



UNIVERSITY OF SASKATCHEWAN

Does increasing the amount of concentrate in an automated milking system (robot) affect risk for ruminal acidosis?

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Feeding management for cows in AMS

- For cows in robotic milking systems, the diet = PMR + concentrate
- Motivate cows to enter AMS
- Precision feeding – programmed diet based on DIM, milk yield, and parity

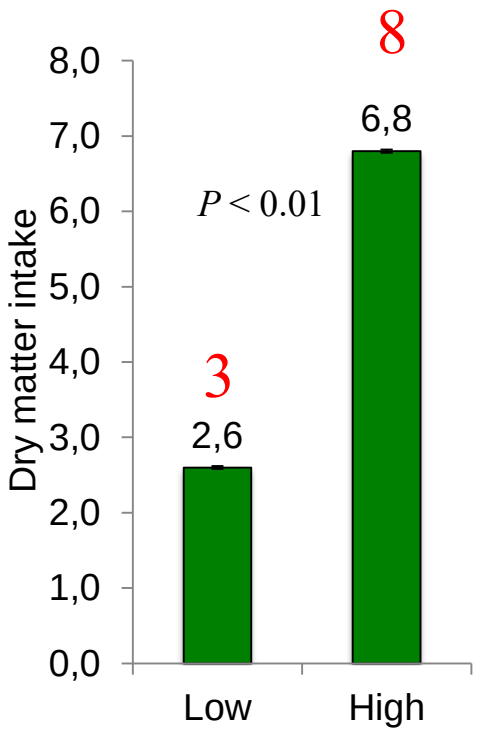
- Salfer and Endres (2014)
  - Free flow = 0.9 to 11.3 kg/d
  - Guided/forced = 0.9 to 8.2 kg/d

- Van Soest et al. (2024)
  - 2.77 milkings/day
  - 1.53 kg of AMS concentrate/milking
  - 4.24 kg/d
  - 77% feed a pelleted concentrate

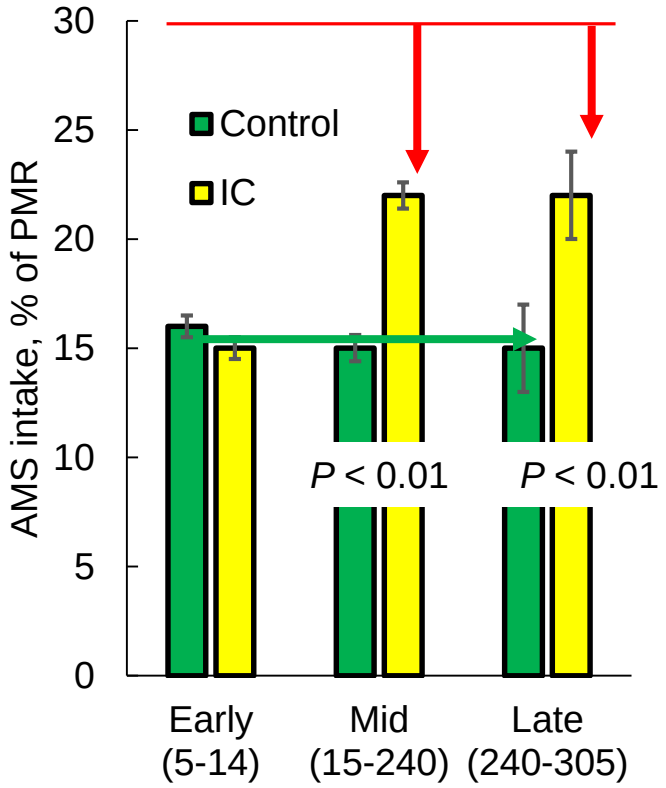
Do cows milked in automated milking systems have greater risk for ruminal acidosis?

Realities in automated milking systems

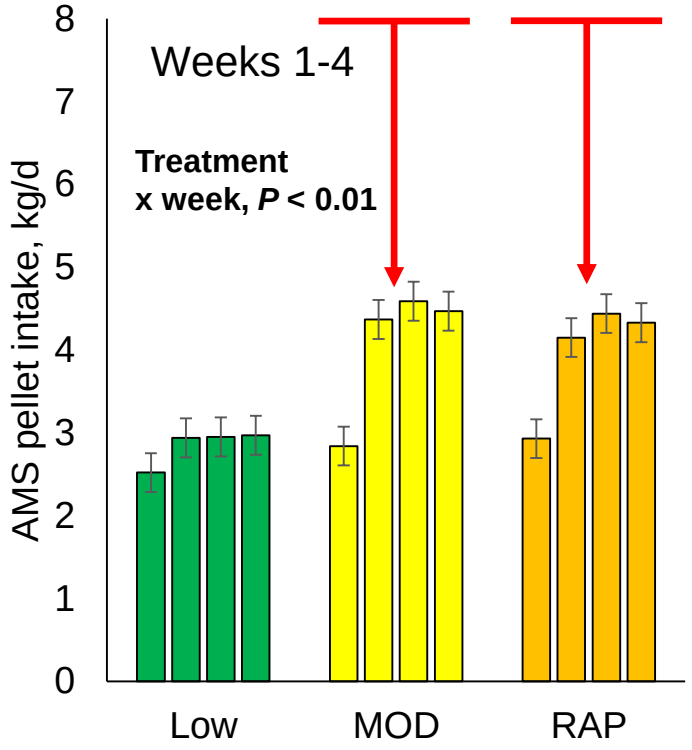
- Computer programmed ≠ delivered ≠ consumed



Bach et al., 2007



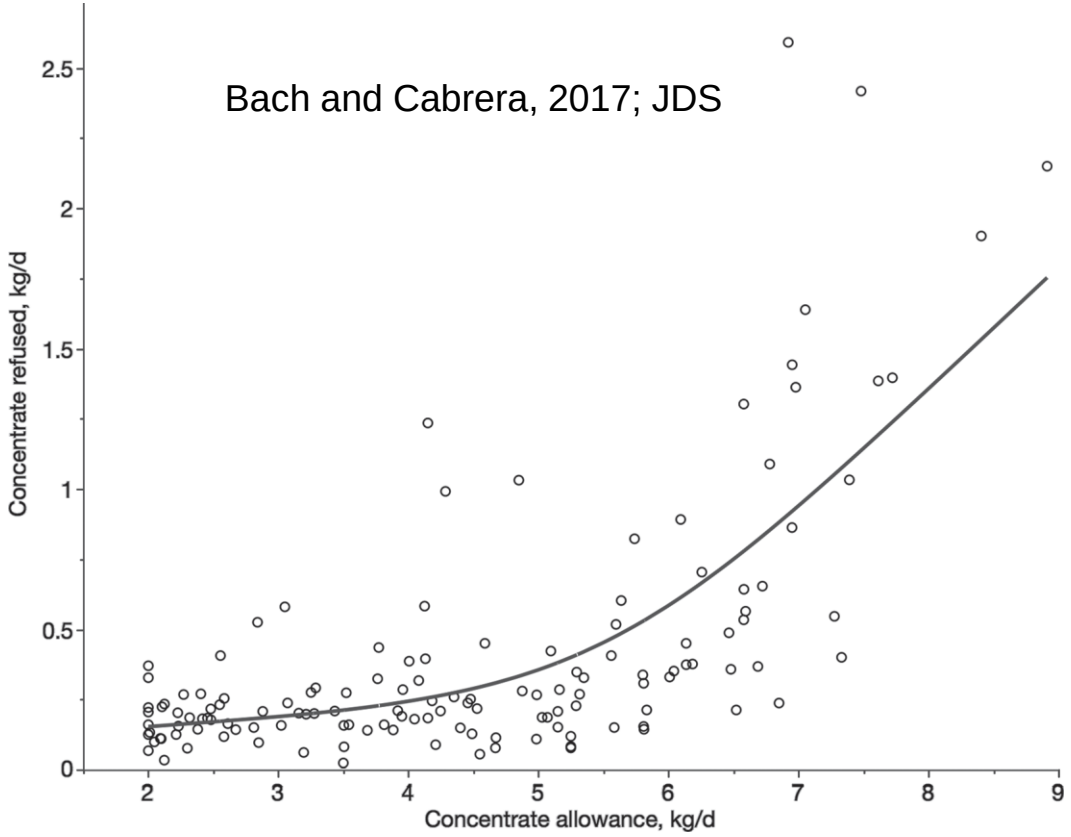
Henriksen et al., 2019; JDS

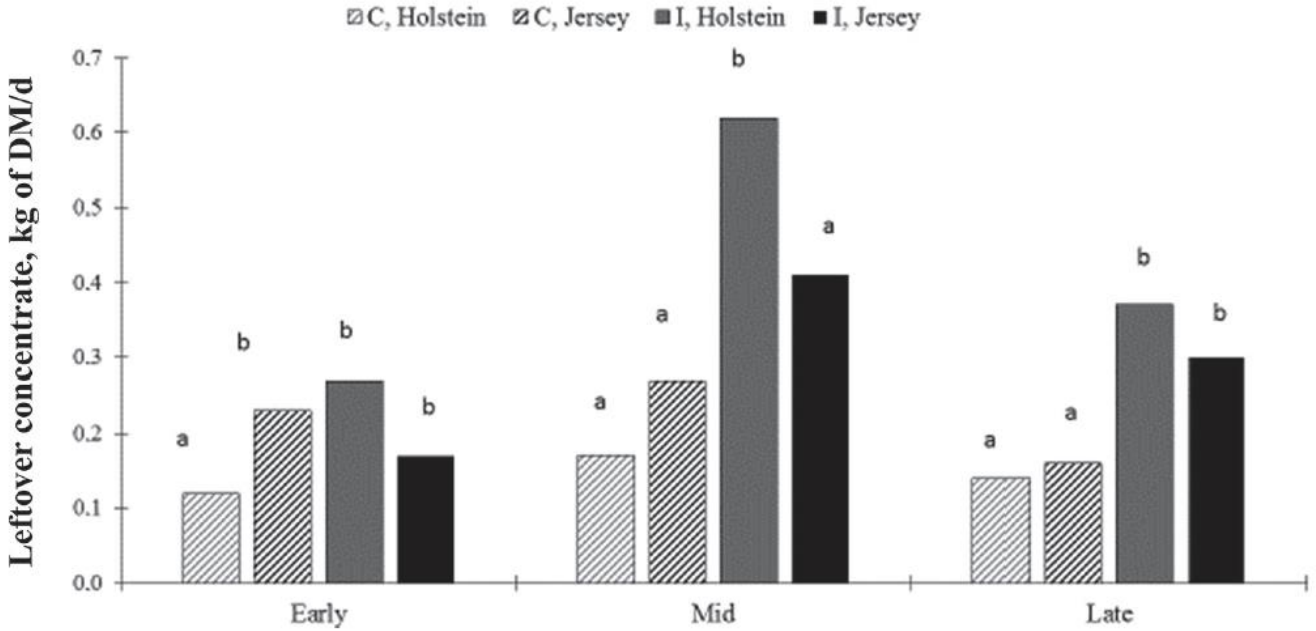


Haisan et al. unpublished

Computer programmed ≠ delivered ≠ consumed

Bach and Cabrera, 2017; JDS



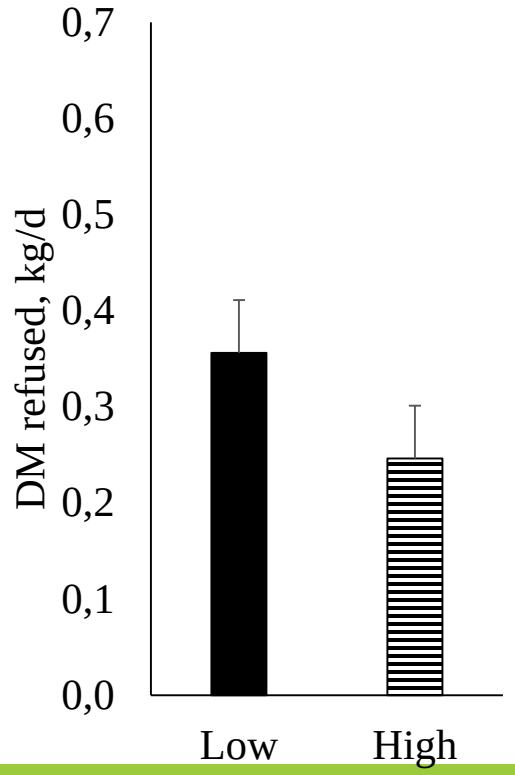


Henriksen et al., 2019; JDS

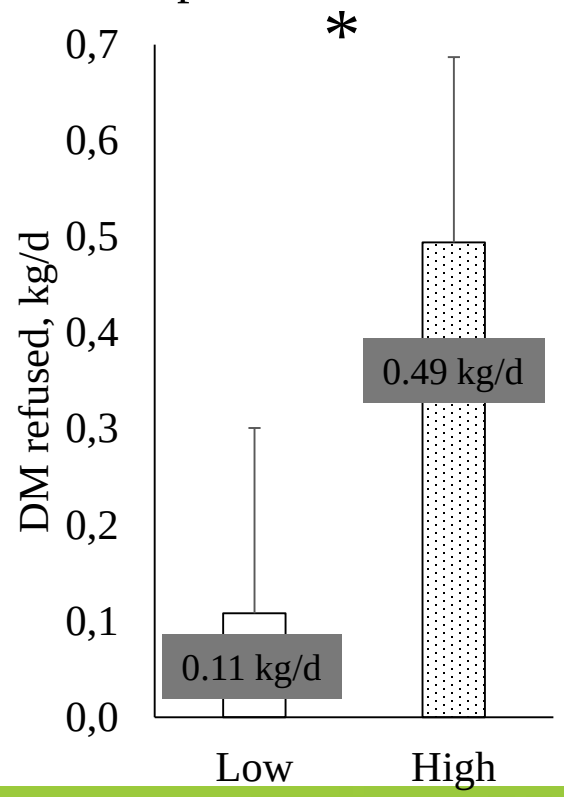
Donde et al. unpublished

Computer programmed ≠ delivered ≠ consumed

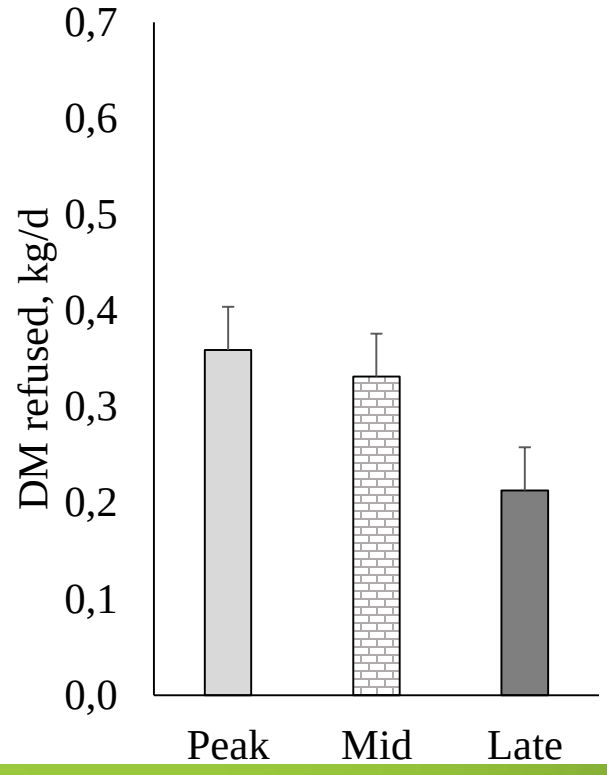
Starch concentration



AMS pellet allocation

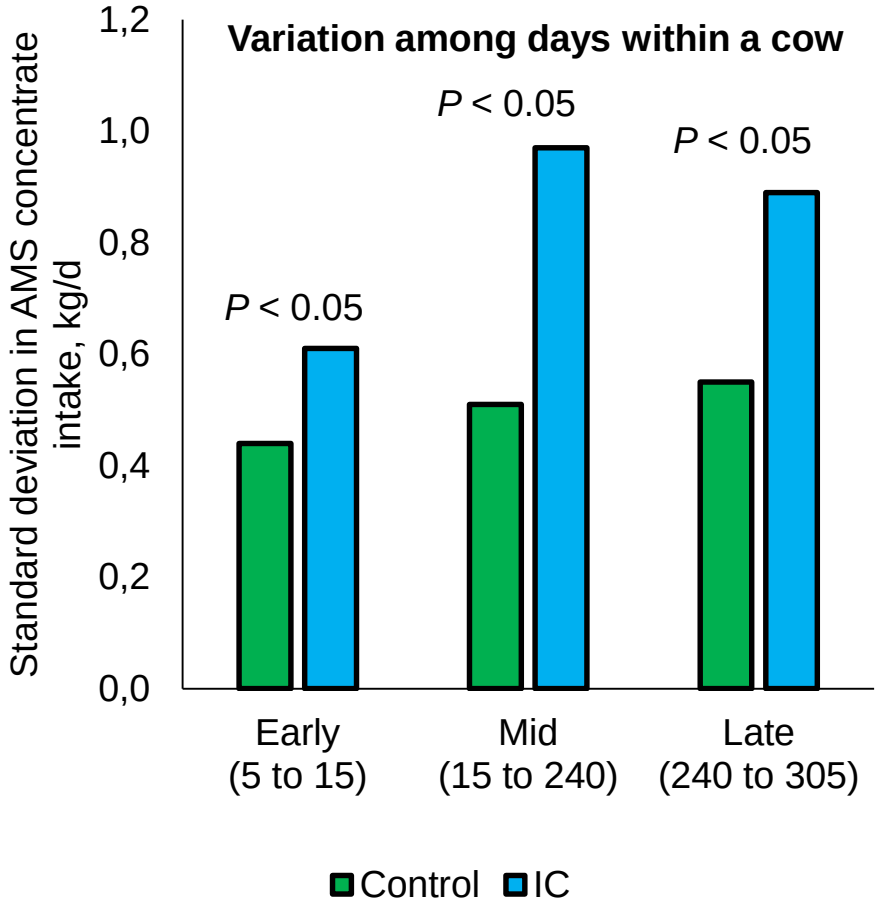


Lactation stage

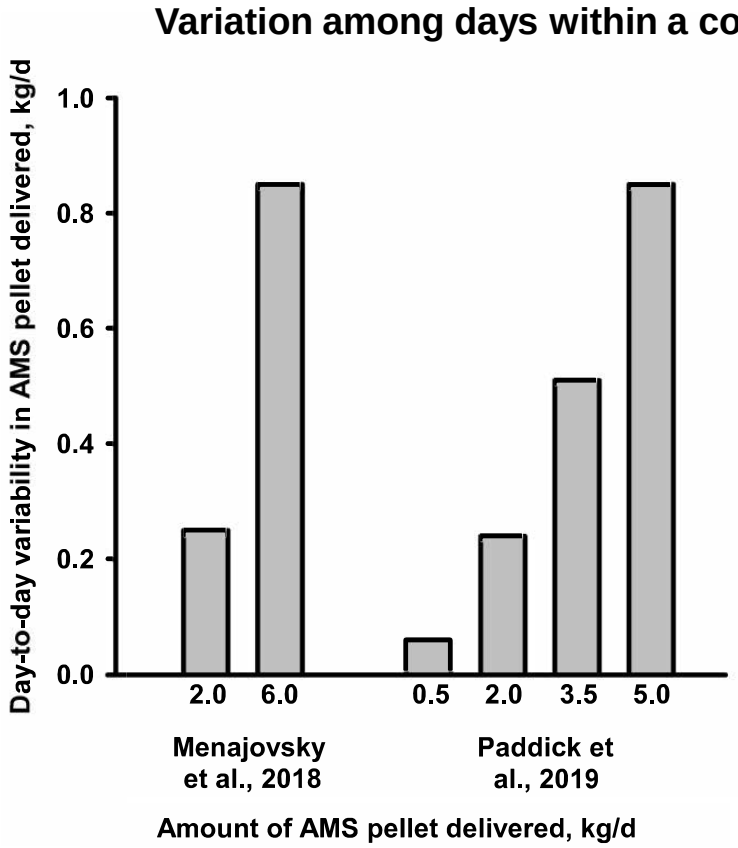


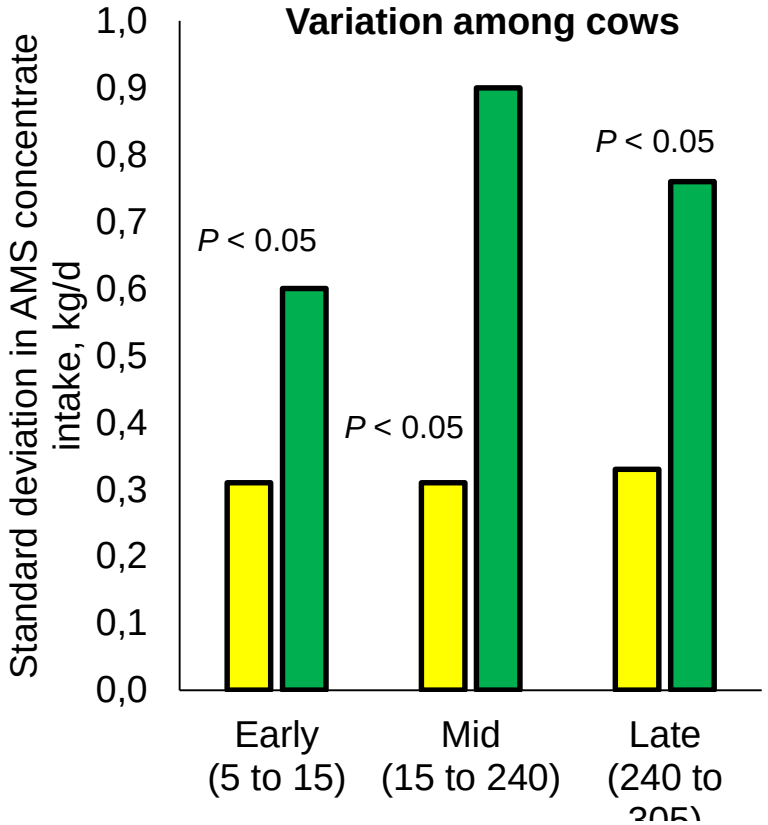
*Indicates means are different ($P < 0.001$)

Increasing AMS concentrate allocation increases day-to-day variability for individual cows



Henriksen et al., 2019; JDS





Henriksen et al., 2019; JDS

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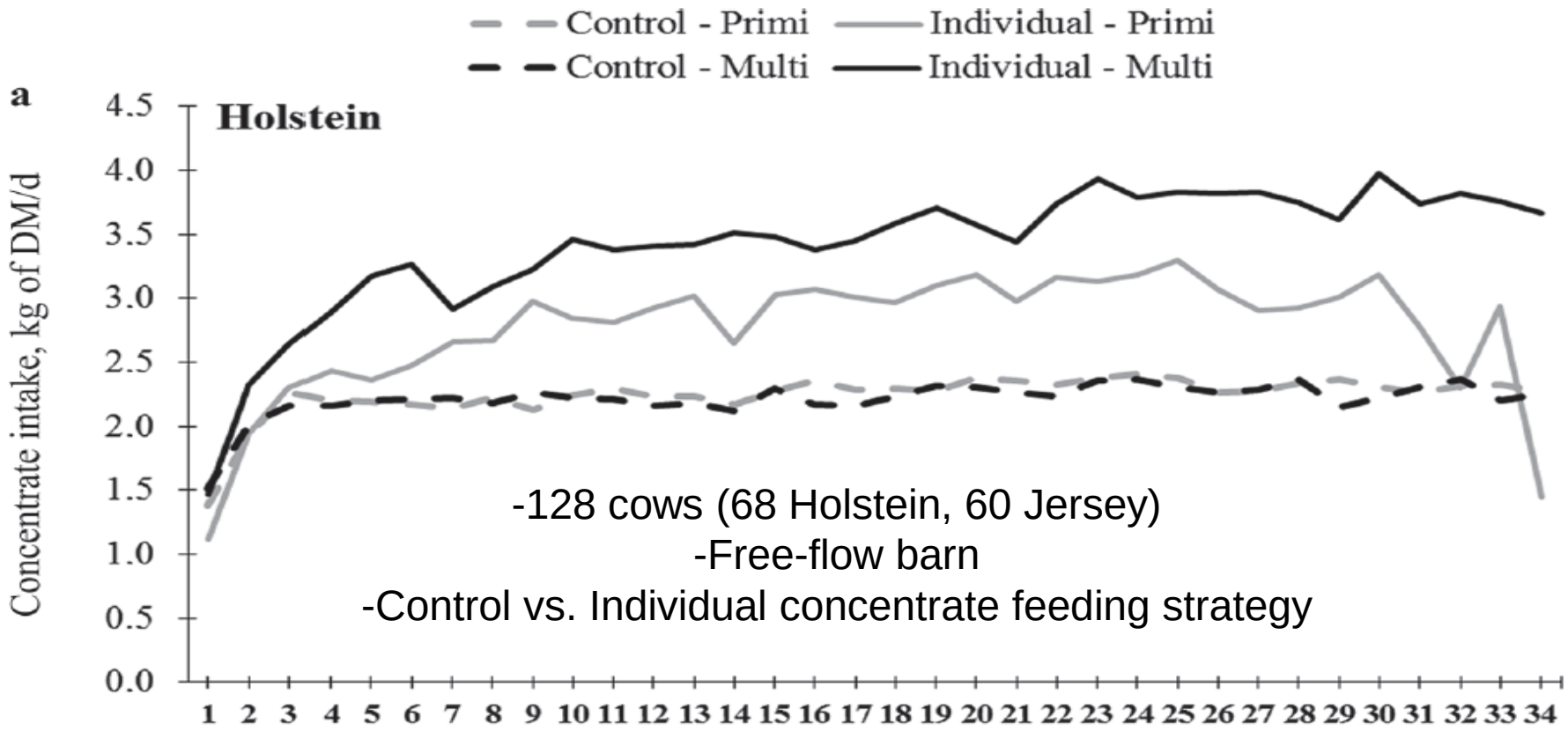
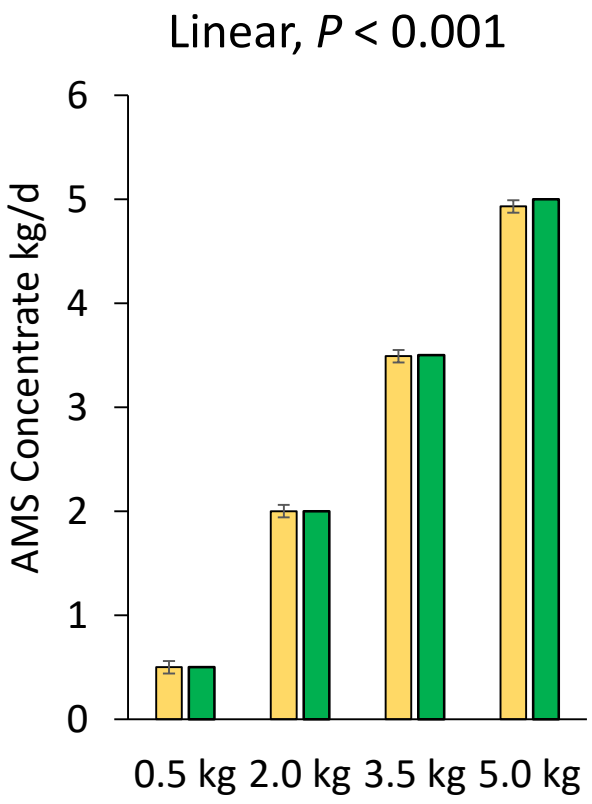
Higher AMS pellet allocation increases variation

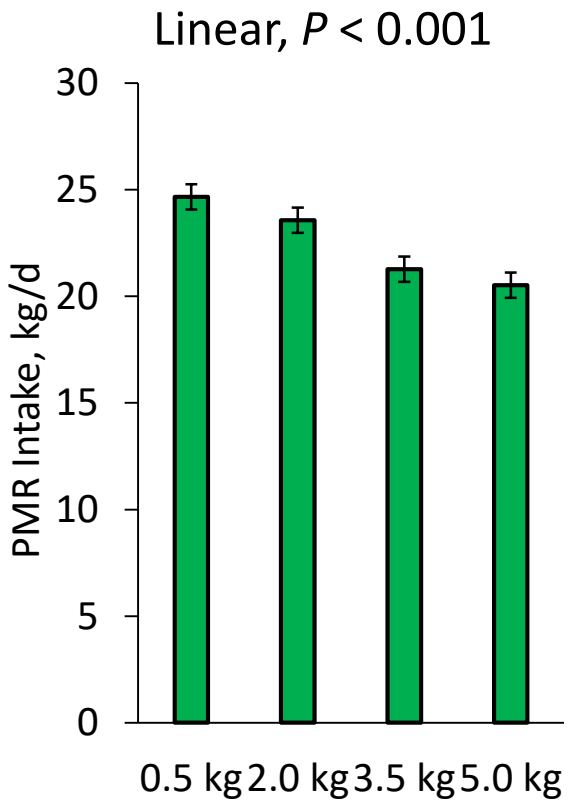


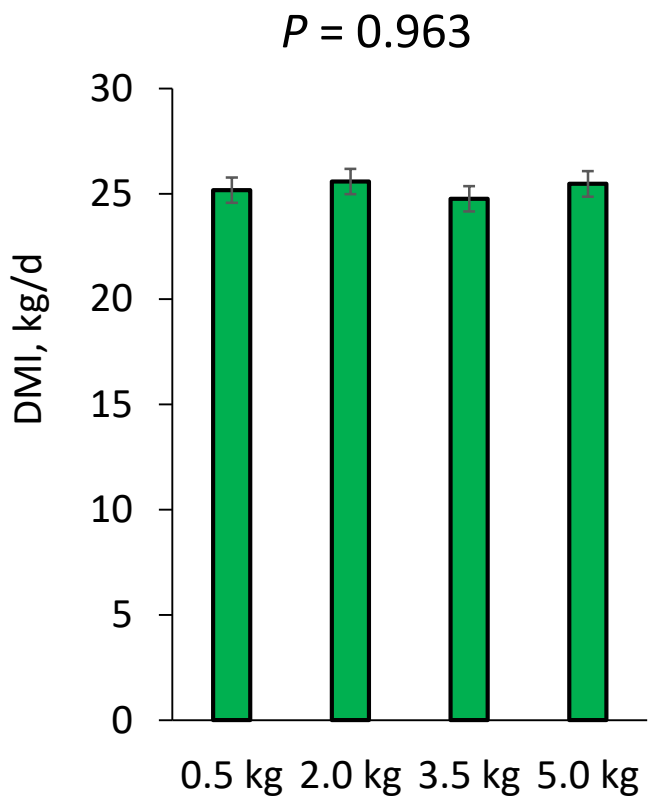
-128 cows (68 Holstein, 60 Jersey)
-Free-flow barn
-Control vs. Individual concentrate feeding strategy

Paddick et al., 2019; JDS

Increasing AMS pellet allocation decreases PMR intake

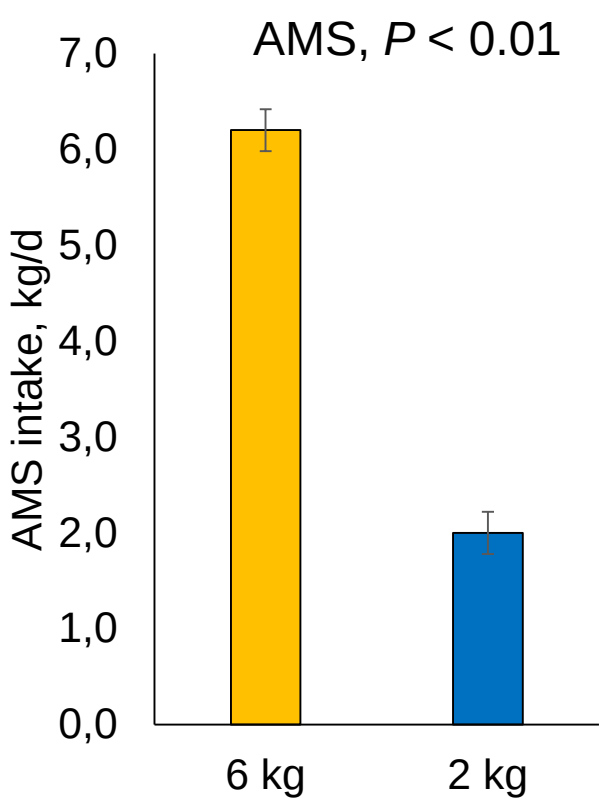


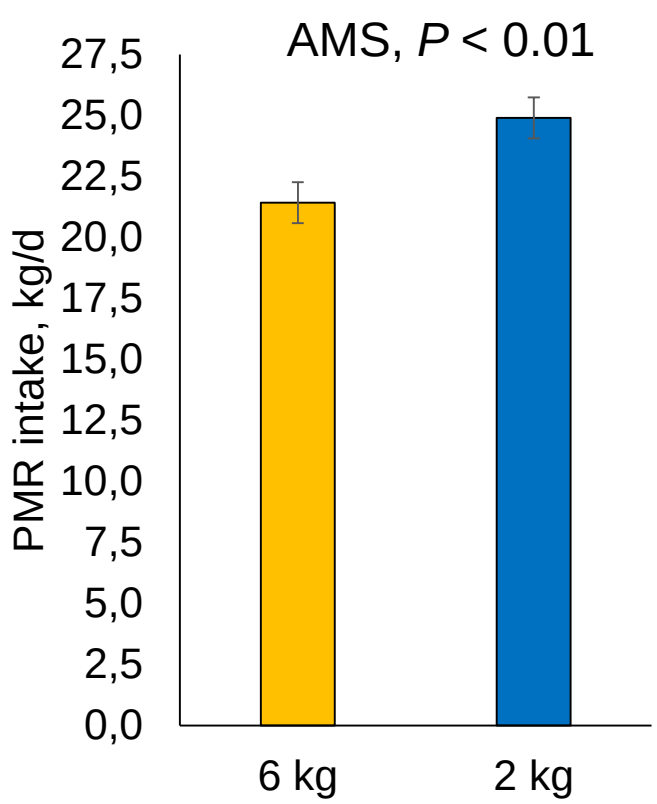


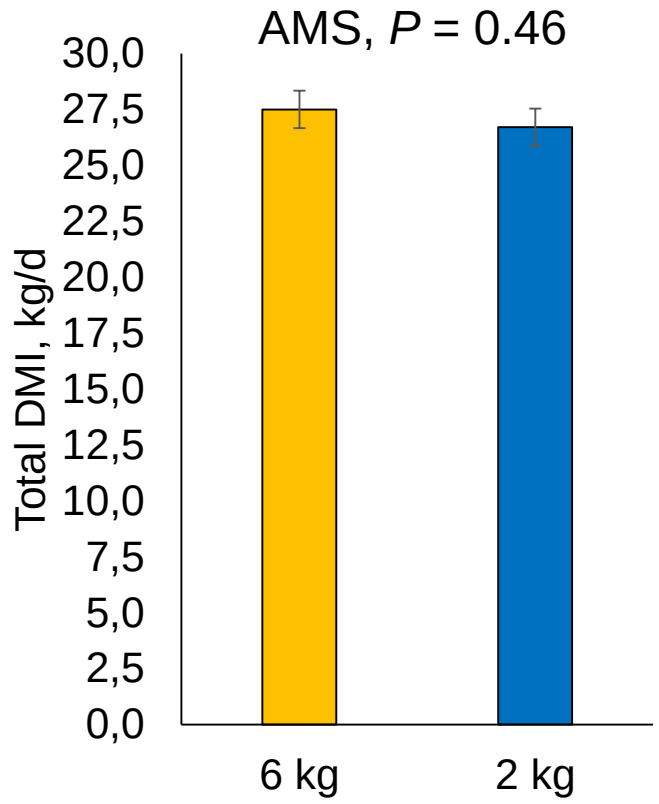


Menajovsky et al., 2018; JDS

Increasing AMS pellet allocation decreases PMR intake







Study	DIM (Average ± SD)	Cows, parity, and study design	Traffic flow	Dietary Strategy	Substitution Ratio (kg DM)
Bach et al., 2007	191 ± 2.13	69 Primiparous and 46 Multiparous, Completely randomized	Free	Isocaloric	**1.14**
Hare et al., 2018	227 ± 25 123 ± 71	5 Multiparous and 3 Primiparous, Cross-over	Guided	Isocaloric	**1.58**
Henriksen et al., 2018	32-320 14-330	22 primiparous Holstein 19 multiparous Holstein 11 wk study	Free	Static PMR with 2 concentrate	**0.58 – 0.92**
Henriksen et al., 2018	29-218 17-267	14 primiparous Jersey 28 multiparous Jersey 11 wk study	Free	Static PMR with 2 concentrate	**0.69-0.50**
Menajovsky et al., 2018	141 ± 13.6	8 Multiparous, Replicated 4 × 4 Latin square	Guided	LF-PMR HF-PMR	**0.89** **0.78**
Henriksen et al., 2019	Early (5 to 14) Mid (15 to 240) Late (240 to 305)	Continuous lactation study 128 cows (68 Holstein + 60 Jersey)	Free	Static PMR	**5** **1.1** **2.9**
Paddick et al., 2019	90.6 ± 9.8	8 Primiparous, Replicated 4 × 4 Latin square	Guided	Isocaloric	**0.97**
Schwanke et al., 2019	47.1 ± 15.0	15 Primiparous, Cross-over	Free	Isocaloric	**0.62**

Impacts of substitution

- Altered dietary characteristics

Milk range	Total DMI	DMI PMR	Haisan Robot Pellet		Allowable milk kg	
kg/day	kg	kg	kg as fed	kg dry matter	ME	MP
40.0 - 41.0	25.00	22.00	3.45 (1.15)	3.00	40.5	42.0
42.0 - 43.0	25.00	22.00	3.45 (1.15)	3.00	43.3	44.8
44.0 - 45.0	25.56	22.00	4.10 (1.37)	3.56	44.7	46.1
46.0 - 47.0	26.37	22.00	5.03 (1.68)	4.37	46.7	48.0
48.0 - 49.0	27.21	22.00	5.99 (2.00)	5.21	48.7	49.8
50.0 - 51.0	28.04	22.00	6.95 (2.32)	6.04	50.7	51.7
52.0 - 53.0	28.88	22.00	7.92 (2.64)	6.88	52.8	53.6
54.0 - 55.0	29.72	22.00	8.89 (2.96)	7.72	54.8	55.5

Milk range				Starch (% DM)	
kg/day	Forage NDF (% DM)	Ruminal pH	Time pH <5.8 (hours)	Total	Fermented
40.0 - 41.0	20.4	6.00	6.77	25.14	20.40
42.0 - 43.0	20.4	6.00	6.77	25.14	20.40
44.0 - 45.0	19.9	5.99	7.14	25.46	20.53
46.0 - 47.0	19.3	5.96	7.68	25.90	20.69
48.0 - 49.0	18.7	5.94	8.23	26.32	20.84
50.0 - 51.0	18.2	5.91	8.79	26.72	20.97
52.0 - 53.0	17.6	5.89	9.34	27.09	21.08
54.0 - 55.0	17.1	5.87	9.90	27.44	21.18

Other factors: Maximum meal size

Constraints

-Maximum meal size of 2.5 kg/d

-No carry-over

	kg offered/d			
	3	6	9	12
Milking frequency	Amount that should be offered/milking			
2.0	1.50	3.00	4.50	6.00
3.0	1.00	2.00	3.00	4.00
3.5	0.86	1.71	2.57	3.42
4.0	0.75	1.50	2.25	3.00

Other factors: Box time and dispensing rate

	Milking duration, min			
	5	7	9	11
Dispensing rate, g/min	Maximum amount offered/milking			
300	1.50	2.10	2.70	3.30
400	2.00	2.80	3.60	4.40
500	2.50	3.50	4.50	5.50
600	3.00	4.20	5.40	6.60

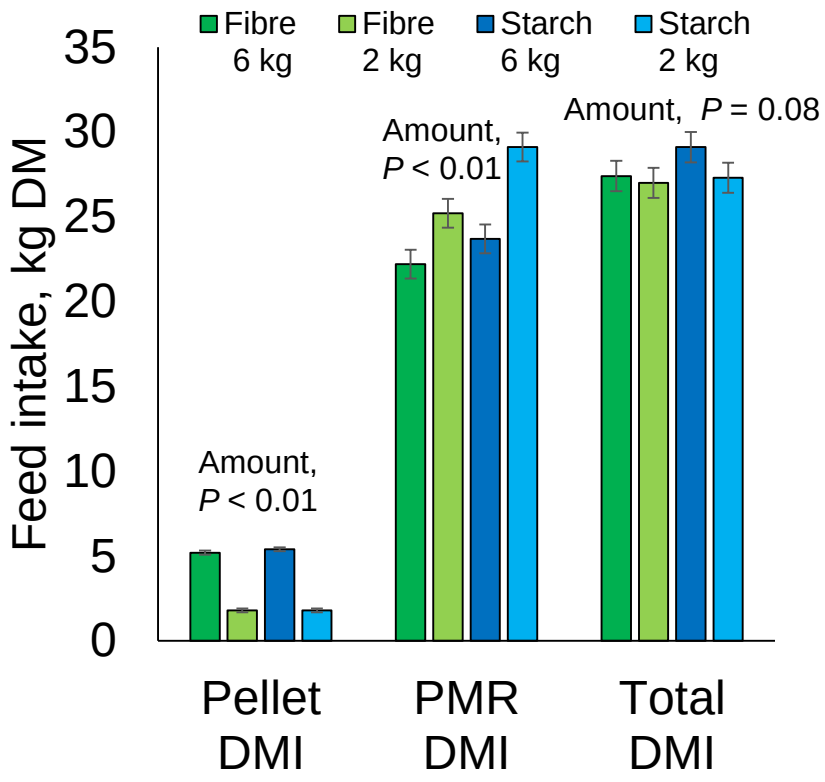
Variable	Min	Mean	Max
Box time, min	4.77	7.16	12.07
Milk harvested, L	8.6	15.2	21.0

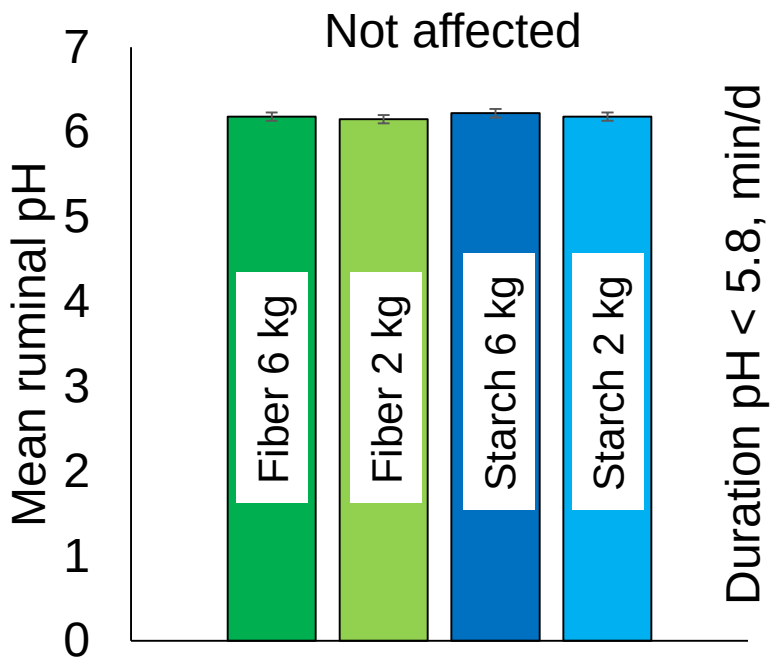
Cow	Time, min	Yield, L/milking	Yield, L/d
1242	4.8	14.9	44.6
1207	5.3	12.7	38.2
1105	5.4	15.8	42.8
1162	5.4	15.8	40.5
1190	5.5	15.5	46.5
1095	5.6	13.5	50.0
1149	5.7	11.7	33.5
1089	5.9	18.6	61.2
1154	5.9	17.5	40.0
1208	5.9	16.1	48.3

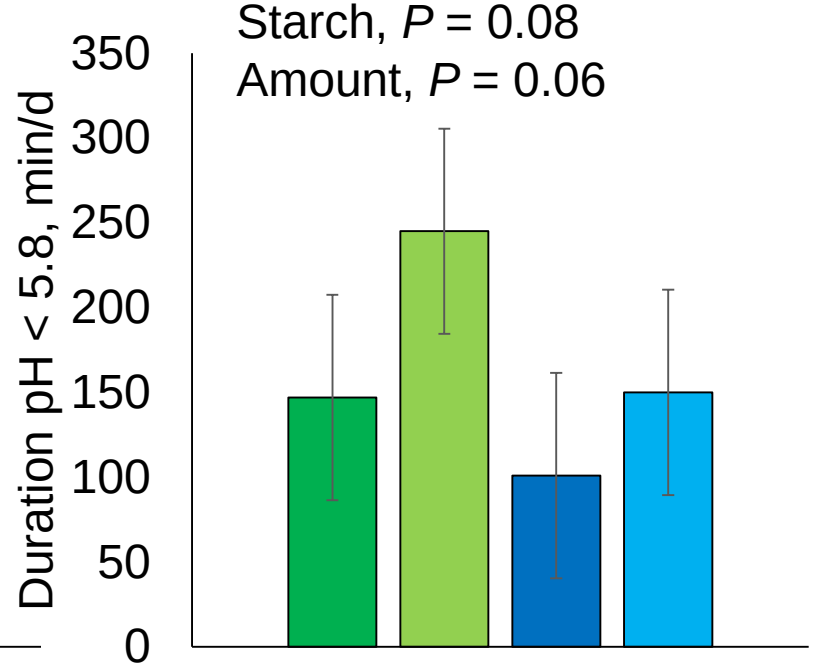
Data from University of Saskatchewan Rayner Dairy Research and Teaching Unit

Pellet amount and starch concentration

- High fiber (33% NDF, 14% starch) vs. high starch (8% NDF, 57% starch)
- Fed twice daily at 3 vs. 1 kg DM in a tie-stall barn

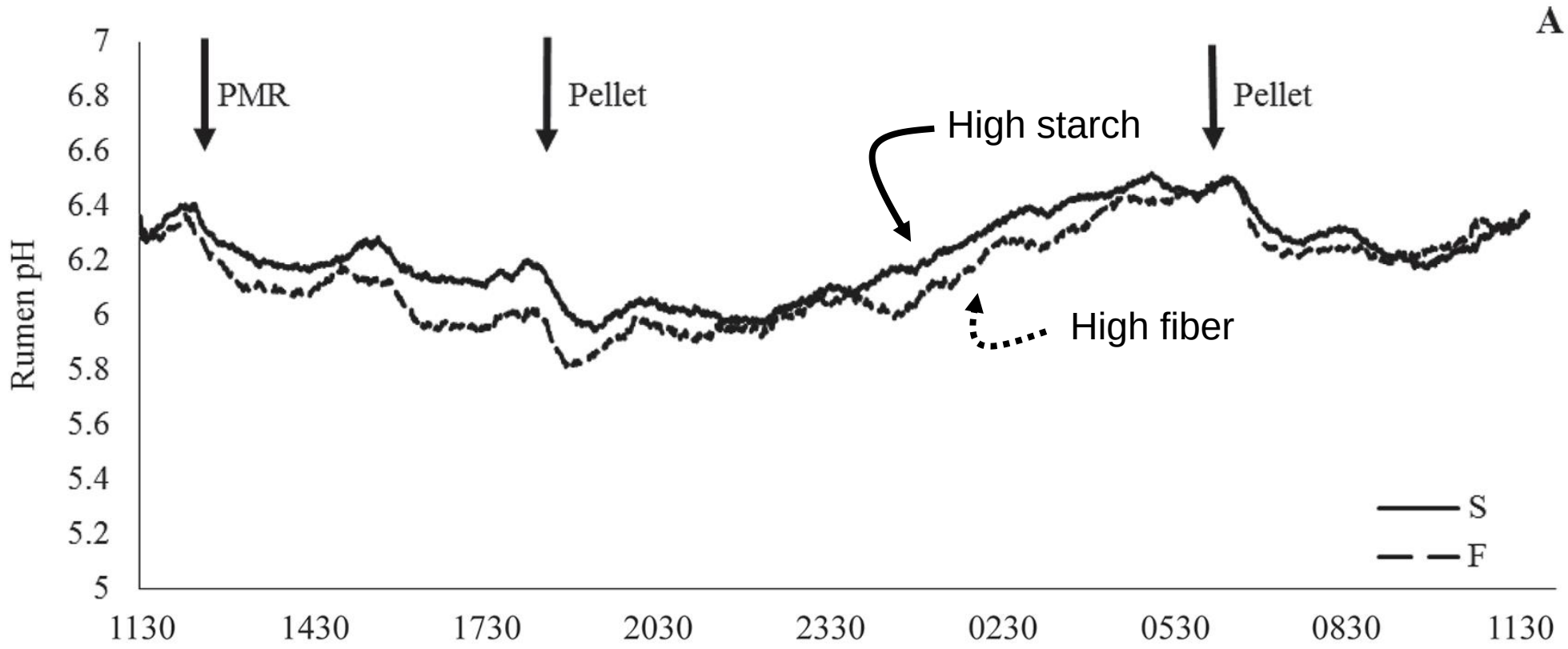






Haisan and Oba, 2020; JDS

Pellet starch has little impact on ruminal pH



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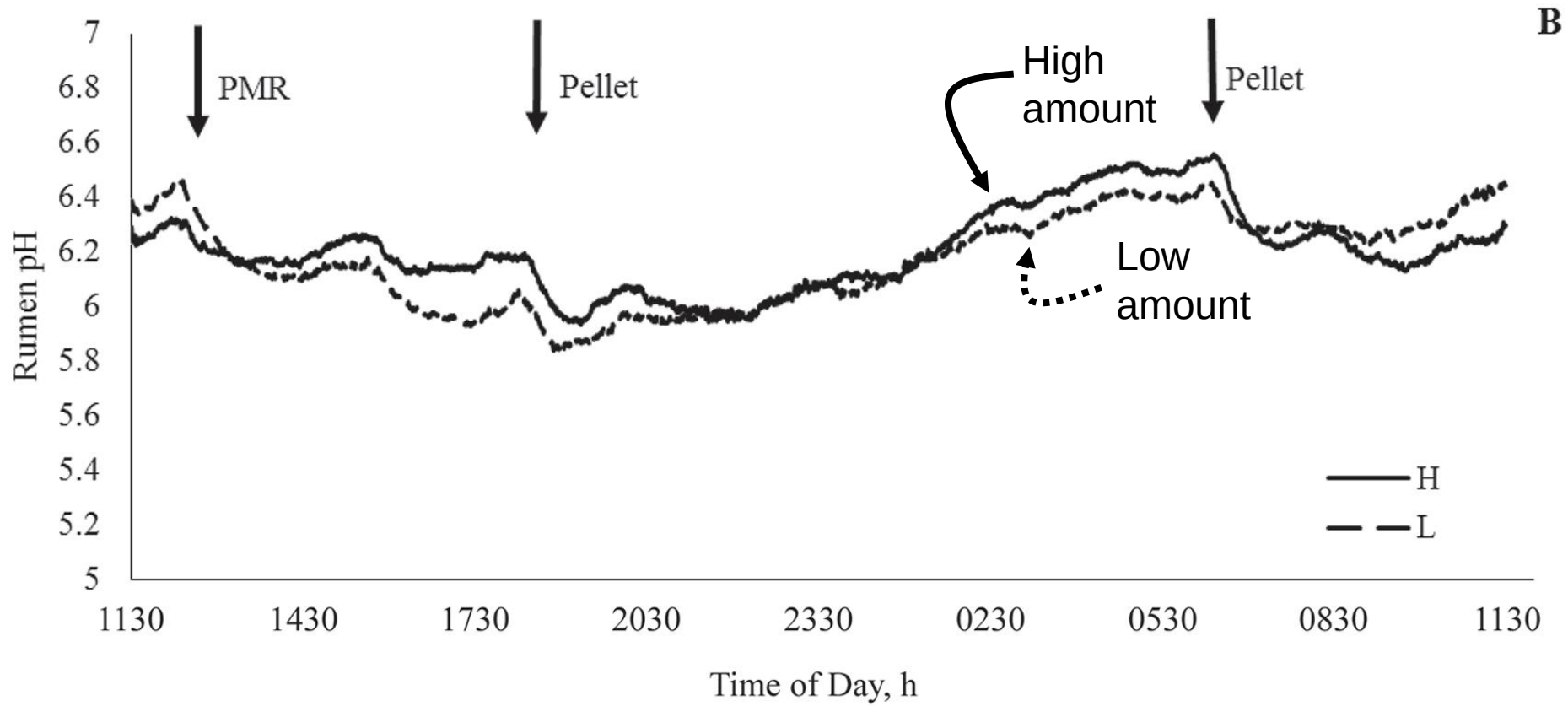
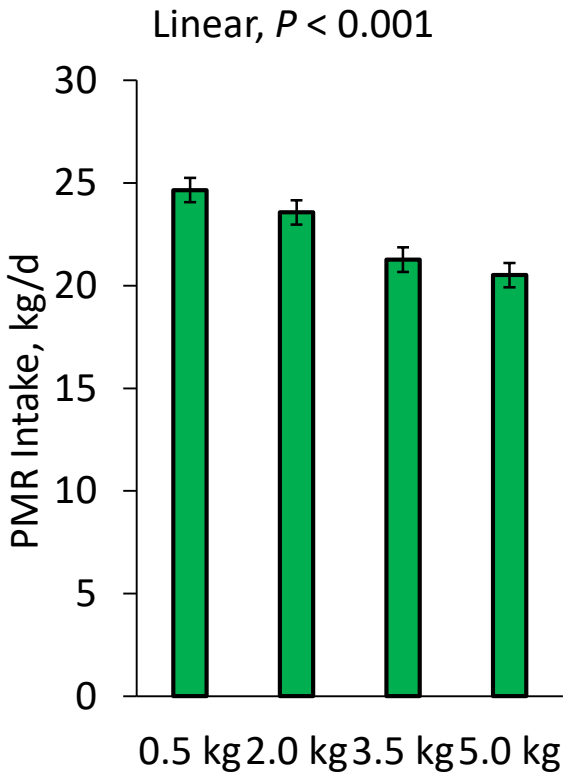
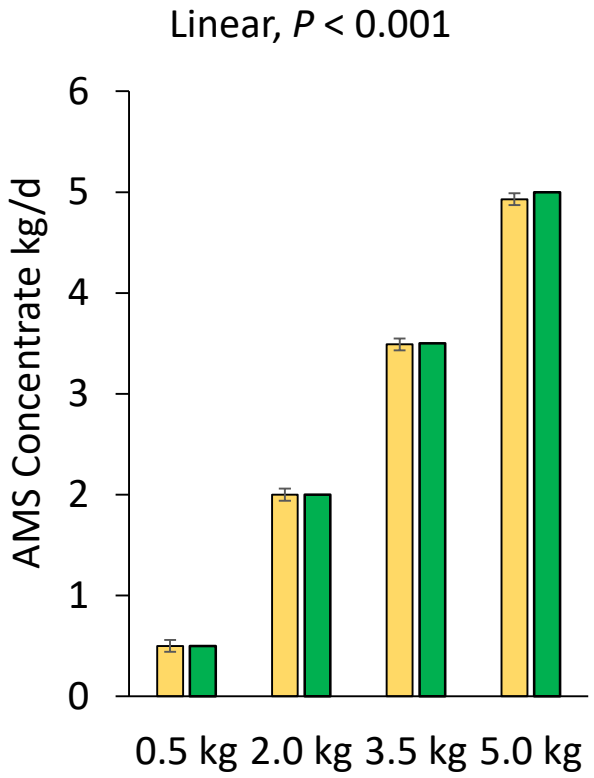
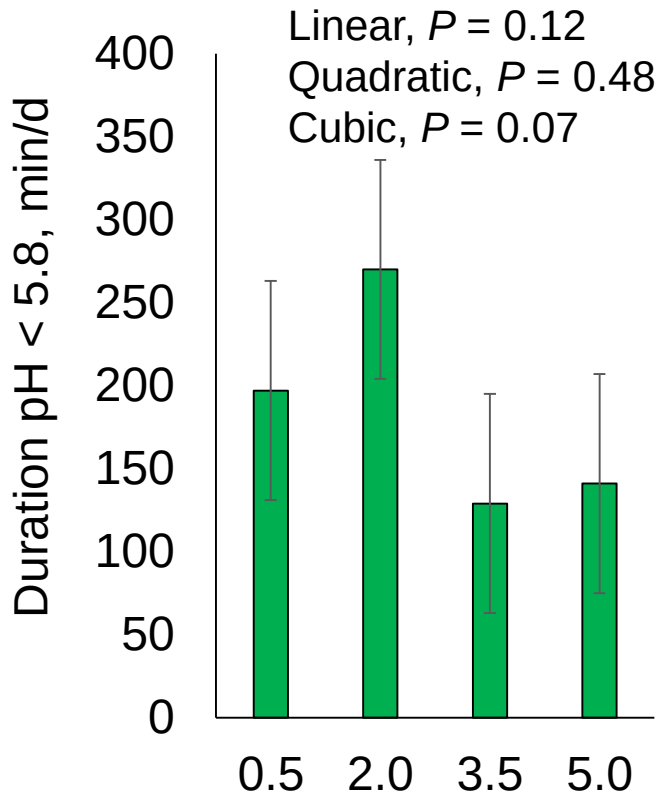


Paddick et al., 2019; JDS

No effect of AMS pellet on minimum, mean, or maximum pH

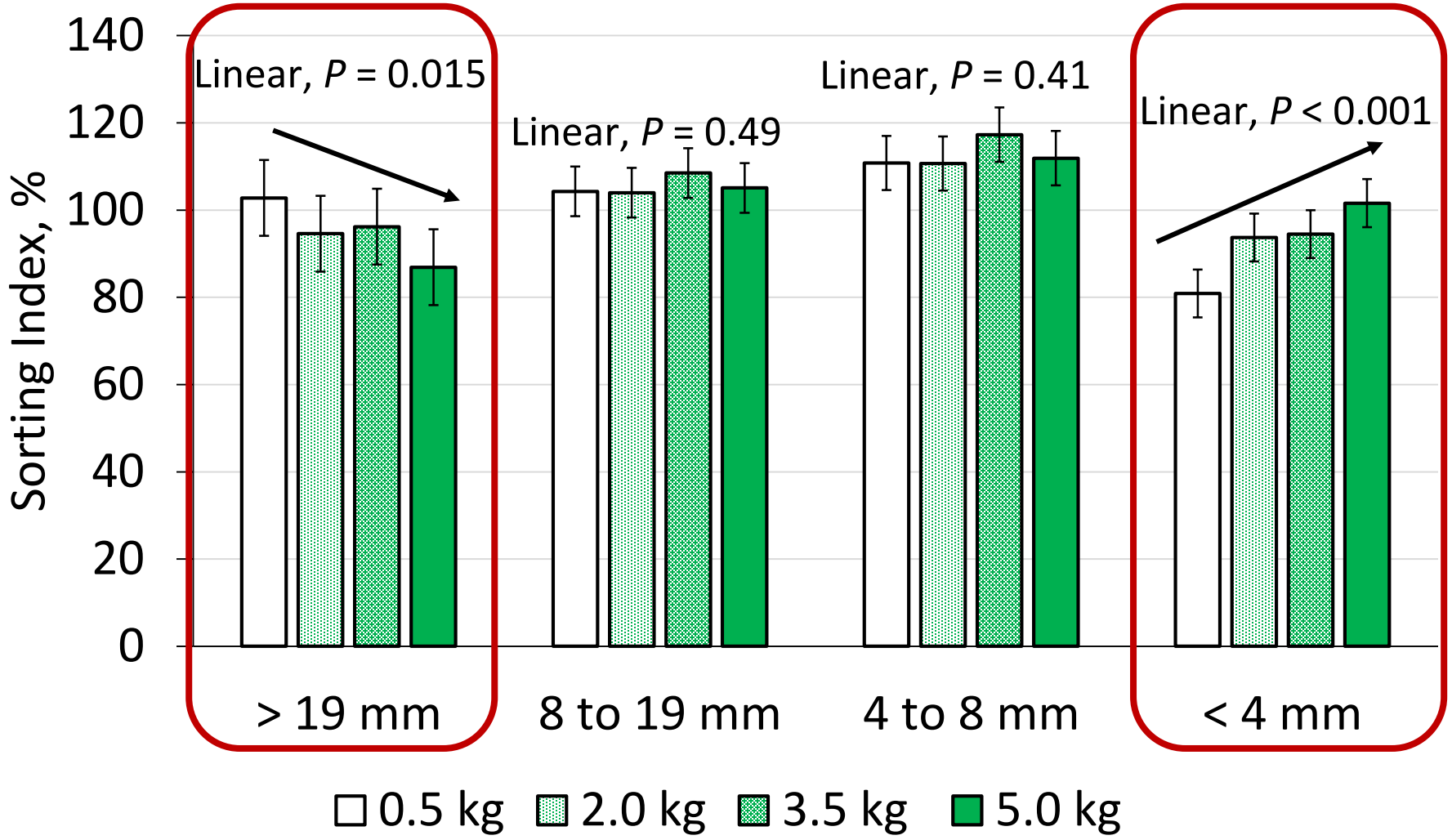






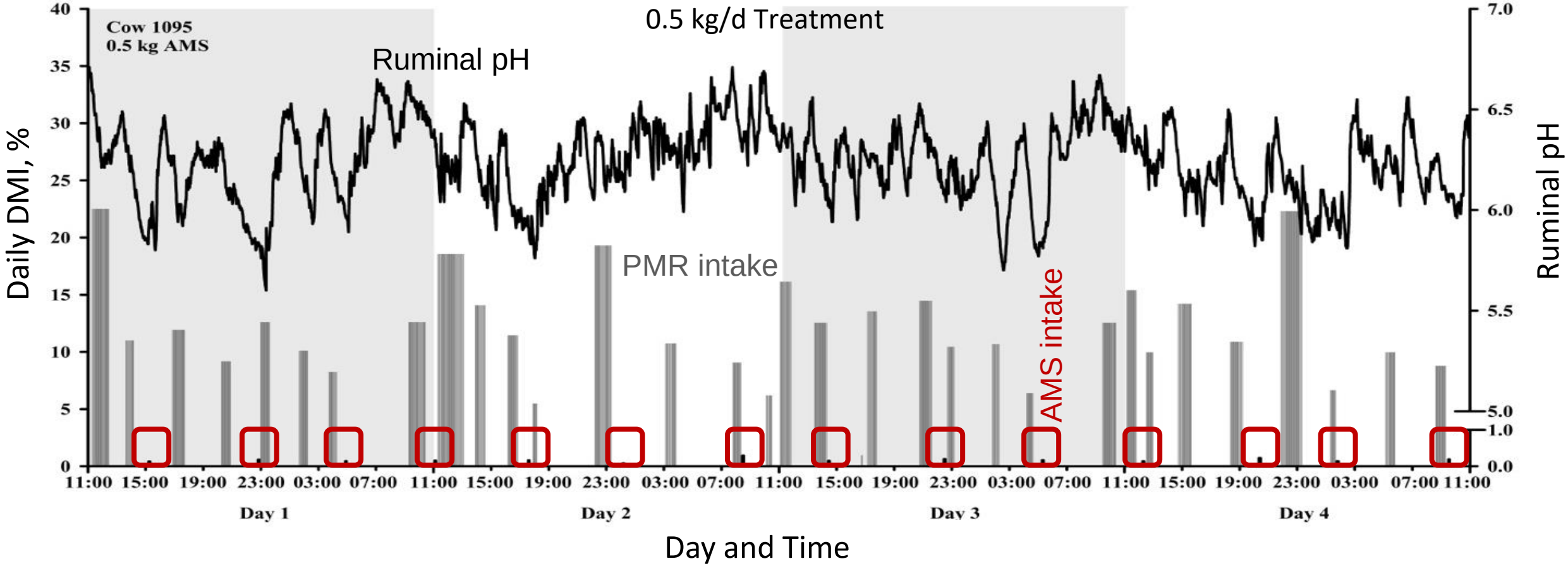
Maximum meal size = 2.5 kg

AMS concentrate may alter sorting of the PMR



Paddick et al., 2019; JDS

Example of a ruminal pH profile for a cow in an AMS



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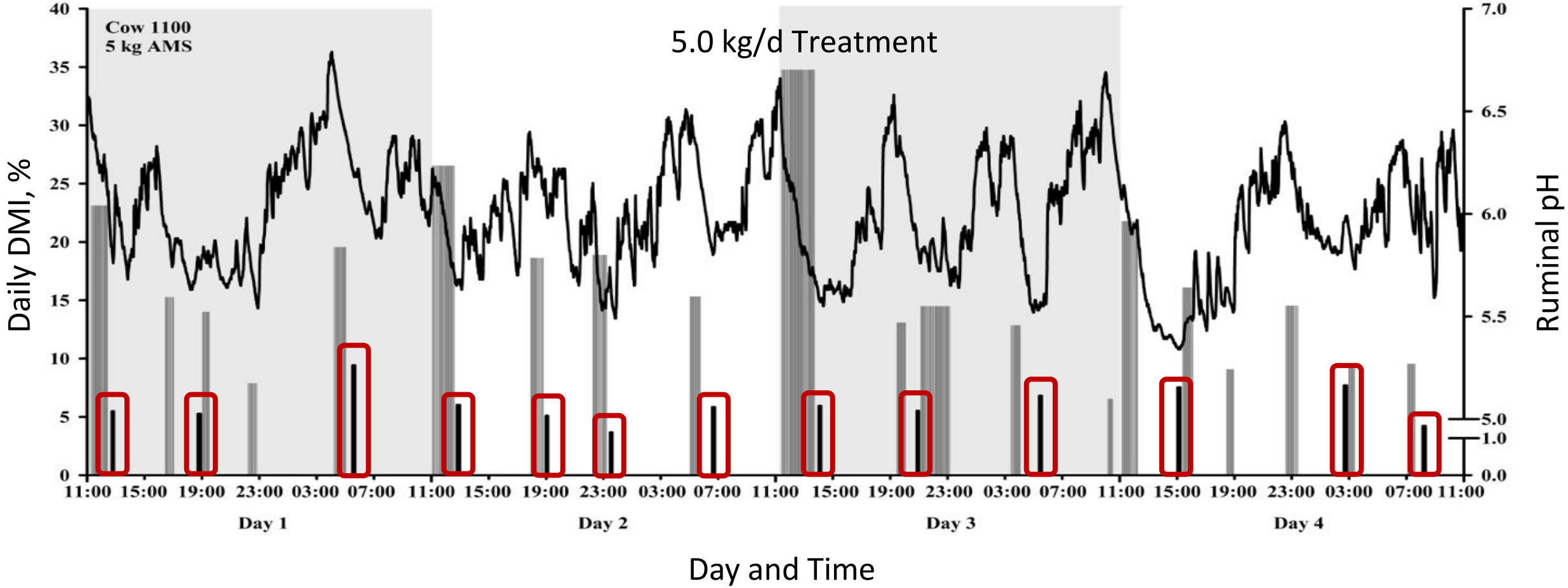
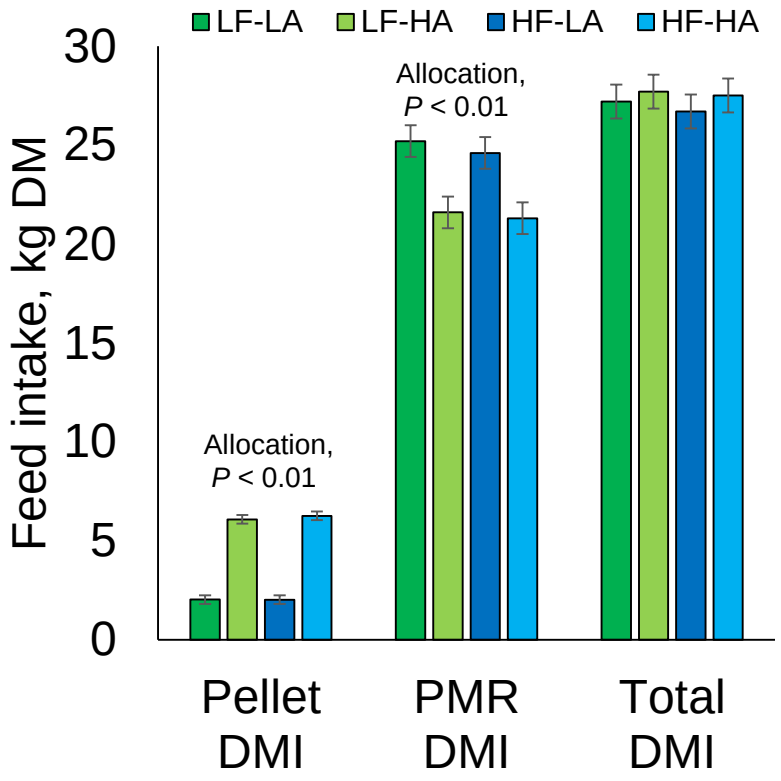
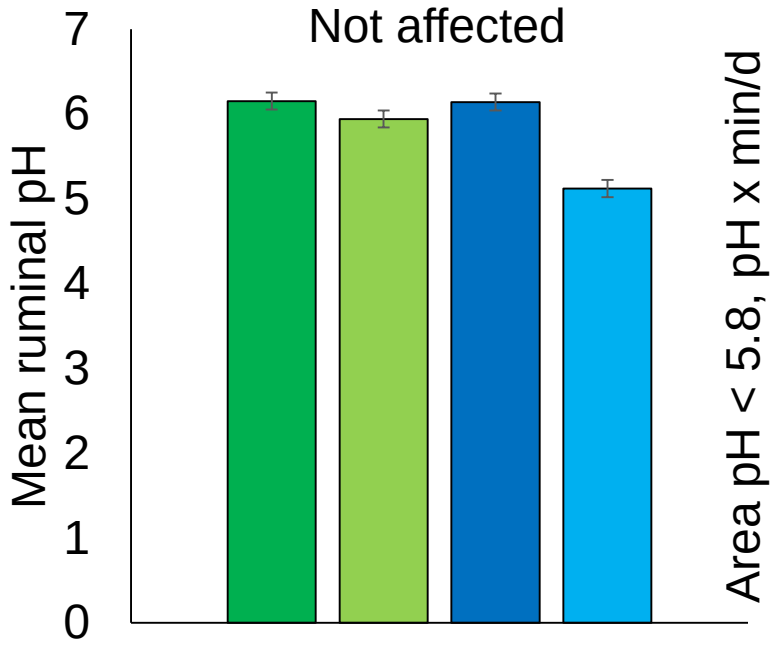
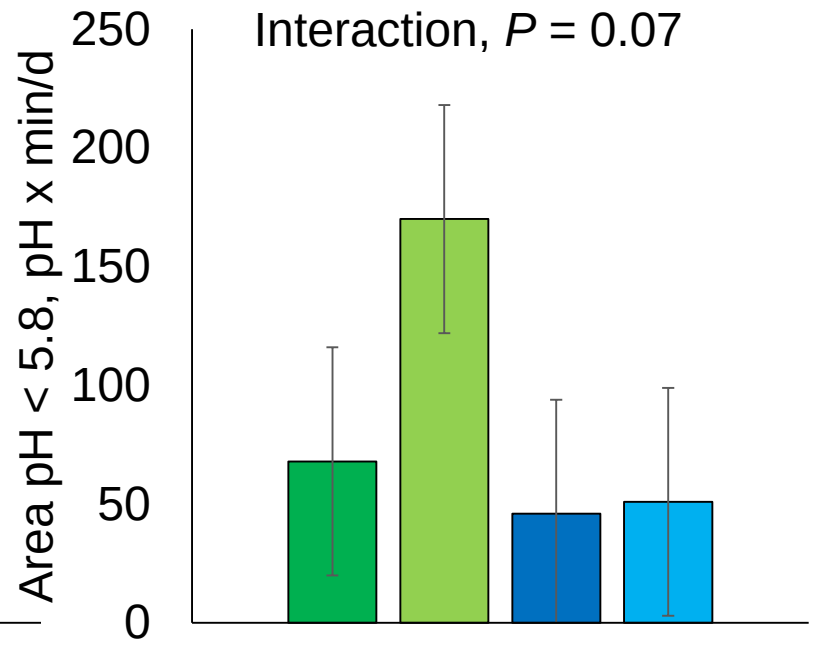


Limited effects arising from AMS allocation on pH

- Low forage PMR (F:C = 54:46), vs. high forage PMR (64:36)
- Low (2 kg/d) or high (6 kg/d) AMS allocation







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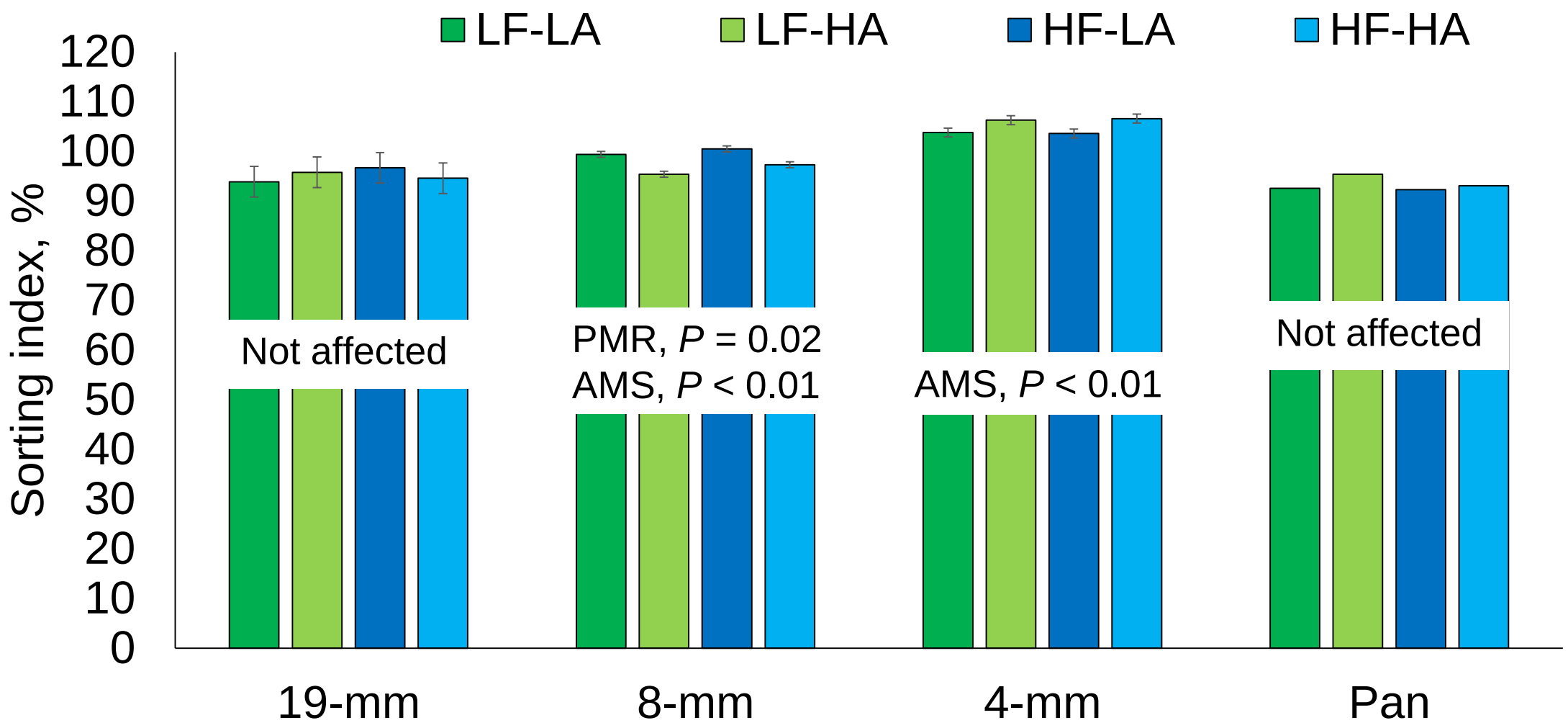


Huot et al 2022; JDS

Is there evidence for risk of ruminal acidosis?

	Dependent variable								
				SARA risk[4]					
	DpH			SARA5.8			SARA6.0		
Characteristic	Adjusted R^2	*P*	Rank	Pseudo-R^2	*P*	Rank	Pseudo-R^2	*P*	Rank
Automatic milking system	0.29	<0.01	3	0.21	<0.01	4	0.27	<0.01	2
Automatic feed pusher	0.13	<0.01	6	0.02	0.11	10	0.09	<0.01	7
Corn silage in the diet	0.23	<0.01	4	0.33	<0.01	3	0.22	<0.01	3
Cow	0.90	<0.01	1	—	—	—	—	—	—
DIM	0.00	0.95	13	—	—	—	—	—	—
Farm	0.44	<0.01	2	0.46	<0.01	1	0.46	<0.01	1
Fat supplementation	0.02	<0.01	12	0.08	<0.01	6	0.07	<0.01	9
Daily feed distribution frequency	0.22	<0.01	5	0.33	<0.01	2	0.21	<0.01	4
Herd size	0.06	<0.01	9	0.14	<0.01	5	0.08	<0.01	8
Monensin	0.03	<0.01	11	0.03	0.03	8	0.09	<0.01	6
Month	0.09	<0.01	7	—	—	—	—	—	—
Number of feeding groups	0.06	<0.01	8	0.04	0.02	7	0.15	<0.01	5
Parity	0.03	<0.01	10	0.02	0.22	9	0.04	0.07	10

[1]n = 5,279.

[2]More than 300 min with reticuloruminal pH <5.8 per day; n = 110.

[3]More than 300 min with reticuloruminal pH <6.0 per day; n = 110.

[4]Pseudo-R^2 = pseudo-McFadden R^2 of the logistic univariate models.

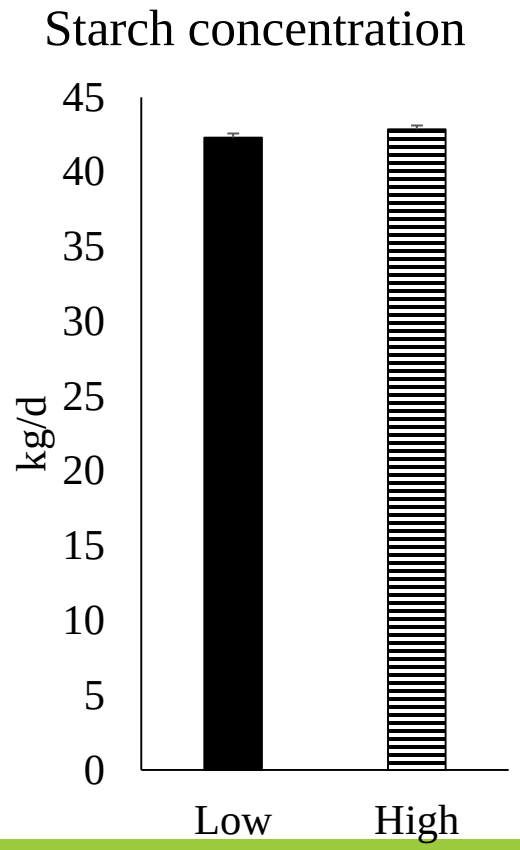
Henriksen et al., 2018; JDS

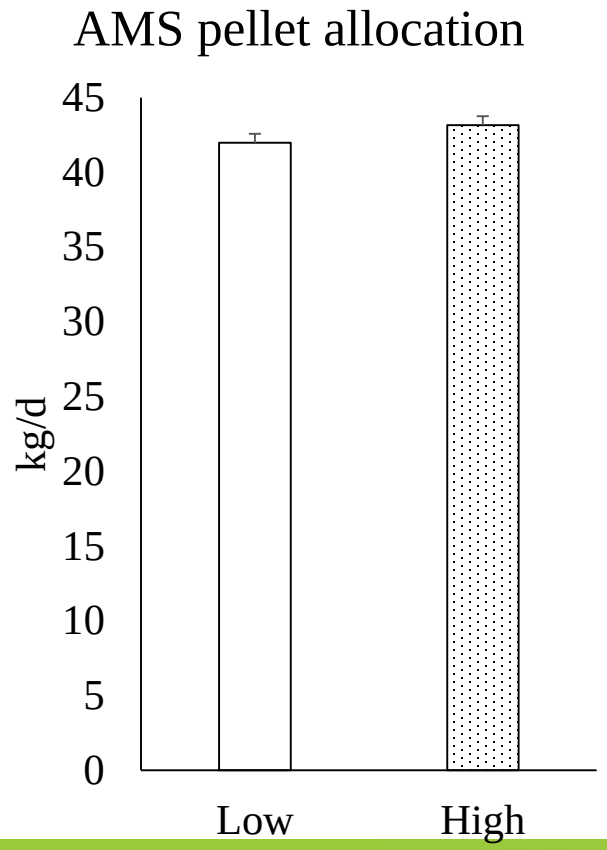
Reducing AMS pellet increases milk fat%

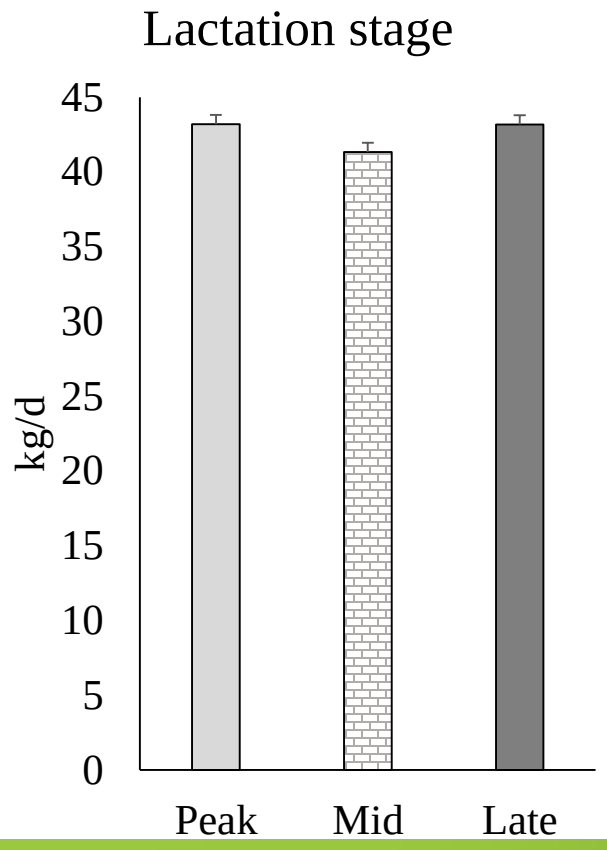
Variable	Increase slope	*P* value	Decrease slope	*P* value
Concentrate intake, kg/d	0.29	< 0.01	-0.31	< 0.01
PMR intake, kg/d	-0.27	< 0.01	0.069	< 0.01
Milkings, no./d	-0.012	NS	-0.012	NS
Milk yield, kg/d	0.051	NS	-0.11	0.03
ECM yield, kg/d	0.082	NS	-0.23	NS
Fat, %	0.0061	NS	0.022	< 0.01

AMS concentrate increased or decreased by 0.5 kg/d
NS = not significant, $P > 0.10$

Feeding high starch and more pellet did not affect milk yield

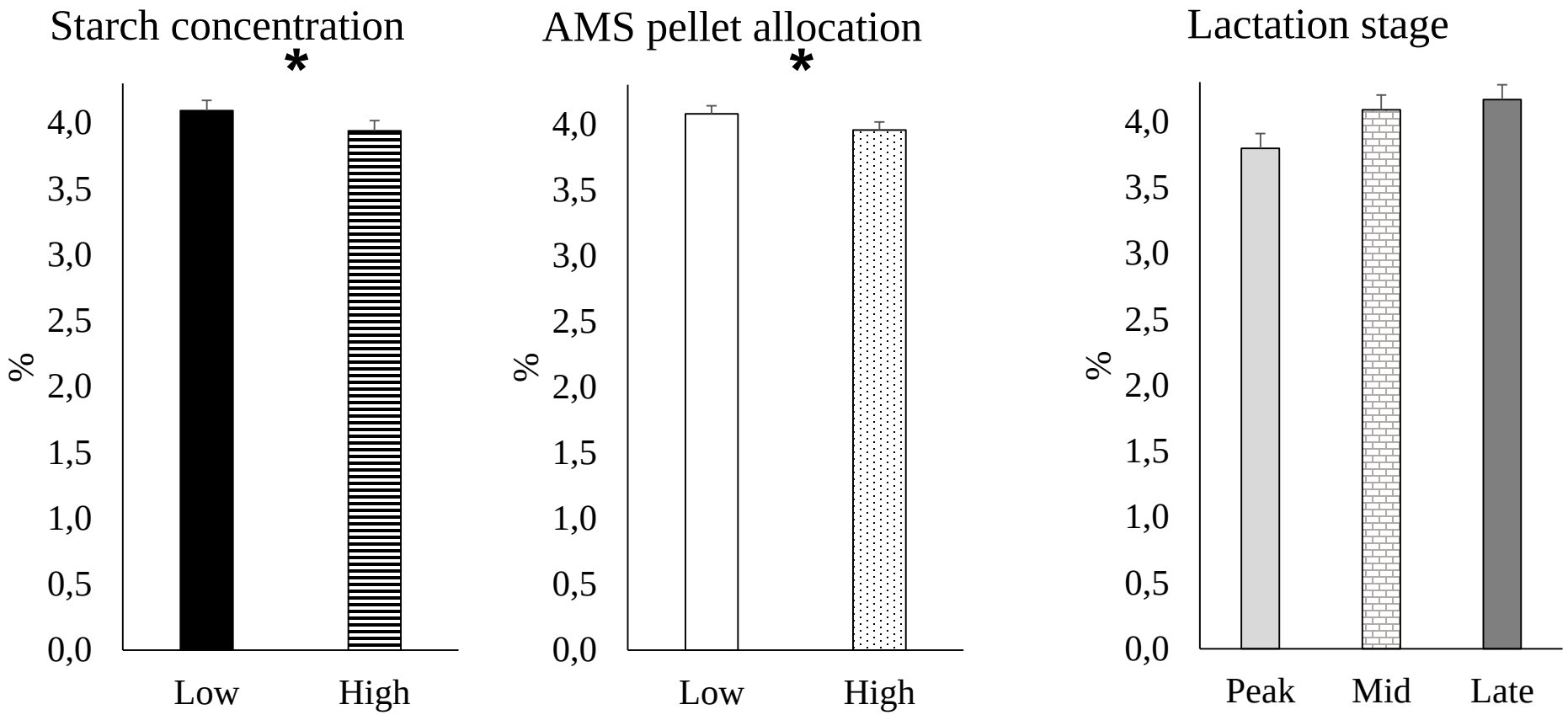






Average milk yield 42.6 kg/d

High starch and high allocation reduce milk fat %



*Indicates means are different ($P < 0.005$)

Haisan et al., unpublished

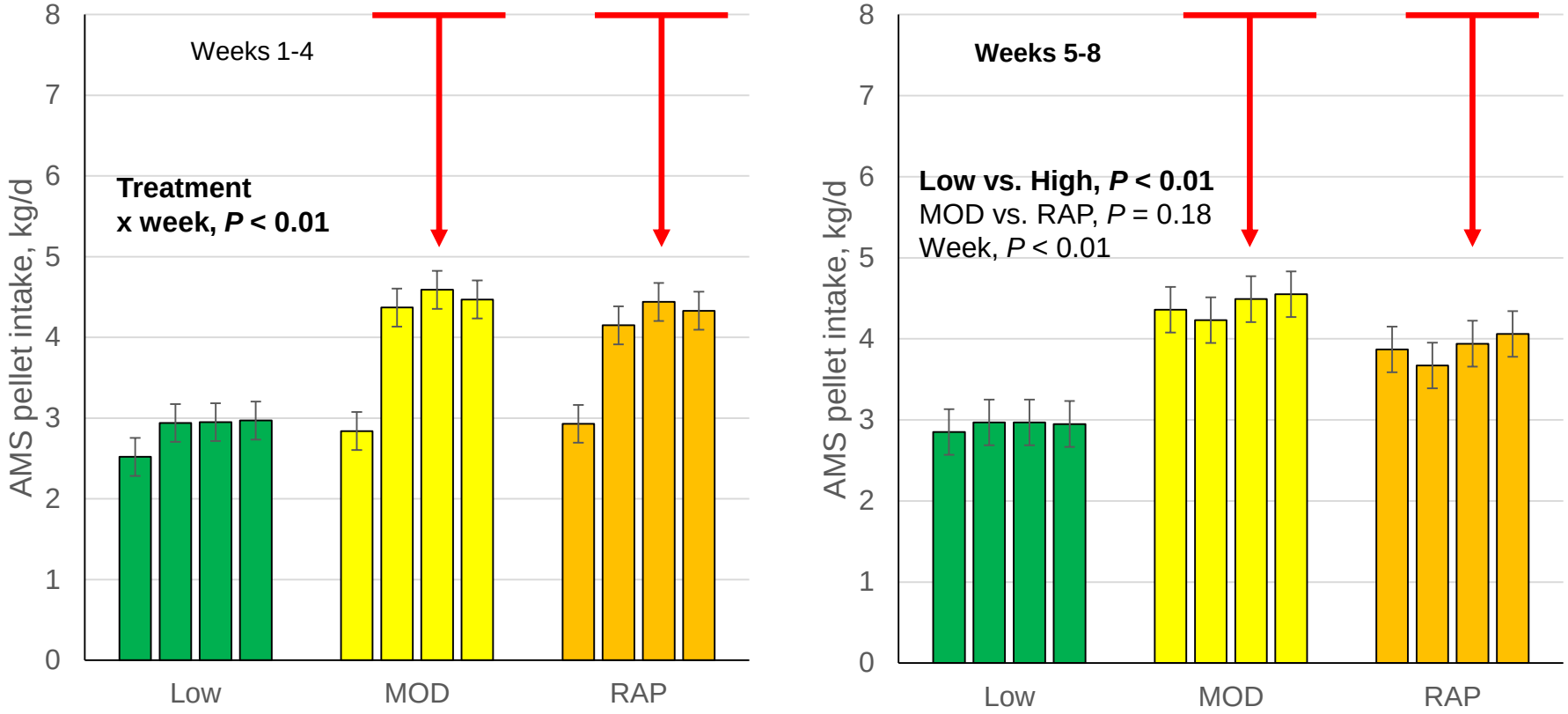
What about in early lactation?

- Static PMR
  - PMR formulated to achieve 87% of ME and 90% of MP allowable milk yield
  - Complete diet targeted for 27 kg DMI, 40 kg milk, 4.1% milk fat, 3.08% true protein
    - Low – 40 ME and 40 MP allowable milk yield
    - High – 42 ME and 42 MP allowable milk yield

- AMS feeding strategy
  - CON: 3 kg/d; n = 20
  - MOD: 3 to 8 kg over 15 d; n = 20
  - RAP: 3 to 8 kg over 5 d; n = 19

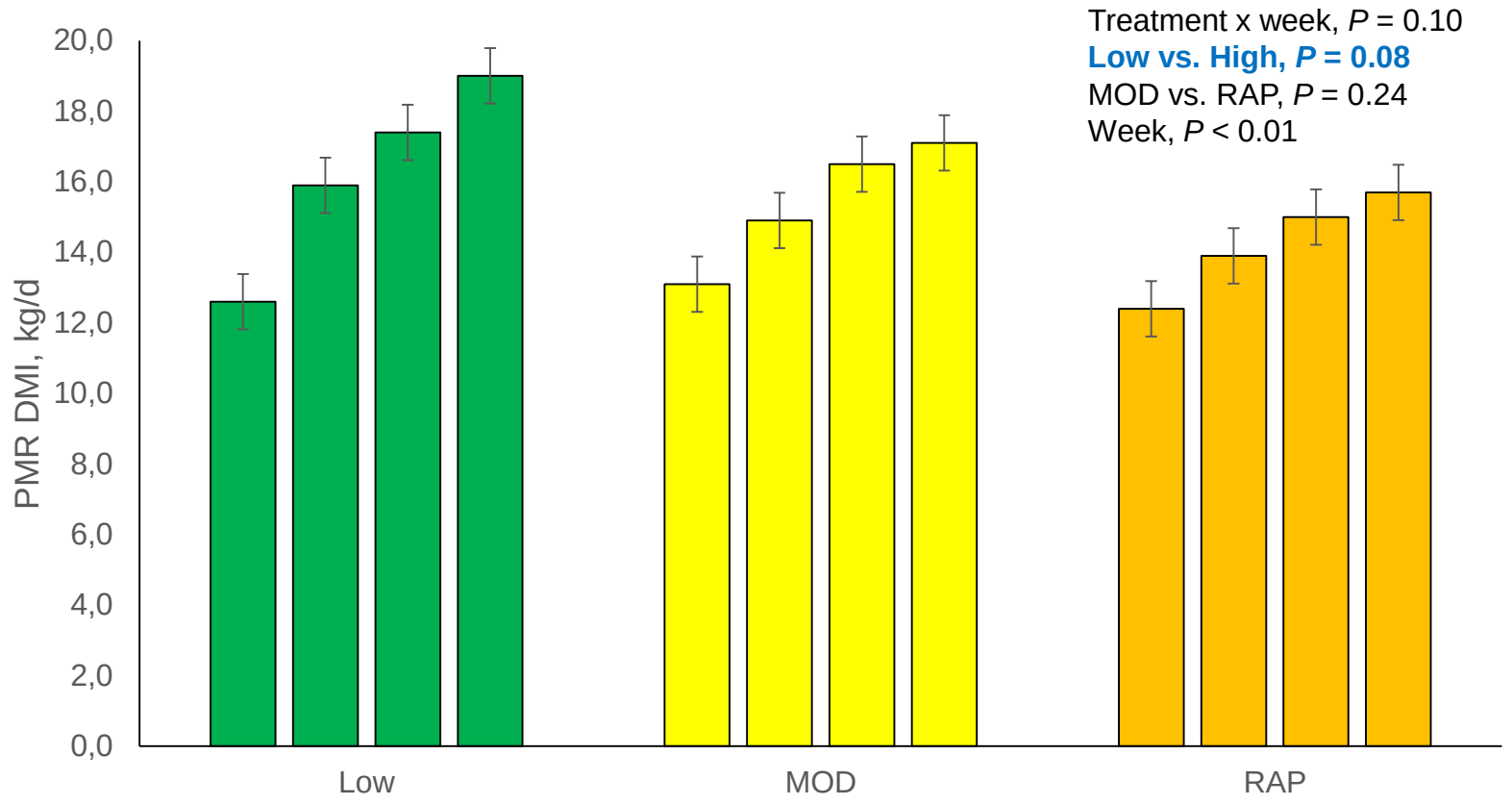
Haisan et al., unpublished

Amount and rate of pellet provision



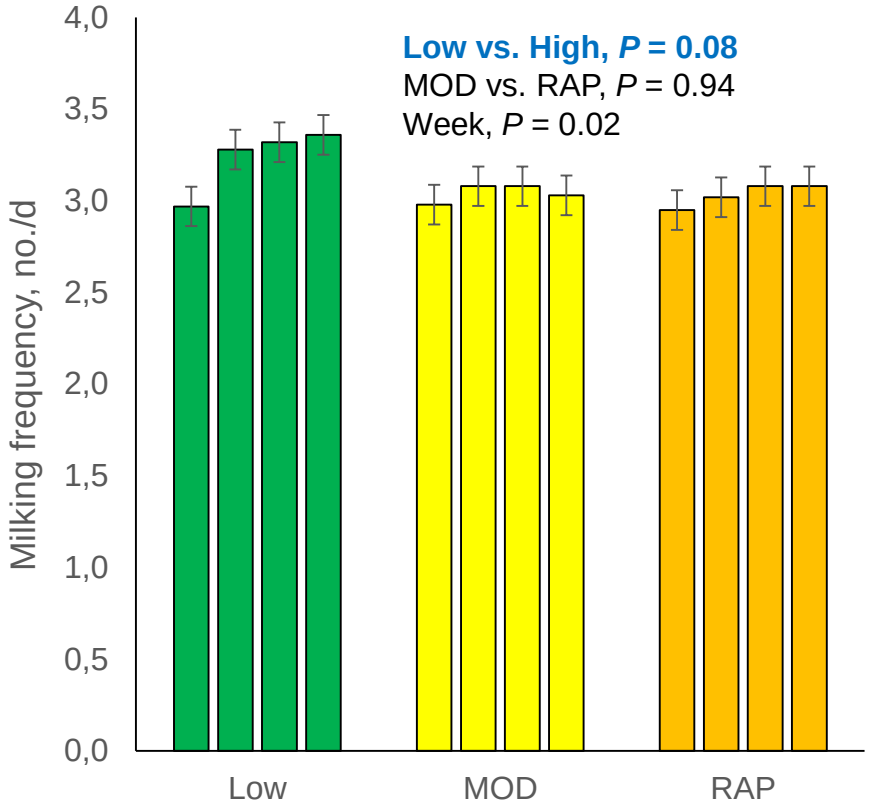
Haisan et al., unpublished

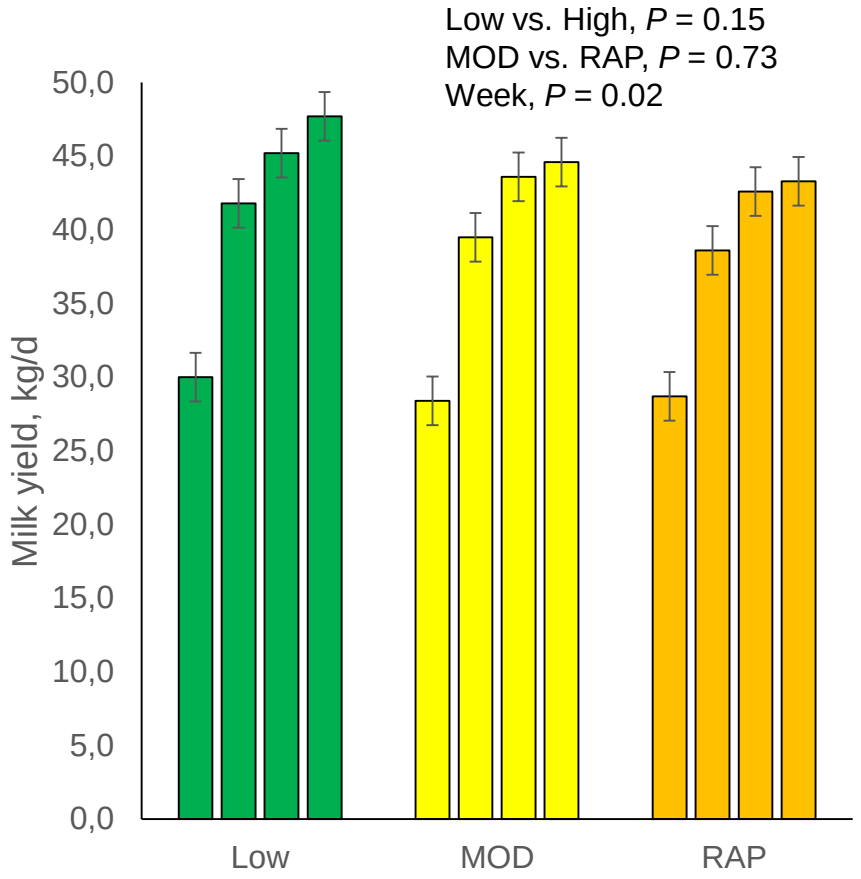
Amount and rate of pellet provision



Haisan et al., unpublished

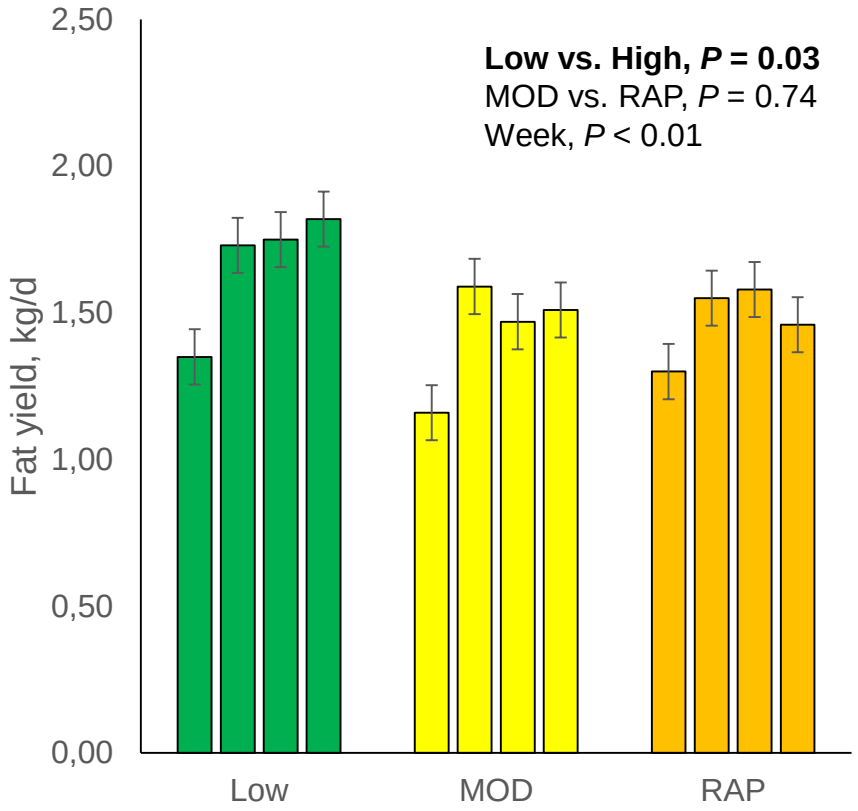
Amount and rate of pellet provision

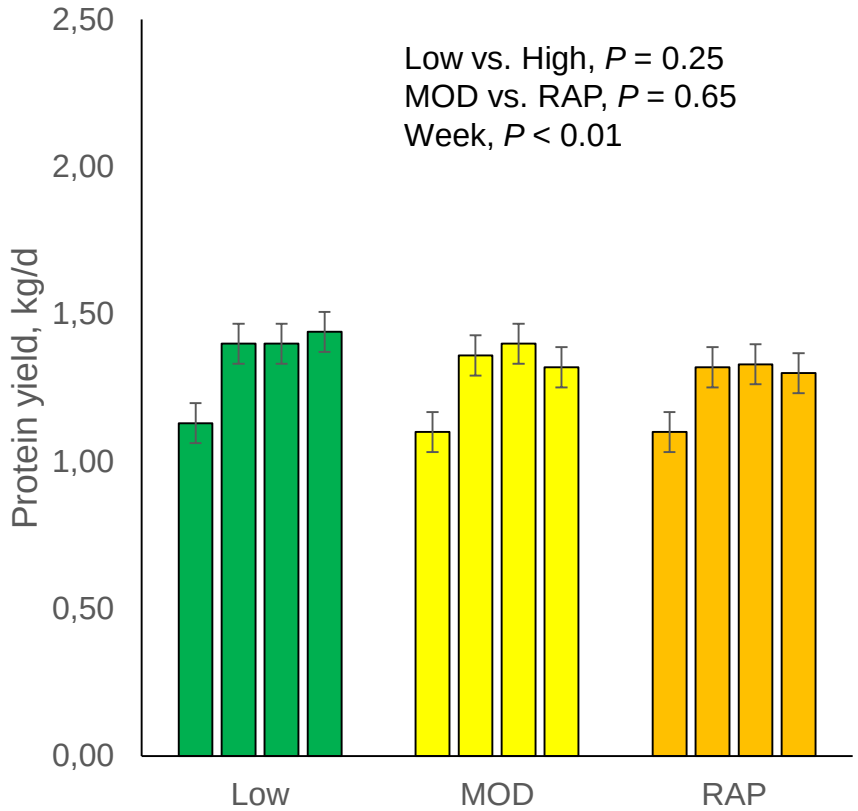




Haisan et al., unpublished

Amount and rate of pellet provision





No differences in BW, BCS, plasma glucose, or serum BHB

Conclusions

- Ruminal fermentation data in robotic systems is quite limiting
- Some suggestions that robotic cows might be at greater risk for ruminal acidosis
- Increasing AMS allocation may reduce milk fat but no evidence for altered ruminal pH
  - Small meal size in the AMS
  - Altered PMR sorting
- Feeding more AMS pellet may reduce milk fat concentrations, but limited effects on milk fat yield

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