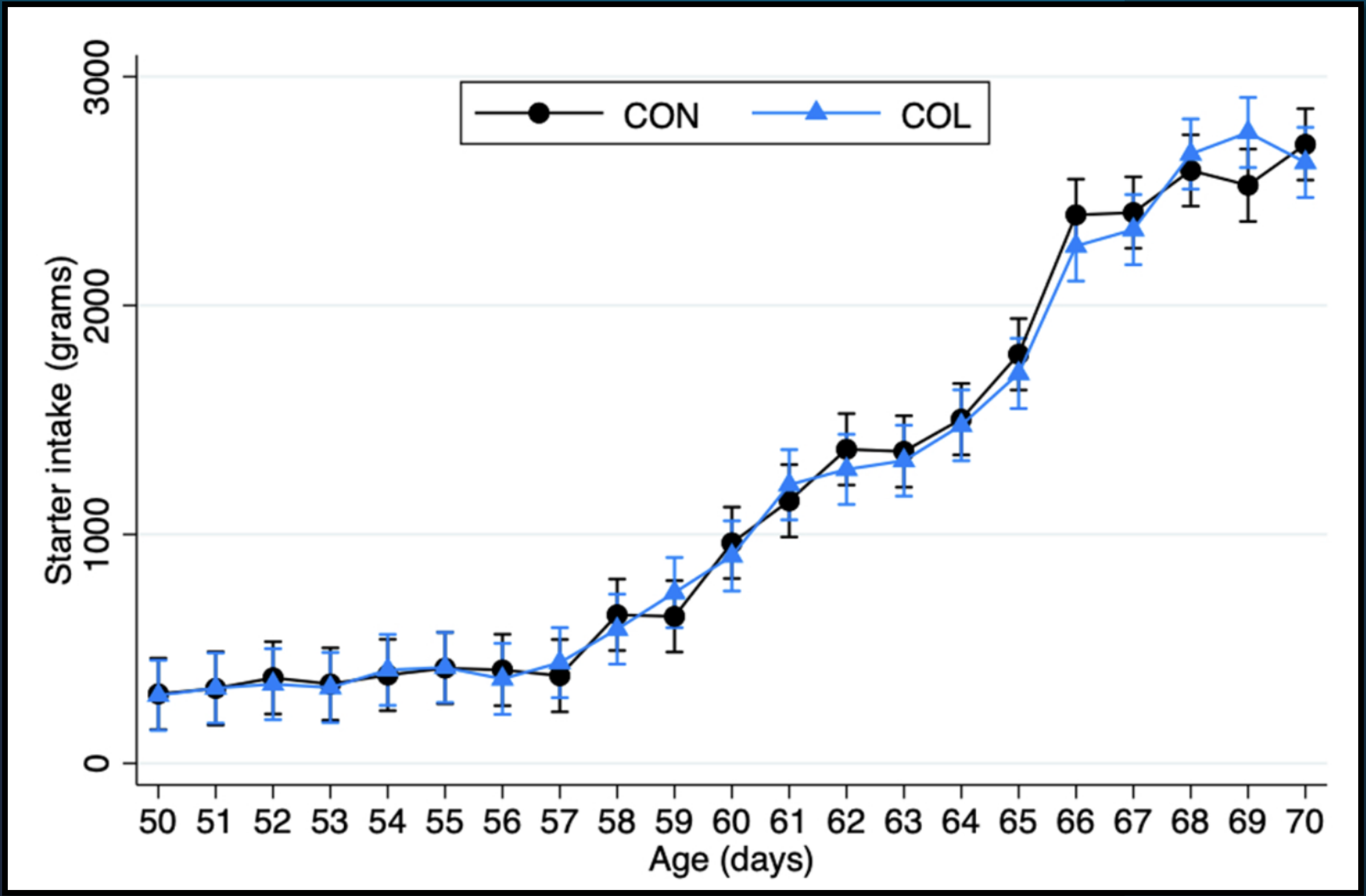
Edwards et al., 2024

Can we use colostrum to assist weaning?

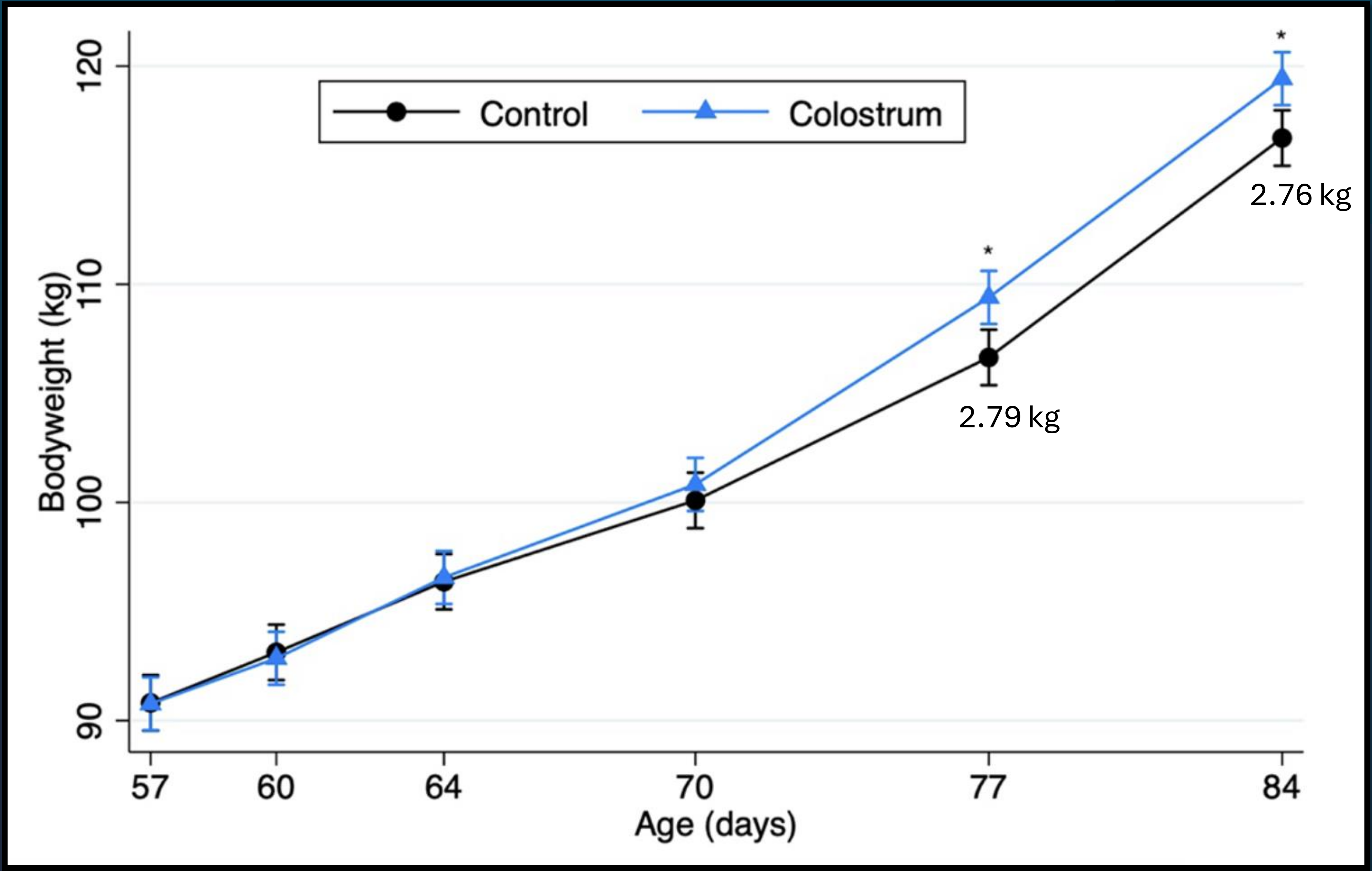
No difference between treatment groups in:

- Intestinal permeability
- Lung consolidation
- BRD score
- Fecal score
- Morbidity

Edwards et al., 2024



Edwards et al., 2024



Edwards et al., 2024

Economic Impact of Gain

For every additional 100 g/d increase in average daily gain *before weaning*, animals produce **155 kg extra milk** in first lactation

Preweaning average daily gain accounts for **22% of the variation** in first-lactation milk yield

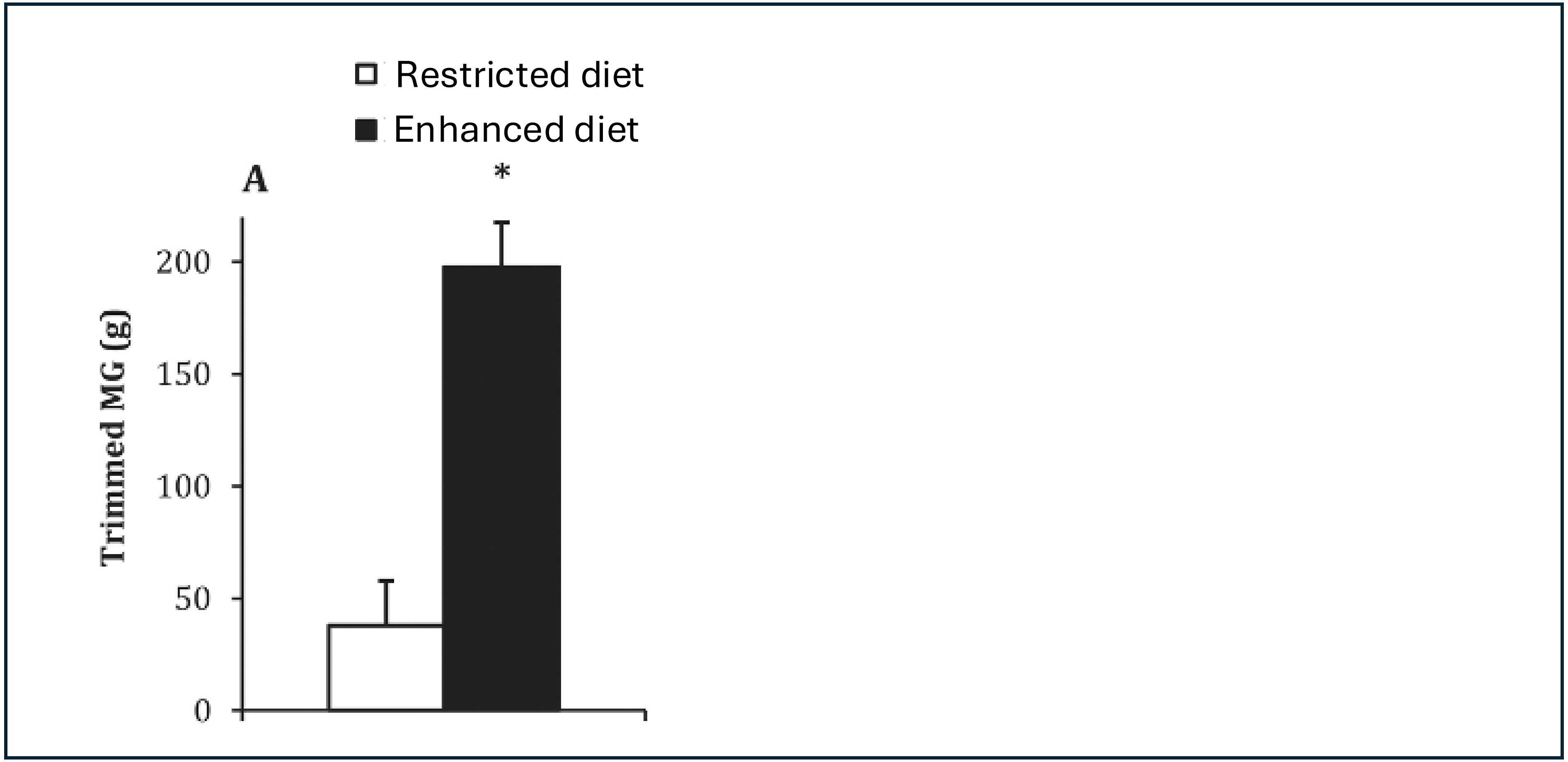
Soberon et al., 2012

Economic Impact of Gain

For every additional 100 g/d increase in average daily gain from *weaning to breeding* there is an associated **820 kg extra milk** across the first 3 lactations

Soberon et al., 2012

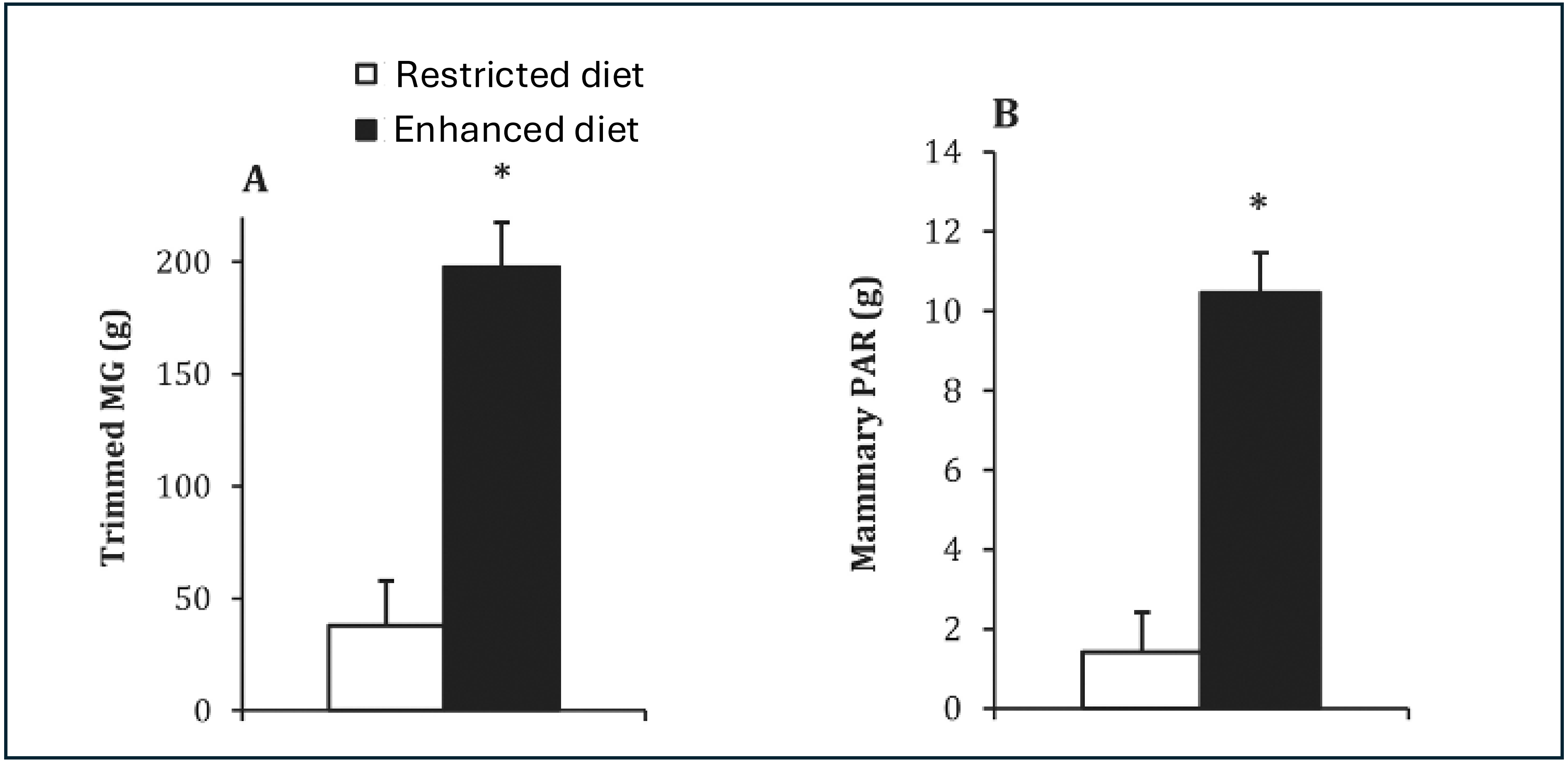
Economic Impact of Growth



Mammary gland weight

Geiger et al., 2016

Economic Impact of Growth



Mammary gland weight

Mammary parenchyma

Geiger et al., 2016

Nutrition and its influence on calf health

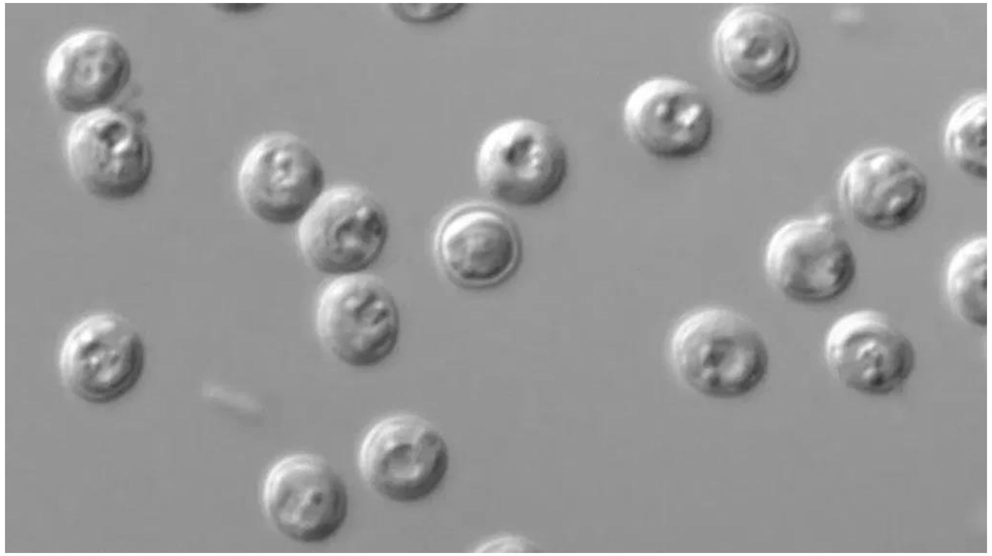
Nutrition and Health

When infected with Cryptosporidium, calves on an intensified milk feeding program performed better

Faster fecal score improvement

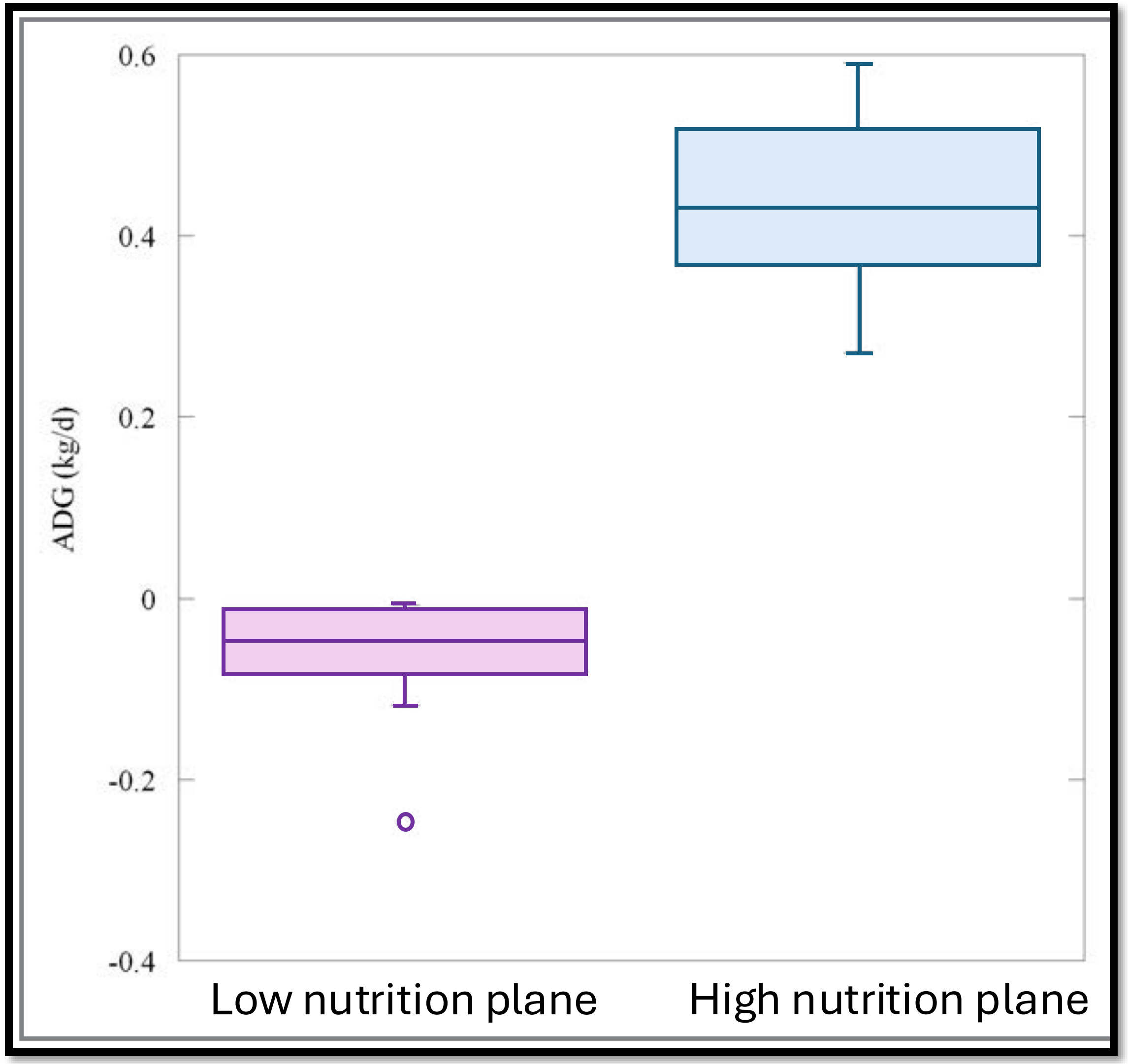
Better ADG

Better feed efficiency



Ollivett et al., 2012

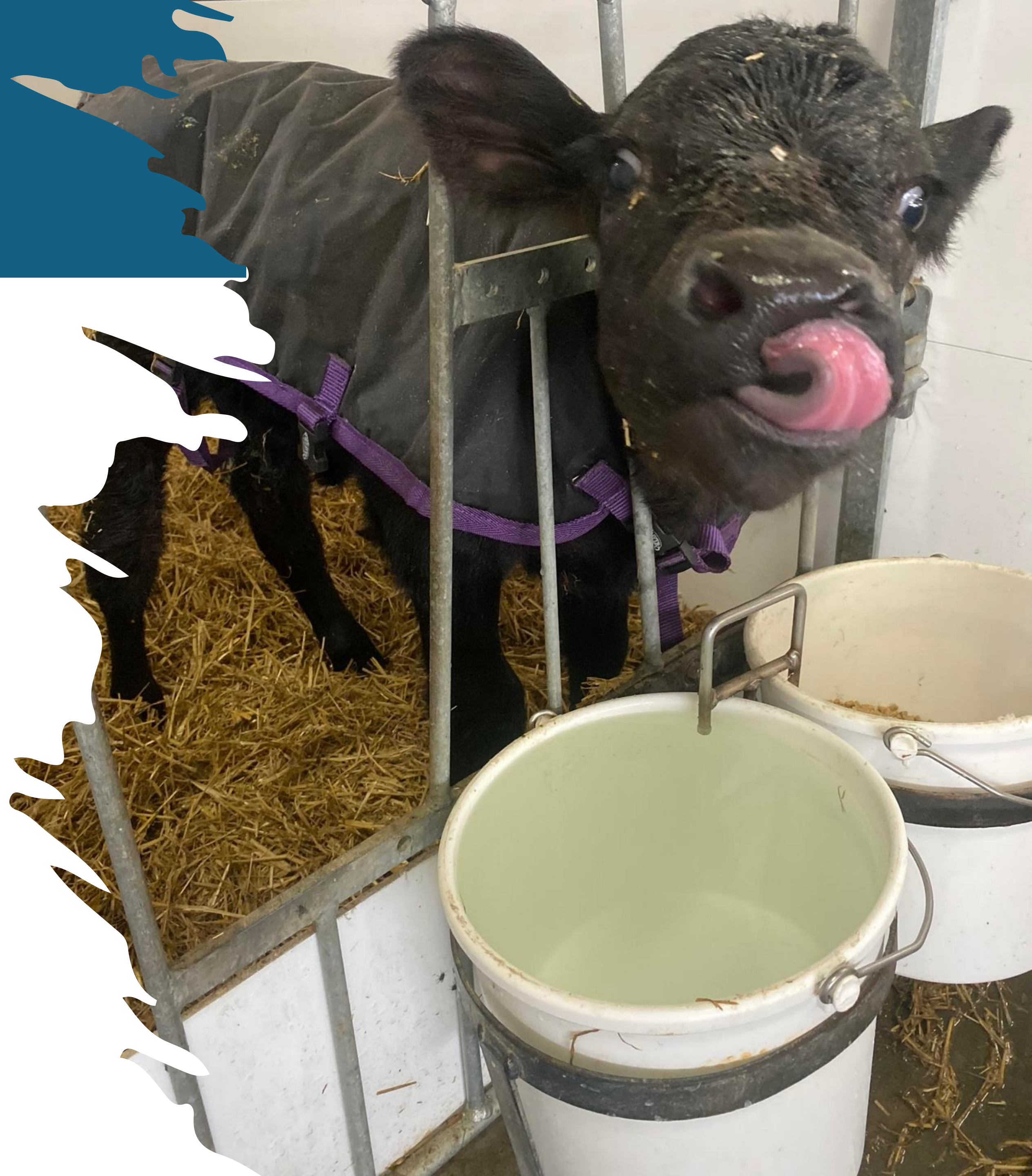
Nutrition and Health



Ollivett et al., 2012

Nutrition and Health

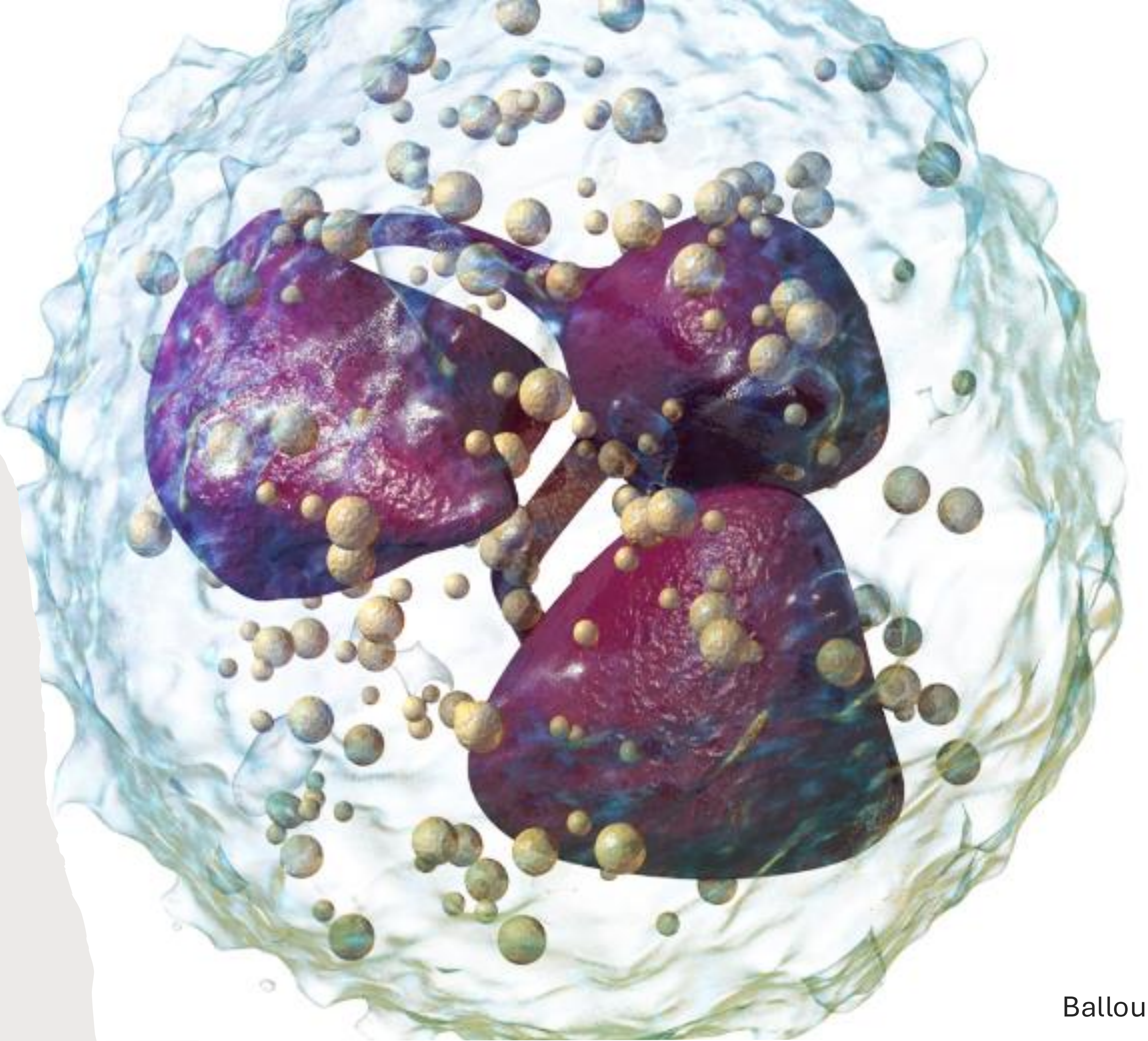
Feeding 4-6 L vs. ≤ 3.8 L decreased BRD by 92%



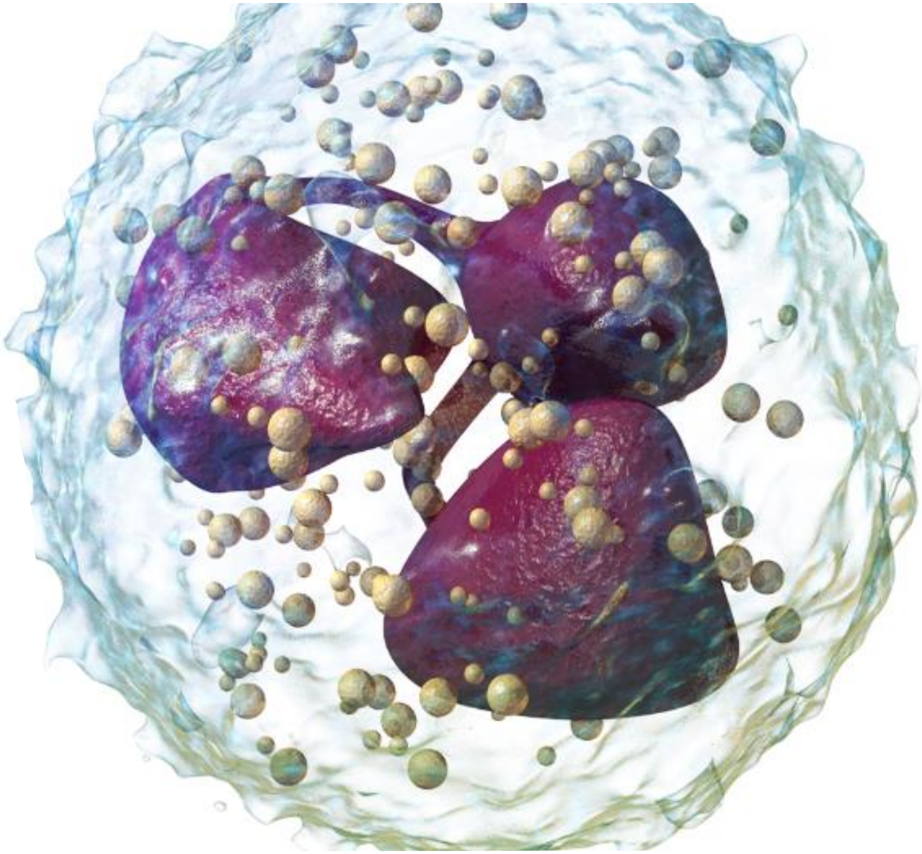
Dubrovsky et al., 2019

Better immune systems with greater planes of nutrition

Better neutrophil oxidative burst



Ballou, 2012



Low plane of nutrition (LPN)

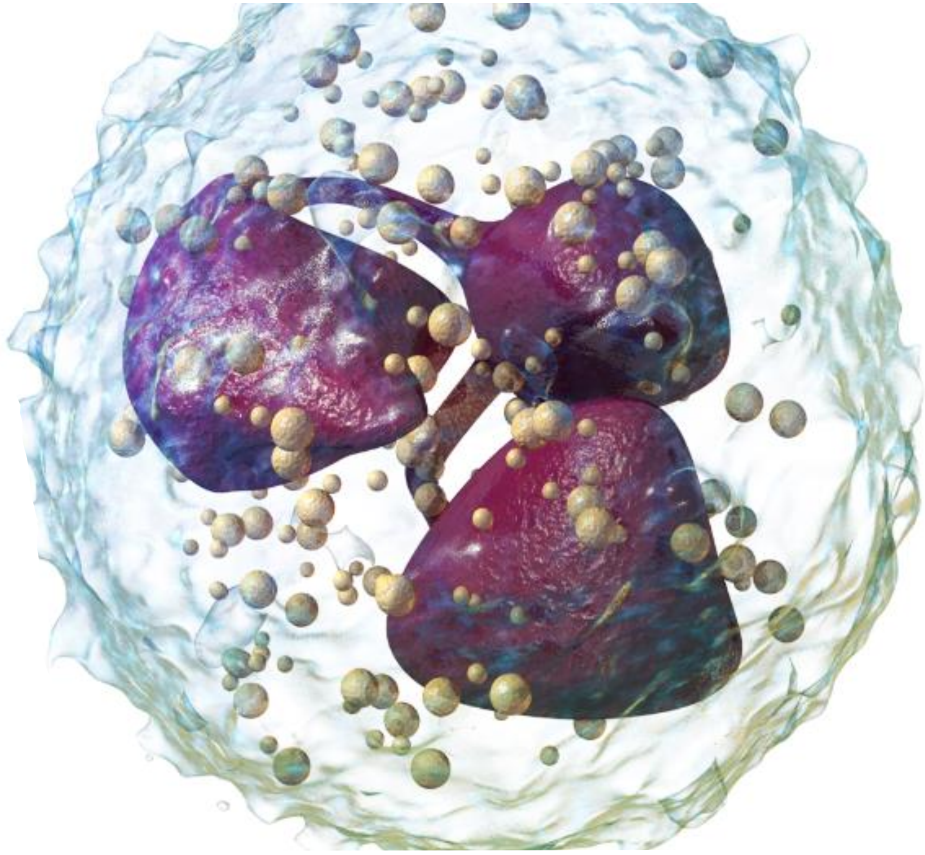
- 436 g of DM per day (0.95 lb)
- 20:20 MR at 10.4% solids DM

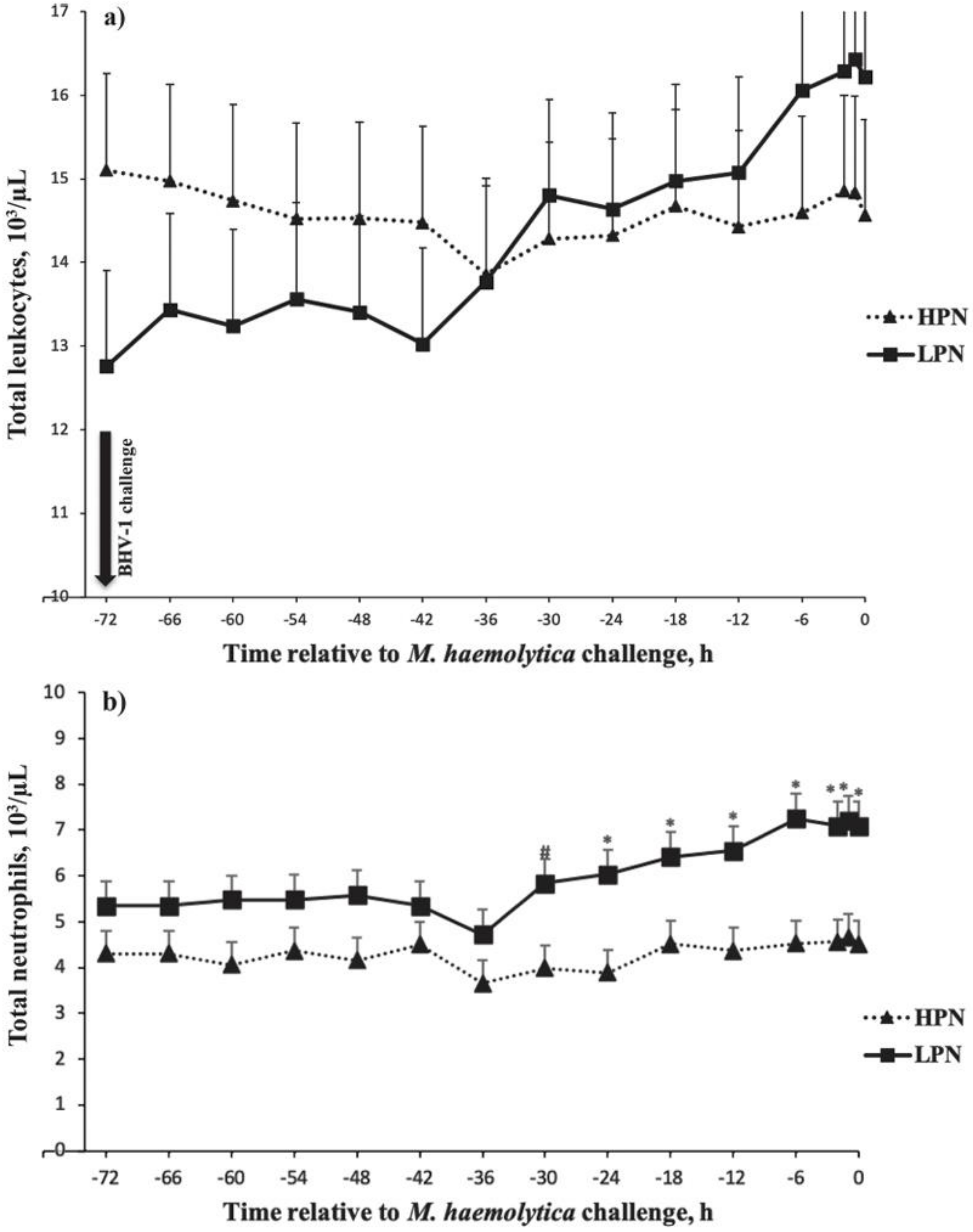
High plane of nutrition (HPN)

- 797 g DM per day (1.75 lb) from d 1 to 10 (14.9% TS)
- 1,180 g DM per day (2.6 lb) from d 11 until weaning (15.5% TS)
- 28:20 MR

Challenged with BHV-1 (IBR) at day 81 and MH at day 83

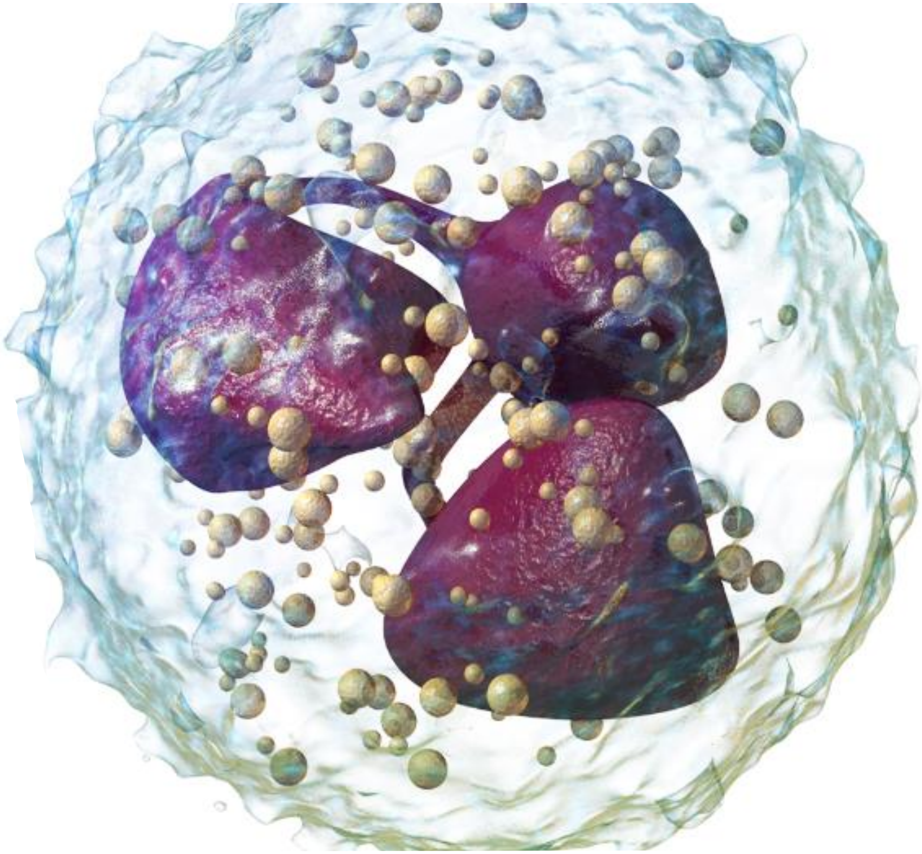
Ballou et al., 2018





LPN more severe pathophysiological responses

Ballou et al., 2018

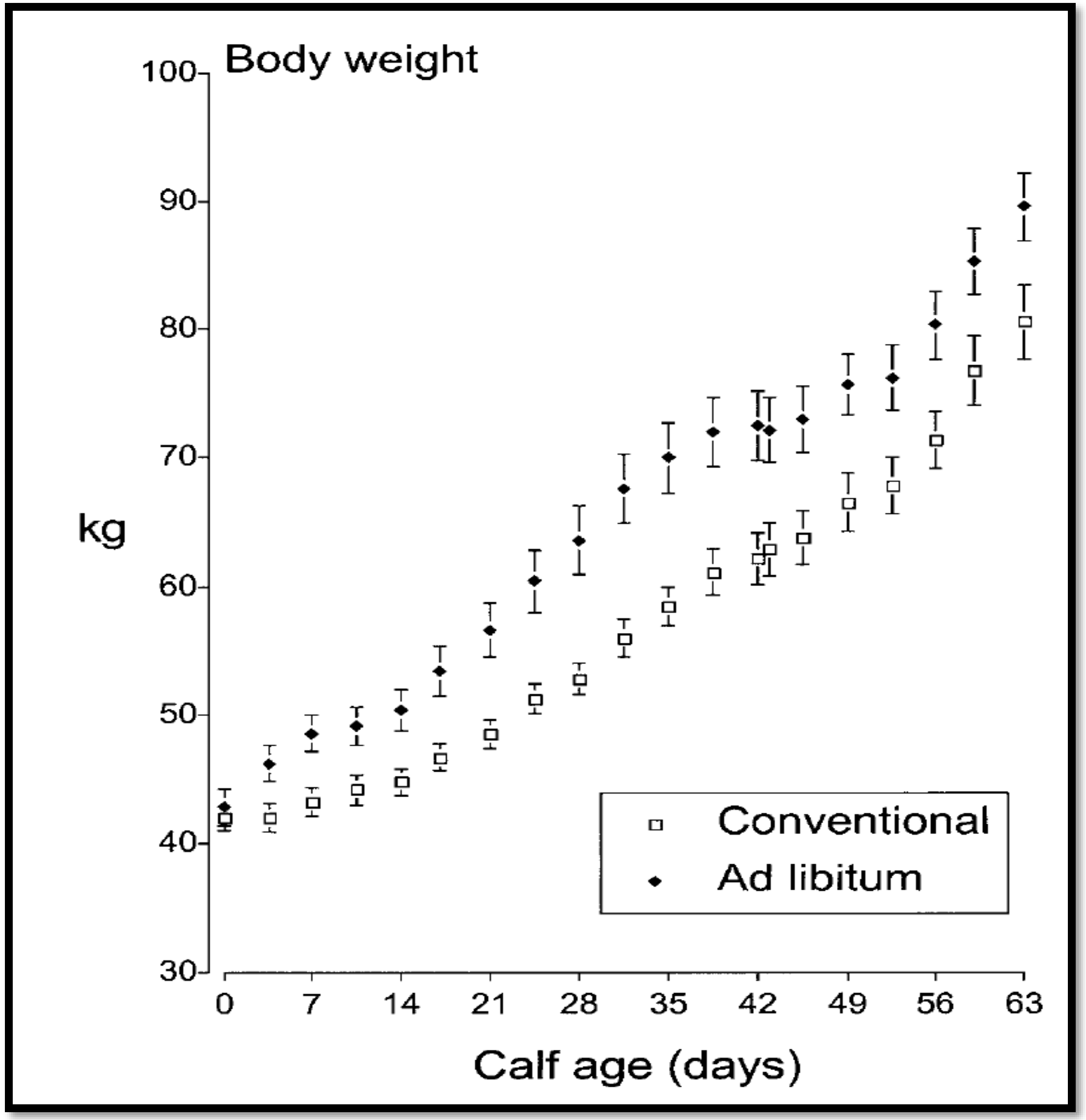


LPN calves:

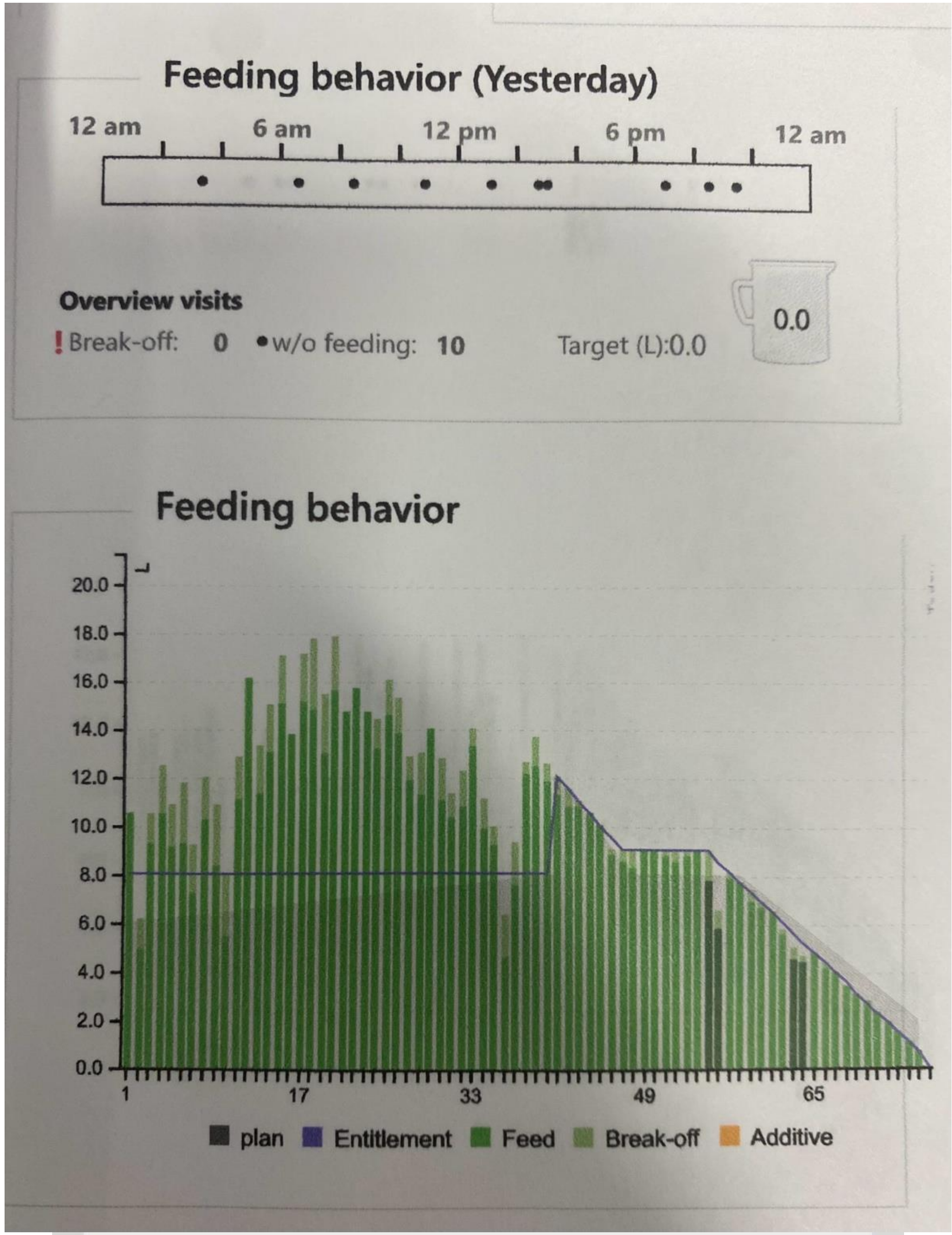
- More severe pathophysiological responses
- Excessive systemic inflammation
- Greater mortality (26% vs. 0%)
- Development of adaptive immune response may be impaired or delayed

Ballou et al., 2018

Nutrition – Feeding Volumes



(Jasper and Weary, 2002)



Nutritional considerations when feeding whole milk

Pickup Date	Test Date	Status	BF	PT	LOS
2024-01-31	2024-02-02	OFFICIAL	3.98	3.02	5.88
2024-01-29	2024-01-31	OFFICIAL	3.98	3	5.87
2024-01-27	2024-01-29	OFFICIAL	4.00	3.03	5.86
2024-01-25	2024-01-26	OFFICIAL	3.95	3.04	5.87
2024-01-23	2024-01-25	OFFICIAL	3.95	3.05	5.88
2024-01-21	2024-01-23	OFFICIAL	4.00	3.05	5.88
2024-01-19	2024-01-23	OFFICIAL	3.96	3.06	5.87
2024-01-17	2024-01-19	OFFICIAL	3.44	3.09	5.88
2024-01-15	2024-01-17	OFFICIAL	4.07	3.07	5.81
2024-01-13	2024-01-15	OFFICIAL	4.05	3.02	5.86
2024-01-11	2024-01-15	OFFICIAL	4.03	3.05	5.87
2024-01-09	2024-01-11	OFFICIAL	4.06	3.06	5.85
2024-01-07	2024-01-09	OFFICIAL	4.13	3.07	5.86
2024-01-05	2024-01-09	OFFICIAL	4.02	3.06	5.86
2024-01-03	2024-01-05	OFFICIAL	4.14	3.10	5.87

-0.518

Pickup Date	Test Date	Status	BF	PT	LOS
2024-06-29	2024-07-02	OFFICIAL	3.40	2.82	5.80
2024-06-27	2024-06-28	OFFICIAL	3.42	2.80	5.80
2024-06-25	2024-06-26	OFFICIAL	3.45	2.81	5.77
2024-06-23	2024-06-24	OFFICIAL	3.36	2.82	5.78
2024-06-21	2024-06-22	OFFICIAL	3.43	2.81	5.80
2024-06-19	2024-06-20	OFFICIAL	3.46	2.81	5.80
2024-06-17	2024-06-18	OFFICIAL	3.44	2.85	5.79
2024-06-15	2024-06-16	OFFICIAL	3.49	2.84	5.82
2024-06-13	2024-06-14	OFFICIAL	3.59	2.84	5.79
2024-06-11	2024-06-12	OFFICIAL	3.64	2.89	5.84
2024-06-09	2024-06-10	OFFICIAL	3.62	2.86	5.82
2024-06-07	2024-06-08	OFFICIAL	3.60	2.87	5.81
2024-06-05	2024-06-06	OFFICIAL	3.60	2.88	5.79
2024-06-03	2024-06-04	OFFICIAL	3.60	2.89	5.78
2024-06-01	2024-06-02	OFFICIAL	3.71	3.00	5.84

Nutrition

Calculation of ME in milk replacer and whole milk	Air dry	100% DM
Moisture	87.5%	12.5%
Ash	0.8%	6.3%
Crude protein, minimum	3.1%	24.4%
Crude fat, minimum	4.0%	32.0%
Crude fiber, maximum	0.00%	0.0%
Lactose	4.7%	37.3%
ME (Mcal/kg):	0.68	5.40
ME (MJ/kg):	2.82	22.60

Source: 2001 NRC Nutrient Requirements of Dairy Cattle. Chapter 10.
ME (Mcal/kg) = (0.057×CP + 0.092 × Fat + 0.0395 × Lactose) × 0.93
Lactose = 100 – Water – Ash – Fat – Protein

Instructions:
Enter values in cells containing blue numbers ONLY.
ME in milk or milk replacer is calculated automatically.
Equations are valid for whole milk and ALL MILK milk replacers ONLY.
Written by Dr. Jim Quigley, Calf Notes.com. © 2009.
For more information see http://www.calfnotes.com

5.44 Mcal/d (22.56 MJ/d)

Calculation of ME in milk replacer and whole milk	Air dry	100% DM
Moisture	87.5%	12.5%
Ash	0.8%	6.3%
Crude protein, minimum	2.9%	22.8%
Crude fat, minimum	3.5%	28.0%
Crude fiber, maximum	0.00%	0.0%
Lactose	5.4%	42.9%
ME (Mcal/kg):	0.65	5.18
ME (MJ/kg):	2.71	21.67

Source: 2001 NRC Nutrient Requirements of Dairy Cattle. Chapter 10.
ME (Mcal/kg) = (0.057×CP + 0.092 × Fat + 0.0395 × Lactose) × 0.93
Lactose = 100 – Water – Ash – Fat – Protein

Instructions:
Enter values in cells containing blue numbers ONLY.
ME in milk or milk replacer is calculated automatically.
Equations are valid for whole milk and ALL MILK milk replacers ONLY.
Written by Dr. Jim Quigley, Calf Notes.com. © 2009.
For more information see http://www.calfnotes.com

5.20 Mcal/d (21.68 MJ/d)

-0.24 Mcal/d (-0.88 MJ/d)

Nutrition

	Calves at Thermoneutral Temperatures for		1	kg/d ADG	
Weight (lb)	Weight (kg)	MEm (MJ/day)	MEg (MJ/day)	Total Energy Required (MJ/day)	Mcal/d
99	45	7.3	13.6	**20.8**	4.98
110	50	7.9	14.1	**22.0**	5.25
132	60	9.0	15.0	**24.1**	5.75
154	70	10.1	15.9	**26.0**	6.22
176	80	11.2	16.7	**27.8**	6.65
198	90	12.2	17.4	**29.6**	7.07

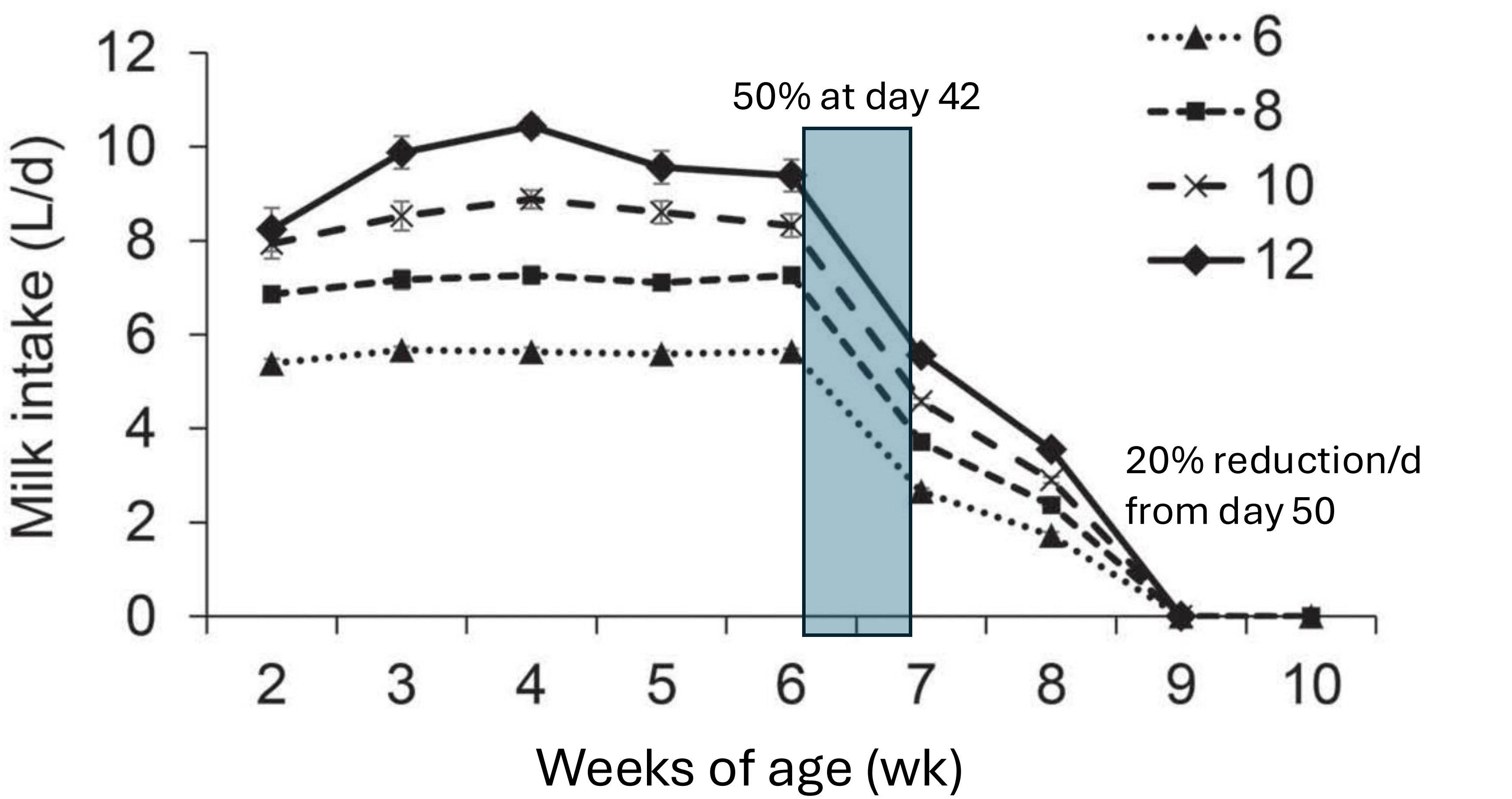
	Extra MEm (MJ) per day for calves 0-3 weeks old (50kg)	
	Temperature °C	**Extra MEm (MJ/day)**
59F	15	0.00
	10	1.06
	5	2.12
32F	0	3.17
	-5	4.23
	-10	5.29
5F	-15	6.35
	-20	7.41
	-25	8.46
-22F	-30	9.52

+ 20-30% for heat and cold stressors

+20% for Jersey calves

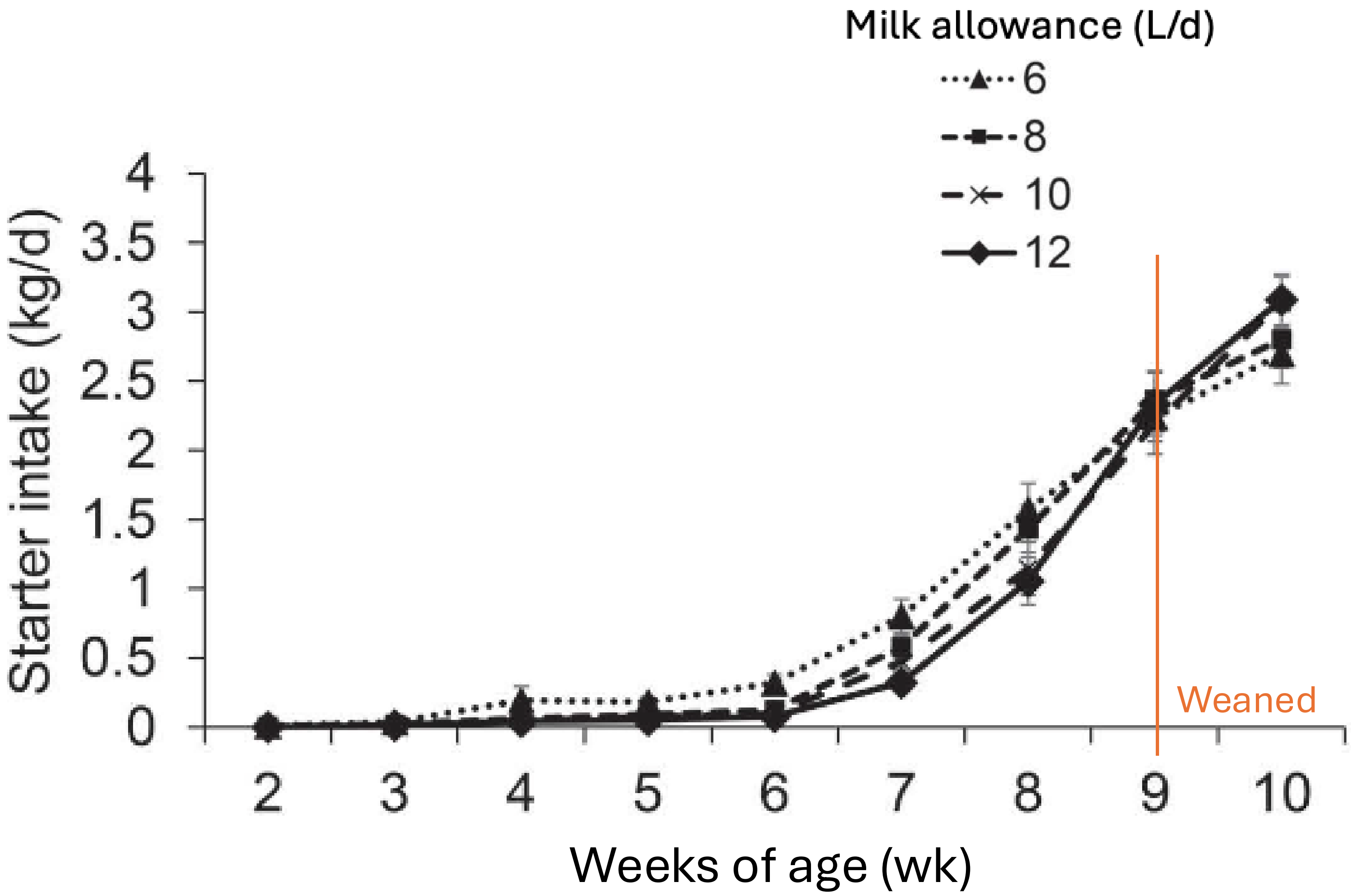
How much milk should we feed?

3.8% BF, 3.2% PT



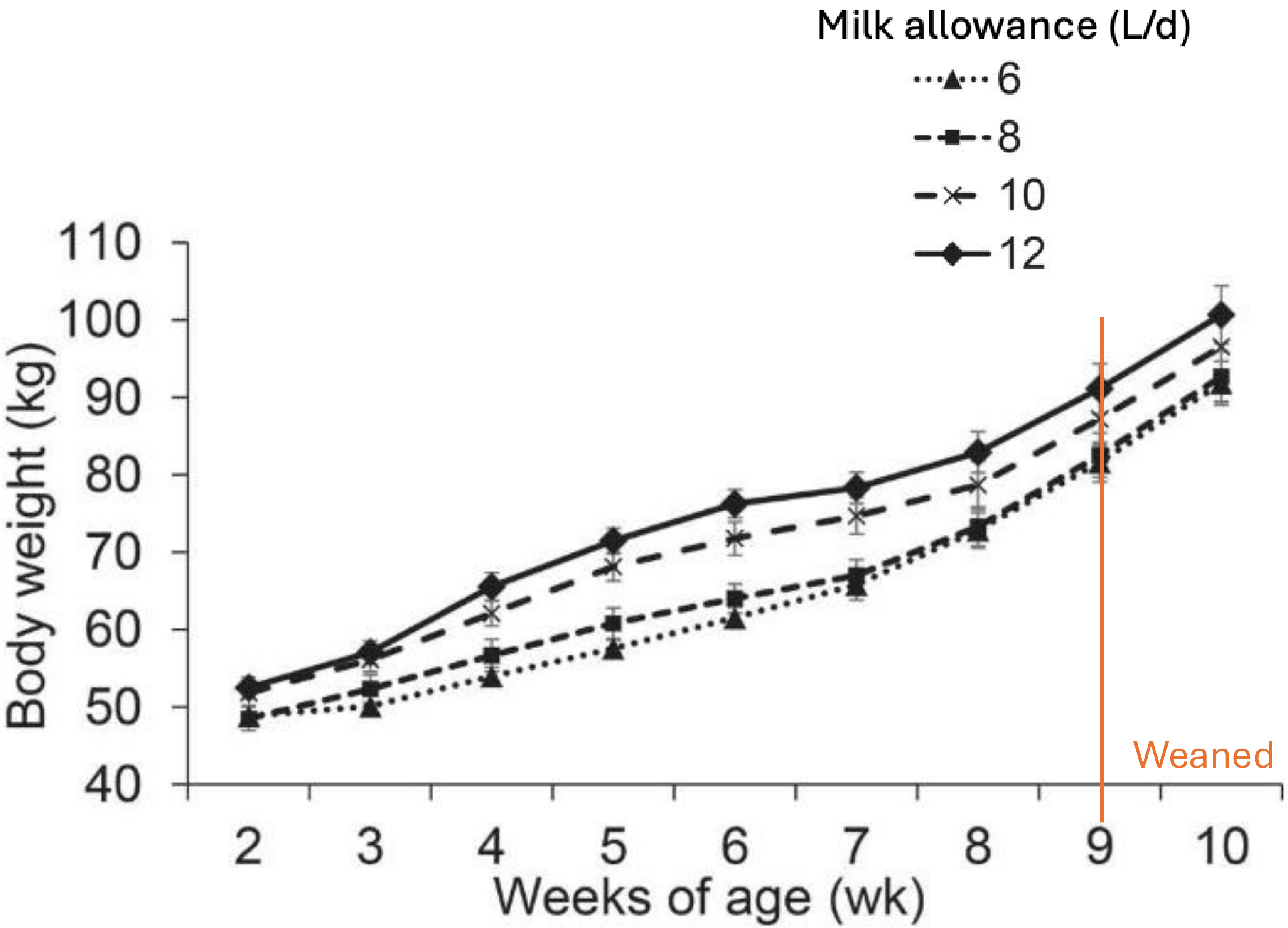
Rosenberger et al., 2017

How much milk should we feed?



Rosenberger et al., 2017

How much milk should we feed?



Rosenberger et al., 2017

How much milk should we feed?

	6 L	8 L	10 L	12 L	*P* value
Preweaning ADG (kg/d)	0.58	0.57	0.65	0.88	0.002
Weaning ADG (kg/d)	0.91	0.89	0.89	0.80	0.51
Postweaning ADG (kg/d)	1.27	1.23	1.32	1.26	0.83

Rosenberger et al., 2017

How much milk should we feed?

	6 L	8 L	10 L	12 L	*P* value
Preweaning ADG (kg/d)	0.58	0.57	0.65	0.88	0.002
Weaning ADG (kg/d)	0.91	0.89	0.89	0.80	0.51
Postweaning ADG (kg/d)	1.27	1.23	1.32	1.26	0.83
Unrewarded visits (#/d)	11.1	3.6	1.7	0.4	< 0.001

Rosenberger et al., 2017

How much milk should we feed?

	6 L	8 L	10 L	12 L	*P* value
Preweaning starter intake (kg/d)	0.3	0.1	0.1	0.05	<0.001
Weaning starter intake (kg/d)	1.2	1.0	0.7	0.5	< 0.01
Postweaning starter intake (kg/d)	2.7	2.8	2.9	2.9	0.13

Rosenberger et al., 2017

How much milk should we feed?

Higher planes of nutrition are associated with improved performance

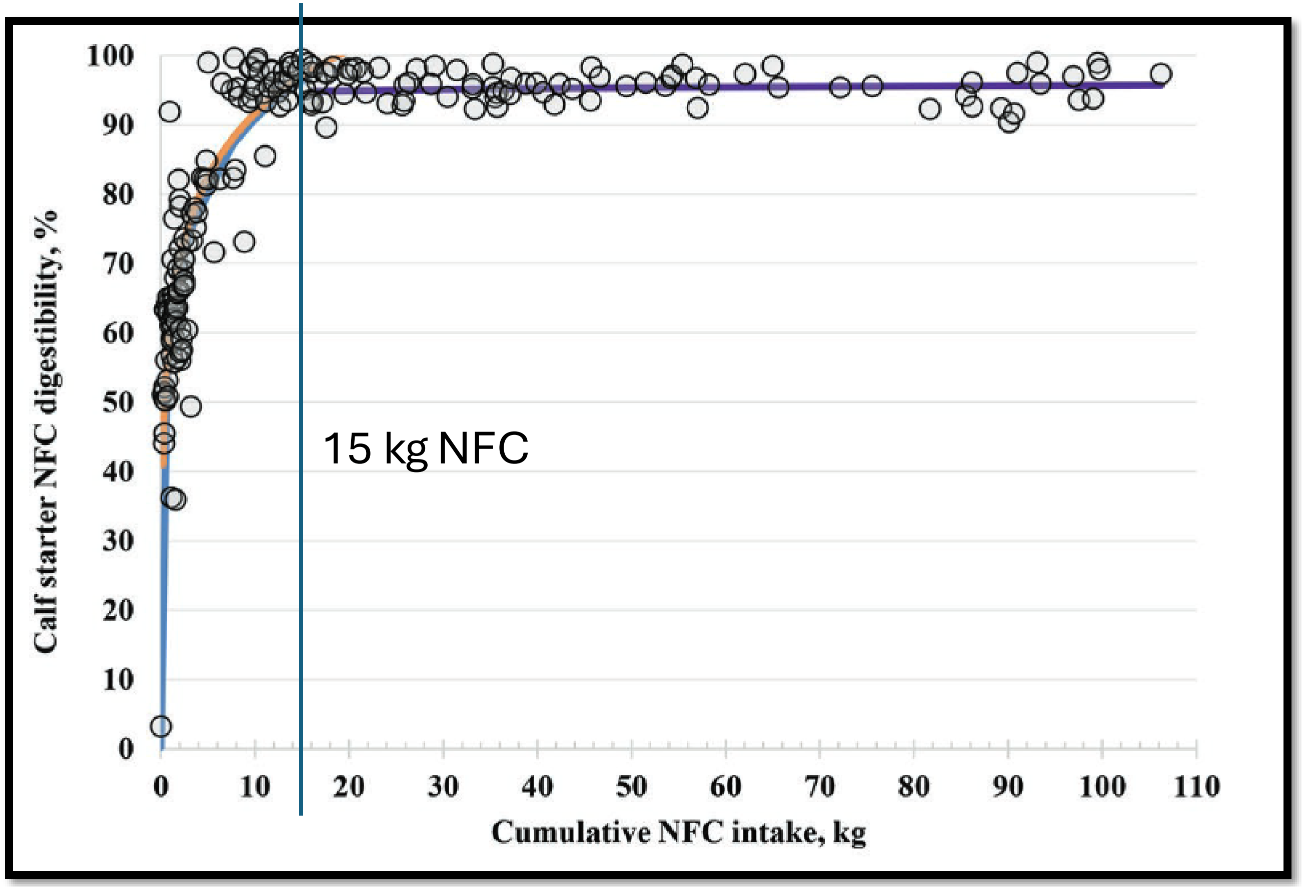
In the first month of life calves:

- Unable to consume large amounts of solid feed
- Have reduced digestibility of nutrients in calf starter
- Do not actually absorb the ME as listed on calf starter

Terré et al., 2007; Hill et al., 2016; Chapman et al., 2016; Quigley et al., 2018

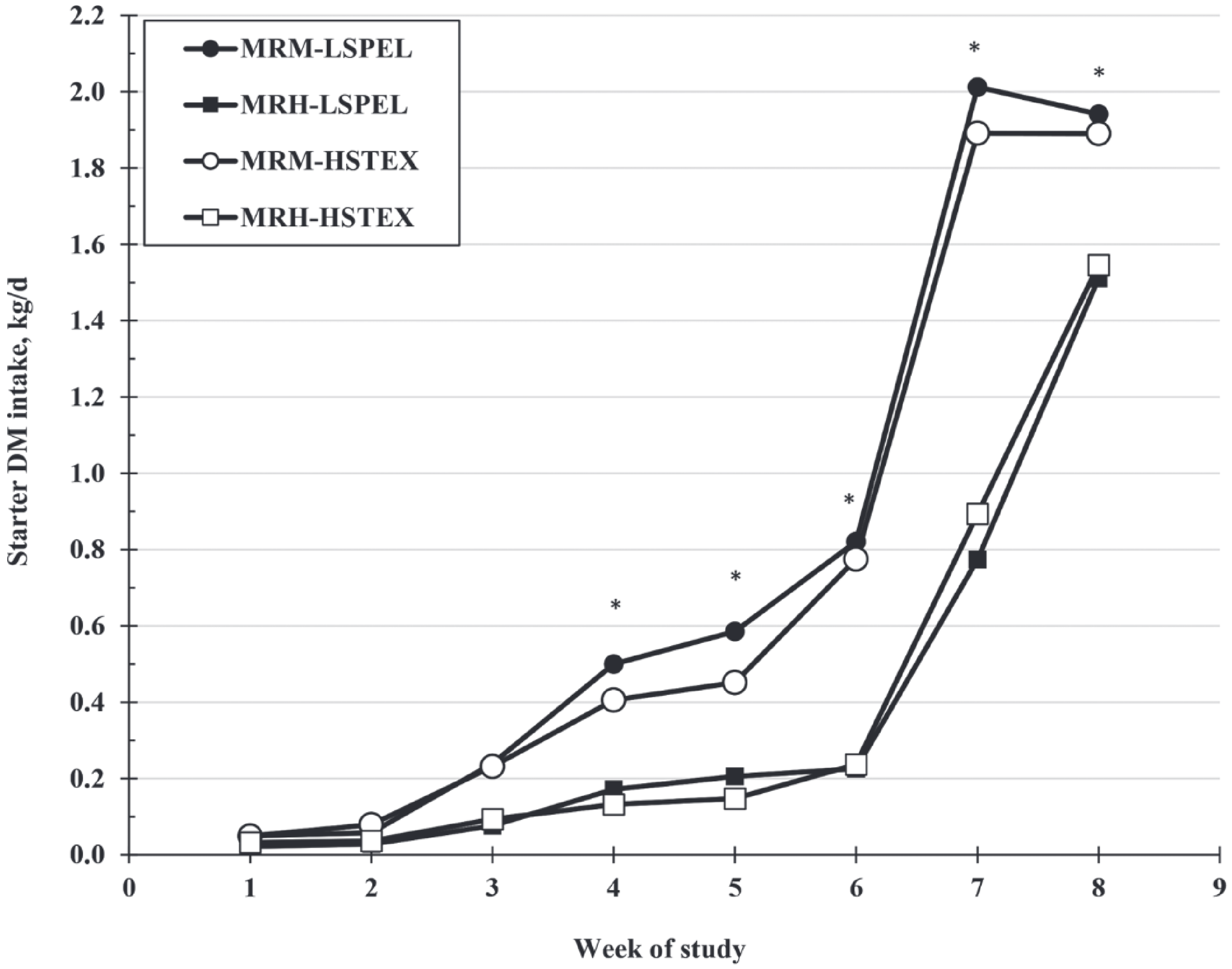
How much milk should we feed?

Digestibility of nutrients in calf starter (especially starch and NDF) is low in young calves and increases with age and starter intake



27 kg total starter intake at 55% NFC

Quigley et al., 2019



Do different milk feeding strategies need different calf starters?

Quigley et al., 2018

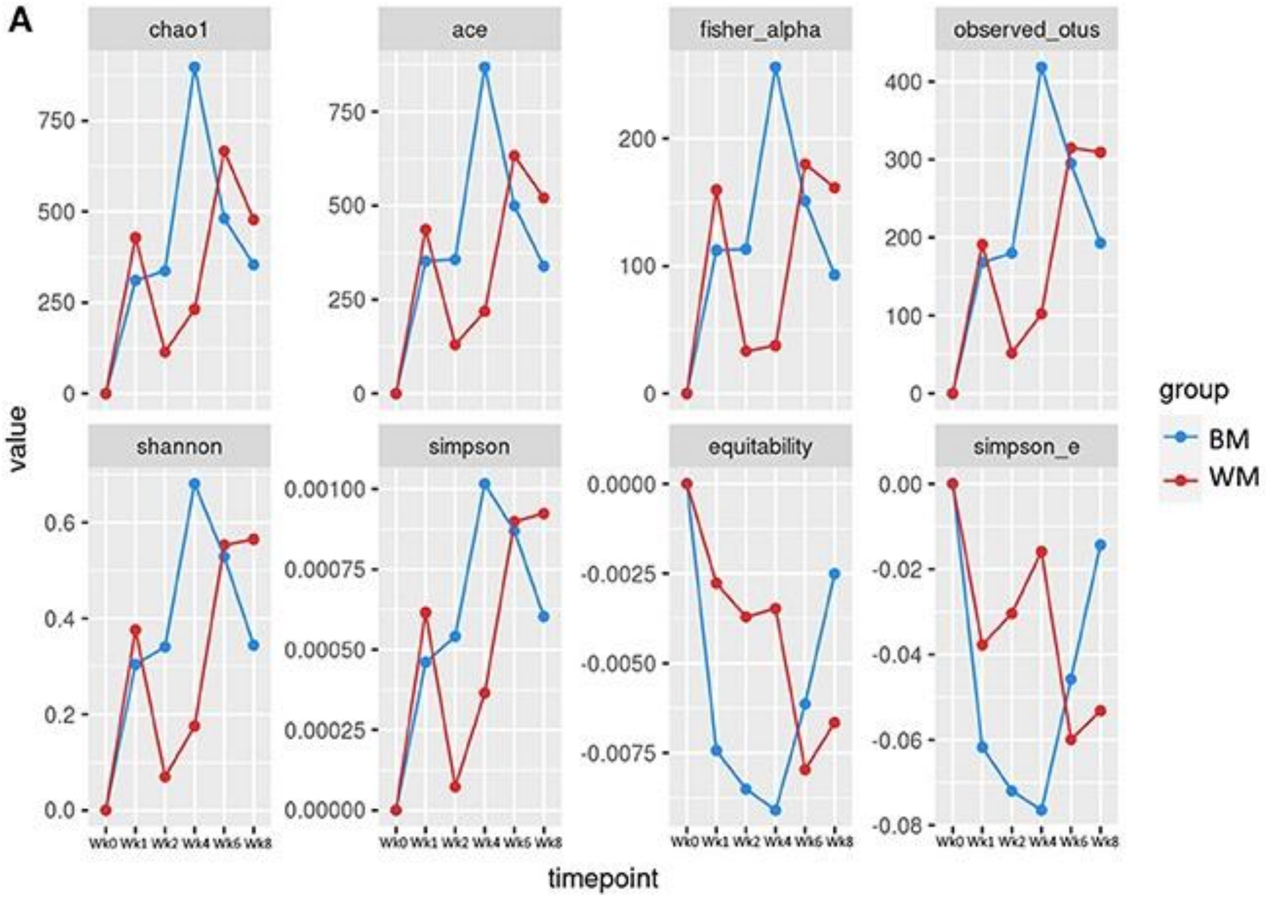
Successful weaning

- At least 8 weeks of age
- Step-down protocol
  - More than 2 weeks
  - Multiple steps
- Starter intake of 1.3 kg/d (~3 lb/d)
  - 60% microbial protein

Should we feed waste milk?

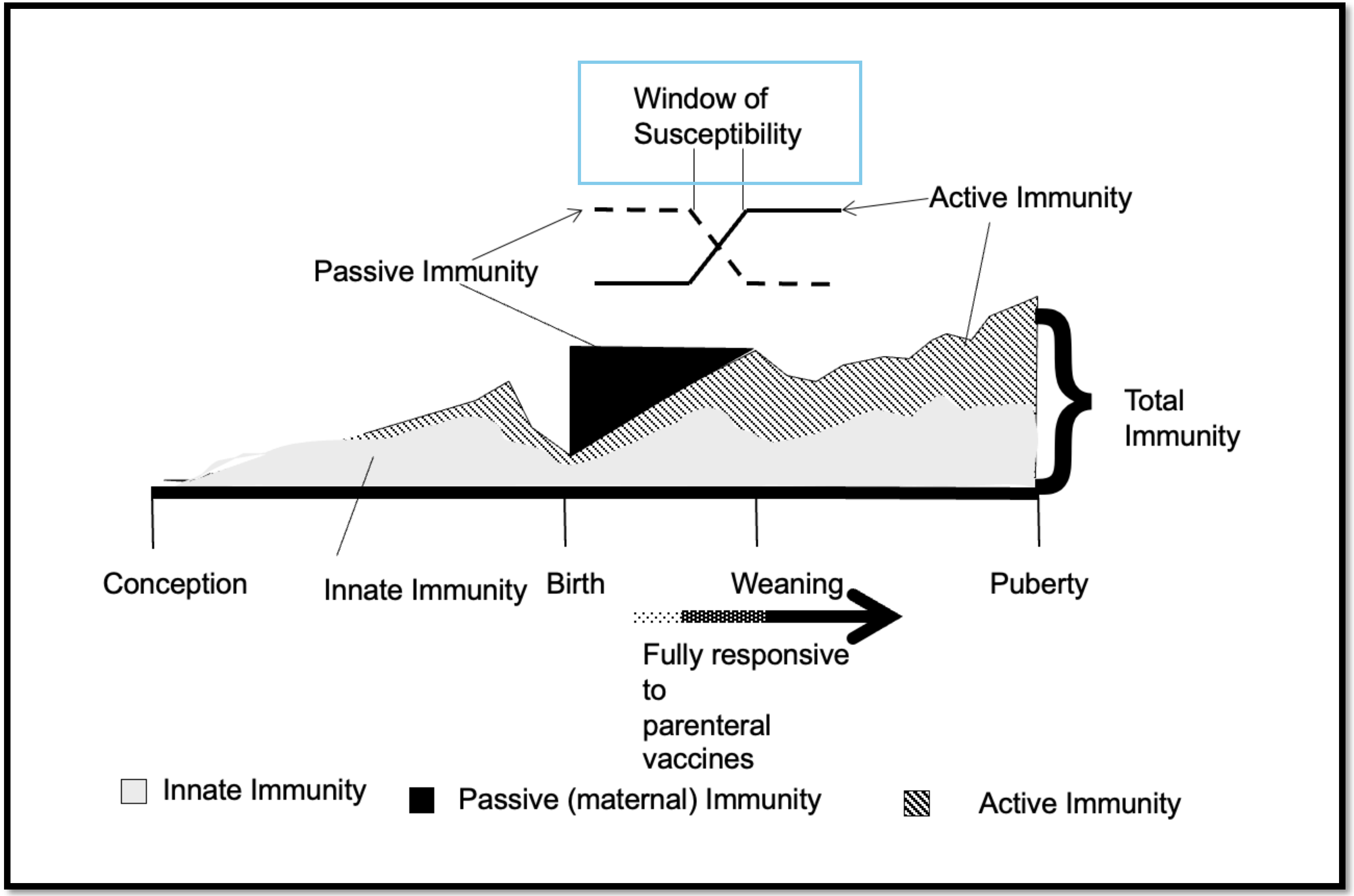
Higher level of diarrhea

Altered fecal microbiome (loss in diversity)

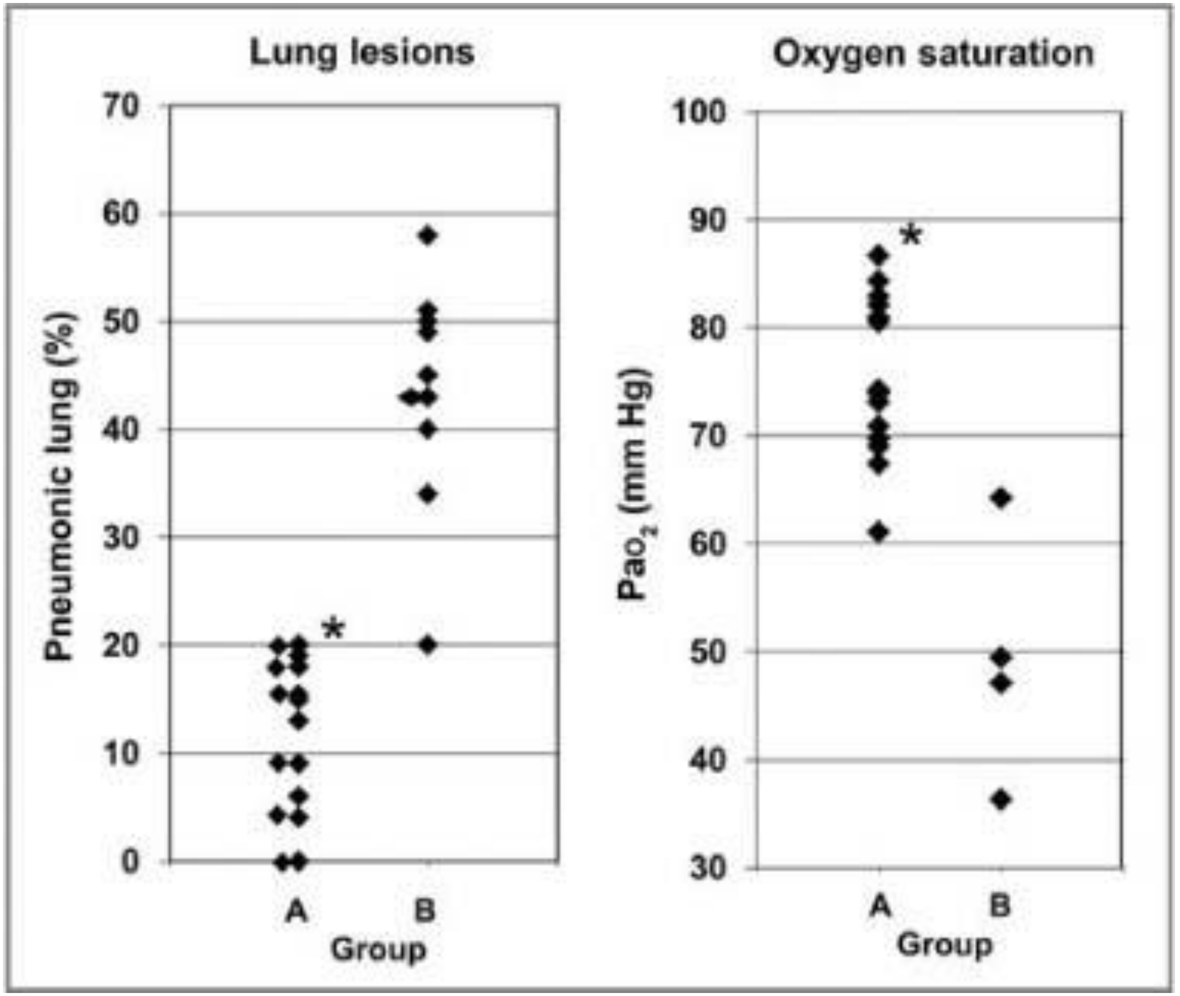


Penati et al., 2021

Vaccinations



Vaccinations



Stimulate mucosal immune system

No maternal antibody interference

Short duration of immunity (~9-12 wk)

Stoltenow et al., 2011; Ellis et al. 2013; Chamorro et al., 2016

Vaccinations

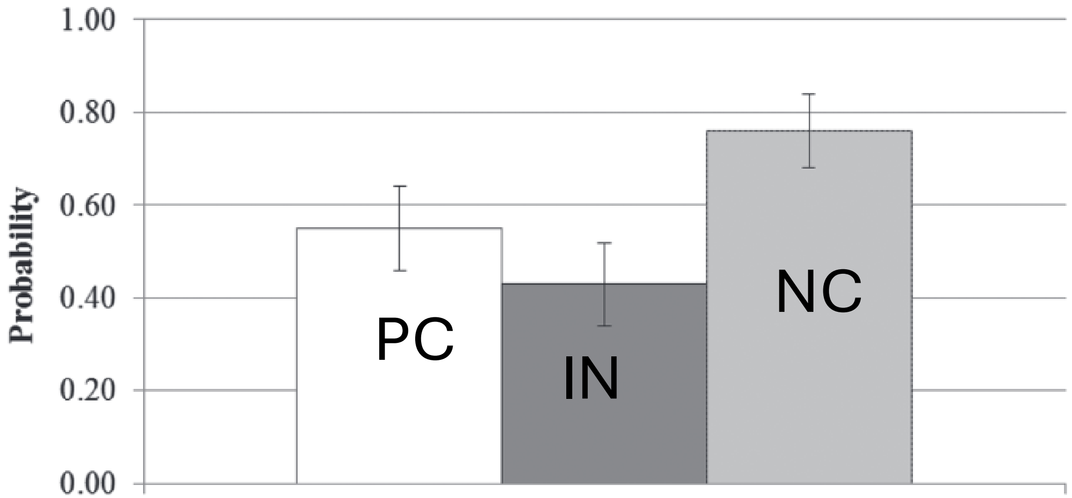
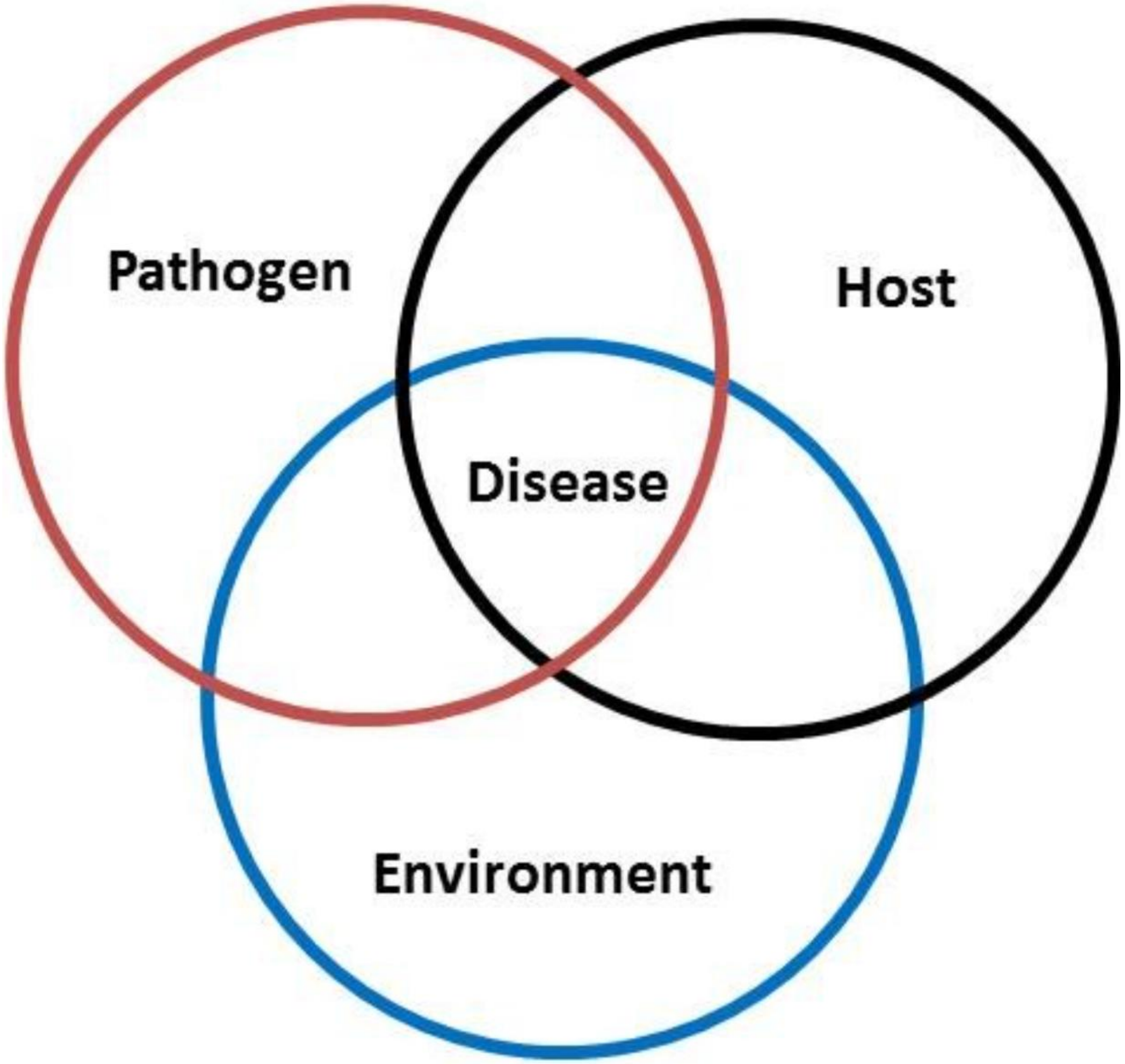


Figure 1. Predicted probability of CON by vaccine protocol after controlling for herd, dystocia, and rib fractures. Error bars represent SEM. CON = occurrence of ≥3 cm lung consolidation at least once in the study period. PC = white; IN = dark gray; NC = light gray. PC = positive control: 2 mL of commercially available multivalent injectable vaccine against bovine respiratory syncytial virus (BRSV), infectious bovine rhinotracheitis (IBR), parainfluenza 3 (PI_3), and bovine viral diarrhea administered subcutaneously at 6 wk of age. IN = intranasal treatment: 2 mL of commercially available trivalent injectable vaccine against BRSV, IBR, and PI_3 administered intranasally at 3 to 6 d and 6 wk of age. NC = negative control: 2 mL of sterile saline administered both intranasally and subcutaneously at 3 to 6 d and 6 wk of age.

Lower probability of lung consolidation in calves given intranasal vaccine (field-based)

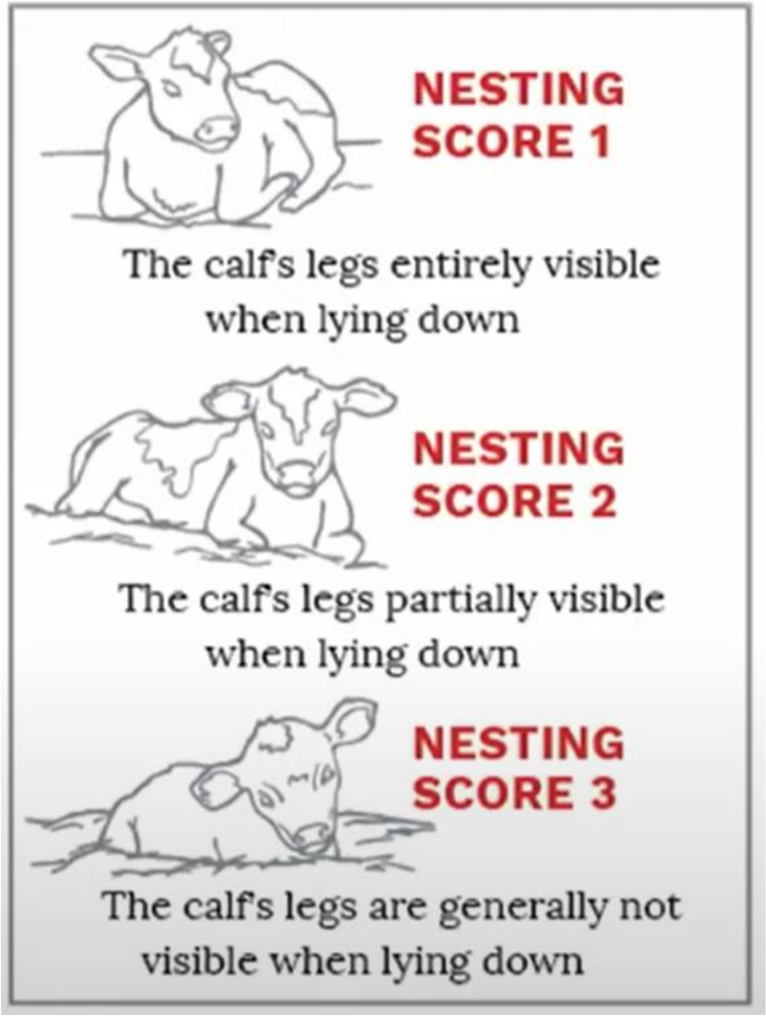
Ollivett et al. 2018


Pathogen
Host
Disease
Environment

Environment

How do we optimize the environment for calves?

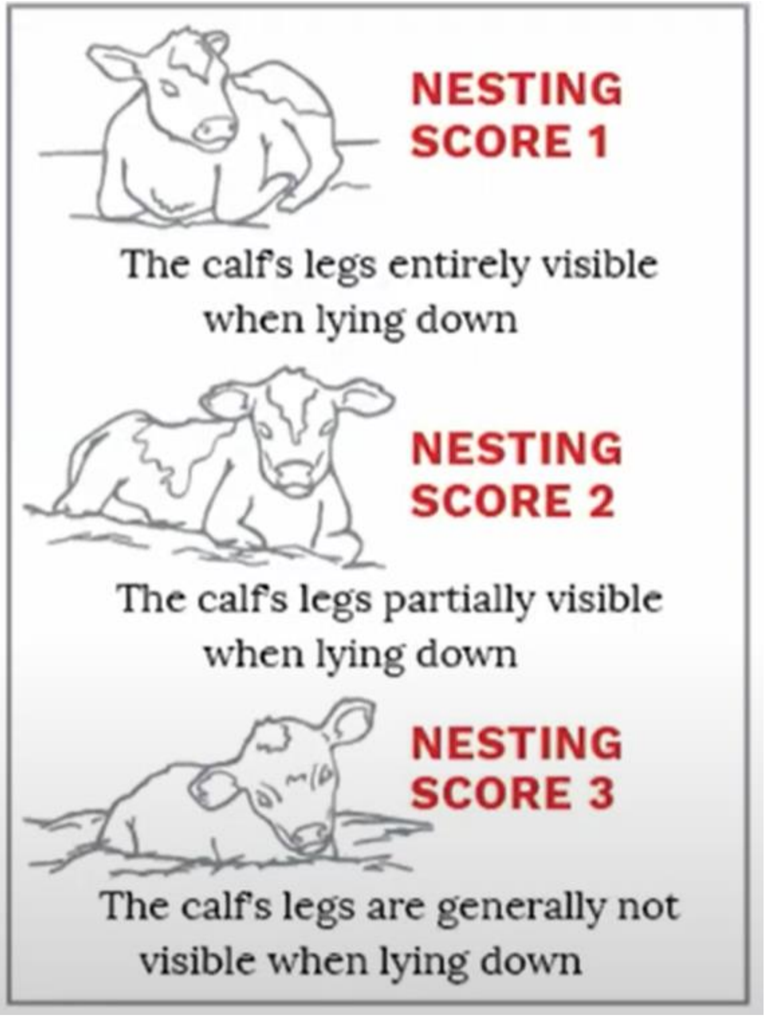
Environment



Norlund, 2008

- Thermoneutral zone of calves:
- 0-1 month: 10-25ºC (50-78ºF)
- > 1 month: 0-25ºC (32-78ºF)

Environment



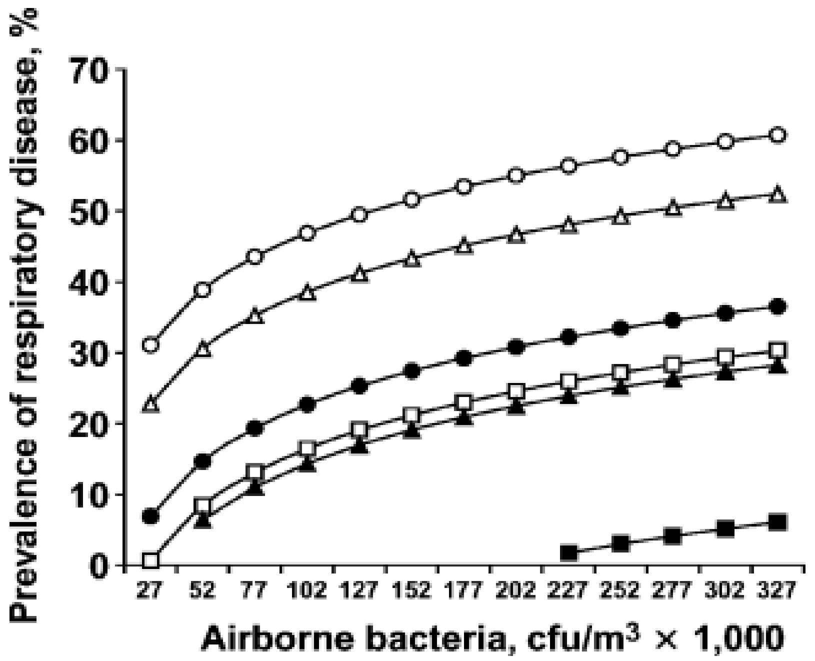


Figure 2. Model of the association between airborne bacterial concentration and prevalence of calf respiratory disease with different combinations of nesting scores and the presence or absence of a solid barrier between each pen. Nesting scores: 1 = legs visible above bedding when lying down; 2 = legs partially visible; 3 = legs not visible. Nesting score 3 and presence of a solid barrier (■); nesting score 3 and absence of a solid barrier (□); nesting score 2 and presence of a solid barrier (▲); nesting score 2 and absence of a solid barrier (△), nesting score 1 and presence of a solid barrier (●); and nesting score 1 and absence of a solid barrier (○).

Journal of Dairy Science Vol. 89 No. 10, 2006

- ● Score 1
- ▲ Score 2
- ■ Score 3

Lago et al., 2006

Environment

Minimize shared air

- Sharing air with weaned animals up to 8 months old = 3.2 times greater odds for within-pen prevalence of BRD

Improve drainage

- Inadequate drainage can lead to high levels of ammonia and humidity

Medrano-Galarza et al., 2018
Norlund and Halbach, 2019

Environment

Minimize crowding

- 45 ft^2 per calf in group-housed calves ideal, 35 ft^2 minimum
- Group sizes small at ideally less than 7 calves

Minimize dust

- Choose low-dust beddings → 42% less BRD in calves
- Fine particulate matter = increased odds of lung consolidation

Svensson, et al., 2003
James, et al., 2017
Dubrovsky et al., 2019
Van Leenen et al., 2021

Environment

4 air changes per hour (ACH) in winter

- Air speed less than 60 ft/min

40+ ACH in summer

Keep relative humidity 55-75%

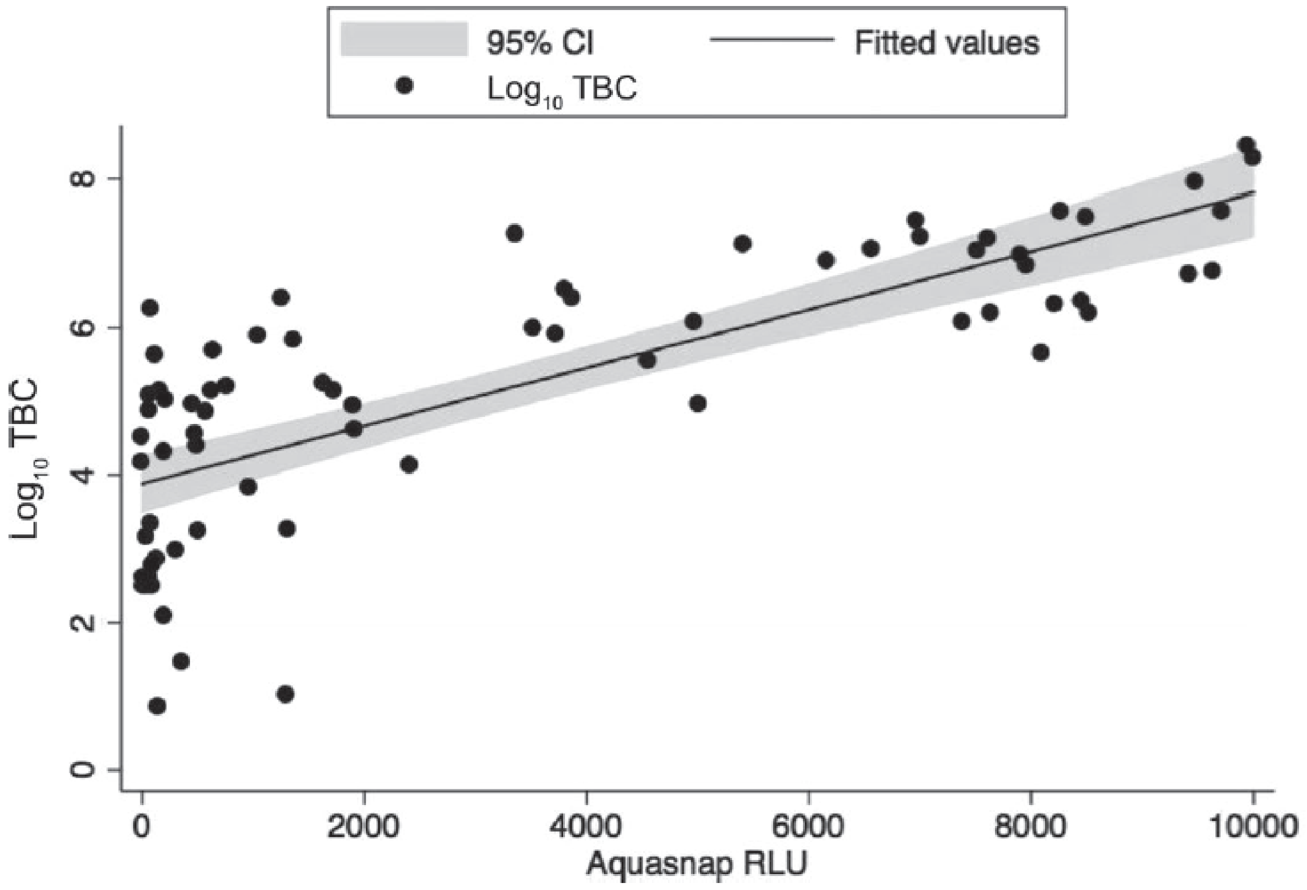
Environment – Cleanliness

Evaluate feeding equipment hygiene with a luminometer

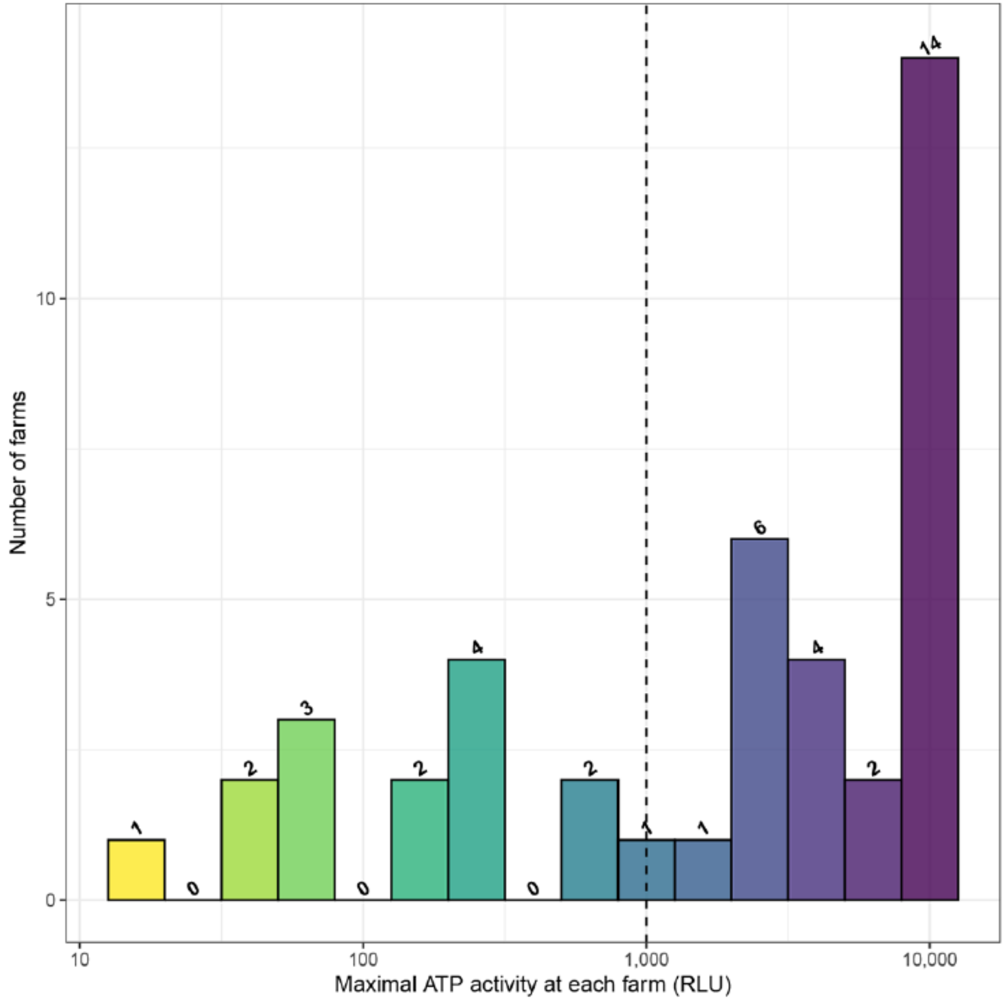
Feeding milk with >100,000 cfu/mL total bacteria and/or >10,000 cfu/mL coliform bacteria increases risk for BRD

Jorgensen et al., 2017

Environment – Cleanliness

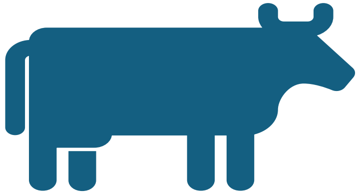


Renaud et al., 2017



Buczinski et al., 2022

Takeaways



Maximize host defenses in utero by managing the dam

Maximize host defenses ex utero with colostrum, nutrition, and vaccination

Optimize environment and hygiene

Farms with successful calf rearing do the basics well

Questions?

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