



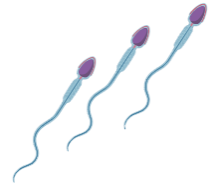
Investigating the long-term impacts of lung consolidation, diagnosed at weaning, in cattle

Ingrid L. B. Fernandes

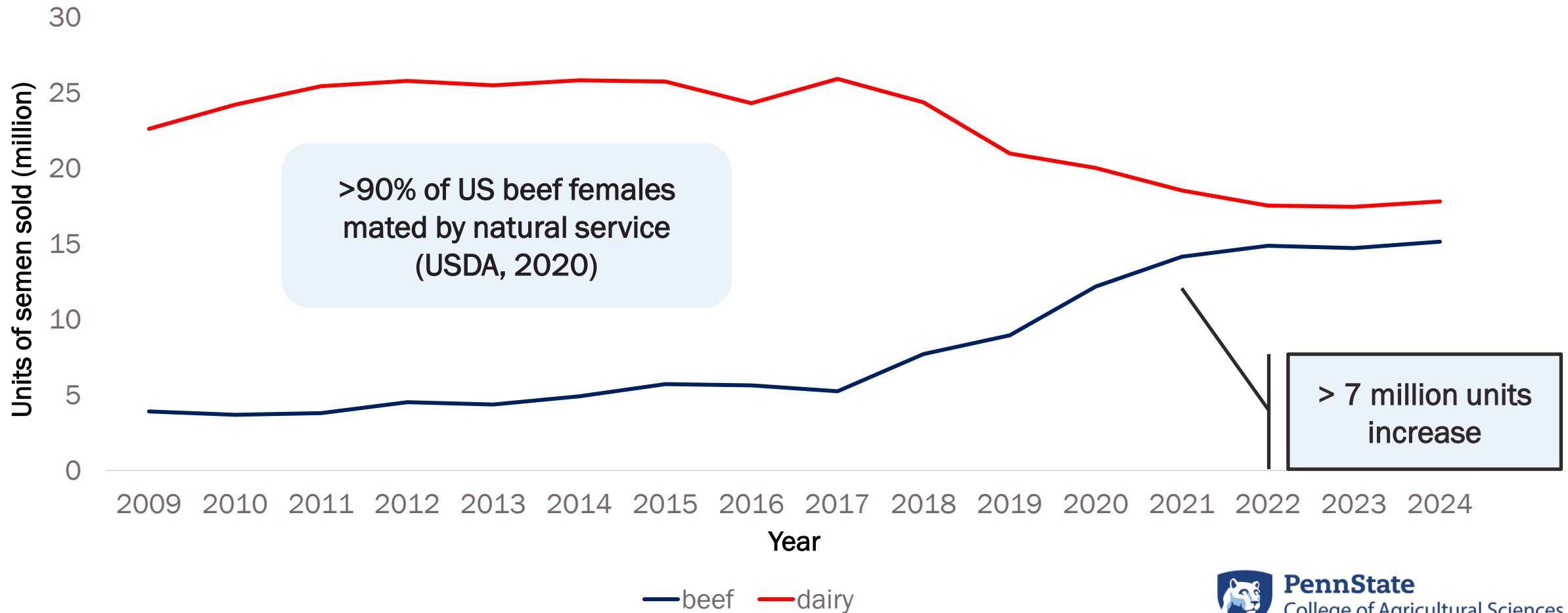
October 28, 2025



U.S. Domestic semen sales

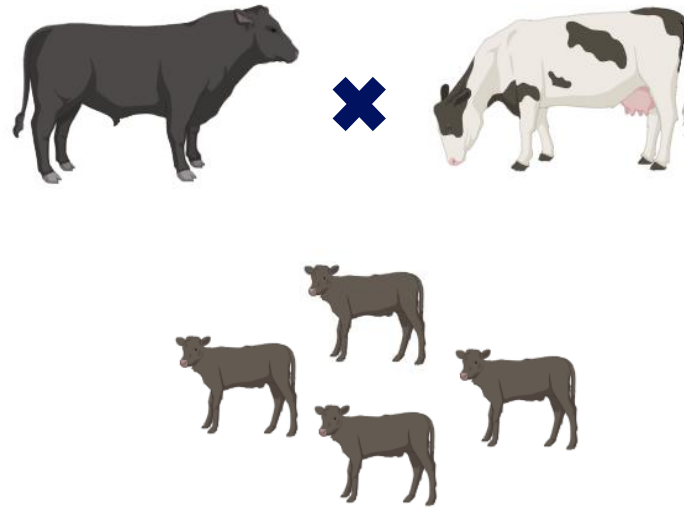


Units of domestic beef and dairy semen sold / year

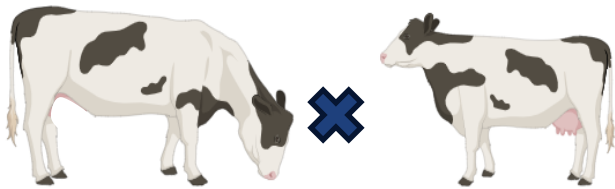


Recent increase in beef x dairy production

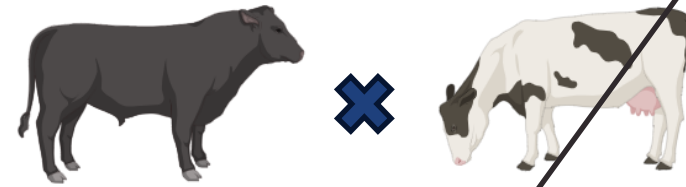
- ~20% of fed cattle



Beef × dairy value



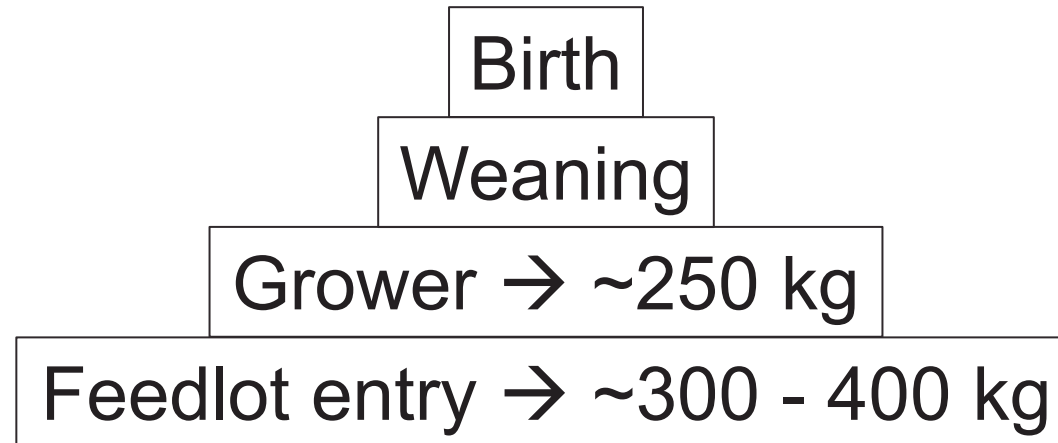
75 – 110 lbs
\$700 – 1,000



65 – 110 lbs
\$1,000 – 1,500

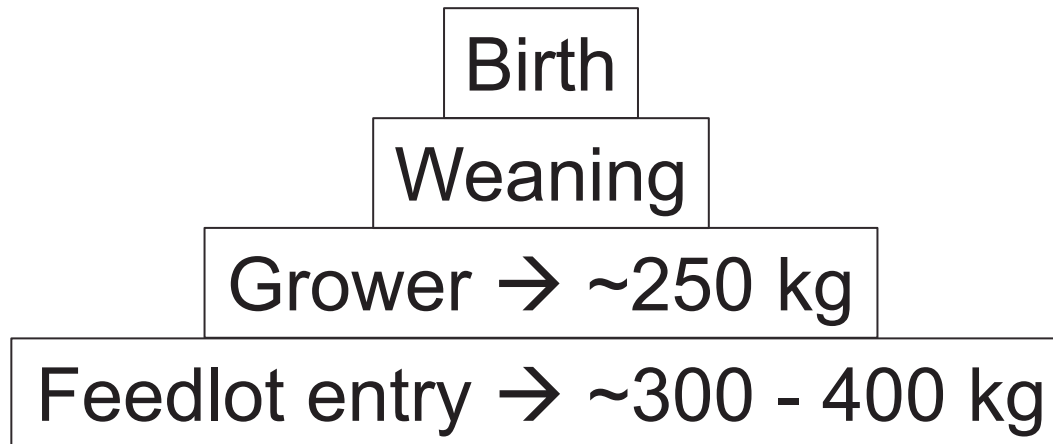
Market sale points

Multiple ownership changes

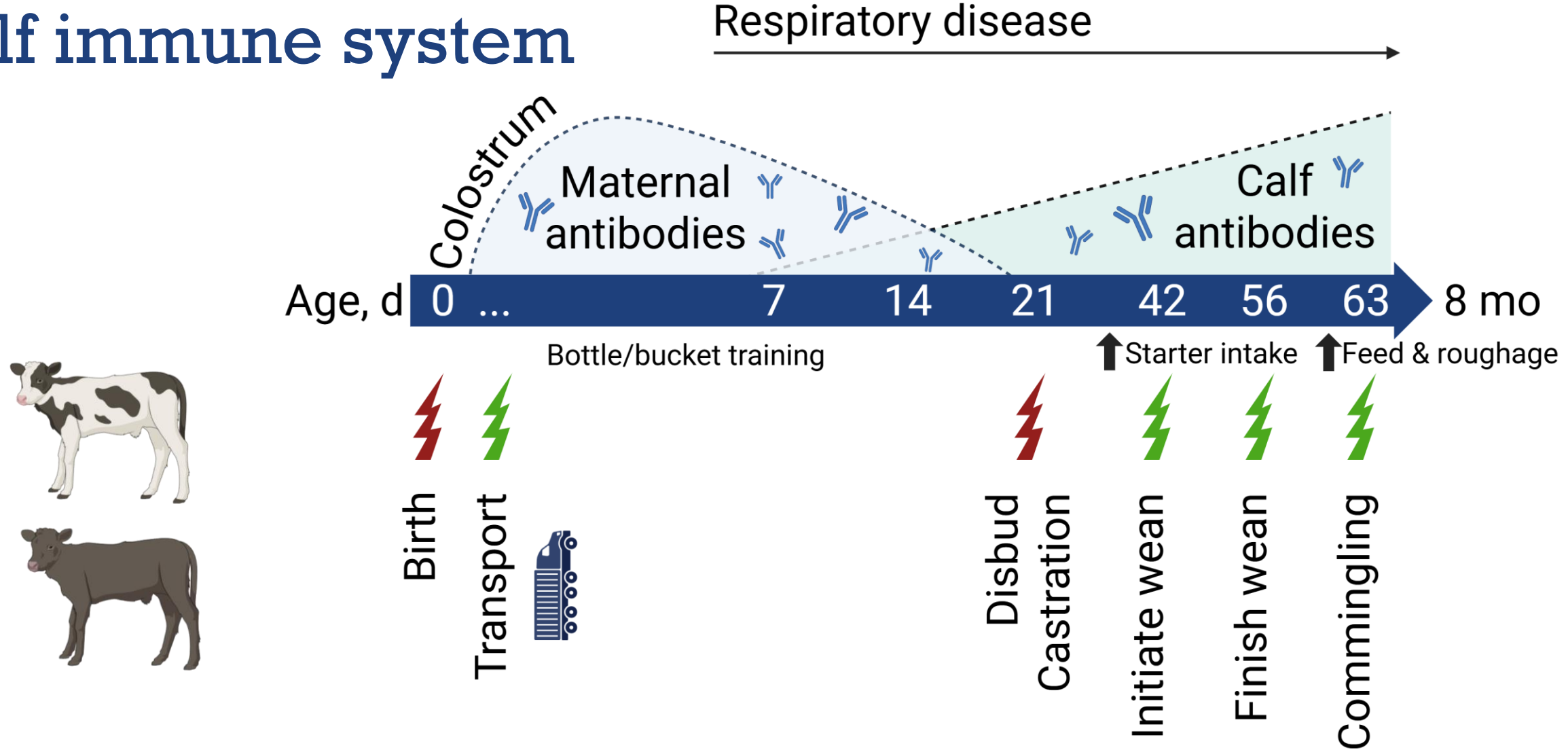


Market sale points

Multiple ownership changes

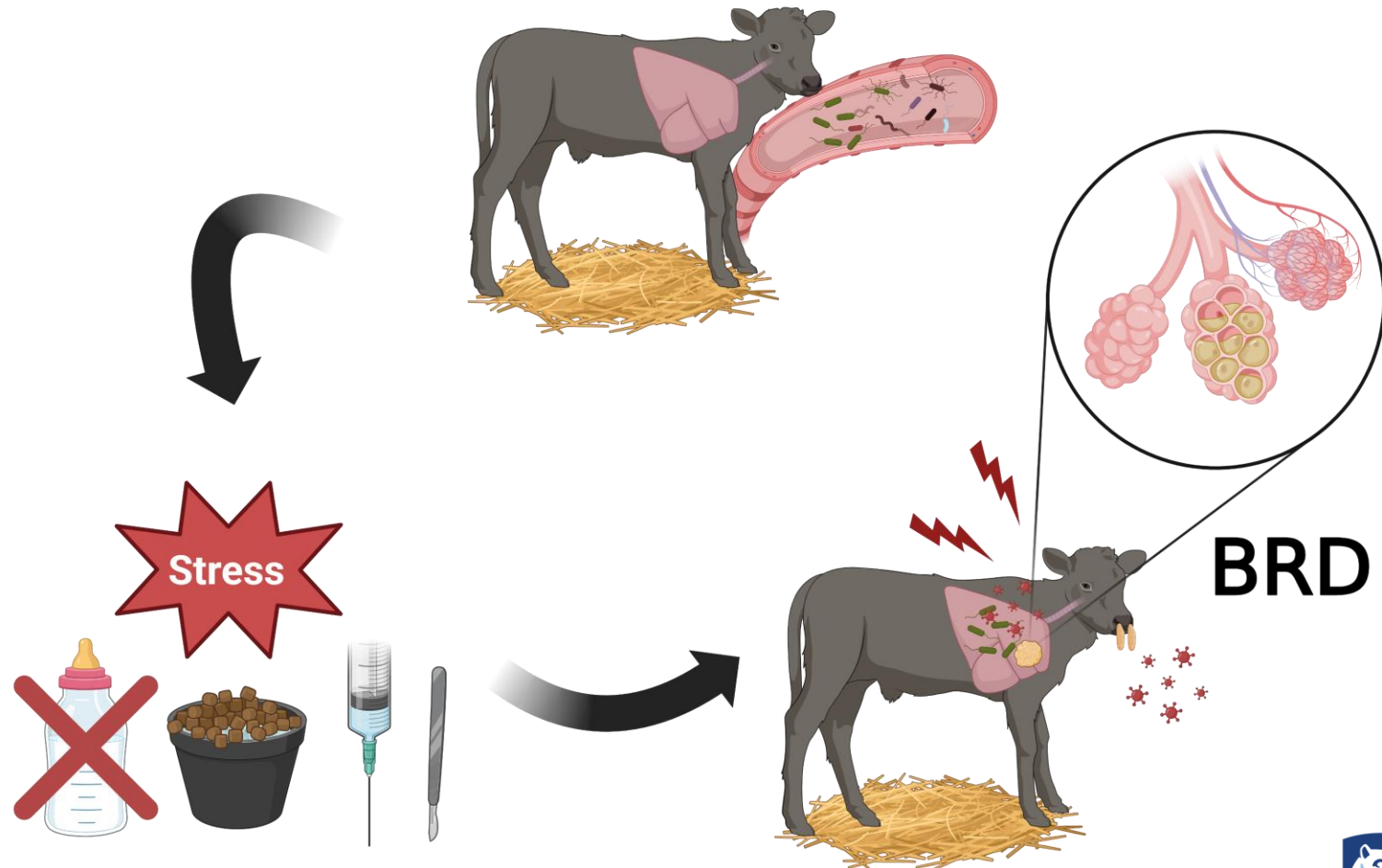


Calf immune system



Bovine Respiratory Disease is complex

Healthy



Urie et al., 2018
Dubrovsky et al., 2019

What are the stressors that contribute to BRD?

Dietary
changes

Castration

Comingling

Transportation

Dehydration

Dehorning

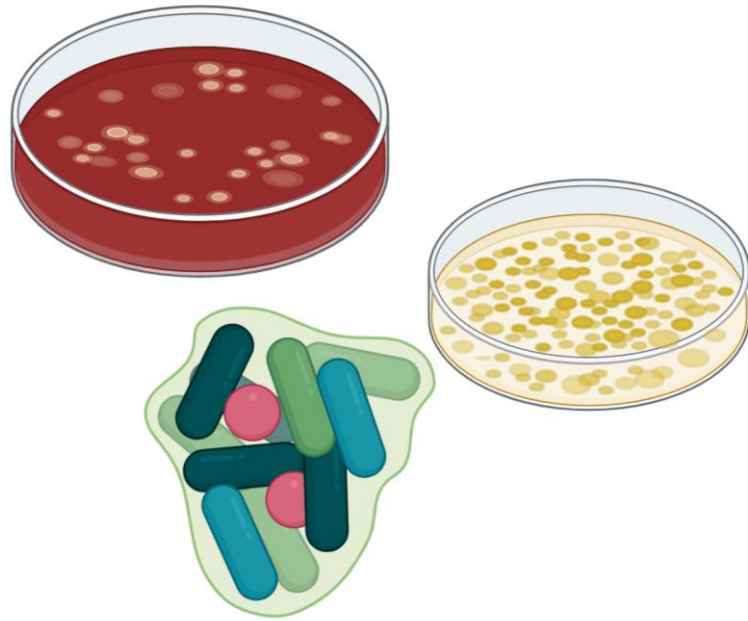
Weaning

Vaccination

Handling



Causative pathogens are commensal



Histophilus somni

Pasteurella multocida

Mannheimia haemolytica

Mycoplasma bovis

Bibersteinia trehalosi

Centeno-Martinez et al., 2022

Timsit et al., 2017

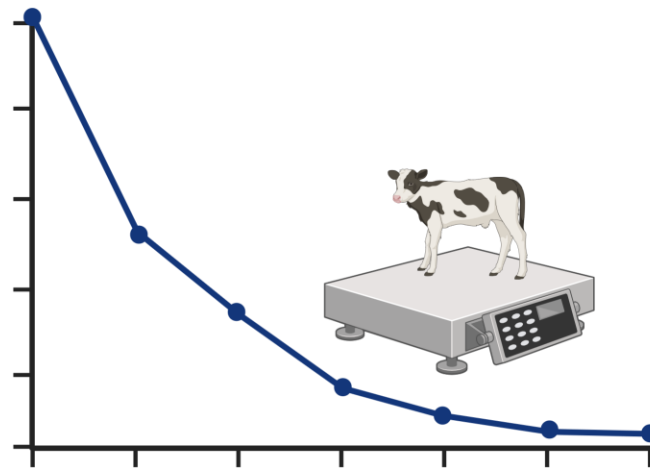
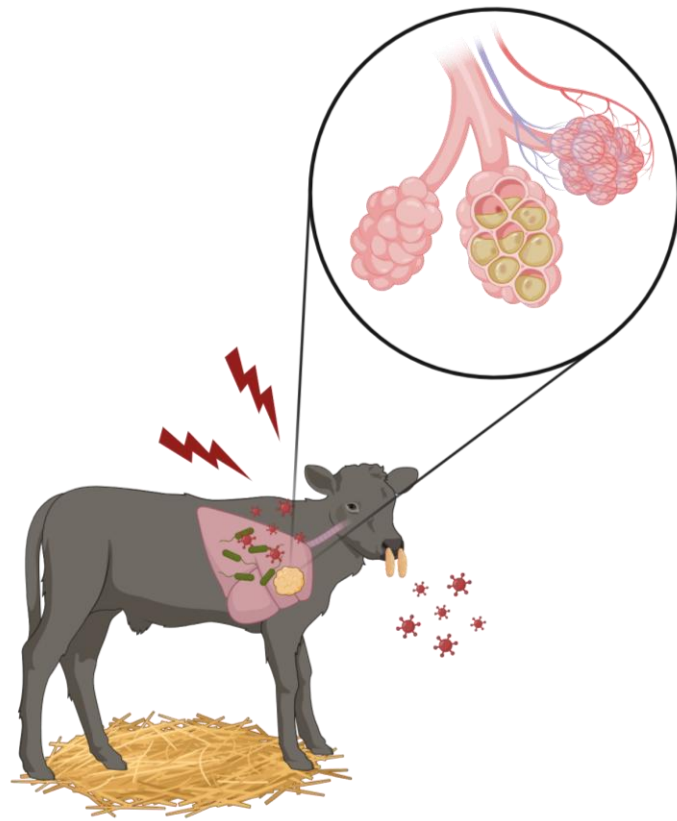
Francoz et al., 2015

Klima et al., 2019

Kudirkiene et al., 2021

Jourquin et al., 2023

Associated with higher odds of showing clinical signs



Francoz et al., 2015

Histophilus somni

Pasteurella multocida

Mannheimia haemolytica

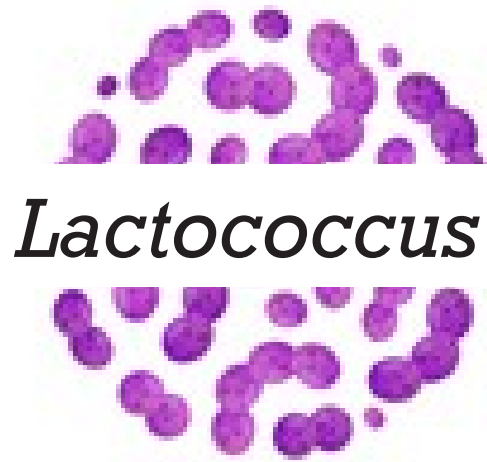
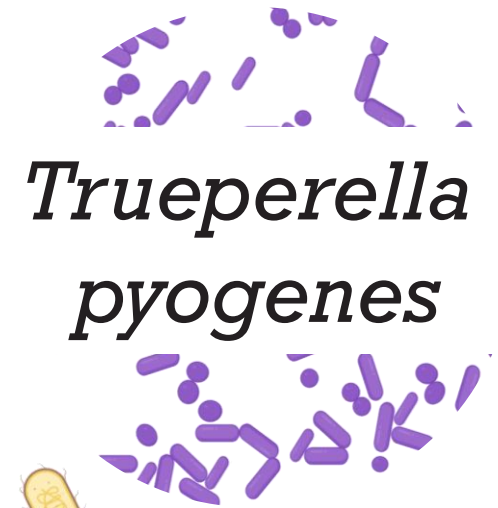
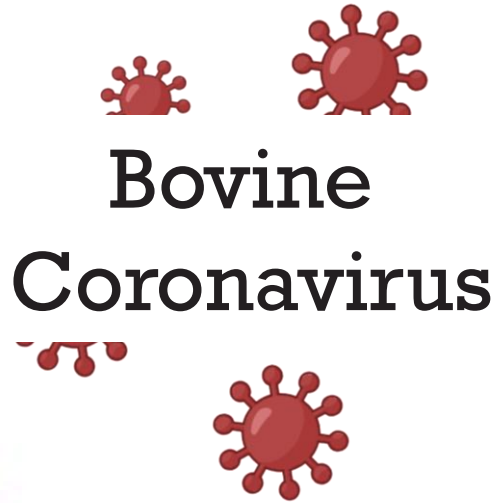
Mycoplasma bovis

Bibersteinia trehalosi



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Other organisms isolated from the respiratory tract



Kudirkiene et al., 2021
Timsit et al., 2017
Raabis et al., 2021

Clinical signs of BRD

- Ear tilt
- Cough
- Heavy breathing
- Ocular or nasal discharge



Scoring systems have been developed

CLINICAL SIGN	SCORE IF NORMAL	SCORE IF ABNORMAL (ANY SERVERITY) ⁴
Eye discharge	0 	2  Or  Or 
Nasal discharge	0 	4  Or  Or 
Ear droop or Head tilt	0 	5  Or  Or 
Cough	0 No cough	2 Spontaneous cough
Breathing	0 Normal	2 Rapid or difficult breathing
Temperature	0 < 102.5° F	2 ≥ 102.5° F



Add scores for all clinical signs, if total score is ≥ 5, calf may be positive for bovine respiratory disease³

1. Love WJ, Lehenbauer TW, Kass PH, Van Eenennaam AL, Aly SS. (2014) Development of a novel clinical scoring system for on-farm diagnosis of bovine respiratory disease in pre-weaned dairy calves. PeerJ 2:e238 <https://peerj.com/articles/238>.

2. Aly SS, Love WJ, Williams DR, Lehenbauer TW, Van Eenennaam AL, Drake C, Kass PH, Farver TB. (2014) Agreement between bovine respiratory disease scoring systems for pre-weaned dairy calves. Animal Health Research Reviews 15: 2 Pages 148-150 http://journals.cambridge.org/repo_A94A150

3. Love WJ, Lehenbauer TW, Van Eenennaam AL, Drake CM, Kass PH, Farver TB, Aly SS. Sensitivity and specificity of on-farm scoring systems and nasal culture to detect bovine respiratory disease complex in preweaned dairy calves. J Vet Diagn Invest. 2016 Mar;28(2):219-28. <http://www.ncbi.nlm.nih.gov/pubmed/26796957>

4. Any abnormality including, but not limited to, the examples shown in the above pictures.

CALIF; positive if total score ≥5

Scoring systems have been developed

Calf Health Scoring Criteria			
0	1	2	3
Rectal temperature			
100-100.9	101-101.9	102-102.9	≥103
Cough			
None	Induce single cough	Induced repeated coughs or occasional spontaneous cough	Repeated spontaneous coughs
Nasal discharge			
Normal serous discharge	Small amount of unilateral cloudy discharge	Bilateral, cloudy or excessive mucus discharge	Copious bilateral mucopurulent discharge
			
Eye scores			
Normal	Small amount of ocular discharge	Moderate amount of bilateral discharge	Heavy ocular discharge
			
Ear scores			
Normal	Ear flick or head shake	Slight unilateral droop	Head tilt or bilateral droop
			

WISC; ≥2 categories with scores of ≥2



credit: Gillian Plaugher



Thoracic lung ultrasonography: gold standard diagnostics

Sensitivity

Scoring clinical signs

72%

Thoracic ultrasonography
Lung consolidation (LC)

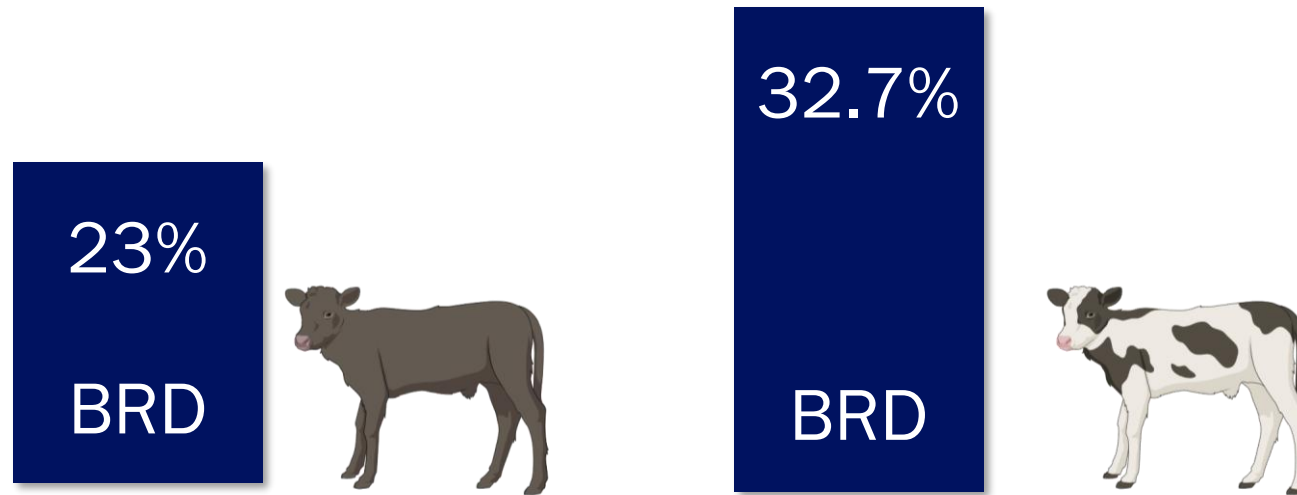
94%

More likely to diagnose BRD

Buczinskiet et al., 2015
Buczinskiet et al., 2018
Lowie et al., 2022
Jourquin et al., 2023

Bovine Respiratory Disease mortality

1995 - 2015



Historically BRD causes economic losses

Calf death loss

\$1,000 / head

\$213
million/year

Medication / labor / ADG

\$42.15 / head

2025?

Lung consolidation $\geq 3 \text{ cm}^2$ reduced ADG

Cuevas-Gómez et al., 2021

-0.12 kg/d

Rhodes et al., 2021

-0.126 kg/d

Long-term?



Pre-weaned dairy calves





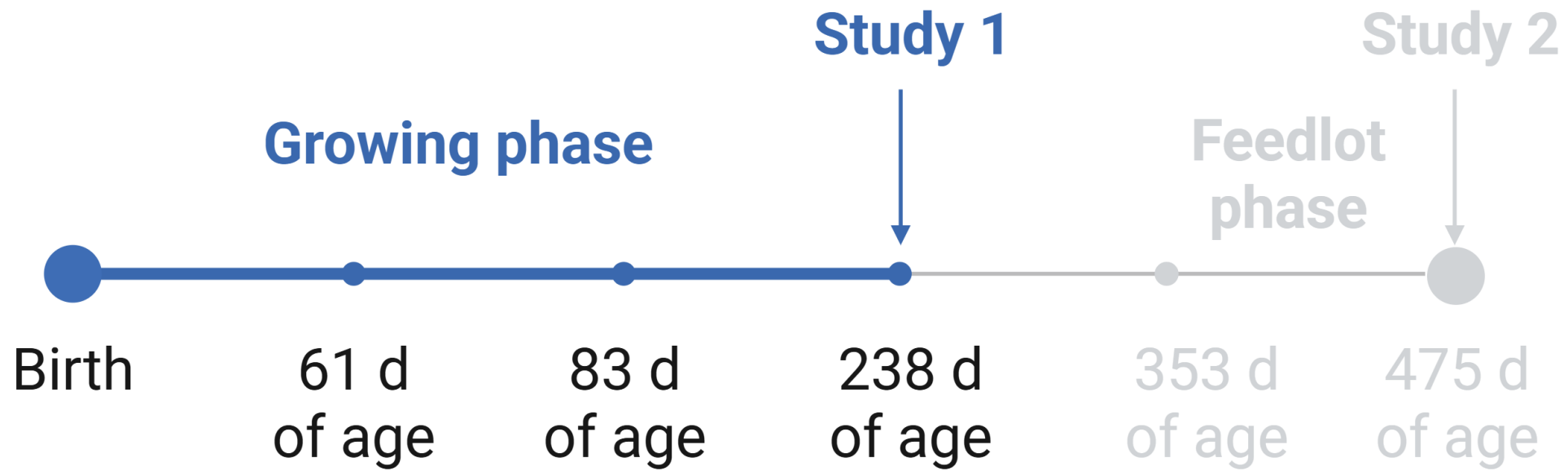
Research

The association of lung consolidation and respiratory pathogens identified at weaning on the growth performance of beef-on-dairy calves

I.L.B. Fernandes¹, A. Welk², D.L. Renaud², D. Sockett³, T.L. Felix¹, M.C. Cantor¹  



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Objectives



Investigate:

1. The association of lung consolidation ($\geq 1 \text{ cm}^2$) at weaning on the growth performance of beef $\times$ dairy calves.

Objectives



Investigate:

1. The association of lung consolidation ($\geq 1 \text{ cm}^2$) at weaning on the growth performance of beef $\times$ dairy calves up to 238 d.
- 2. The effect of differentiated lung consolidation severity (none, 1 to 2 cm^2 , and $\geq 3 \text{ cm}^2$) on calf ADG.**

Objectives

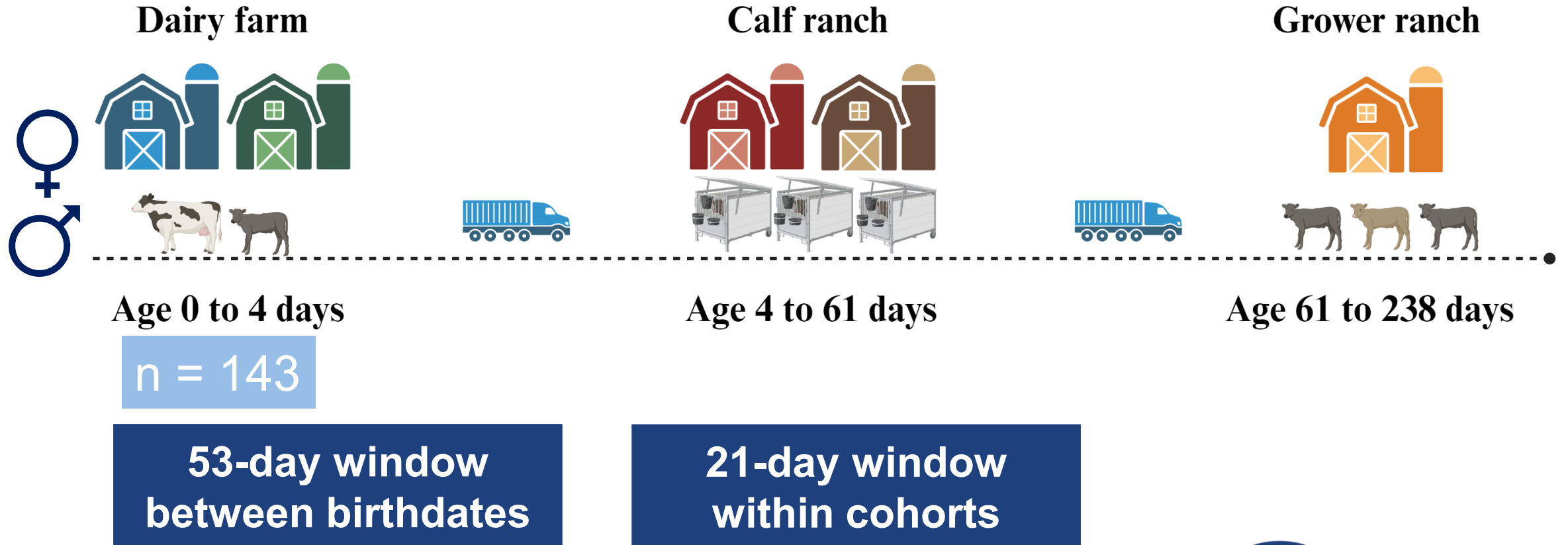


Investigate:

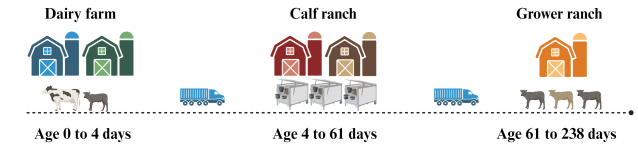
1. The association of lung consolidation ($\geq 1 \text{ cm}^2$) at weaning on the growth performance of beef $\times$ dairy cattle up to 238 d.
2. The effect of differentiated lung consolidation scores (none, 1 to 2 cm^2 , and $\geq 3 \text{ cm}^2$) on calf ADG.
3. The odds of pathogen shedding at weaning on lung consolidation and ADG.



Management description

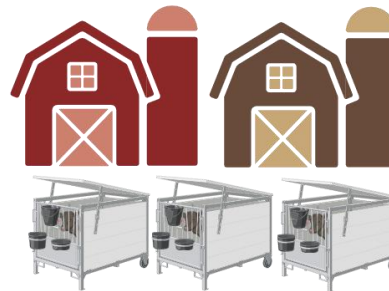


Cattle and management description



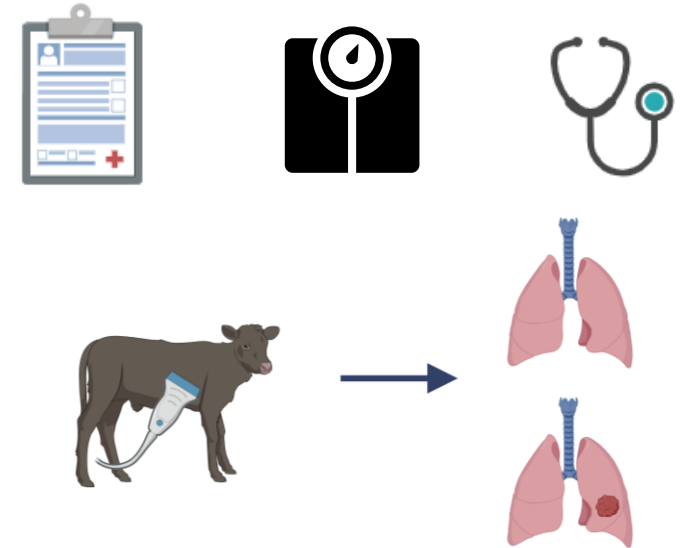
Weaned at 57 ± 14 d of age

Calf ranch

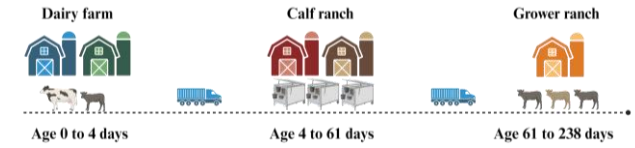


Age 4 to 61 days

At 61 ± 14 days of age



Lung ultrasonography

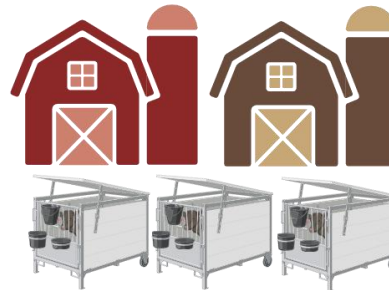


Lung ultrasonography
($\geq 1 \text{ cm}^2$):

Positive = BRD

Negative = Control

Calf ranch



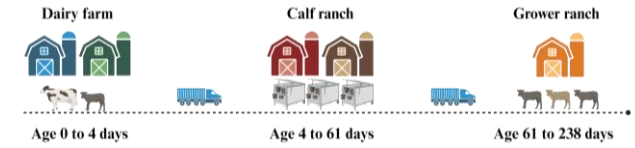
Age 4 to 61 days

Lung consolidation score:

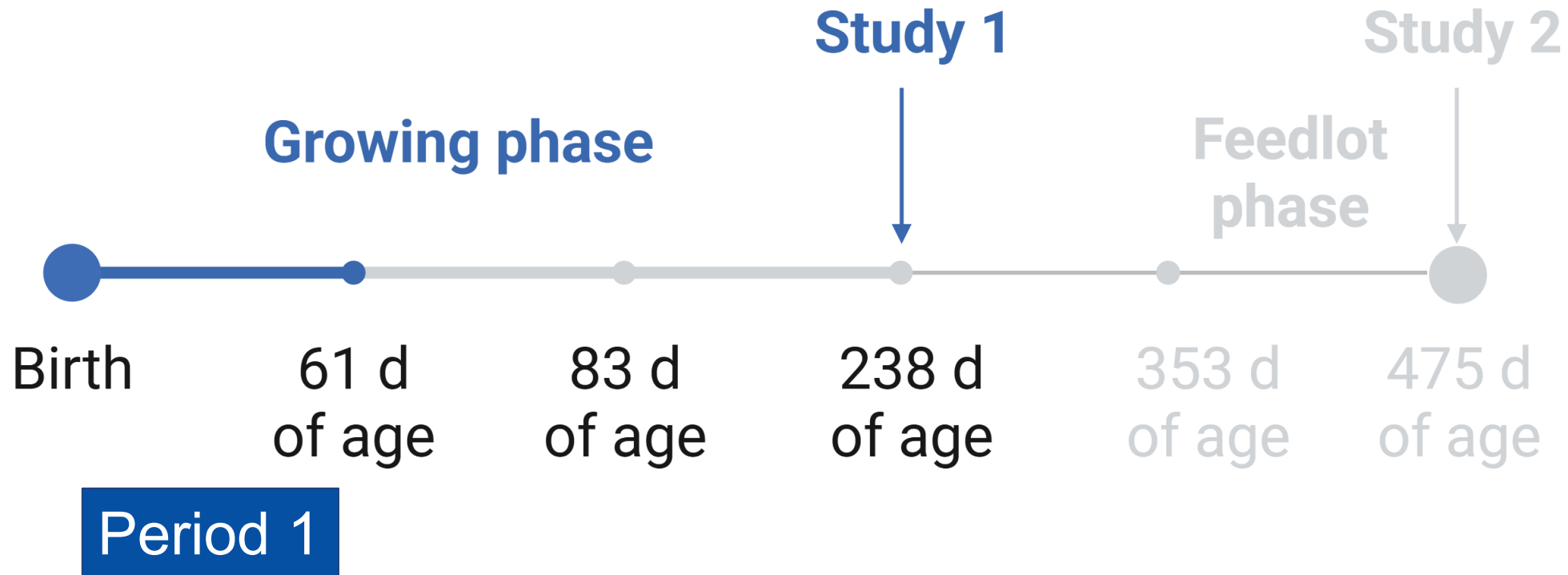
LCS:

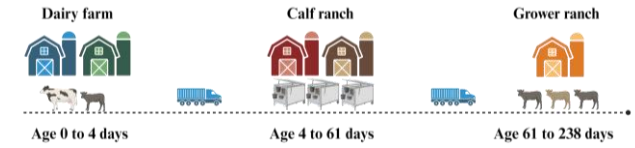
1 to $< 3 \text{ cm}^2$

$= 3 \text{ cm}^2$

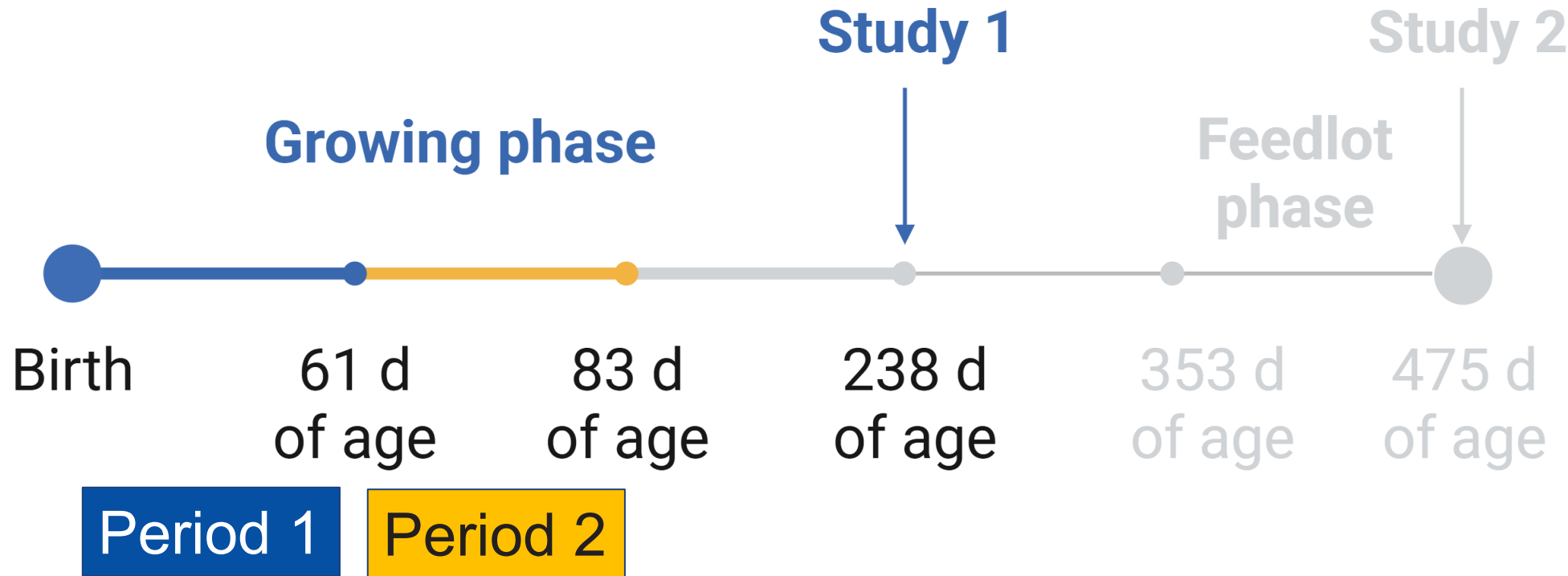


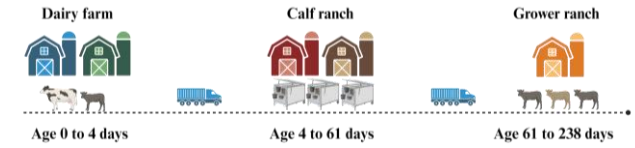
Average daily gain



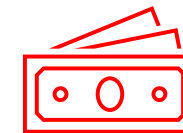
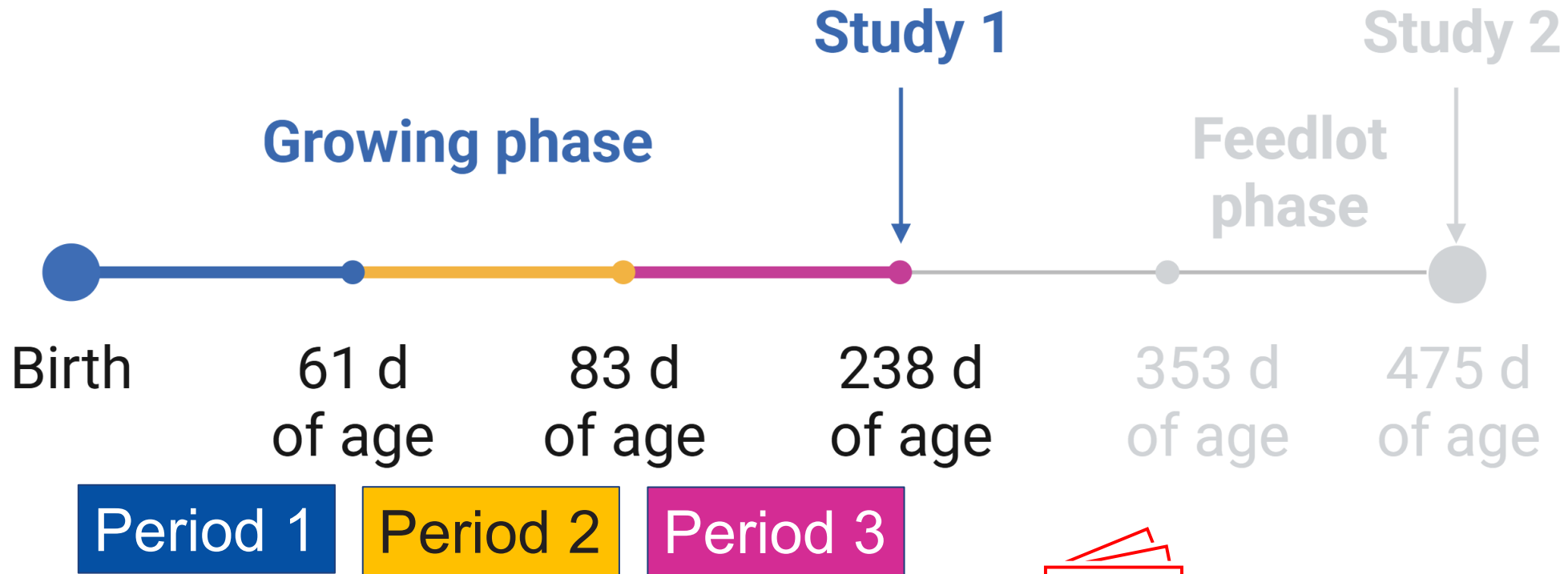


Average daily gain





Average daily gain



Major points of sale

Pair-match enrollment criteria for pathogen analysis

BRD

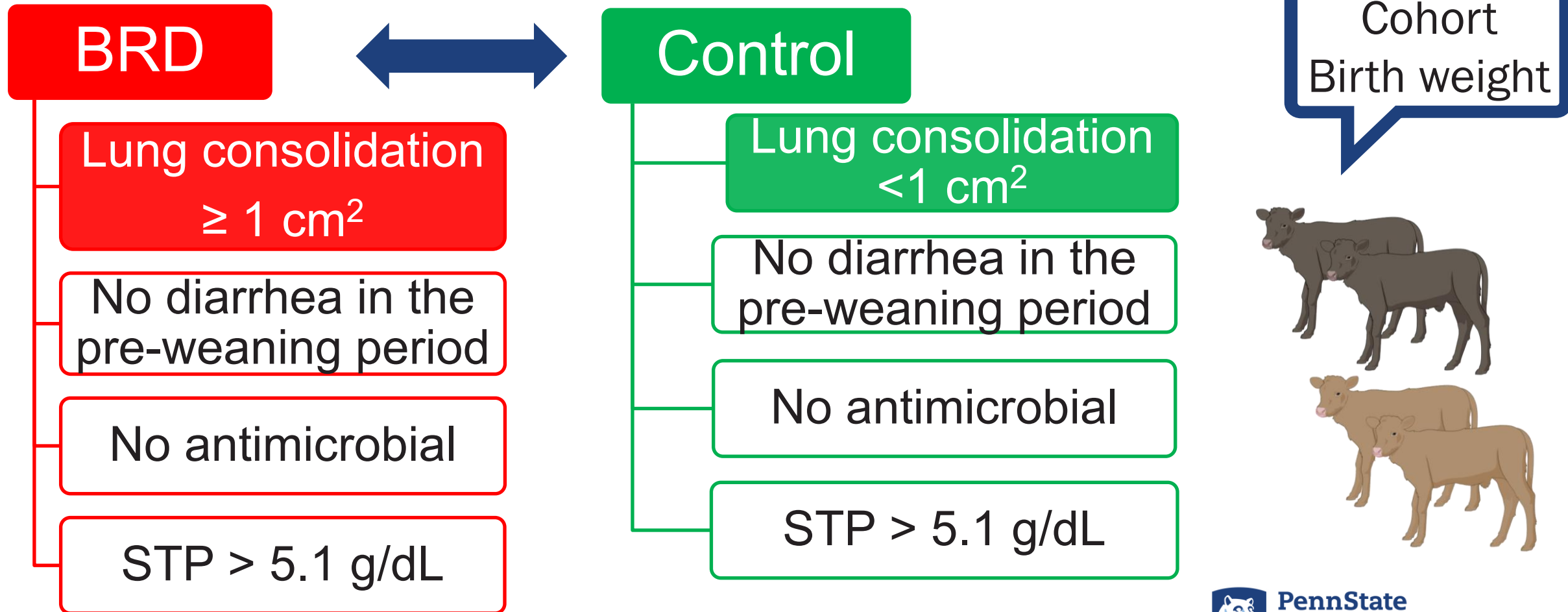
Lung consolidation
 $\geq 1 \text{ cm}^2$

No diarrhea in the
pre-weaning period

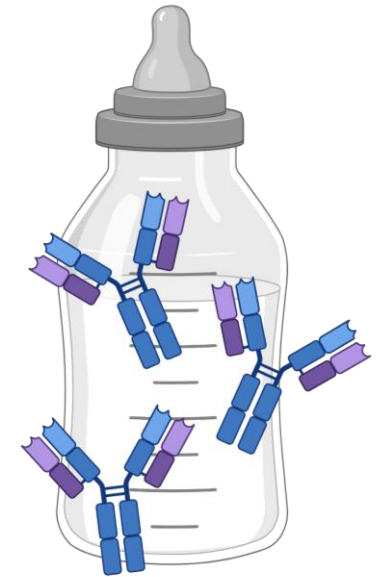
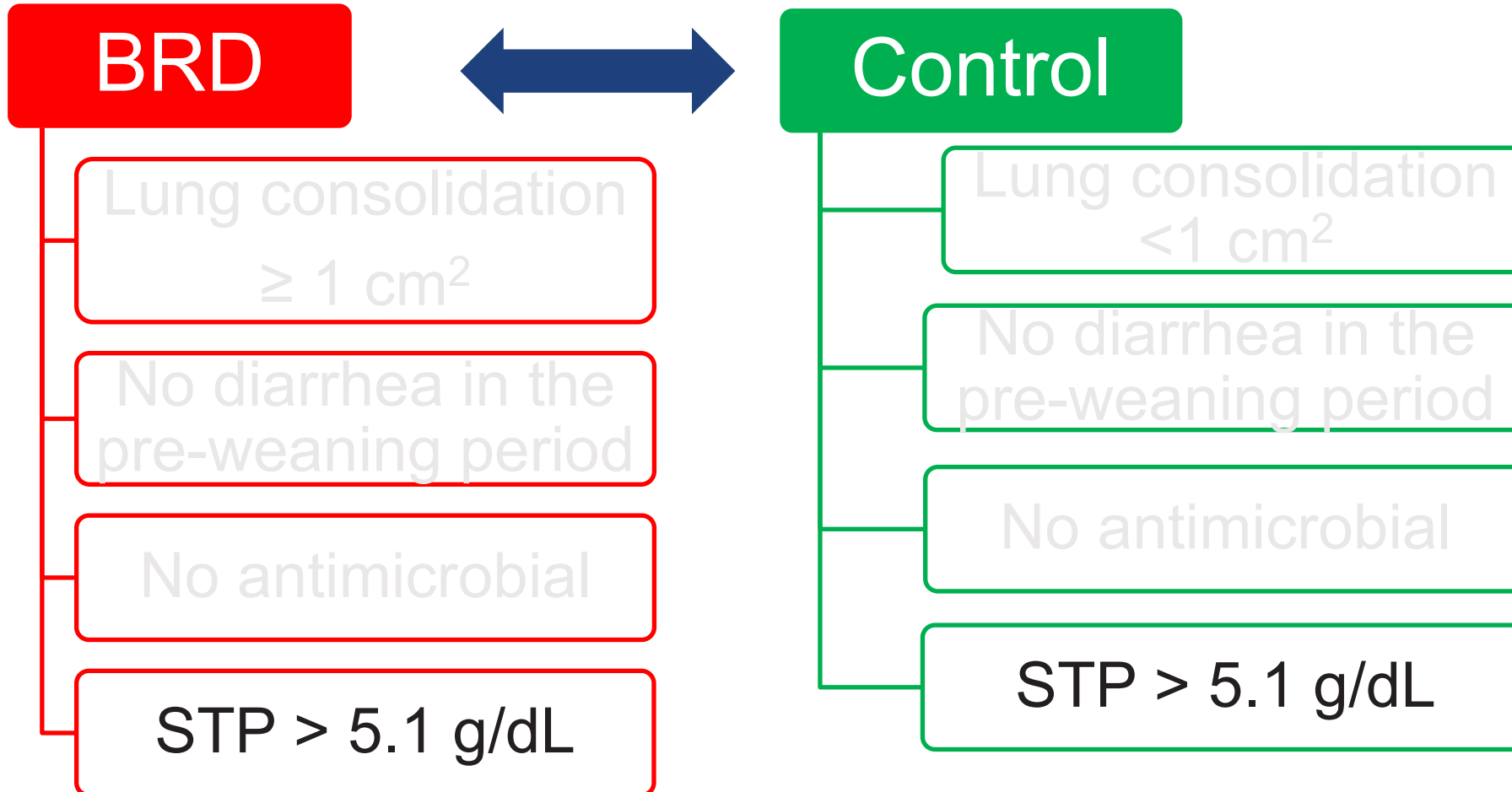
No antimicrobial

STP $> 5.1 \text{ g/dL}$

Pair-match enrollment criteria for pathogen analysis



Pair-match enrollment criteria for pathogen analysis



Nasopharyngeal swabs were taken from the pair-matched calves

- Culture:

P. multocida

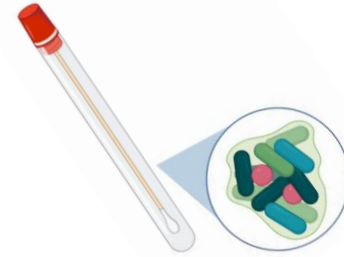
B. trehalosi

M. haemolytica

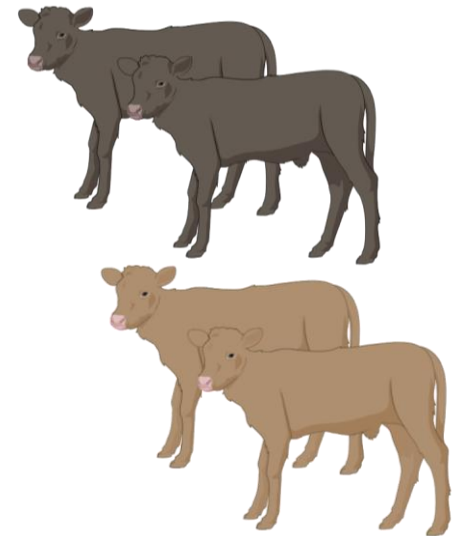
H. somni

Salmonella spp.

- PCR:
M. bovis



BRD
Control





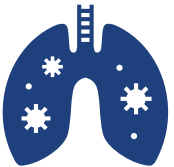
Results

Pasteurella multocida was the most isolated pathogen

35 BRD cases and 35 healthy controls

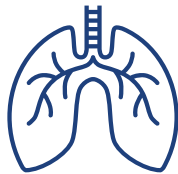
P. multocida 

Case



20

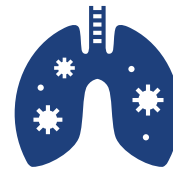
Control



9

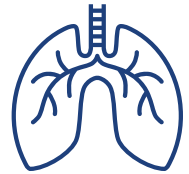
B. trehalosi 

Case



1

Control



1

57% BRD cases and 26% healthy controls



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Control calves had lower odds of *P. multocida* shedding

79%

OR 0.21 with 95% CI: 0.08-0.60 $P < 0.001$

LC = 1 and 2 cm²

90%

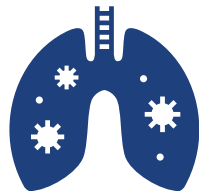
OR 0.10 with 95% CI: 0.04-0.24 $P = 0.001$

LC = 3 cm²

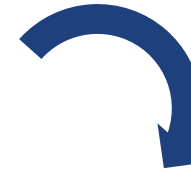
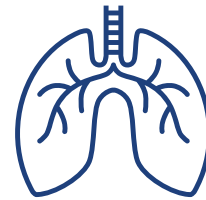
P. multocida did not reduce ADG

P. multocida 

No pathogen isolated



$0.96 \pm 0.03 \text{ kg/d}$



$0.94 \pm 0.03 \text{ kg/d}$

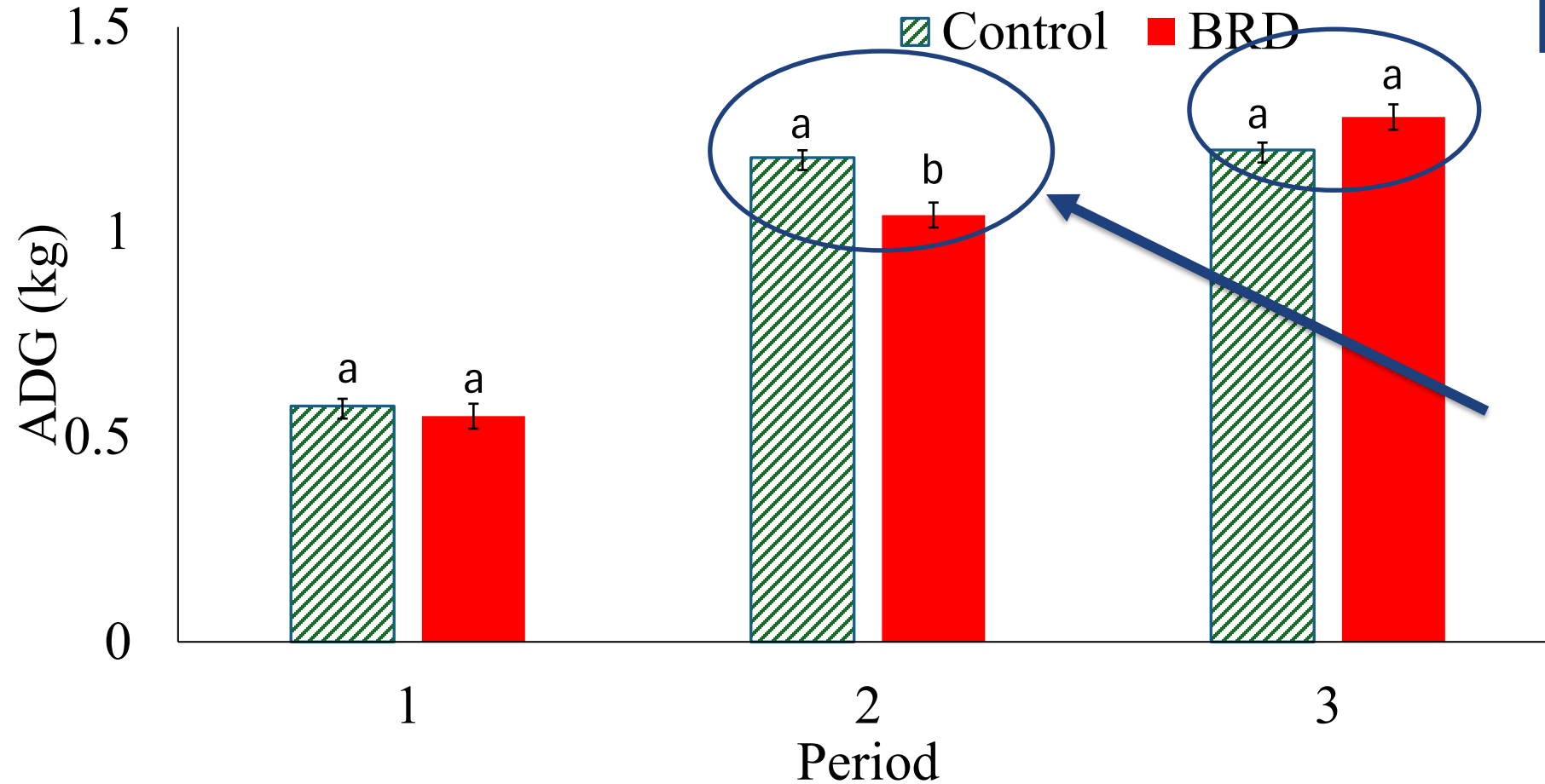
$P = 0.51$



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Control calves gained better than calves diagnosed with BRD during period 2

37 BRD ($\geq 1 \text{ cm}^2$)
106 Control



$0.14 \pm 0.03 \text{ kg/d}$

Age 0 to 61 days (period 1)

Age 61 to 83 days (period 2)

Age 83 to 238 days (period 3)



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Does lung consolidation severity matter?



Treatment starting point



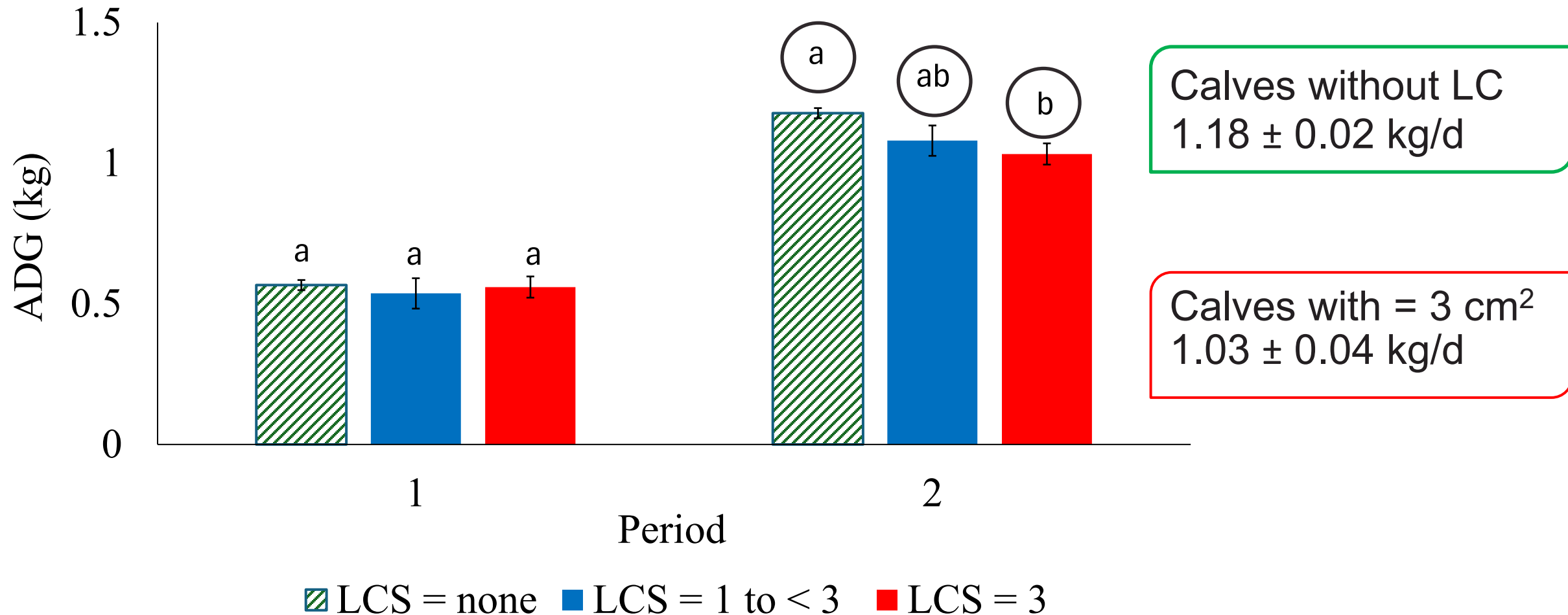
1 cm²

2 cm²

3 cm²



Calves with LC of 1 to 2 cm² did not differ from calves without LC (none)



Age 0 to 61 days (period 1)

Age 61 to 83 days (period 2)

Age 83 to 238 days (period 3)

Findings from study 1

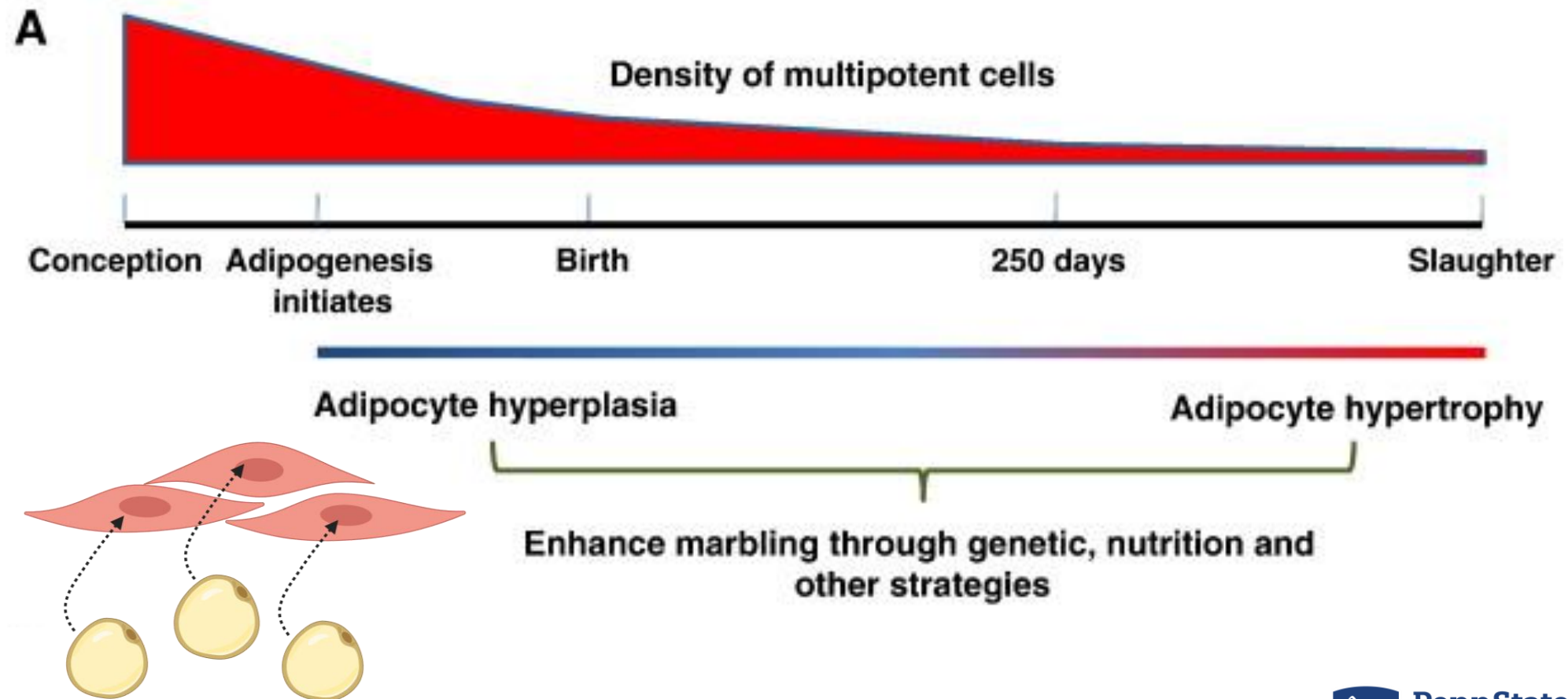
Corroborated previous Holstein work in pre-weaned calves

Calves suffer **140 g** ADG loss up to 83 days of age

Calves overcome losses in ADG by 238 days of age

P. multocida was associated with LC but not with ADG

Intramuscular Adipogenesis





JOURNAL ARTICLE ACCEPTED MANUSCRIPT

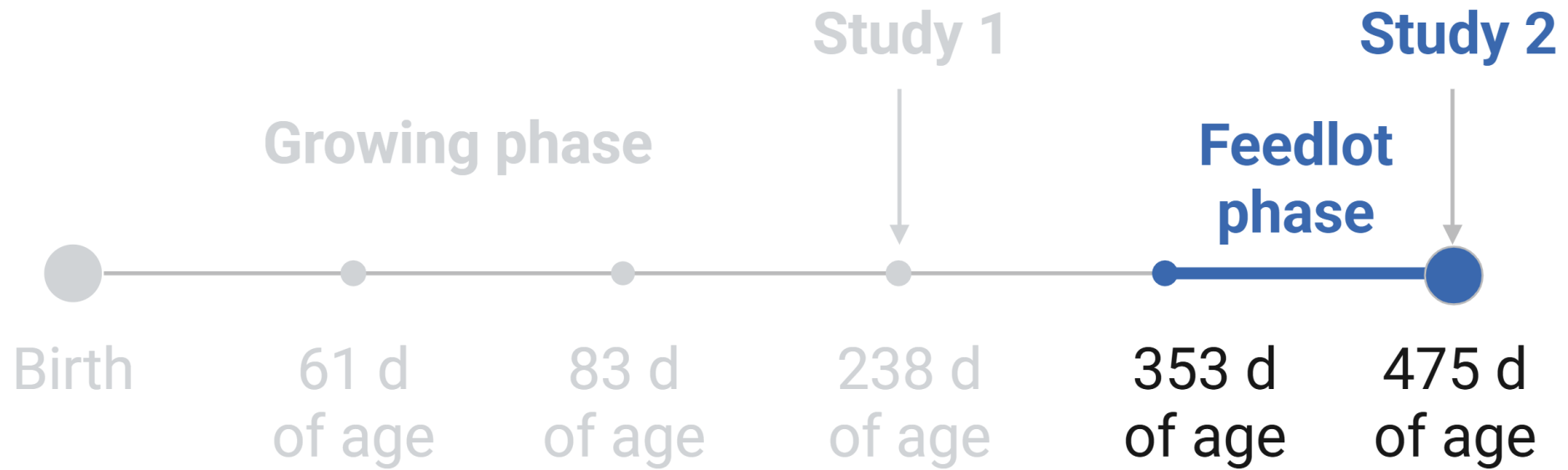
The association of lung consolidation in beef × dairy cattle at weaning with feedlot growth performance, carcass characteristics, liver health, and liver microbiome diversity

Ingrid L B Fernandes, Melissa C Cantor, Ana Fonseca, Erika Ganda, Tara L Felix 

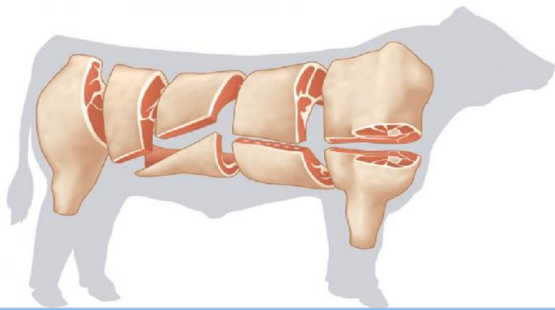


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Lifetime study



Carcass traits are impacted in cattle affected by BRD



Number of BRD treatments

Hot carcass weight

Marbling

1X

2X

≥ 3 X

-1%

-8%

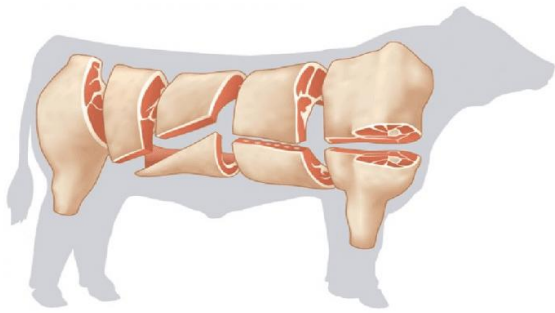
-11%

-5%

-13%

-14%

Limitations - methods



Number of BRD treatments

1X

2X

≥ 3 X

Treatment records
Lung lesions at slaughter

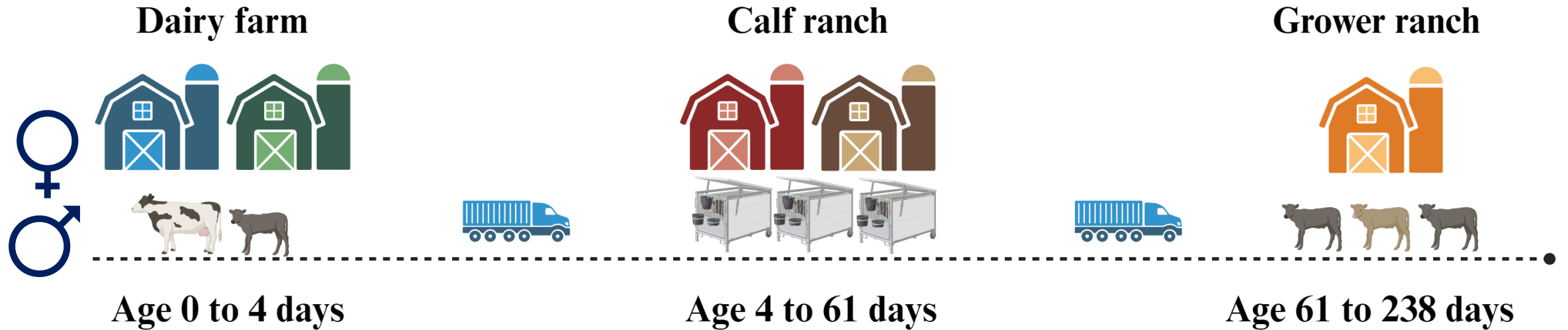
Objectives



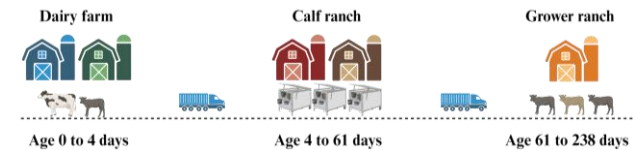
Investigate:

The association of BRD diagnosed by lung consolidation (≥ 1 cm) at weaning (61 ± 14 d of age) with feedlot growth performance, carcass traits in beef $\times$ dairy cattle

Management description



Transportation



Grower

353 ± 53 d of age



Feedlot

Feedlot growth performance



12 days
adaptation

680 kg
♂

635 kg
♀

Initial weight taken



5 slaughter days
41 days



Feedlot

Feed intake

Dry matter intake



GrowSafe



Feedlot

Carcass assessment

Hot carcass weight



Marbling score

Yield Grade

Back fat

Ribeye area



Packing plant



Results

BRD at weaning did not affect cattle growth performance in the feedlot

Item	Healthy	BRD	SEM	P-value
n, head	104	25		
Growing phase (birth – 354 d)				
ADG, kg/d	1.10			
Feedlot				
Initial BW, kg	432	42	5.90	0.48
Final BW, kg	641	638	6.11	0.69
ADG, kg/d	1.75	1.77	0.04	0.73
DMI, kg/d	13.82	13.83	0.23	0.96
G:F	0.126	0.128	0.003	0.58
Days of age, d	477	474	2.50	0.30

Fed to a targeted weight

BRD at weaning did not affect cattle carcass traits at slaughter

Item	CONTROL	BRD	SEM	<i>P</i> -value
n, head	104	35	-	-
HCW, kg	394	394	3.86	0.92
Dressing Percentage, %	61.5	61.7	0.28	0.53
Ribeye area, cm ²	97.39	96.58	1.24	0.56
Marbling score	495 ^a	463 ^b	14.23	0.05
12th rib fat thickness, cm	1.15	1.11	0.06	0.56
Yield Grade	2.11	2.11	0.10	0.97

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BRD at weaning did not affect cattle carcass traits at slaughter

Item	CONTROL	BRD	SEM	<i>P</i> -value
n, head	104	35	-	-
HCW, kg	394	394	3.86	0.92
Dressing Percentage, %	61.5	61.7	0.28	0.53
Ribeye area, cm ²	97.39	96.58	1.24	0.56
Marbling score	495 ^a	463 ^b	14.23	0.05
12th rib fat thickness, cm	1.15	1.11	0.06	0.56
Yield Grade	2.11	2.11	0.10	0.97

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Marbling score: 300 – 399 = Select; 400 – 499 = Low Choice; 500 – 599 = Choice; 600 – 699 = High Choice; 700 to 999 = Prime

Intramuscular Adipogenesis

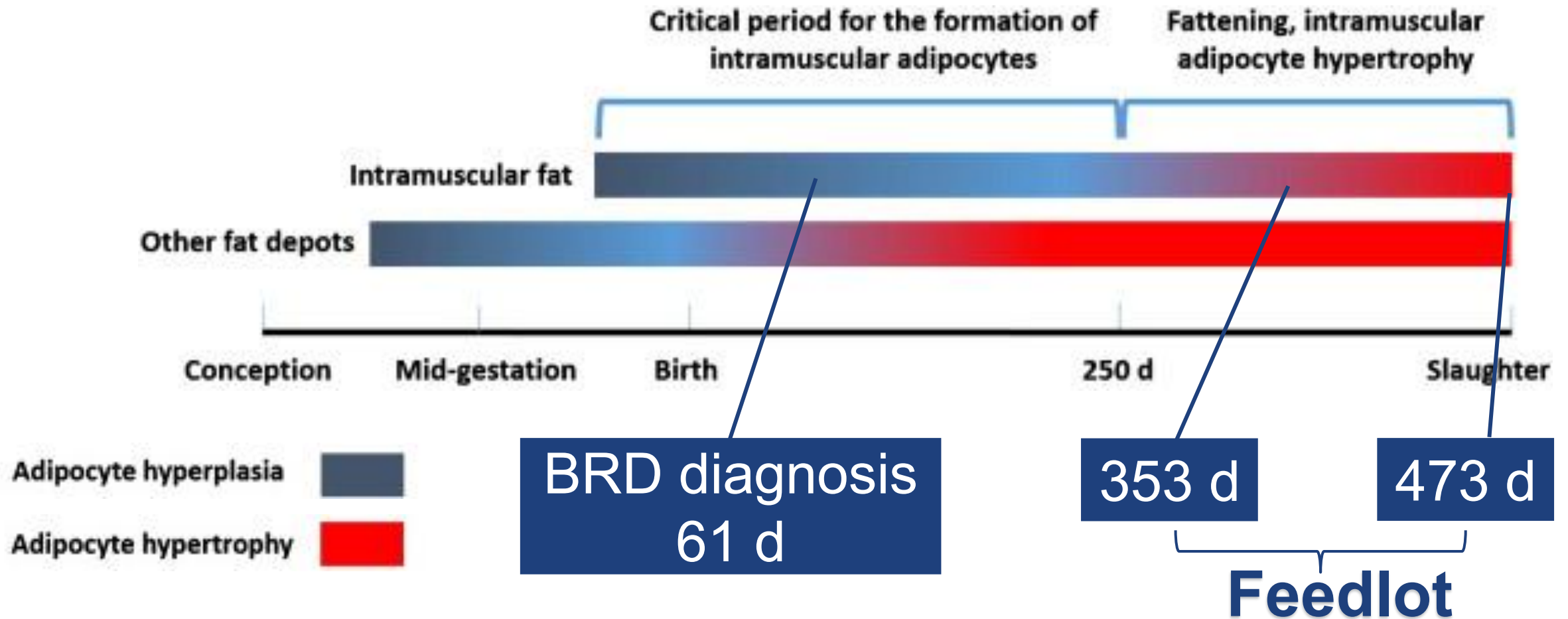


Image adapted from Du (2015)

Carcass quality grid



Upper 2/3
choice and
above

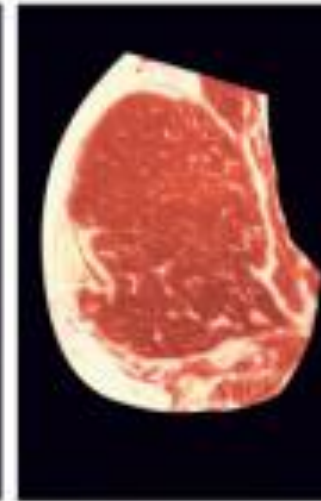
Low choice

Select

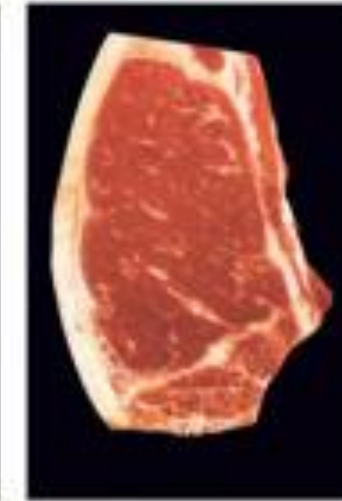
Degrees of Marbling	A ³
Slightly Abundant	PRIME
Moderate	
Modest	CHOICE
Small	
Slight	SELECT
Traces	
Practically Devoid	STANDARD



**Moderately
Abundant**



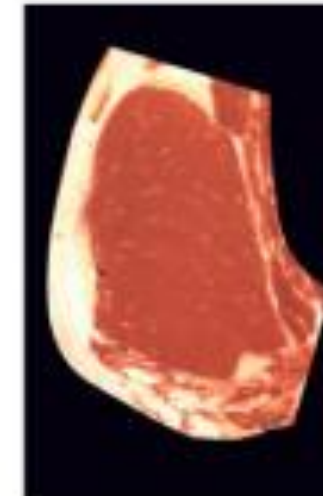
**Slightly
Abundant**



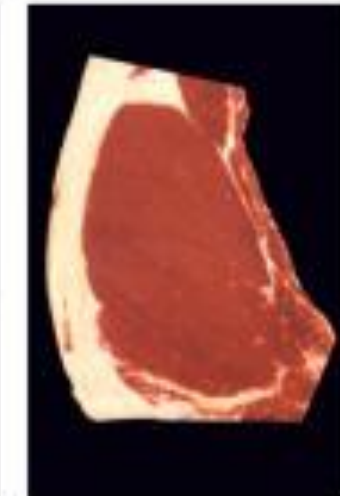
Moderate



Modest



Small



Slight

BRD at weaning reduced marbling score



CONTROL

Select = 9% (9/104)

**Upper 2/3 choice and above
= 34% (35/104)**



USDA
PRIME



USDA
CHOICE



USDA
SELECT

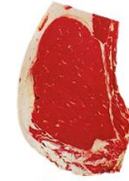
BRD

Select – 20% (7/35)

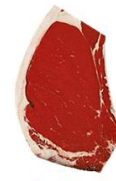
**Upper 2/3 choice and above
= 14% (5/35)**



USDA
PRIME



USDA
CHOICE



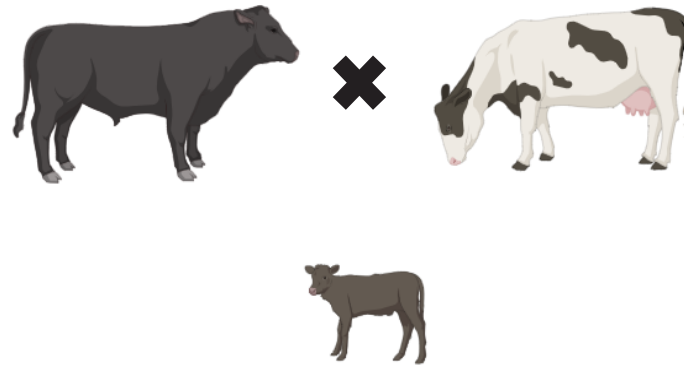
USDA
SELECT



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Conclusions

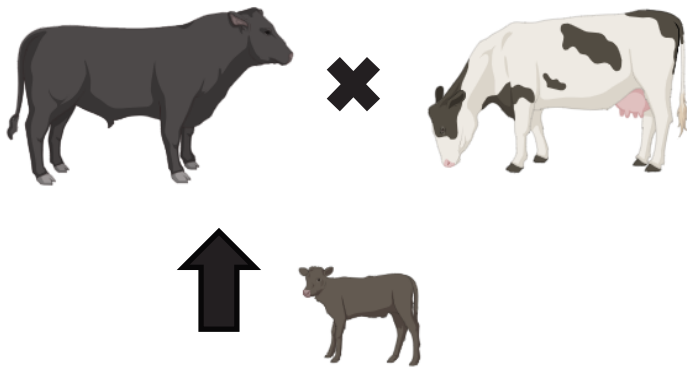
The reduction in ADG observed in BEEF X DAIRY calves in the first study agreed with previous studies with dairy calves.



Conclusions

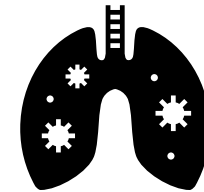


Early life BRD insults had lasting impacts beyond growth, affecting meat quality at slaughter



High value

BRD



Risk the quality and productivity

A unique study analyzing the beef × dairy lifecycle



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Questions?

Ingrid Fernandes

ingridfernandes@psu.edu



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