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SUPPLEMENTAL TABLES AND FIGURES FOR THE FOLLOWING PAPER PUBLISHED
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**Production and metabolic responses of Montbéliarde and Holstein cows during
periparturient period and a sequential feed restriction challenge**

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INTERPRETIVE SUMMARY

Production and metabolic responses of Montbéliarde and Holstein cows during periparturient period and a sequential feed restriction challenge. Dairy cows face challenges derived from climate change, including variations in feed availability and quality. We studied the responses and resilience of Montbéliarde and Holstein cows during early lactation and to a sequence of four short partial feed restrictions, each followed by a period of normal feeding. Holstein cows produced more milk and used more fat reserves during early lactation compared to Montbéliarde cows. These differences continued during the feed restrictions, especially during the first two. Cows were able to respond to and recover from short restrictions, demonstrating resilience in both breeds.

Supplemental Table S1. Prepartum intake, energy balance, BW and BCS of Holstein (HOLS) and Montbéliarde (MONT) multiparous cows.

	Breed	Period		<i>P</i> -value (wk -4 to calving)			
		wk -4 to calving		Breed	Week	Breed × week	Parity ²
DMI (kg/d)	HOLS	15.2	(14.4, 15.9)	< 0.001	< 0.001	0.54	NS
	MONT	13.2	(12.6, 13.9)				
Energy balance (MJ/d)	HOLS	31.2	(27.2, 35.4)	< 0.001	< 0.001	0.47	NS
	MONT	20.0	(16.2, 23.7)				
Body weight (kg)	HOLS	778	(753, 803)	0.07	< 0.001	0.86	< 0.01
	MONT	748	(726, 770)				
BCS (0 to 5 scale)	HOLS	3.07	(2.87, 3.27)	0.07	< 0.01	0.44	NS
	MONT	3.32	(3.14, 3.50)				

¹ Values are LSM and (95% CI)

² 2 vs 3 or 4 lactations. Parity (second or third and greater) effects were tested and included in the model whenever *P*-value ≤ 0.10.

Supplemental Table S2. Milk and milk component yield of Holstein (HOLS) and Montbéliarde (MONT) multiparous cows from calving to 10 wks of lactation and from 18 to 22 weeks of lactation¹.

	Breed	Period		<i>P</i> -value (from calving to wk 10)				Period		<i>P</i> -value (from wk 18 to 22) ⁵		
		From calving to wk 10 ²		Breed	Week	Breed × Week	Parity ⁴	From week 18 to 22 ³		Breed	Week	Breed × Week
Milk yield (kg/d)	HOLS	37.0	(35.2, 38.7)	< 0.001	< 0.001	0.35	0.03	31.8	(30.3, 33.2)	< 0.001	< 0.001	0.62
	MONT	30.7	(29.1, 32.3)					28.0	(26.7, 29.2)			
Fat yield (kg/d)	HOLS	1.463	(1.392, 1.534)	< 0.001	< 0.001	0.11	< 0.01	1.282	(1.225, 1.340)	< 0.01	< 0.001	0.37
	MONT	1.228	(1.164, 1.292)					1.168	(1.116, 1.220)			
Protein yield (kg/d)	HOLS	1.146	(1.092, 1.200)	< 0.01	< 0.001	0.03	0.05	1.060	(1.015, 1.105)	0.04	< 0.001	0.65
	MONT	1.039	(990, 1.087)					0.997	(0.957, 1.038)			
Lactose yield (kg/d)	HOLS	1.820	(1.729, 1.911)	< 0.001	< 0.001	0.79	0.07	1.532	(1.459, 1.605)	0.001	< 0.001	0.28
	MONT	1.520	(1.438, 1.602)					1.359	(1.293, 1.425)			

¹ Values are LSM and (95% CI)

² 40 cows (22 MONT and 18 HOLS).

³ 38 cows (21 MONT and 17 HOLS).

⁴ 2 vs 3 or 4 lactations. Parity (second or third and greater) effects were tested and included in the model whenever *P*-value ≤ 0.10.

⁵ Parity effects (2 vs 3 or 4 lactations) were not significant for all variables during mid-lactation period, except for a trend observed for milk fat yield (*P* = 0.07).

Supplemental Table S3. Milk and milk component yield, PDI balance, energy conversion efficiency and BW in Holstein (HOLS) and Montbéliarde (MONT) multiparous cows subjected to a nutritional challenge composed of a sequence of four 4-d periods of feed restriction^{1,2}.

	Breed	Period								<i>P</i> -value ³		
		Before	FR1	Recovery 1, 10 d	FR2	Recovery 2, 3 d	FR3	Recovery 3, 3 d	FR4	Recovery 4, 10 d	Breed	Breed × Period
Milk yield (kg/d)	HOLS	a 37.3 ^y (35.8, 38.8)	cde 30.1 ^y (28.6, 31.6)	b 32.9 ^y (31.4, 34.4)	def 29.4 ^y (27.9, 30.9)	cd 30.5 ^y (29, 32)	fg 27.8 ^y (26.3, 29.4)	ef 28.8 ^y (27.3, 30.3)	g 26.9 ^y (25.4, 28.4)	c 31.2 ^y (29.7, 32.7)	< 0.001	0.001
	MONT	31.9 ^z (30.6, 33.2)	26.3 ^z (25, 27.6)	28.3 ^z (27, 29.6)	25.3 ^z (24, 26.6)	26.2 ^z (24.9, 27.5)	25.4 ^z (24.1, 26.7)	25.5 ^z (24.2, 26.8)	24.2 ^z (22.9, 25.5)	27.3 ^z (26, 28.6)		
Fat yield (kg/d)	HOLS	a 1.463 ^y (1.400, 1.522)	b 1.293 ^y (1.234, 1.352)	bc 1.247 ^y (1.194, 1.306)	c 1.207 ^y (1.148, 1.266)	de 1.116 ^y (1.056, 1.175)	d 1.133 (1.074, 1.193)	e 1.053 (0.994, 1.112)	de 1.086 (1.026, 1.145)	c 1.195 ^y (1.136, 1.254)	< 0.01	0.02
	MONT	1.315 ^z (1.2561, 1.368)	1.168 ^z (1.114, 1.221)	1.134 ^z (1.081, 1.188)	1.105 ^z (1.052, 1.158)	1.012 ^z (0.959, 1.066)	1.059 (1.005, 1.112)	0.998 (0.945, 1.051)	1.043 (0.989, 1.096)	1.101 ^z (1.047, 1.154)		
Protein yield (kg/d)	HOLS	a 1.175 (1.126, 1.225)	cd 0.894 (0.844, 0.944)	b 1.021 (0.971, 1.070)	cde 0.883 (0.833, 0.933)	c 0.914 (0.864, 0.964)	de 0.840 (0.790, 0.890)	cd 0.884 (0.834, 0.934)	e 0.829 (0.779, 0.879)	b 1.006 (0.956, 1.056)	0.18	0.35
	MONT	1.125 (1.082, 1.167)	0.869 (0.826, 0.911)	0.965 (0.922, 1.007)	0.832 (0.789, 0.874)	0.865 (0.822, 0.907)	0.846 (0.804, 0.889)	0.857 (0.815, 0.899)	0.808 (0.765, 0.850)	0.952 (0.910, 0.995)		
Lactose yield (kg/d)	HOLS	a 1.870 ^y (1.795, 1.946)	c 1.486 ^y (1.410, 1.562)	b 1.615 ^y (1.539, 1.691)	de 1.426 ^y (1.350, 1.502)	cd 1.476 ^y (1.400, 1.552)	e 1.353 ^y (1.278, 1.429)	e 1.373 ^y (1.297, 1.449)	f 1.298 ^y (1.222, 1.374)	c 1.502 ^y (1.426, 1.577)	< 0.001	< 0.01
	MONT	1.610 ^z (1.542, 1.678)	1.298 ^z (1.230, 1.366)	1.386 ^z (1.310, 1.455)	1.233 ^z (1.165, 1.302)	1.273 ^z (1.205, 1.342)	1.241 ^z (1.173, 1.310)	1.216 ^z (1.147, 1.284)	1.169 ^z (1.100, 1.237)	1.318 ^z (1.250, 1.387)		
PDI balance (g/d) ⁴	HOLS	521 ^y (379, 662)	-547 (-611, -484)	551 (409, 693)	-511 (-575, -447)	721 ^y (579, 863)	-396 ^y (-459, -332)	974 ^y (832, 1116)	-367 (-430, -303)	693 (552, 835)	<0.01	<.01
	MONT	309 ^z (181, 437)	-567 (-624, -509)	451 (323, 579)	-513 (-570, -455)	511 ^z (383, 639)	-490 ^z (-548, -433)	671 ^z (543, 799)	-405 (-463, -348)	525 (396, 653)		
ECE (MJ secreted / MJ intake) ⁵	HOLS	c 0.61 (0.57, 0.65)	a 1.09 (1.04, 1.14)	d 0.57 (0.54, 0.6)	a 1.03 (0.99, 1.07)	e 0.52 (0.49, 0.54)	b 0.94 (0.90, 0.97)	e 0.47 (0.43, 0.50)	b 0.91 (0.86, 0.96)	e 0.52 (0.50, 0.54)	0.81	0.46
	MONT	0.61 (0.58, 0.64)	1.04 (1.00, 1.09)	0.56 (0.53, 0.58)	1.00 (0.97, 1.03)	0.53 (0.50, 0.55)	0.95 (0.91, 0.98)	0.51 (0.47, 0.54)	0.91 (0.86, 0.95)	0.53 (0.51, 0.55)		

		a	e	ab	ef	c	fg	d	g	b		
Body weight (kg)	HOLS	695 (668, 722)	653 (626, 680)	689 (662, 717)	647 (620, 674)	676 (648, 703)	642 (615, 670)	668 (641, 696)	636 (609, 664)	683 (656, 710)	0.36	< 0.01
	MONT	705 (681, 730)	666 (642, 691)	702 (677, 726)	668 (643, 692)	691 (666, 715)	662 (638, 687)	685 (660, 710)	662 (638, 687)	697 (672, 721)		

¹ Each feed restriction (FR1, FR2, FR3 and FR4) consisted of 4 d of restricted feed allowance to meet 50% of individual NE_L requirements that were calculated before the challenge period (INRA, 2007). The first feed restriction period (**FR1**) was initiated at 87 ± 9 DIM. FR1 was followed by 10 days of measurements at ad libitum intake (**Recovery 1**), FR2, FR3 and FR4 were separated by 3 days of ad libitum intake (**Recovery 2** and **Recovery 3**), 10 d of measurements at ad libitum intake were recorded after FR4 (**Recovery 4**).

² Values are LSM and (95% CI), 40 cows (22 MONT and 18 HOLS).

³ Period effect significant for all variables ($P < 0.001$), parity effects (2 vs 3 or 4 lactations) significant for fat yield ($P = 0.04$) and lactose yield ($P = 0.02$). A Trend for a covariate effect of DIM at start of the challenge was observed for milk yield ($P = 0.08$).

⁴ Balance of protein truly digestible in the small intestine (INRA, 2007)

⁵ Energy conversion efficiency expressed as MJ NE_L secreted / MJ NE_L intake.

y, z Breed means not sharing a common superscript differ within the period ($P \leq 0.05$)

a – g Period means (main period effects) not sharing a common superscript differ ($P \leq 0.05$)

Supplemental Table S4. Plasma insulin and IGF-1 concentrations in Holstein (HOLS) and Montbéliarde (MONT) multiparous cows subjected to a nutritional challenge composed of a sequence of four 4-d periods of feed restriction^{1,2}.

	Breed	Period									<i>P</i> -value ³	
		Before	FR1	Recovery 1	FR2	Recovery 2	FR3	Recovery 3	FR4	Recovery 4	Breed	Breed × Period
Insulin (μ U/mL) ⁴	HOLS	a 9.2 (6.7, 12.5)	b 4.3 (3.1, 5.8)	a 9.1 (6.7, 12.4)					b 4.6 (3.4, 6.2)		0.13	0.53
	MONT	7.8 (5.9, 10.4)	2.8 (2.1, 3.7)	8.2 (6.2, 10.8)					3.4 (2.5, 4.5)			
IGF-1 (ng/dL) ⁴	HOLS	a 136 (118, 154)	b 98 (80, 116)	a 140 (122, 158)					b 117 (99, 135)		0.29	0.34
	MONT	153 (137, 170)	111 (95, 128)	154 (138, 170)					117 (100, 133)			

¹ Each feed restriction period (FR1, FR2, FR3 and FR4) consisted of 4 d of restricted feed allowance to meet 50% of individual NE_L requirements that were calculated before the challenge period (INRA, 2007). The first feed restriction period (**FR1**) was started at 87 ± 9 DIM. FR1 was followed by 10 d at ad libitum intake (**Recovery 1**), FR2, FR3 and FR4 were separated by 3 days of ad libitum intake (**Recovery 2** and **Recovery 3**), and ad libitum intake after FR4 (**Recovery 4**).

² Values are LSM and (95% CI); 40 cows (22 MONT and 18 HOLS).

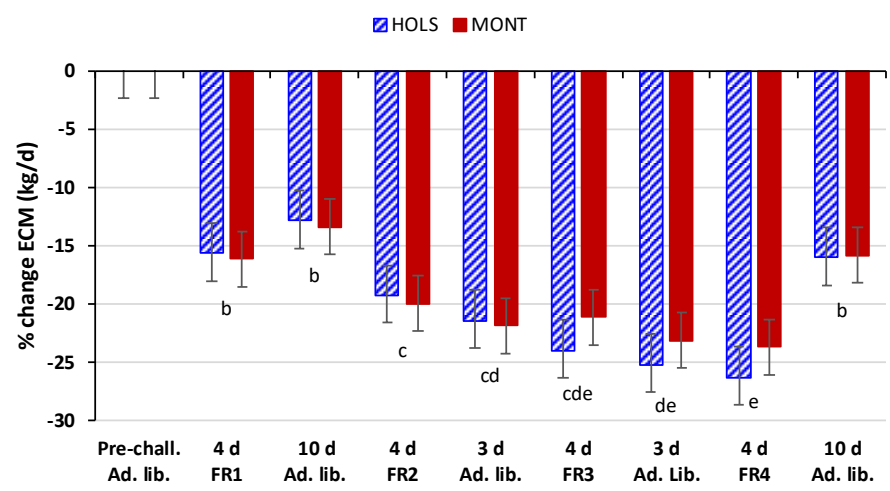
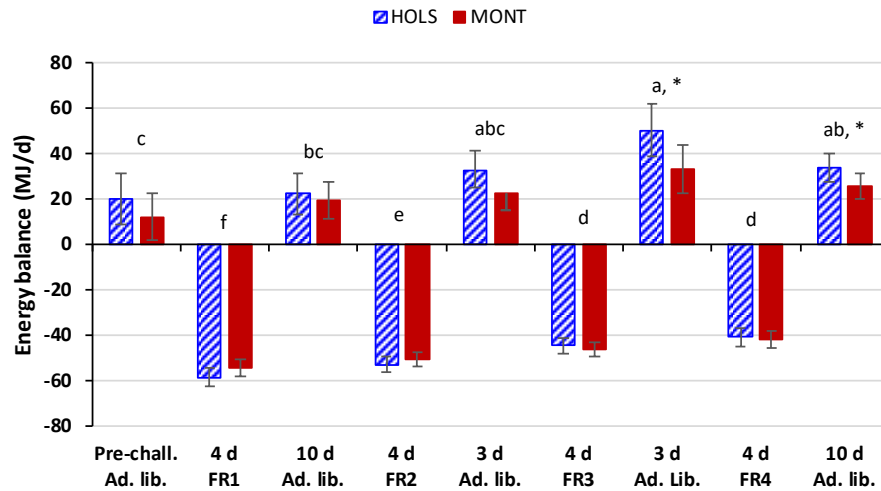
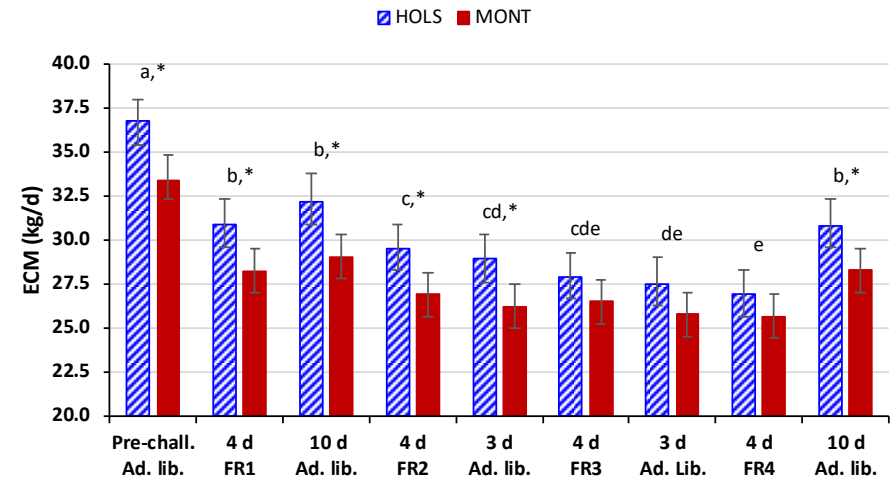
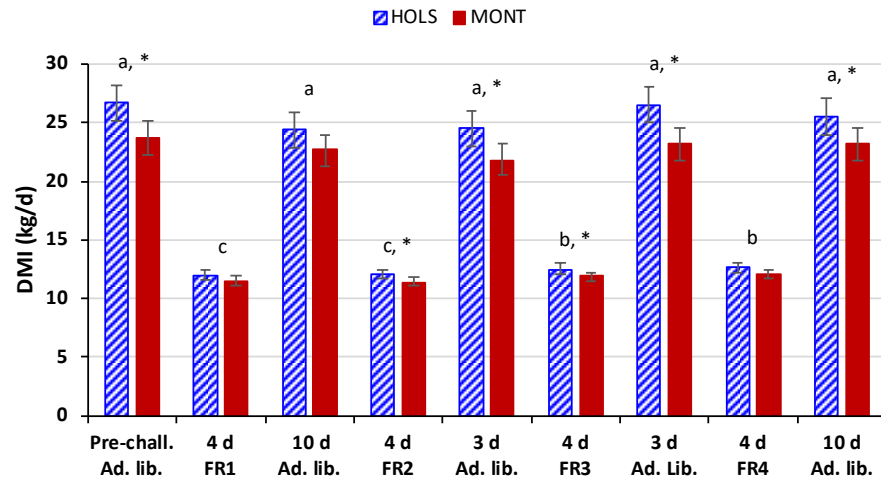
³ Period effect were significant for all variables ($P < 0.001$), parity effects (2 vs 3 or 4 lactations) were not significant.

⁴ Analyzed in samples collected before and at the end of FR1, before FR2, and at the of FR4.

a, b: Period means (main period effects) not sharing a common superscript differ ($P \leq 0.05$).

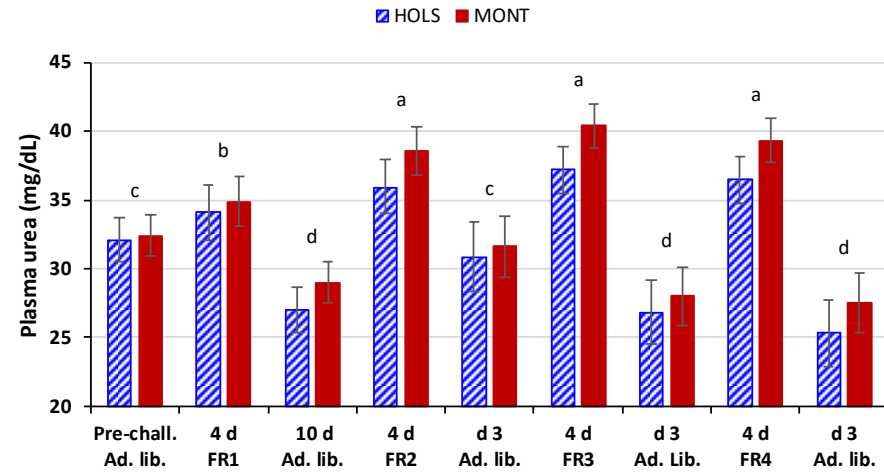
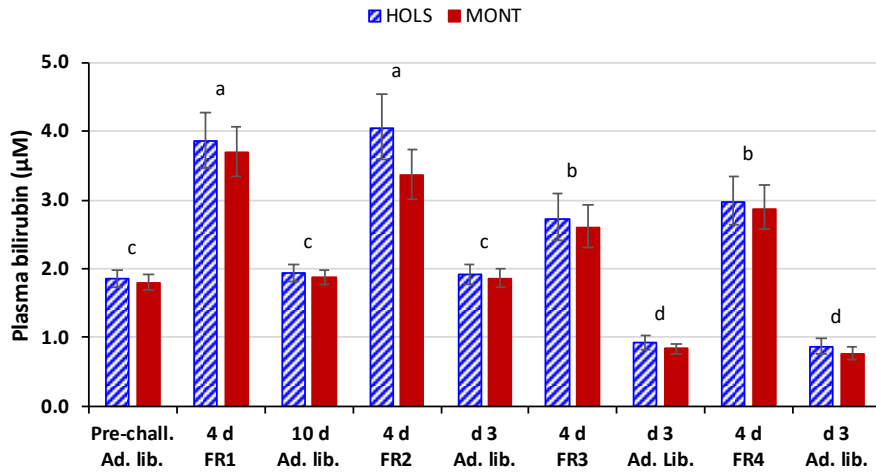
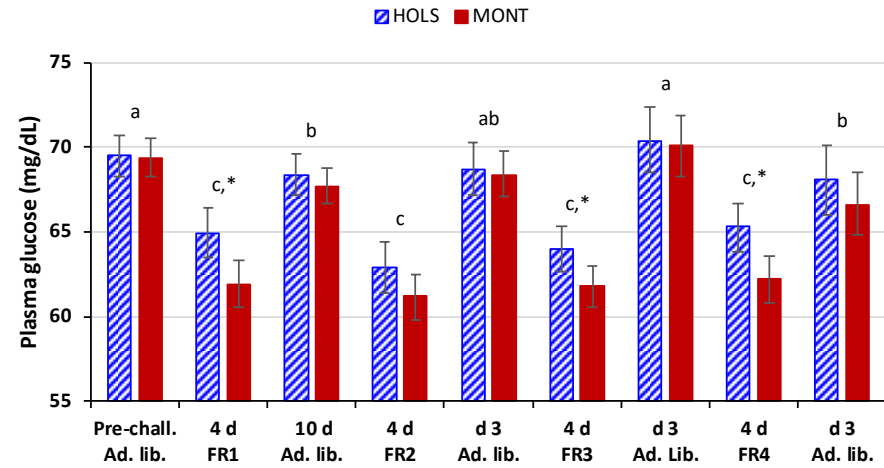
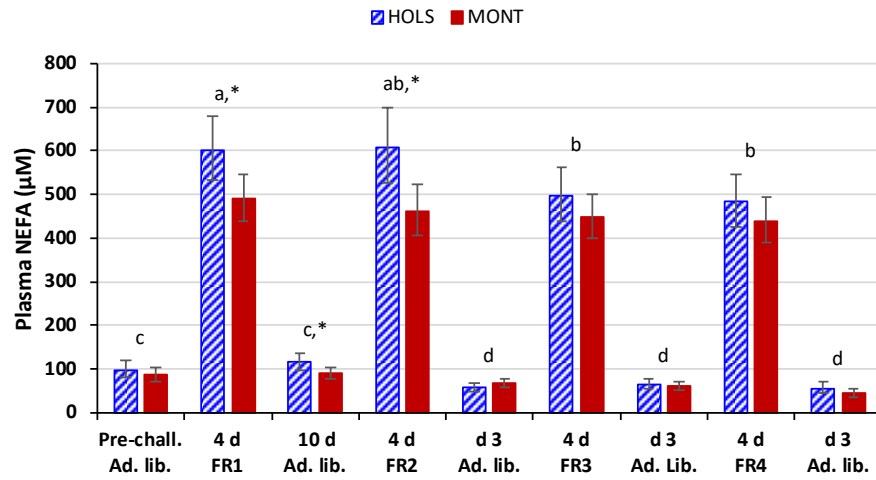
Supplemental Figure S1. Dry matter intake (DMI), energy balance, energy-corrected milk yield (ECM) and percentage change in ECM in multiparous Holstein (HOLS; n = 18) and Montbéliarde (MONT; n = 22) cows subjected to a nutritional challenge composed of a sequence of four 4-d periods of partial feed restriction. Each feed restriction period (FR1, FR2, FR3 and FR4) consisted of 4 d of restricted feed allowance to meet 50% of individual NE_L requirements (INRA, 2007) that were calculated before the challenge. The first feed restriction period (FR1) was initiated at 87 ± 9 DIM, and was followed by 10 days of measurements at ad libitum intake (Ad.lib.); FR2, FR3 and FR4 were separated by 3 days of ad libitum intake, and 10 d of intake and production measurements were recorded at ad libitum intake after FR4. Daily data was analyzed using cow means calculated for each variable within each period of the nutritional challenge. Values are LSM and bars are 95% CI. *P*-values of fixed effects in the statistical models are presented in Table 4. * Breed means differ within the period ($P \leq 0.05$). a – e Period means (main period effects) not sharing a common superscript differ ($P \leq 0.05$).

Supplemental Figure S1.



Supplemental Figure S2. Plasma nonesterified fatty acid (NEFA), glucose, urea and bilirubin concentrations in multiparous Holstein (HOLS; n = 18) and Montbéliarde (MONT; n = 22) cows subjected to a nutritional challenge composed of a sequence of four 4-d periods of partial feed restriction. Each feed restriction period (FR1, FR2, FR3 and FR4) consisted of 4 d of restricted feed allowance to meet 50% of individual NE_L requirements (INRA, 2007) that were calculated before the challenge. The first feed restriction period (FR1) was initiated at 87 ± 9 DIM, and was followed by 10 days of measurements at ad libitum intake (Ad.lib.); FR2, FR3 and FR4 were separated by 3 days of ad libitum intake. Data was analyzed using cow means calculated for each variable within each period of the nutritional challenge. The period ‘pre-chall.’ corresponds to samples collected on d -4, -3 and 0 relative to FR1; The period FR1 correspond to samples collected on d 1, 2, 3, 4 of FR1; The periods FR2, FR3 and FR4 correspond to samples collected on d 2 and d 4 of FR2, FR3 and FR4, respectively. Samples were collected on d 1, 2, 3, 7 and 10 d after refeeding at ad libitum intake after FR1, and 3 d after refeeding at ad libitum intake following FR2, FR3, and FR4. Values are LSM and bars are 95% CI. *P*-values of fixed effects in the statistical models are presented in Table 5. * Breed means differ within the period ($P \leq 0.05$). a – d Period means (main period effects) not sharing a common superscript differ ($P \leq 0.05$).

Supplemental Figure S2.



Supplemental Figure S3. Heatmap illustrating Spearman rank correlations between selected variables recorded during early lactation and the same variables recorded during each period of the nutritional challenge in multiparous cows. The analyses were conducted separately for **A)** Holstein (n = 18) and **B)** Montbéliarde (n = 22) cows. The variables studied by correlation were energy corrected milk yield (ECM), dry matter intake (DMI), energy balance (EB), and plasma NEFA concentrations. Individual cow means were calculated separately during early lactation and each period of the nutritional challenge. The nutritional challenge was composed of a sequence of four 4-d periods of partial feed restriction. Each feed restriction period (FR1, FR2, FR3 and FR4) consisted of 4 d of restricted feed allowance to meet 50% of individual NE_L requirements (INRA, 2007) that were calculated individually before the nutritional challenge. The first feed restriction period (FR1) was initiated at 87 ± 9 DIM, and was followed by 10 days of measurements at ad libitum intake (Recovery 1); FR2, FR3 and FR4 were separated by 3 days of ad libitum intake (Recovery 2 and Recovery 3), 10 d of intake and production measurements were recorded at ad libitum intake after FR4 (Recovery 4). Early lactation data for ECM, DMI and EB were recorded weekly from calving until wk 10 of lactation. Plasma NEFA concentrations were analyzed on wk 1, 2, 3, 4, 6 and 8 of lactation. During the sequential nutritional challenge, daily records were used for ECM, DMI and EB. For plasma NEFA concentrations, the “pre.challenge” is the average concentration of d -4, -3 and 0 relative to FR1; ‘FR1’ is the average of d 1, 2, 3, 4 of FR1; ‘FR2’, ‘FR3’ and ‘FR4’ are averages of d 2 and d 4. ‘Recovery 1’ is the average of concentration of d 5, 6, 7, 8, and 11 and 14 relative to FR1 initiation (i.e. 1, 2, 3, 7 and 10 d after refeeding at ad libitum intake post-FR1); ‘Recovery 2’, ‘Recovery 3’ and ‘Recovery 4’ are concentrations 3 d after refeeding at ad libitum intake following the end of the preceding FR. Nonsignificant correlations ($P > 0.05$) are crossed by an 'x'.

Supplemental Figure S3.

A) Holstein



Supplemental Figure S3.

B) Montbéliarde

