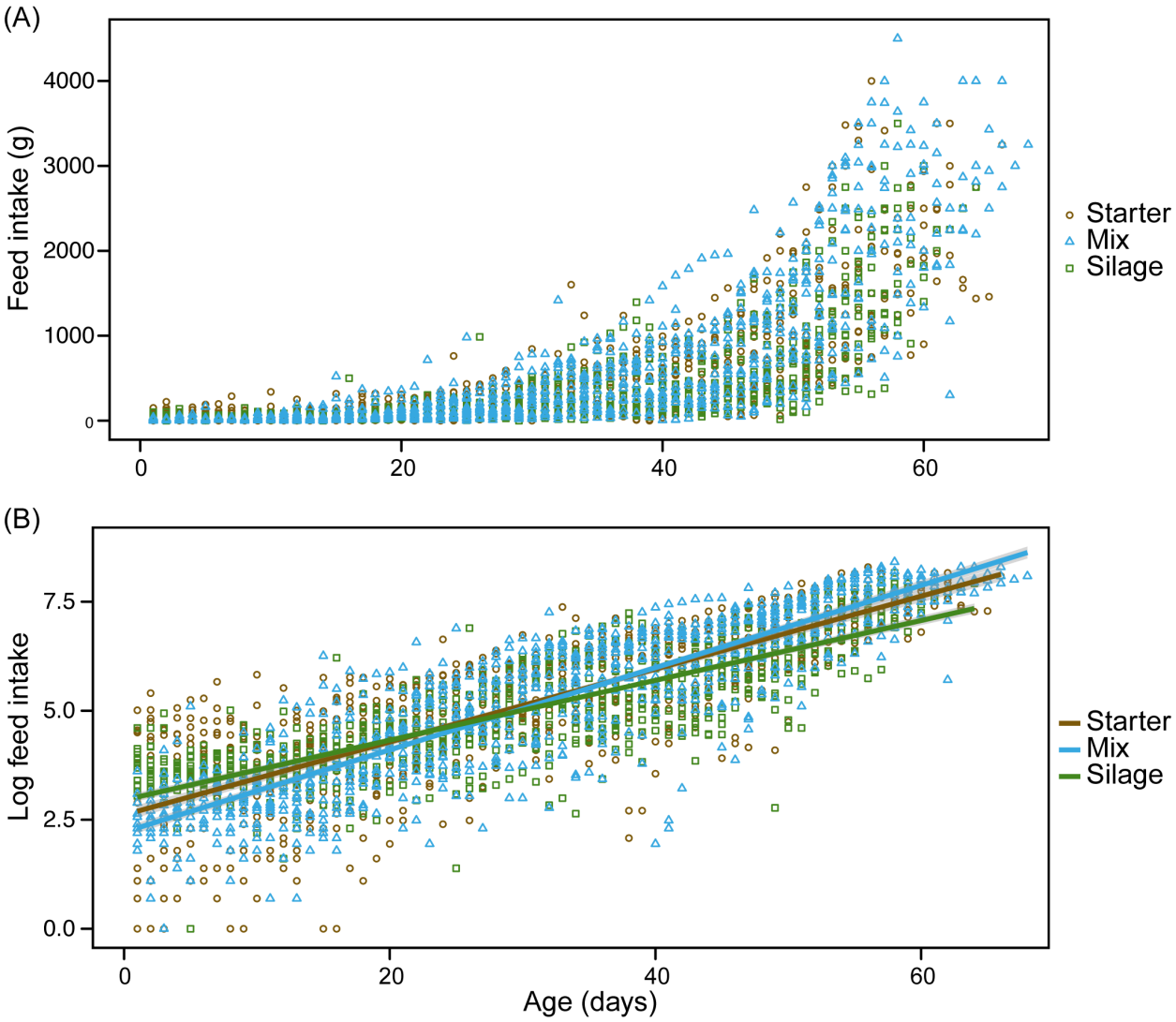

Figure S1. Calf supplement intake. Supplement intake (g/day) by diet from birth to weaning. A) Raw supplement intake. B) Log-transformed supplement intake to fit a linear model. Calf starter (brown, circle), corn silage (green, square), mixture (blue, triangle).

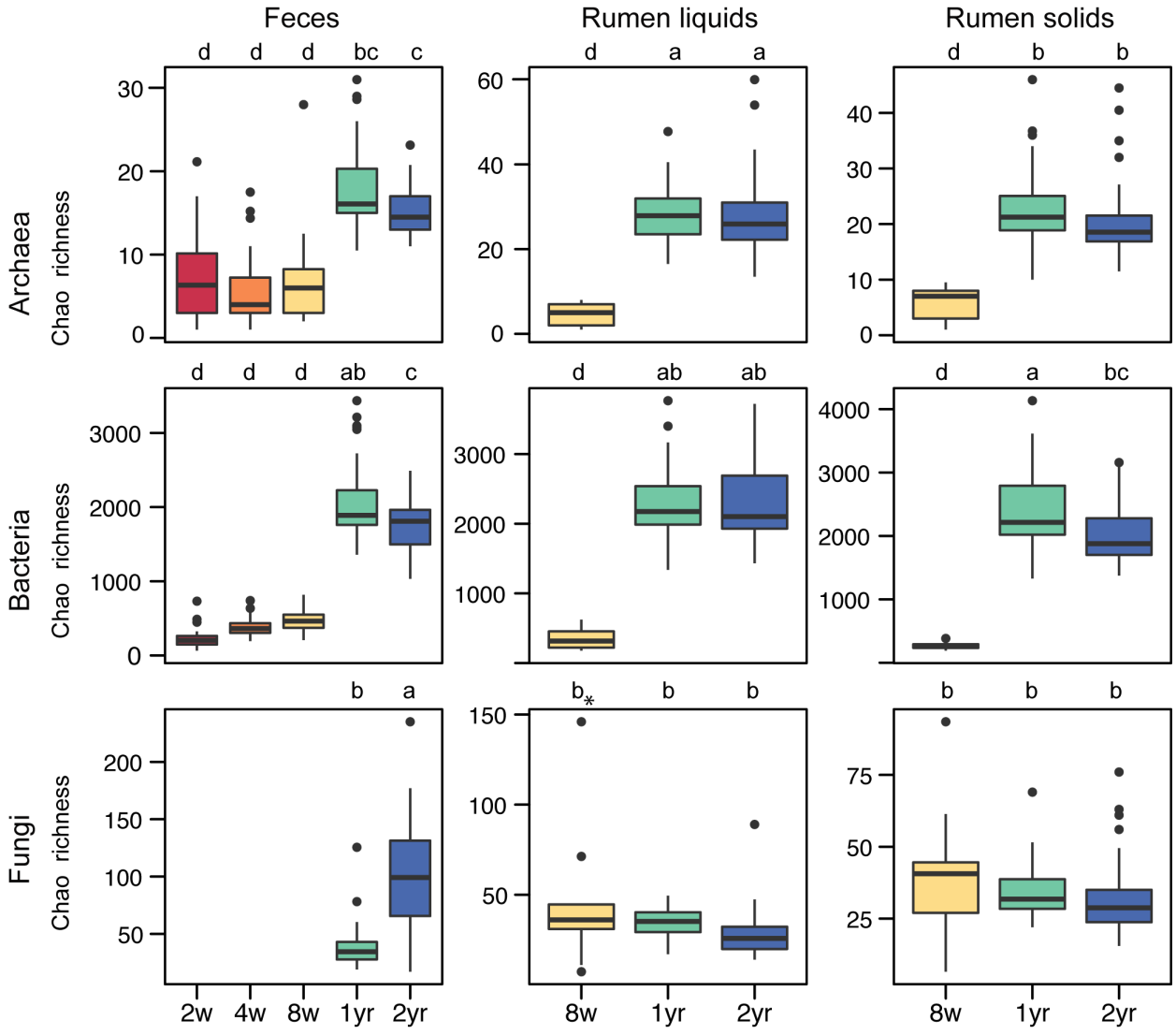

Figure S2. Richness of the microbiota in cows raised on different diets. Chao's richness of archaeal, bacterial, and fungal communities in feces as well as rumen liquids and solids. Boxes are colored by animal age for 2-week (red), 4-week (orange), 8-week (yellow), 1-year (green), and 2-year (blue). Ages with significantly different richness across each amplicon are indicated by different letters. Asterisks denote groups containing significant diet differences (TukeyHSD, $P < 0.05$, Table S3).

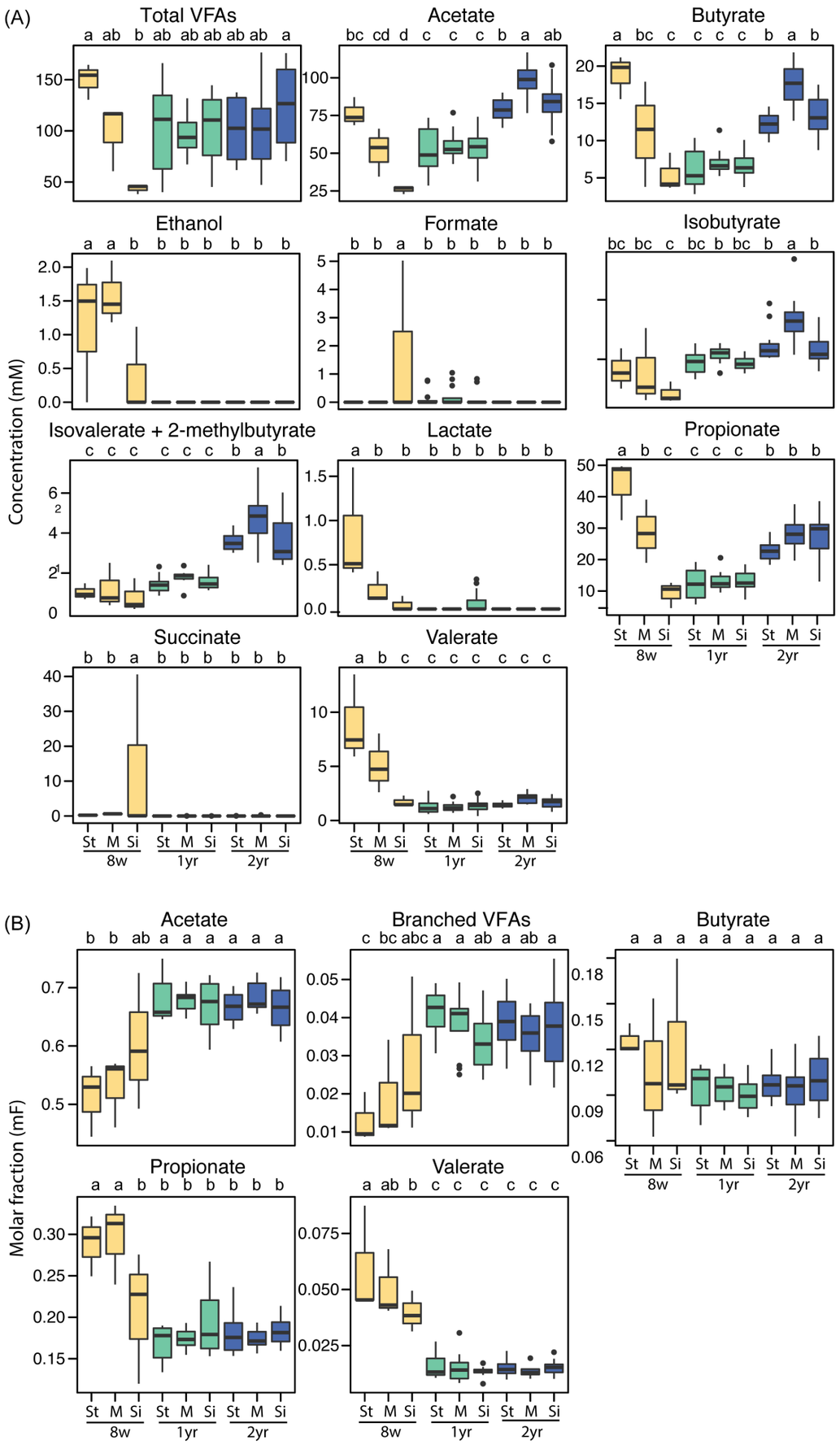

Figure S3. Short chain organic acid (SCOA) profiles. (A) SCOA concentrations and (B) VFA molar fractions in rumen liquids at 8 weeks, 1 year, and 2 years. Boxes are colored by animal age for 8-weeks (yellow), 1-year (green), and 2-years (blue). Letters within each plot denote significantly different groups (TukeyHSD, Table S3). Calf starter (St), corn silage (Si), mixed diet (M).

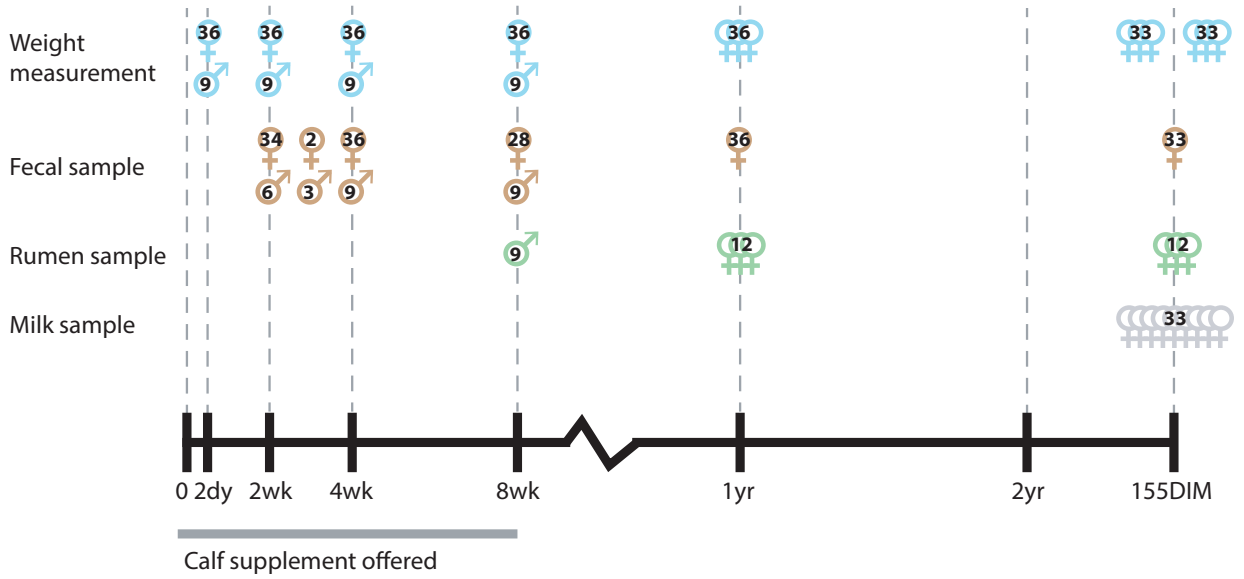

Figure S4. Experimental design indicating timing of fecal, rumen, and milk sampling as well as weight measurements. Male calves (♂) were sacrificed at weaning (8 weeks) while female calves (♀) were retained through first lactation. Numbers indicate animals sampled at each time point and overlapping symbols indicate samples or measurements taken on consecutive days. DMI: days in milk

Table S1a. Nutritional analysis of feed components by % dry matter (DM)

	CP	Starch	Sugar (ESC)	Fat (EE)	Ash	ADF	NDF	Ca	Mg	P	K	S	Lasalocid (antibiotic, g/ton)
Calf starter	22.68	42.30	1.75	2.82	6.52	5.18	11.06	1.02	0.22	0.59	1.13	0.28	60
Corn silage	7.2	33.3	-	3.4	-	23.9	39	0.23	-	0.23	0.7	-	0
Alfalfa haylage	22.5	3.1	-	2.8	-	30.1	37.5	1.3	-	0.40	2.83	-	0
Cracked corn	8.1	73.7	-	4.3	-	3.5	9.7	0.02	-	0.29	0.44	-	0
Heifer vitamins	0	0.01	-	0	-	0	0	25.4	-	1.13	1.14	-	0
Grass silage base	14.5	3.6	-	3	-	37	52	0.83	-	0.36	2.9	-	0
Wheat straw	3.8	-	-	1.7	-	54.3	80.4	0.27	-	0.08	1.4	-	0
Heifer base	0	0.008	-	0	-	0	0	25.9	-	1.11	1.13	-	0
Corn, high moisture shell	8.2	69.4	-	2.9	-	2.6	7.0	0.03	-	0.33	0.44	-	0
Corn, grade shell	9.0	68.0	-	4.2	-	3.5	9.7	0.03	-	0.29	0.44	-	0

Values are averages across the sampling period as crops vary slightly by year. CP: crude protein, ESC: ethanol soluble carbohydrates, EE: ether extraction, ADF: acid detergent fiber, NDF: neutral detergent fiber

Table S1b. Feed components offered at different ages (%DM)

	0-8 weeks Diet A	0-8 weeks Diet B	0-8 weeks Diet C	2-3 months*	3-5 months	6-10 months	11-14 months	15+ months	Lactating
Calf starter	100	0	50	17.3 - 100	17.3	0	0	0	0
Corn silage	0	100	50	0 - 22.2	22.2	30.7	25.7	20.6	28.8
Alfalfa haylage	0	0		0 - 44.5	44.5	32.1	38.6	39.0	28.8
Cracked corn	0	0		0 - 14.8	14.8	8.9	0	0	0
Heifer vitamins	0	0		0 - 1.2	1.2	1.5	1.4	0	0
Grass silage base	0	0		0	0	16.1	17.2	21.7	0
Wheat straw	0	0		0	0	0	14.3	17.4	0
Heifer base	0	0		0	0	0	0	1.3	0
Dry distillers grains	0	0		0	0	10.7	2.9	0	4.2
Corn, high moisture shell	0	0		0	0	0	0	0	16.3
Corn, grade shell	0	0		0	0	0	0	0	5.5
Soybeans	0	0		0	0	0	0	0	7.4
Canola meal	0	0		0	0	0	0	0	6.5
USDA minerals	0	0		0	0	0	0	0	2.5

*This time period was transitional with a gradual daily change from the 8 week to the 3 month diet

Table S8. Calculating milk production and overall efficiency in dairy cows.

Cow	DMI (kg/d)	SCC (x1000)	Milk loss (kg/d)[a]	Mastitis (MJ/d)[b]	DCC	Preg (MJ/d)[c]	Wt1 (kg)	Wt2 (kg)	Dys wts	Δwt (MJ/d)[d]	Maint (MJ/d)[e]	ECM (kg/d)	Milk (MJ/d)[f]	Total energy output (MJ/d)[g]	MPE (MJ milk/kg DMI)	Efficiency (total output MJ/kg DMI)
5015	22.30	12.73	0.00	0.00	38	0	575	583	10	16.77	39.49	45.19	129.71	185.97	5.82	8.34
5017	19.17	6.69	0.00	0.00	8	0	531	523	10	-16.77	36.80	34.61	99.35	119.38	5.18	6.23
5019	19.82	63.81	0.00	0.00	75	0	615	610	10	-10.48	41.20	46.78	134.28	165.00	6.77	8.32
5020	34.44	59.19	0.00	0.00	75	0	669	675	10	12.58	44.17	43.86	125.90	182.65	3.66	5.30
5022	20.88	105.82	0.68	1.95	58	0	593	623	10	62.89	40.98	32.22	92.49	198.31	4.43	9.50
5026	24.42	145.58	1.36	3.91	73	0	576	592	10	33.54	39.76	43.82	125.78	202.99	5.15	8.31
5027	24.52	113.93	0.68	1.95	43	0	622	622	10	0.00	41.70	42.42	121.76	165.41	4.97	6.75
5028	17.15	168.27	1.36	3.91	76	0	611	609	10	-4.19	41.07	35.19	101.01	141.80	5.89	8.27
5031	29.68	319.30	2.04	5.86	1	0	565	576	8	28.82	39.07	31.30	89.83	163.58	3.03	5.51
5032	38.19	25.85	0.00	0.00	0	0	621	628	10	14.67	41.83	35.63	102.27	158.77	2.68	4.16
5034	28.65	21.72	0.00	0.00	41	0	576	599	10	48.21	39.94	36.26	104.09	192.24	3.63	6.71
5035	18.27	283.69	2.04	5.86	0	0	581	587	10	12.58	39.76	37.73	108.29	166.49	5.93	9.11
5037	17.76	39.20	0.00	0.00	72	0	574	573	10	-2.10	39.22	44.47	127.65	164.77	7.19	9.28
5038	21.06	152.58	1.36	3.91	0	0	582	609	10	56.60	40.35	30.17	86.59	187.45	4.11	8.90
5039	34.96	271.12	1.36	3.91	72	0	701	699	10	-4.19	45.55	49.03	140.75	186.02	4.03	5.32
5041	27.79	42.04	0.00	0.00	8	0	668	684	10	33.54	44.38	40.01	114.85	192.77	4.13	6.94
5042	30.68	45.36	0.00	0.00	73	0	609	623	10	29.35	41.37	38.46	110.38	181.10	3.60	5.90
5044	32.56	30.59	0.00	0.00	82	0	674	672	10	-4.19	44.22	58.42	167.69	207.72	5.15	6.38
5045	37.93	343.50	2.04	5.86	77	0	667	656	10	-23.06	43.66	38.58	110.74	137.20	2.92	3.62
5046	19.07	875.58	2.72	7.82	76	0	559	560	10	2.10	38.50	45.00	129.17	177.59	6.77	9.31
5047	32.86	246.71	1.36	3.91	73	0	699	680	10	-39.83	45.05	40.96	117.57	126.70	3.58	3.86
5048	17.25	271.48	1.36	3.91	77	0	523	529	10	12.58	36.77	30.95	88.84	142.10	5.15	8.24
5049	15.30	975.67	2.72	7.82	21	0	610	640	10	62.89	41.83	42.98	123.37	235.91	8.06	15.42
5050	18.22	2682	4.08	11.73	0	0	595	603	10	16.77	40.54	36.14	103.75	172.79	5.69	9.48
5051	31.68	1658	3.40	9.77	75	0	574	579	10	10.48	39.38	34.06	97.75	157.38	3.09	4.97
5052	29.57	56.52	0.00	0.00	74	0	662	653	10	-18.87	43.48	41.97	120.47	145.08	4.07	4.91

5053	26.99	30.33	0.00	0.00	0	0	547	546	10	-2.10	37.82	39.67	113.86	149.58	4.22	5.54
5054	15.69	159.48	1.36	3.91	75	0	547	550	10	6.29	37.94	34.35	98.59	146.73	6.29	9.35
5057	14.98	212.96	1.36	3.91	0	0	619	617	7	-5.99	41.49	39.68	113.89	153.30	7.60	10.23
5058	29.61	18.07	0.00	0.00	0	0	593	606	10	27.25	40.54	35.53	101.99	169.78	3.44	5.73
5059	36.77	29.81	0.00	0.00	42	0	621	634	10	27.25	41.98	48.00	137.78	207.01	3.75	5.63
5062	35.21	42.31	0.00	0.00	36	0	567	566	10	-2.10	38.86	40.33	115.76	152.52	3.29	4.33
5063	30.32	227.85	1.36	3.91	73	0	612	619	10	14.67	41.36	49.53	142.16	202.10	4.69	6.67

Dry matter intake (DMI), somatic cell count (SCC), days carrying calf (DCC), pregnancy (preg), energy corrected milk (ECM), milk production efficiency (MPE)

[a] Calculated from SCC based on (1).

[b] milk loss kg/d * 4.184 MJ/Mcal * 0.68605 Mcal/kg (energy content of milk (1))

[c] 0 if DCC < 190 (2)

[d] (wt2 - wt1)/dys *4.184 MJ/Mcal *5.01 Mcal/kg (mean value energy content of wt at a body condition score (BCS) of 3.5)

[e] mean wt^0.75 *4.184 MJ/Mcal *0.08 (maintenance factor (2))

[f] ECM kg/d *4.184 MJ/Mcal * 0.68605 Mcal/kg (energy content of milk (1))

[g] mastitis + preg + Δwt + maintenance + milk (all MJ/d)

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