

# Nutrient Requirement Tables

## 14

Requirements for rumen degradable protein (RDP), rumen undegradable protein (RUP), and total protein are dependent on animal factors, the concentration of available energy in the diet, and dry matter intake. The dietary requirement for minerals depends on animal factors and the bioavailability of the minerals which differs among feedstuffs and diets. Tables of nutrient requirements are included to provide users with general guidelines and to illustrate how dietary factors influence requirements of some nutrients. The computer model uses animal and dietary factors to estimate requirements and will produce the most accurate estimates of requirements for specific situations and specific diet formulations. Users are strongly encouraged to use model-generated requirements.

### LACTATING COWS

Tables 14-1 through 14-6 show RDP, RUP, and total crude protein (CP) requirements for small and large breed lactating cows at different production levels as generated by the computer model. These tables also illustrate the effect of dietary energy concentration (Tables 14-2 vs. 14-3 and 14-5 vs. 14-6) and the effect of intake (Tables 14-1 vs. 14-2 and 14-4 vs. 14-5) on protein requirements. Tables 14-7 through 14-9 provide estimates of nutrient requirements of lactating (early and mid) and dry cows. These tables were also generated using the computer model, but the subcommittee has included its recommendations for certain nutrients that require special consideration, when using the model. Dietary requirements for minerals shown in Tables 14-7 through 14-9 are applicable only to the diets included in the tables. Different diets, because of differences in bioavailability of minerals may yield different dietary requirements for minerals.

The values in the tables are the subcommittee's best estimates of requirements when cattle are fed specific dietary formulations under nonstressful environmental

conditions. These tables (Tables 14-1 through 14-16) are intended as guides, and readers are encouraged to pay careful attention to footnotes in the tables. The computer model allows great flexibility in accounting for many dietary, environmental, and management factors that affect animal performance in contrast to the static numbers presented in tables.

### HEIFERS

The equations outlined in Chapter 16 were used to develop tables containing guidelines for the nutrient requirements of dairy replacement heifers (Tables 14-12 through 14-16). At a predicted DMI, the TDN concentration needed to meet the requirements for maintenance and gain were determined. The requirements obtained with the computer program may differ slightly from those in Tables 14-12 through 14-15 because the model-predicted supply of nutrients affects the calculation of some dietary requirements. These differences are due to variation in RUP intestinal digestibility, predicted diet TDN, and mineral bioavailabilities as described below. These tables are guidelines only and the NRC computer program should be used to evaluate the nutritional adequacy of specific diets. These requirement tables were calculated to approximate the requirements obtained with the computer program when heifers are fed a typical diet at the model-predicted dry matter intake, using the following assumptions.

1. The TDN used is the TDN discounted to account for depression in digestibility at intakes above maintenance.
2. DE (Mcal) was assumed to equal  $4.409 \times \text{TDN} (\text{kg})$ . In the model, this value varies slightly among diets.
3. An RUP intestinal digestibility of 67 percent was assumed. This value ranges from 60 percent for diets based entirely on very mature forages fed to heifers with low requirements to approximately 75 percent for diets typi-

cally fed to animals with high requirements in which much of the supplemental protein comes from concentrates. Thus, the dietary RUP needed to meet the requirement for metabolizable protein should be increased approximately 10 percent if most of the diet consists of mature forages and can be decreased 10 percent if the diet is based on combinations of forages and concentrates typically fed to animals with high requirements.

4. Body weights and daily gains in the table are expressed on a full body weight basis although, in the model, they are converted to shrunk (96 percent of BW) and empty body (89.1 percent of SBW) weights to compute requirements.

5. It is assumed that there is no stress due to weather and that the body condition score of the animal is 3.

6. Net requirements were converted to dietary requirements by assuming an average bioavailability of 40 percent for calcium and 67 percent for phosphorus. These values were obtained by formulating diets for target ADG across a range of body weights. Across these diets, the bioavailability of phosphorus was relatively constant (near 67 percent), but calcium bioavailability ranged from 32 percent for diets with no supplemental calcium to 41 percent for diets supplemented with calcium carbonate.

7. For pregnant heifers, body weight (BW) includes the conceptus weight (kg) shown, which is computed using the equation in the model assuming that birth weight equals 6.275 percent of mature weight.

8. For pregnant heifers, reported daily gains are heifer ADG with and without conceptus (ADG in parentheses include the conceptus gain (kg/d), which is computed with the model equation). The requirements for pregnancy are included in the total requirements.

The body weights and daily gains in the tables were selected to reflect likely values for heifers in both typical and accelerated heifer rearing programs. Some of the trends that are apparent in the tables include:

1. The effects of mature weight and current body weight on net energy and protein requirements are evident in the

tables. Animals that have higher rates of gain have higher energy and protein requirements for growth and, as the animal matures, the amount of energy required for a particular daily gain increases. However, RUP and RDP requirements are more complicated. The factors affecting these calculations are: If two heifers have similar current body weights, but different mature weights, the required TDN concentration of the diet is higher for animals with the smaller mature weight because the NE<sub>C</sub> requirement is higher. The higher TDN permits the growth of more microbes provided that adequate RDP is available. Thus, the RDP requirements are higher in the animals with the smaller mature size.

2. Stage of growth of the heifer also affects CP and RUP requirements. When mature size increases, the physiological age at which an animal reaches a specific weight is reduced. The result is that the efficiency with which protein is used for growth increases. The increase in the amount of net protein required for growth by animals with larger mature sizes at a set body weight and ADG may be offset by the higher efficiency of use of the absorbed protein.

3. As a result of these two factors, RUP and CP required may actually be lower for animals with a larger mature weight at a given body weight and ADG than for animals with smaller mature weights. These interactions are illustrated below for a body weight of 300 kg and an ADG of 0.8 kg/day for both mature sizes.

Mature weight, kg	450	650
% of mature weight	67	41
NE <sub>C</sub> required, Mcal/day	3.13	2.38
DMI, kg/d	7.1	7.1
Diet TDN, %	67.7	63.4
Net protein required, g/d	114	136
Equivalent body weight, kg	319	221
Efficiency of MP use for NP, %	47.1	58.2
MP required, g/d	524	525
MP from microbial protein, g/d	443	409
RDP required/g/d	736	685
RUP required, g/d	151	183
CP required, g/d	887	868

TABLE 14-1 Daily Nutrient Requirements of Small Breed Cows (live weight = 454 kg) in Early Lactation (intake estimated at 11 days in milk). Values are Appropriate for the Diet Below With 78% TDN<sup>a</sup>

Milk (kg)	Fat (%)	True Protein (%)	DMI (kg)	LW change (kg)	NE <sub>L</sub> (Mcal)	RDP (g)	RUP (g)	RDP (%)	RUP (%)	CP (%)
15	4.0	3.0	9.4	-0.3	19.0	1060	500	11.3	5.3	16.6
15	4.0	3.5	9.4	-0.3	19.4	1060	630	11.3	6.7	18.0
15	4.0	4.0	9.4	-0.4	19.8	1060	760	11.3	8.1	19.4
15	4.5	3.0	9.7	-0.3	19.7	1090	490	11.2	5.1	16.3
15	4.5	3.5	9.7	-0.4	20.1	1090	620	11.2	6.4	17.6
15	4.5	4.0	9.7	-0.5	20.5	1090	750	11.2	7.7	18.9
15	5.0	3.0	9.9	-0.4	20.4	1110	480	11.2	4.8	16.0
15	5.0	3.5	9.9	-0.5	20.8	1110	610	11.2	6.2	17.4
15	5.0	4.0	9.9	-0.5	21.2	1110	740	11.2	7.5	18.7
30	4.0	3.0	12.9	-1.4	30.1	1410	1170	10.9	9.1	20.0
30	4.0	3.5	12.9	-1.6	30.9	1410	1430	10.9	11.1	22.0
30	4.0	4.0	12.9	-1.7	31.8	1410	1690	10.9	13.1	24.0
30	4.5	3.0	13.5	-1.5	31.5	1460	1150	10.8	8.5	19.3
30	4.5	3.5	13.5	-1.7	32.3	1460	1410	10.8	10.4	21.2
30	4.5	4.0	13.5	-1.9	33.2	1460	1670	10.8	12.4	23.2
30	5.0	3.0	14.0	-1.6	32.8	1510	1140	10.8	8.1	18.9
30	5.0	3.5	14.0	-1.8	33.7	1510	1400	10.8	10.0	20.8
30	5.0	4.0	14.0	-2.0	34.6	1510	1660	10.8	11.9	22.7

<sup>a</sup>Diet used for this table consisted of 15% immature legume silage, 33% normal corn silage, 34% ground high moisture shelled corn, 12% soybean meal (48% crude protein), 2.5% tallow, 1.5% menhaden fish meal, and 2% mineral and vitamin mix. Requirements are dependent upon the diet fed. Requirements shown do not include nutrients needed for live weight change. Live weight change is based on assumed NE<sub>L</sub> intake minus requirements. Requirements for RUP do not include protein provided by loss in body reserves or required for gain in body reserves. Requirement for total CP assumes RDP and RUP are met. Requirement for total CP will increase if RDP requirement is not met.

TABLE 14-2 Daily Nutrient Requirements of Small Breed Cows (live weight = 454 kg) in Midlactation (intake estimated at 90 days in milk). Values Are Appropriate for the Diet Below with 78% TDN<sup>a</sup>

Milk (kg)	Fat (%)	True Protein (%)	DMI (kg)	LW change (kg)	NE <sub>L</sub> (Mcal)	RDP (g)	RUP (g)	RDP (%)	RUP (%)	CP (%)
20	4.0	3.0	16.0	1.0	22.7	1680	560	10.5	3.5	14.0
20	4.0	3.5	16.0	0.8	23.2	1680	740	10.5	4.6	15.1
20	4.0	4.0	16.0	0.7	23.8	1680	910	10.5	5.7	16.2
20	4.5	3.0	16.5	0.9	23.6	1730	550	10.5	3.3	13.8
20	4.5	3.5	16.5	0.8	24.2	1730	720	10.5	4.4	14.9
20	4.5	4.0	16.5	0.7	24.8	1730	900	10.5	5.5	16.0
20	5.0	3.0	17.0	0.9	24.5	1770	540	10.4	3.2	13.6
20	5.0	3.5	17.0	0.8	25.1	1770	710	10.4	4.2	14.6
20	5.0	4.0	17.0	0.6	25.7	1770	880	10.4	5.2	15.6
30	4.0	3.0	19.5	0.4	30.1	1980	1010	10.2	5.2	15.4
30	4.0	3.5	19.5	0.2	30.9	1980	1270	10.2	6.5	16.7
30	4.0	4.0	19.5	0	31.8	1980	1530	10.2	7.8	18.0
30	4.5	3.0	20.3	0.3	31.5	2040	990	10.0	4.9	14.9
30	4.5	3.5	20.3	0.1	32.3	2040	1250	10.0	6.2	16.2
30	4.5	4.0	20.3	-0.1	33.2	2040	1510	10.0	7.4	17.4
30	5.0	3.0	21.1	0.2	32.8	2100	980	10.0	4.6	14.6
30	5.0	3.5	21.1	0	33.7	2100	1240	10.0	5.9	15.9
30	5.0	4.0	21.1	-0.2	34.6	2100	1500	10.0	7.1	17.1
40	4.0	3.0	23.1	-0.3	37.5	2240	1470	9.7	6.4	16.1
40	4.0	3.5	23.1	-0.6	38.6	2240	1820	9.7	7.9	17.6
40	4.0	4.0	23.1	-0.8	39.8	2240	2160	9.7	9.4	19.1
40	4.5	3.0	24.2	-0.5	39.3	2310	1460	9.5	6.0	15.5
40	4.5	3.5	24.2	-0.7	40.5	2310	1800	9.5	7.4	16.9
40	4.5	4.0	24.2	-1.0	41.7	2310	2150	9.5	8.9	18.4
40	5.0	3.0	25.2	-0.7	41.2	2390	1450	9.5	5.8	15.3
40	5.0	3.5	25.2	-0.9	42.3	2390	1790	9.5	7.1	16.6
40	5.0	4.0	25.2	-1.1	43.5	2390	2140	9.5	8.5	18.0

<sup>a</sup>Diet used for this table consisted of 15% immature legume silage, 33% normal corn silage, 34% ground high moisture shelled corn, 12% soybean meal (48% crude protein), 2.5% tallow, 1.5% menhaden fish meal, and 2% mineral and vitamin mix. Requirements are dependent upon the diet fed. Requirements shown do not include nutrients needed for live weight change. Live weight change is based on assumed NE<sub>L</sub> intake minus requirements. Requirements for RUP do not include protein provided by loss in body reserves or required for gain in body reserves. Requirement for total CP assumes RDP and RUP are met. Requirement for total CP will increase if RDP requirement is not met.

TABLE 14-3 Daily Nutrient Requirements of Small Breed Cows (live weight = 454 kg) in Midlactation (intake estimated at 90 days in milk). Values are Appropriate for the Diet Below with 68% TDN<sup>a</sup>

Milk (kg)	Fat (%)	True Protein (%)	DMI (kg)	LW change (kg)	NE <sub>L</sub> (Mcal)	RDP (g)	RUP (g)	RDP (%)	RUP (%)	CP (%)
10	4.0	3.0	12.4	0.9	15.3	1240	230	10.0	1.9	11.9
10	4.0	3.5	12.4	0.8	15.6	1240	320	10.0	2.6	12.6
10	4.0	4.0	12.4	0.8	15.9	1240	420	10.0	3.4	13.4
10	4.5	3.0	12.7	0.9	15.7	1270	230	10.0	1.8	11.8
10	4.5	3.5	12.7	0.8	16.0	1270	320	10.0	2.5	12.5
10	4.5	4.0	12.7	0.8	16.3	1270	410	10.0	3.2	13.2
10	5.0	3.0	12.9	0.9	16.2	1290	220	10.0	1.7	11.7
10	5.0	3.5	12.9	0.8	16.5	1290	310	10.0	2.4	12.4
10	5.0	4.0	12.9	0.8	16.8	1290	400	10.0	3.1	13.1
20	4.0	3.0	16.0	0.4	22.7	1560	680	9.8	4.3	14.1
20	4.0	3.5	16.0	0.3	23.2	1560	860	9.8	5.4	15.2
20	4.0	4.0	16.0	0.2	23.8	1560	1040	9.8	6.5	16.3
20	4.5	3.0	16.5	0.4	23.6	1610	660	9.8	4.0	13.8
20	4.5	3.5	16.5	0.3	24.2	1610	840	9.8	5.1	14.9
20	4.5	4.0	16.5	0.2	24.8	1610	1030	9.8	6.2	16.0
20	5.0	3.0	17.0	0.4	24.5	1660	650	9.8	3.8	13.6
20	5.0	3.5	17.0	0.2	25.1	1660	830	9.8	4.9	14.7
20	5.0	4.0	17.0	0.1	25.7	1660	1010	9.8	5.9	15.7
30	4.0	3.0	19.5	-0.1	30.1	1870	1130	9.6	5.8	15.4
30	4.0	3.5	19.5	-0.3	30.9	1870	1400	9.6	7.2	16.8
30	4.0	4.0	19.5	-0.4	31.8	1870	1670	9.6	8.6	18.2
30	4.5	3.0	20.3	-0.2	31.5	1940	1110	9.6	5.5	15.1
30	4.5	3.5	20.3	-0.3	32.3	1940	1380	9.6	6.8	16.4
30	4.5	4.0	20.3	-0.5	33.2	1940	1650	9.6	8.1	17.7
30	5.0	3.0	21.1	-0.2	32.8	2000	1090	9.5	5.2	14.7
30	5.0	3.5	21.1	-0.4	33.7	2000	1360	9.5	6.4	15.9
30	5.0	4.0	21.1	-0.6	34.6	2000	1630	9.5	7.7	17.2

<sup>a</sup>Diet used for this table consisted of 40% mid-maturity legume hay, 27% normal corn silage, 23% cracked dry shelled corn, 8% soybean meal (48% crude protein), and 2% mineral and vitamin mix. Requirements are dependent upon the diet fed. Requirements shown do not include nutrients needed for live weight change. Live weight change is based on assumed NE<sub>L</sub> intake minus requirements. Requirements for RUP do not include protein provided by loss in body reserves or required for gain in body reserves. Requirement for total CP assumes RDP and RUP are met. Requirement for total CP will increase if RDP requirement is not met.

TABLE 14-4 Daily Nutrient Requirements Of Large Breed Cows (Live Weight = 680 kg) In Early Lactation (intake estimated at 11 days in milk). Values Are Appropriate For The Diet Below With 78% TDN<sup>a</sup>

Milk (kg)	Fat (%)	True Protein (%)	DMI (kg)	LW change (kg)	NE <sub>L</sub> (Mcal)	RDP (g)	RUP (g)	RDP (%)	RUP (%)	CP (%)
20	3.0	2.5	12.0	0	23.0	1360	500	11.3	4.2	15.5
20	3.0	3.0	12.0	-0.2	23.6	1360	670	11.3	5.6	16.9
20	3.0	3.5	12.0	-0.3	24.2	1360	850	11.3	7.1	18.4
20	3.5	2.5	12.4	-0.1	23.9	1400	480	11.3	3.9	15.2
20	3.5	3.0	12.4	-0.2	24.5	1400	660	11.3	5.3	16.6
20	3.5	3.5	12.4	-0.4	25.1	1400	840	11.3	6.8	18.1
20	4.0	2.5	12.7	-0.2	24.9	1440	470	11.3	3.7	15.0
20	4.0	3.0	12.7	-0.3	25.4	1440	650	11.3	5.1	16.5
20	4.0	3.5	12.7	-0.4	26.0	1440	820	11.3	6.5	17.8
30	3.0	2.5	14.0	-0.6	29.2	1570	860	11.2	6.1	17.4
30	3.0	3.0	14.0	-0.8	30.1	1570	1130	11.2	8.1	19.3
30	3.0	3.5	14.0	-1.0	30.9	1570	1390	11.2	9.9	21.1
30	3.5	2.5	14.5	-0.7	30.6	1620	850	11.2	5.9	17.0
30	3.5	3.0	14.5	-0.9	31.4	1620	1110	11.2	7.7	18.8
30	3.5	3.5	14.5	-1.1	32.3	1620	1370	11.2	9.4	20.6
30	4.0	2.5	15.1	-0.9	32.0	1670	830	11.1	5.5	16.6
30	4.0	3.0	15.1	-1.0	32.8	1670	1090	11.1	7.2	18.3
30	4.0	3.5	15.1	-1.2	33.7	1670	1350	11.1	8.9	20.0
40	3.0	2.5	16.0	-1.2	35.3	1760	1230	11.0	7.7	18.7
40	3.0	3.0	16.0	-1.5	36.5	1760	1580	11.0	9.9	20.9
40	3.0	3.5	16.0	-1.7	37.7	1760	1930	11.0	12.1	23.1
40	3.5	2.5	16.7	-1.4	37.2	1830	1210	11.0	7.2	18.2
40	3.5	3.0	16.7	-1.6	38.4	1830	1560	11.0	9.3	20.3
40	3.5	3.5	16.7	-1.9	39.6	1830	1910	11.0	11.4	22.4
40	4.0	2.5	17.4	-1.6	39.1	1900	1190	10.9	6.8	17.8
40	4.0	3.0	17.4	-1.8	40.2	1900	1540	10.9	8.9	19.8
40	4.0	3.5	17.4	-2.0	41.4	1900	1890	10.9	10.9	21.8

<sup>a</sup>Diet used for this table consisted of 15% immature legume silage, 33% normal corn silage, 34% ground high moisture shelled corn, 12% soybean meal (48% crude protein), 2.5% tallow, 1.5% Menhaden fish meal, and 2% mineral and vitamin mix. Requirements are dependent upon the diet fed. Requirements shown do not include nutrients needed for live weight change. Live weight change is based on assumed NE<sub>L</sub> intake minus requirements. Requirements for RUP do not include protein provided by loss in body reserves or required for gain in body reserves. Requirement for total CP assumes RDP and RUP are met. Requirement for total CP will increase if RDP requirement is not met.

TABLE 14-5 Daily Nutrient Requirements Of Large Breed Cows (Live Weight = 680 kg) In Midlactation (intake estimated at 90 days in milk). Values Are Appropriate For The Diet Below With 78% TDN<sup>a</sup>

Milk (kg)	Fat (%)	True Protein (%)	DMI (kg)	LW change (kg)	NE <sub>L</sub> (Mcal)	RDP (g)	RUP (g)	RDP (%)	RUP (%)	CP (%)
35	3.0	2.5	22.7	1.3	32.2	2370	820	10.4	3.6	14.1
35	3.0	3.0	22.7	1.1	33.2	2370	1130	10.4	5.0	15.4
35	3.0	3.5	22.7	0.9	34.2	2370	1430	10.4	6.3	16.7
35	3.5	2.5	23.6	1.2	33.8	2450	800	10.4	3.4	13.8
35	3.5	3.0	23.6	1.0	34.8	2450	1110	10.4	4.7	15.1
35	3.5	3.5	23.6	0.8	35.9	2450	1410	10.4	6.0	16.4
35	4.0	2.5	24.5	1.1	35.4	2520	780	10.3	3.2	13.5
35	4.0	3.0	24.5	0.9	36.5	2520	1090	10.3	4.4	14.7
35	4.0	3.5	24.5	0.7	37.5	2520	1390	10.3	5.7	16.0
45	3.0	2.5	25.7	0.8	38.3	2620	1190	10.2	4.6	14.8
45	3.0	3.0	25.7	0.5	39.7	2620	1580	10.2	6.1	16.3
45	3.0	3.5	25.7	0.3	41.0	2620	1970	10.2	7.7	17.9
45	3.5	2.5	26.9	0.7	40.4	2710	1170	10.1	4.3	14.4
45	3.5	3.0	26.9	0.4	41.8	2710	1560	10.1	5.8	15.9
45	3.5	3.5	26.9	0.2	43.1	2710	1950	10.1	7.2	17.3
45	4.0	2.5	28.1	0.5	42.5	2800	1150	10.0	4.1	14.1
45	4.0	3.0	28.1	0.3	43.8	2800	1540	10.0	5.5	15.4
45	4.0	3.5	28.1	0	45.2	2800	1930	10.0	6.9	16.8
55	3.0	2.5	28.7	0.3	44.5	2850	1570	9.9	5.5	15.4
55	3.0	3.0	28.7	0	46.1	2850	2060	9.9	7.2	17.1
55	3.0	3.5	28.7	-0.4	47.7	2850	2540	9.9	8.9	18.8
55	3.5	2.5	30.2	0.1	47.1	2960	1560	9.8	5.2	15.0
55	3.5	3.0	30.2	-0.2	48.7	2960	2040	9.8	6.8	16.6
55	3.5	3.5	30.2	-0.6	50.7	2960	2510	9.8	8.3	18.1
55	4.0	2.5	31.7	-0.1	49.6	3060	1540	9.7	4.9	14.5
55	4.0	3.0	31.7	-0.5	51.2	3060	2020	9.7	6.4	16.0
55	4.0	3.5	31.7	-0.8	52.8	3060	2490	9.7	7.9	17.5

<sup>a</sup>Diet used for this table consisted of 15% immature legume silage, 33% normal corn silage, 34% ground high moisture shelled corn, 12% soybean meal (48% crude protein), 2.5% tallow, 1.5% menhaden fish meal, and 2% mineral and vitamin mix. Requirements are dependent upon the diet fed. Requirements shown do not include nutrients needed for live weight change. Live weight change is based on assumed NE<sub>L</sub> intake minus requirements. Requirements for RUP do not include protein provided by loss in body reserves or required for gain in body reserves. Requirement for total CP assumes RDP and RUP are met. Requirement for total CP will increase if RDP requirement is not met.

TABLE 14-6 Daily Nutrient Requirements Of Large Breed Cows (Live Weight = 680 kg) In Midlactation (intake estimated at 90 days in milk). Values Are Appropriate For The Diet Below With 68% TDN<sup>a</sup>

Milk (kg)	Fat (%)	True Protein (%)	DMI (kg)	LW change (kg)	NE <sub>L</sub> (Mcal)	RDP (g)	RUP (g)	RDP (%)	RUP (%)	CP (%)
25	3.0	2.5	19.6	1.0	26.0	1940	620	9.9	3.2	13.1
25	3.0	3.0	19.6	0.8	26.8	1940	840	9.9	4.3	14.2
25	3.0	3.5	19.6	0.7	27.5	1940	1070	9.9	5.5	15.4
25	3.5	2.5	20.3	0.9	27.2	2000	600	9.9	3.0	12.9
25	3.5	3.0	20.3	0.8	27.9	2000	820	9.9	4.0	13.9
25	3.5	3.5	20.3	0.6	28.7	2000	1050	9.9	5.2	15.1
25	4.0	2.5	21.0	0.9	28.4	2060	580	9.8	2.8	12.6
25	4.0	3.0	21.0	0.7	29.1	2060	810	9.8	3.9	13.7
25	4.0	3.5	21.0	0.6	29.8	2060	1030	9.8	4.9	14.7
35	3.0	2.5	22.7	0.6	32.2	2210	990	9.7	4.4	14.1
35	3.0	3.0	22.7	0.4	33.2	2210	1300	9.7	5.7	15.4
35	3.0	3.5	22.7	0.2	34.2	2210	1620	9.7	7.1	16.8
35	3.5	2.5	23.6	0.5	33.8	2290	960	9.7	4.1	13.8
35	3.5	3.0	23.6	0.3	34.8	2290	1280	9.7	5.4	15.1
35	3.5	3.5	23.6	0.1	35.9	2290	1600	9.7	6.7	16.4
35	4.0	2.5	24.5	0.4	35.4	2370	940	9.7	3.8	13.5
35	4.0	3.0	24.5	0.2	36.5	2370	1260	9.7	5.1	14.8
35	4.0	3.5	24.5	0	37.5	2370	1570	9.7	6.4	16.1
45	3.0	2.5	25.7	0.1	28.3	2470	1370	9.6	5.3	14.9
45	3.0	3.0	25.7	-0.1	39.7	2470	1780	9.6	6.9	16.5
45	3.0	3.5	25.7	-0.4	41.0	2470	2180	9.6	8.5	18.1
45	3.5	2.5	26.9	0	40.4	2570	1340	9.6	5.0	14.6
45	3.5	3.0	26.9	-0.2	41.8	2570	1750	9.6	6.5	16.1
45	3.5	3.5	26.9	-0.5	43.1	2570	2160	9.6	8.0	17.6
45	4.0	2.5	28.1	-0.1	42.5	2670	1310	9.5	4.7	14.2
45	4.0	3.0	28.1	-0.3	43.8	2670	1720	9.5	6.1	15.6
45	4.0	3.5	28.1	-0.6	45.2	2670	2130	9.5	7.6	17.1

<sup>a</sup>Diet used for this table consisted of 40% mid-maturity legume hay, 27% normal corn silage, 23% cracked dry shelled corn, 8% soybean meal (48% crude protein), and 2% mineral and vitamin mix. Requirements are dependent upon the diet fed. Requirements shown do not include nutrients needed for live weight change. Live weight change is based on assumed NE<sub>L</sub> intake minus NE<sub>L</sub> requirements. Requirements for RUP do not include protein provided by loss in body reserves or required for gain in body reserves. Requirement for total CP assumes RDP and RUP are met. Requirement for total CP will increase if RDP requirement is not met.

TABLE 14-7 Nutrient Requirements of Lactating Dairy Cows as Determined Using Sample Diets

Days in milk Dry matter intake input	Holstein = 680 kg Bwt, Mature Bwt = 680 kg, BCS = 3.0, 65 mos age, Milk fat = 3.5%, milk true protein = 3.0%, lactose = 4.8%, Default environmental conditions				Jersey = 454 kg Bwt, mature Bwt = 454 kg, BCS = 3.0, 65 mos age milk fat = 4.2%, milk true protein = 3.6%, lactose = 4.8% Default environmental conditions					
	90 Model predicted	90 Model predicted	90 Model predicted	90 Model predicted	90 Model predicted <sup>h</sup>	90 Model predicted <sup>h</sup>	90 Model predicted	50 Model predicted <sup>h</sup>	120 Model predicted <sup>h</sup>	90 Model predicted <sup>h</sup> + 5% <sup>h</sup>
Milk production (kg)	25	35	45	54.4	25	35	40	35	35	35
Milk production (lbs)	55	77	99	120	55	77	88	77	77	77
Dry matter intake (kg)	20.3	23.6	26.9	30	18	21.7	23.5	19.8	22.2	22.7
Dry matter intake (lbs)	44.7	51.9	59.2	66	39.6	47.7	51.7	43.6	48.8	49.9
Daily wt change (kg)	0.5	0.3	0.1	-0.2	0	-0.2	-0.5	-0.7	-0.1	0
Days to gain one condition score	221	316	1166		3777					4247
Days to lose one condition score				544		241	110	80	532	
Energy <sup>a</sup>										
NE <sub>L</sub> (Mcal/day)	27.9	34.8	41.8	48.3	27.7	35.6	39.5	35.6	35.6	35.6
NE <sub>L</sub> (Mcal/kg)	1.37	1.47	1.55	1.61	1.54	1.64	1.68	1.8 a	1.6	1.57
NE <sub>L</sub> (Mcal/lb)	0.62	0.67	0.7	0.73	0.7	0.74	0.76	0.82	0.73	0.71
Protein										
Metabolizable protein (g/d)	1862	2407	2954	3476	1991	2639	2965	2579	2656	2672
Diet % MP	9.2	10.2	11	11.6	11.1	12.2	12.6	13	12	11.8
Rumen degradable protein (g/d)	1937	2298	2636	2947	1747	2125	2288	1971	2167	2206
Diet % RDP	9.5	9.7	9.8	9.8	9.7	9.8	9.7	10	9.8	9.7
Rumen undegradable protein (g/d)	933	1291	1677	2089	1151	1632	1865	1670	1619	1611
Diet % RUP	4.6	5.5	6.2	6.9	6.4	7.5	7.9	8.4	7.3	7.1
% RDP + % RUP (crude protein) <sup>b</sup>	14.1	15.2	16.0	16.7	16.1	17.3	17.6	18.4	17.1	16.8
Fiber and carbohydrate <sup>c</sup>										
NDF, min %	25-33	25-33	25-33	25-33	25-33	25-33	25-33	25-33	25-33	25-33
ADF, min %	17-21	17-21	17-21	17-21	17-21	17-21	17-21	17-21	17-21	17-21
NFC, max %	36-44	36-44	36-44	36-44	36-44	36-44	36-44	36-44	36-44	36-44
Minerals										
Absorbable calcium (g/day)	52.1	65	76.5	88	50.7	65.2	72.4	65.2	65.2	65.2
Dietary Ca %	0.62	0.61	0.67	0.6	0.57	0.57	0.63	0.66	0.54	0.53
Absorbable phosphorus (g/day)	44.2	56.5	68.8	80.3	41.4	54.1	60.4	52.2	54.6	55.1
Dietary P %	0.32	0.35	0.36	0.38	0.33	0.37	0.36	0.44	0.35	0.34
Mg <sup>d</sup> %	0.18	0.19	0.2	0.21	0.18	0.19	0.2	0.21	0.19	0.19
Cl %	0.24	0.26	0.28	0.29	0.24	0.26	0.27	0.28	0.25	0.25
K <sup>e</sup> %	1	1.04	1.06	1.07	1.02	1.03	1.04	1.07	1.03	1.02
Na %	0.22	0.23	0.22	0.22	0.2	0.2	0.2	0.22	0.2	0.19
S %	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Co mg/kg	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11
Cu mg/kg <sup>f</sup>	11	11	11	11	10	10	10	11	10	9
I mg/kg <sup>g</sup>	0.6	0.5	0.44	0.4	0.44	0.4	0.34	0.4	0.36	0.35
Fe mg/kg	12.3	15	17	18	14	16	17	18	16	15
Mn mg/kg	14	14	13	13	12	12	12	13	12	12
Se mg/kg	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Zn mg/kg	43	48	52	55	45	49	51	54	48	47
Vitamin A (IU/day)	75000	75000	75000	75000	49500	49500	49500	49500	49500	49500
Vitamin D (IU/day)	21000	21000	21000	21000	13500	13500	13500	13500	13500	13500
Vitamin E (IU/day)	545	545	545	545	360	360	360	360	360	360
Vitamin A (IU/kg)	3685	3169	2780	2500	2772	2300	2123	2520	2247	2198
Vitamin D (IU/kg)	1004	864	758	680	755	627	579	687	613	600
Vitamin E (IU/kg)	27	23	20	18	20	17	16	18	16	16
Sample diets used in model to generate tables. Ingredients listed as kg /day DM.										
Corn silage, normal	8.48	8.21	5.61	12.02	8.96	7.77	7.39	7.1	7.96	8.15
Soybean meal, solv. 48% CP	1.01	1.62	1.41	2.39	2.16	2.78	1.67	2.54	2.85	2.91
Legume forage silage, mid-maturity	3.85	4.57			2.67	3.1		2.83	3.18	3.25
Corn grain, steam flaked	1.8	4.33	7.08	6.35	2.6	4.91	5.88	4.48	5.03	5.15
Calcium carbonate	0.04	0.07	0.09	0.02	0.06	0.04	0.03	0.04	0.04	0.04
Monosodium phosphate (1 H <sub>2</sub> O)	0.02	0.02	0.04	0.06	0.01	0.01	0.03	0.01	0.01	0.01
Soybean meal, expellers							1.16			
Legume forage hay, immature				6.16	5.42		4.59			
Sodium chloride	0.12	0.011	0.12	0.14	0.1	0.1	0.12	0.09	0.1	0.1
Grass hay, c-3, mid-mat	4.47	3.21	0.98	0.93	0.85	0.95	0.97			
Vitamin and mineral premix	0.54	0.49	0.51	0.49	0.5	0.5	0.5	0.45	0.51	0.52
Bermudagrass hay, coastal				0.87						

Continues

TABLE 14-7 (*continued*)

Days in milk Dry matter intake input	Holstein = 680 kg Bwt, Mature Bwt = 680 kg, BCS = 3.0, 65 mos age, Milk fat = 3.5%, milk true protein = 3.0%, lactose = 4.8%, Default environmental conditions				Jersey = 454 kg Bwt, mature Bwt = 454 kg, BCS = 3.0, 65 mos age milk fat = 4.2%, milk true protein = 3.6%, lactose = 4.8% Default environmental conditions					
	90 Model predicted	90 Model predicted	90 Model predicted	90 Model predicted	90 Model predicted <sup>b</sup>	90 Model predicted <sup>b</sup>	90 Model predicted	50 Model predicted <sup>b</sup>	120 Model predicted <sup>b</sup>	90 Model predicted <sup>b</sup> + 5% <sup>c</sup>
Cottonseed, whole with lint			2.53	2.24		1.02	1.64	0.94	1.05	1.07
Tallow				0.29		0.24	0.21	0.22	0.24	0.25
Calcium soaps of fatty acids				0.29		0.18	0.21	0.17	0.19	0.19
Blood meal, ring dried			0.23	0.31		0.11	0.1	0.1	0.11	0.12
Sorghum, sudan type, silage			2.26							
Sample diet evaluation										
NE <sub>L</sub> (Mcal/kg)	1.49	1.55	1.57	1.58	1.54	1.59	1.57	1.62	1.58	1.57
Undiscounted TDN %	65	69	71	74	69	73	75	73	73	73

<sup>a</sup>Recommended energy content of early lactation rations must be limited to prevent rumen acidosis. Cow must therefore be expected to utilize body reserves to meet energy needs at highest levels of milk production. See fiber and NFC restrictions.

<sup>b</sup>Equivalent to crude protein requirement only if RDP and RUP are perfectly balanced.

<sup>c</sup>These are the minimum fiber (or maximum NFC) concentrations needed to maintain rumen health and milk fat test (see Chapter 4).

<sup>d</sup>Assumes that active transport of magnesium across the rumen wall is intact. High dietary potassium and excess non-protein nitrogen often interfere with Mg absorption. Under these conditions dietary Mg should be increased to 0.3%–0.35% (see Chapter 6).

<sup>e</sup>Heat stress may increase the need for potassium (see Chapter 6).

<sup>f</sup>High dietary molybdenum, sulfur, and iron can interfere with copper absorption increasing the requirement (see Chapter 6).

<sup>g</sup>Diets high in goitrogenic substances increase the iodine requirement (see Chapter 6).

<sup>h</sup>Diet composition is the same in all four cases of the Jersey cow producing 35 kg milk. Amount of dry matter consumed varies with days in milk and the use of predicted vs. actual dry matter intake in the model.

TABLE 14-8 Nutrient Requirements and Required Diet Nutrient Concentrations for Fresh Cows Fed an Example Fresh-Cow Ration

	Holstein = 680 kg Bwt, Mature Bwt = 680 kg, BCS = 3.3, 58 mos age milk fat = 3.5%, milk true protein = 3.0%, milk lactose = 4.8%			Jersey = 454 kg Bwt, Mature Bwt = 454 kg, BCS = 3.3, 58 mos. Age milk fat = 4.2%, milk true protein = 3.6%, milk lactose = 4.8%		
	Default environmental conditions					
Days in milk	11 Model predicted	11 Model predicted + 20%	11 Model predicted	11 Model predicted + 20%	11 Model predicted	11 Model predicted + 20%
Dry matter intake input						
Milk production (kg)	25	25	35	35	25	25
Milk production (lbs)	55	55	77	77	55	55
Dry matter intake (kg)	13.5	16.1	15.6	18.8	11.9	14.3
Dry matter intake (lbs)	29.7	35.4	34.3	41.4	26.2	31.5
Daily wt change (kg)	-0.9	0	-1.6	-0.6	-1.4	-0.7
Days to gain one condition score	99	4886	55	143	41	83
Days to lose one condition score						
Energy <sup>a</sup>						
NE <sub>L</sub> (Mcal/day)	27.9	27.9	34.8	34.8	27.7	27.7
NE <sub>L</sub> (Mcal/kg)	2.06	1.73	2.23	1.85	2.33	1.93
NE <sub>L</sub> (Mcal/lb)	0.94	0.79	1.01	0.84	1.06	0.88
Protein <sup>b</sup>						
Metabolizable protein (g/d)	1643	1725	2157	2254	1801	1875
Diet % MP	12.2	10.7	13.8	12.0	15.1	13.1
Rumen degradable protein (g/d)	1421	1683	1634	1931	1244	1469
Diet % RDP	10.5	10.5	10.5	10.3	10.5	10.3
Rumen undegradable protein (g/d)	949	863	1405	1045	1265	1202
Diet % RUP	7.0	5.4	9.0	5.6	10.6	8.4
% RDP + % RUP (crude protein) <sup>c</sup>	17.5	15.9	19.5	15.9	21.1	18.7
Fiber and carbohydrate <sup>d</sup>						
NDF, min %	25-33	25-33	25-33	25-33	25-33	25-33
ADF, min %	17-21	17-21	17-21	17-21	17-21	17-21
NFC, max %	36-44	36-44	36-44	36-44	36-44	36-44
Minerals						
Absorbable calcium (g/day)	52.1	52.1	64	64	51	51
Dietary Ca %	0.74	0.65	0.79	0.68	0.80	0.70
Absorbable phosphorus (g/ day)	37.3	40.0	49.0	52.0	35.0	37.7
Dietary P %	0.38	0.34	0.42	0.37	0.40	0.36
Mg <sup>e</sup> %	0.27	0.23	0.29	0.24	0.27	0.22
Cl %	0.36	0.30	0.40	0.33	0.36	0.30
K <sup>f</sup> %	1.19	1.11	1.24	1.14	1.19	1.10
Na %	0.34	0.29	0.34	0.28	0.31	0.26
S %	0.2	0.2	0.2	0.2	0.2	0.2
Co mg/kg	0.11	0.11	0.11	0.11	0.11	0.11
Cu mg/kg <sup>g</sup>	16	13	16	13	15	12
I mg/kg <sup>h</sup>	0.88	0.74	0.77	0.64	0.67	0.56
Fe mg/kg	19	16	22	19	21	17
Mn mg/kg	21	17	21	17	19	15
Se mg/kg	0.3	0.3	0.3	0.3	0.3	0.3
Zn mg/kg	65	54	73	60	67	56
Vitamin A (IU/day)	75000	75000	75000	75000	49900	49900
Vitamin D (IU/day)	21000	21000	21000	21000	13600	13600
Vitamin E (IU/day)	545	545	545	545	363	363
Vitamin A (IU/kg)	5540	4646	4795	3978	4193	3490
Vitamin D (IU/kg)	1511	1267	1308	1085	1143	951
Vitamin E (IU/kg)	40	34	35	29	31	25

Continues

TABLE 14-8 (*continued*)

Sample diet used in model to generate tables. Ingredients listed as % DM.

Corn silage, normal	36.44
Corn grain, steam flaked	18.29
Soybean meal, expellers	7.65
Soybean meal, solv. 48% CP	2.53
Legume forage hay, immature	20.17
Cottonseed, whole with lint	8.41
Calcium soaps of fatty acids	0.65
Blood meal, ring dried	1.02
Calcium carbonate	0.56
Monosodium phosphate (1 H <sub>2</sub> O)	0.4
Sodium chloride	0.7
Vitamin and mineral premix	3.18

Sample "fresh cow" diet evaluation

NDF %	31.6				
Forage NDF %	23.7				
ADF %	21				
NFC %	41.4				
Undiscounted TDN	71				
Diet NE <sub>L</sub> (Mcal/kg), dependent on DMI	1.75	1.73	1.73	1.70	1.72
Crude protein %	17.4				1.69

<sup>a</sup>Recommended energy content of early lactation rations must be limited to prevent rumen acidosis. Cow must therefore be expected to utilize body reserves to meet energy and protein requirements of early lactation. See fiber and NFC restrictions.

<sup>b</sup>It will be nearly impossible to meet the metabolizable protein needs of the high producing fresh cow due to low dry matter intake and the difficulty formulating rations with such high RUP.

<sup>c</sup>Equivalent to crude protein requirement only if RDP and RUP are perfectly balanced.

<sup>d</sup>These are the minimum fiber (or maximum NFC) concentrations needed to maintain rumen health and milk fat test (see Chapter 4).

<sup>e</sup>Assumes that active transport of magnesium across the rumen wall is intact. High dietary potassium and excess non-protein nitrogen often interfere with Mg absorption.

Under these conditions dietary Mg should be increased to 0.3%–0.35% (see Chapter 6).

<sup>f</sup>Heat stress may increase the need for potassium (see Chapter 6).

<sup>g</sup>High dietary molybdenum, sulfur, and iron can interfere with copper absorption increasing the requirement (see Chapter 6).

<sup>h</sup>Diets high in goitrogenic substances increase the iodine requirement (see Chapter 6).

## 270 Nutrient Requirements of Dairy Cattle

TABLE 14-9 Nutrient Requirements and Diet Concentrations Needed to Meet Requirements for Dry Cows as Determined Using Example Diets

REQUIREMENTS OF A DIET TO MEET TISSUE DEMANDS Holstein Cow, mature body weight without conceptus = 680 kg, BCS = 3.3, Calf wt = 45 kg Gaining 0.67 kg/day with conceptus			
Days pregnant	240	270	279
Current body wt (with conceptus) kg	730	751	757
Age (months)	57	58	58
Dry matter intake (kg)	14.4	13.7	10.1
Dry matter intake (lbs)	31.7	30.1	22.2
Energy			
NE <sub>L</sub> (Mcal/day required)	14.0	14.4	14.5
NE <sub>L</sub> (Mcal/kg required)	0.97	1.05	1.44
Protein			
Metabolizable protein (g/d)	871	901	810
Diet % MP	6.0	6.6	8.0
Rumen degradable protein (g/day)	1114	1197	965
Diet % RDP	7.7	8.7	9.6
Rumen undegradable protein (g/day)	317	292	286 <sup>a</sup>
Diet % RUP	2.2	2.1	2.8 <sup>a</sup>
% RDP + % RUP (crude protein) <sup>b</sup>	9.9	10.8	12.4
Fiber and carbohydrate <sup>c</sup>			
Minimum % NDF	33	33	33
Minimum % ADF	21	21	21
Maximum % NFC	42	42	42
Minerals			
Absorbable calcium (g)	18.1	21.5	22.5
Dietary Ca %	0.44	0.45	0.48
Absorbable phosphorus (g)	19.9	20.3	16.9
Dietary P %	0.22	0.23	0.26
Mg <sup>d</sup> %	0.11	0.12	0.16
Cl %	0.13	0.15	0.20
K %	0.51	0.52	0.62
Na %	0.10	0.10	0.14
S %	0.2	0.2	0.2
Co mg/kg	0.11	0.11	0.11
Cu mg/kg <sup>e</sup>	12	13	18
I mg/kg	0.4	0.4	0.5
Fe mg/kg	13	13	18
Mn mg/kg	16	18	24
Se mg/kg	0.3	0.3	0.3
Zn mg/kg	21	22	30
Vitamin A (IU/day)	80300	82610	83270
Vitamin D (IU/day)	21900	21530	22710
Vitamin E (IU/day)	1168	1202	1211
Vitamin A (IU/kg)	5576	6030	8244
Vitamin D (IU/kg)	1520	1645	2249
Vitamin E (IU/kg)	81	88	120
Sample diets used in model to generate tables			
Ingredient (kg DM)			
Corn silage, normal		4.32	4.03
Soybean meal, solv. 48% CP			0.27
Grass silage, C-3, mid-mat	8.1	7.35	3.73
Corn grain, ground hi moist			0.31
Beet sugar pulp, dried			1.42
Wheat straw	5.79	1.56	
Sodium chloride	0.02	0.02	0.02
Vitamin and mineral premix	0.46	0.41	0.31
Calcium carbonate			
Monosodium phosphate (1 H <sub>2</sub> O)			
Magnesium oxide			
Calcium phosphate (Di-)			

Continues

TABLE 14-9 (*continued*)

REQUIREMENTS OF A DIET TO MEET TISSUE DEMANDS Holstein Cow, mature body weight without conceptus = 680 kg, BCS = 3.3, Calf wt = 45 kg Gaining 0.67 kg/day with conceptus			
<b>Sample dry cow diet evaluation</b>			
NDF %	62.2	53.9	46.5
Forage NDF %	62.2	53.9	39.5
ADF %	39.7	33.5	27.8
NFC %	19.6	27.2	34.7
Undiscounted TDN	51	57	63
Diet NE <sub>L</sub> (Mcal/kg), dependent on DMI	1.12	1.33	1.49
NE <sub>L</sub> (Mcal/day supplied by example diet)	16.1	18.1	15

<sup>a</sup>RUP corrected from model prediction to provide actual RUP requirement if diet had been formulated to meet RDP requirement. Protein in many cases will not be balanced for RDP before the metabolizable protein requirement of the dry cow is met. When this occurs the RUP requirement determined by the model increases to compensate for the lost microbial protein. When RDP is inadequate the energy derived from the diet may be less than predicted by model due to incomplete digestion as a result of reduced bacterial activity in the rumen.

<sup>b</sup>% RUP + % RDP = Crude protein required only if ration is perfectly balanced for RDP and RUP. Rumen function may require that the crude protein content of the dry cow ration be 12%, despite the needs of the cow being met at lower CP levels.

<sup>c</sup>These are the minimum fiber (or maximum NFC) concentrations needed to maintain rumen health and milk fat test (see Chapter 4). Actual concentrations may need to be higher (or lower for NFC) depending on energy requirements of the cow. For transition and early lactation cows, diets should meet these minimum and maximum constraints and be formulated to contain 1.60 Mcal/kg of NE<sub>L</sub> (see Chapter 9).

<sup>d</sup>High dietary potassium and excess non-protein nitrogen can interfere with Mg absorption.

<sup>e</sup>High dietary molybdenum, sulfur, and iron can interfere with copper absorption increasing the requirement (see text).

<sup>f</sup>Diets high in goitrogenic substances increase the iodine requirement (see text).

TABLE 14-10 Example Diet Incorporating Dietary Guidelines Suggested in Chapter 9 for Transitioning a Heifer (entering first lactation) During the Later Dry Period to Acclimate Her To the Lactating Ration and To Reduce Metabolic Disease

This animal must be entered into the model as a replacement heifer to accommodate growth requirements. Tissue requirements for a heifer (270 d pregnant, weighing 625 kg with conceptus, mature body weight of 680 kg, consuming 10.6 kg dry matter / day, gaining 300 g body weight plus 660 g conceptus weight each day, and a current body condition score of 3.3) and nutrient densities of an example ration that follows the recommendation guidelines.

	Guidelines for close-up heifer diet	Nutrients required by tissues (as assessed with the example diet)	Example close-up heifer ration
	Recommendations that differ from requirement		Nutrients supplied
Energy			
NE <sub>L</sub> (Mcal/day)		14.8	16.9
NE <sub>L</sub> (Mcal/kg)	1.54–1.62 <sup>a</sup>	1.40	1.59
Protein			
Metabolizable protein (g/d)		888	1027
Diet % MP		8.4	9.7
Rumen degradable protein (g/day)		1052	1067
Diet % RDP		9.9	10.2
Rumen undegradable protein (g/day)		336	511
Diet % RUP		3.2	4.9
% RDP + % RUP (crude protein <sup>b</sup> )	13.5–15.0 <sup>c</sup>	13.1	15.0
Fiber and carbohydrate <sup>d</sup>			
Minimum % NDF	33 <sup>c</sup>	25–33	39.1
Minimum % ADF	21 <sup>c</sup>	17–21	23.4
Maximum % NFC	43 <sup>c</sup>	36–43	39.4
Minerals			
Absorbable calcium (g)		22.4	24.5
Dietary Ca %		0.40	0.44
Absorbable phosphorus (g)		16.6	25.4
Dietary P %	0.3–0.4 <sup>e</sup>	0.23	0.37
Mg %	0.35–0.40 <sup>f</sup>	0.14	0.40
Cl %		0.16	0.44
K %	0.55 <sup>g</sup>	0.55	1.54
Na %		0.12	0.13
S %		0.20	0.19
Co mg/kg		0.11	0.11
Cu mg/kg		16	16
I mg/kg		0.4	0.4
Fe mg/kg		26	26
Mn mg/kg		22	22
Se mg/kg		0.3	0.3
Zn mg/kg		30	30
Vitamin A (IU/day)	75000 <sup>h</sup>	68750	75000
Vitamin D (IU/day)	20000 <sup>h</sup>	18750	20000
Vitamin E (IU/day)	1200 <sup>h</sup>	848	1200
Vitamin A (IU/kg)		6486	7075
Vitamin D (IU/kg)		1769	1887
Vitamin E (IU/kg)		80	113
Dietary cation-anion difference (Na + K) – (Cl + S), meq/kg		24	203

Continues

TABLE 14-10 (*continued*)

Sample diet used in model to generate tables	Ingredient (kg DM/day)	Example Close-up heifer diet
Corn silage, normal		4.58
Soybean meal, solv. 48% CP		1.07
Grass silage, C-3, mid-mat		2.44
Corn grain, ground high moist		1.04
Beet sugar pulp, dried		0.95
Sodium chloride		0.02
Vitamin and mineral premix		0.39
Magnesium oxide		0.04
Calcium phosphate (Di-)		0.02

<sup>a</sup>Energy increased to prepare rumen for lactation ration, promote feed intake, and reduce displaced abomasum after calving.

<sup>b</sup>% RUP + % RDP = Crude protein required only if ration is perfectly balanced for RDP and RUP.

<sup>c</sup>Protein may not be balanced for RDP before the metabolizable protein requirement of the animals is met. When this occurs the RUP requirement is increased to compensate for the lost microbial protein. In addition energy derived from the diet may be diminished due to incomplete digestion as a result of reduced bacterial activity in the rumen.

<sup>d</sup>Suggested carbohydrate profile to reduce displacement of the abomasum.

<sup>e</sup>A level which will provide adequate phosphorus even on the day of calving when DMI is low.

<sup>f</sup>A level which will allow passive absorption of magnesium across the rumen wall to maintain adequate blood magnesium concentration.

<sup>g</sup>Goal would be to limit potassium to the requirement of the heifer to reduce udder edema. Very difficult to achieve.

<sup>h</sup>A level which will provide adequate vitamins even on the day of calving when DMI is low, utilizing requirements of cows, not replacement heifers.

TABLE 14-11 Example Diet Incorporating Dietary Guidelines Suggested in Chapter 9 for Transitioning a Cow (entering 2nd lactation or greater) During the Last Weeks of Gestation to Acclimate Her To a Lactating Ration and To Reduce Metabolic Disease

Tissue requirements for a cow (270 d pregnant, weighing 751 kg with conceptus, mature body weight of 680 kg, consuming 13.7 kg dry matter/day, and a current body condition score of 3.3) with the nutrients supplied by the example rations that follow the recommendation guidelines.

	Nutrients needed to meet requirement of tissues as determined with example diet	Guidelines for standard close-up diet	Guidelines for "anionic" close-up diet	Example standard close-up diet	Example "anionic" close-up diet
		Recommendations that differ from simply meeting tissue requirement	Recommendations that differ from simply meeting tissue requirement	Nutrients supplied	Nutrients supplied
<b>Energy</b>					
NE <sub>L</sub> (Mcal/day)	14.4			22.0	21.5
NE <sub>L</sub> (Mcal/kg diet)	1.05	1.54–1.62 <sup>a</sup>	1.54–1.62 <sup>a</sup>	1.61	1.58
<b>Protein</b>					
Metabolizable protein (g/d)	910			164	1133
Diet % MP	6.6			8.5	8.3
Rumen degradable protein (g/day)	1358			1104	1075
Diet % RDP	9.9			8.1	7.8
Rumen undegradable protein (g/day)	172 <sup>b</sup>			640	621
Diet % RUP	1.3 <sup>b</sup>			4.7	4.5
% RDP + % RUP (crude protein) <sup>c</sup>	10.2	12.0 <sup>d</sup>	12.0 <sup>d</sup>	12.8	12.3
<b>Fiber and carbohydrate<sup>e</sup></b>					
Minimum % NDF	25–33	33	33	38.2	37.2
Minimum % ADF	17–21	21	21	22.4	21.8
Maximum % NFC	36–44	43	43	42.8	41.6
<b>Minerals</b>					
Absorbable calcium (g)	21.5			32.0	95.0
Dietary Ca %	0.45		0.6–1.5 <sup>f</sup>	0.43	0.98
Absorbable phosphorus (g)	20.3			28	36
Dietary P %	0.23	0.3–0.4 <sup>g</sup>	0.3–0.4	0.3	0.37
Mg %	0.12	0.35–0.40 <sup>h</sup>	0.35–0.40 <sup>h</sup>	0.39	0.38
Cl %	0.15		0.8–1.2 <sup>i</sup>	0.42	0.89
K <sup>j</sup> %	0.52			1.35	1.32
Na %	0.1			0.16	0.15
S %	0.2		0.3–0.4 <sup>i</sup>	0.18	0.31
Co mg/kg	0.11			0.11	0.11
Cu mg/kg	13			13	13
I mg/kg	0.4			0.4	0.4
Fe mg/kg	13			13	13
Mn mg/kg	18			18	18
Se mg/kg	0.3			0.3	0.3
Zn mg/kg	22			22	22
Vitamin A (IU/day)	82610	100000 <sup>k</sup>	100000 <sup>k</sup>	100000	100000
Vitamin D (IU/day)	22530	25000 <sup>k</sup>	25000 <sup>k</sup>	25000	25000
Vitamin E (IU/day)	1202	1200 <sup>k</sup>	1200 <sup>k</sup>	1803	1803
Vitamin A (IU/kg)	6030			7300	7300
Vitamin D (IU/kg)	1644			1824	1824
Vitamin E (IU/kg)	88			132	132
Dietary cation-anion difference (Na + K) – (Cl + S), meq/kg	10	10	–75 to 0 <sup>l</sup>	185	–41

Continues

TABLE 14-11 (*continued*)

Tissue requirements for a cow (270 d pregnant, weighing 751 kg with conceptus, mature body weight of 680 kg, consuming 13.7 kg dry matter/day, and a current body condition score of 3.3) with the nutrients supplied by the example rations that follow the recommendation guidelines.

Nutrients needed to meet requirement of tissues as determined with example diet	Guidelines for standard close-up diet	Guidelines for “anionic” close-up diet	Example standard close-up diet	Example “anionic” close-up diet
	Recommendations that differ from simply meeting tissue requirement	Recommendations that differ from simply meeting tissue requirement	Nutrients supplied	Nutrients supplied
<b>Sample diets used in model to generate tables</b>				
<b>Ingredient (kg DM/day)</b>				
Corn silage, normal		No added anion diet	Anionic diet	
Soybean meal, solv. 48% CP	5.55	5.40		
Grass silage, C-3, mid-mat	0.79	0.77		
Corn grain, ground hi moist	2.48	2.42		
Beet sugar pulp, dried	2.16	2.10		
Sodium chloride	2.15	2.09		
Vitamin and mineral premix	0.03	0.03		
Calcium carbonate	0.43	0.42		
Magnesium oxide		0.05	0.03	
Calcium phosphate (Di-)		0.02	0.07	
Magnesium sulfate (7 H <sub>2</sub> O, Epsom salts) <sup>m</sup>			0.14	
Calcium chloride (2 H <sub>2</sub> O, 77–80% CaCl <sub>2</sub> ) <sup>m</sup>			0.14	

<sup>a</sup>Energy increased to prepare rumen for lactation ration, promote feed intake, and reduce displaced abomasum after calving.

<sup>b</sup>RUP corrected from model prediction to provide RUP requirement if diet can be formulated to meet RDP requirement.

<sup>c</sup>% RUP + % RDP = Crude Protein Required only if ration is perfectly balanced for RDP and RUP.

<sup>d</sup>Protein in most cases will not be balanced for RDP before the metabolizable protein requirement of the dry cow is met. When this occurs the RUP requirement determined by the model increases to compensate for the lost microbial protein. When RDP is inadequate the energy derived from the diet may be less than predicted by model due to incomplete digestion as a result of reduced bacterial activity in the rumen. In order to improve rumen digestion the recommendation is to exceed the cow's requirement for metabolizable protein to meet the RDP requirement of the rumen.

<sup>e</sup>Suggested carbohydrate profile to reduce displacement of the abomasum.

<sup>f</sup>Utilizing the DCAD concept to prevent milk fever, diet calcium does not have to be limited.

<sup>g</sup>A level which will provide adequate phosphorus even on the day of calving when DMI is low.

<sup>h</sup>A level which will allow passive absorption of magnesium across the rumen wall to maintain adequate blood magnesium concentration.

<sup>i</sup>Adding anions to the ration to reduce hypocalcemia.

<sup>j</sup>Goal would be to limit potassium to the requirement of the cow. Very difficult to achieve.

<sup>k</sup>A level which will provide adequate vitamins even on the day of calving when DMI is low.

<sup>l</sup>Monitoring urine pH can help titrate the correct DCAD of the ration.

<sup>m</sup>More palatable sources of anions than used in this example are available and would likely impair DMI less.

TABLE 14-12 Daily Nutrient Requirements (DM basis) of Small Breed (mature weight = 450 kg) Non-Bred Heifers

BW kg	ADG kg/d	DMI kg/d	TDN %	NE <sub>m</sub> Mcal/d	NE <sub>c</sub> Mcal/d	ME Mcal/d	RDP g/d	RUP g/d	RDP %	RUP %	CP <sup>a</sup> %	Ca g/d	P g/d
100	0.3	3.0	56.5	2.64	0.47	6.0	255	110	8.6	3.7	12.4	14	7
	0.4	3.0	58.6	2.64	0.64	6.4	270	143	9.0	4.7	13.7	18	8
	0.5	3.1	60.7	2.64	0.82	6.7	284	175	9.3	5.7	15.0	21	10
	0.6	3.1	62.9	2.64	1.00	7.0	298	207	9.6	6.7	16.3	25	11
	0.7	3.1	65.2	2.64	1.19	7.3	310	239	10.0	7.7	17.7	28	12
	0.8	3.1	67.7	2.64	1.37	7.6	323	270	10.4	8.7	19.0	31	13
	0.3	4.0	56.5	3.57	0.63	8.2	346	95	8.6	2.4	11.0	15	8
	0.4	4.1	58.6	3.57	0.87	8.7	366	124	9.0	3.0	12.0	19	10
150	0.5	4.1	60.7	3.57	1.11	9.1	385	152	9.3	3.7	12.9	22	11
	0.6	4.2	62.9	3.57	1.36	9.5	403	180	9.6	4.3	13.9	25	12
	0.7	4.2	65.3	3.57	1.61	9.9	421	207	10.0	4.9	14.9	28	13
	0.8	4.2	67.7	3.57	1.86	10.3	437	234	10.4	5.5	15.9	31	14
	0.3	5.0	56.5	4.44	0.79	10.2	429	81	8.6	1.6	10.3	17	10
	0.4	5.1	58.6	4.44	1.08	10.7	454	106	9.0	2.1	11.1	20	11
	0.5	5.1	60.7	4.44	1.38	11.3	478	131	9.3	2.6	11.8	23	12
	0.6	5.2	62.9	4.44	1.68	11.8	500	156	9.6	3.0	12.6	26	13
200	0.7	5.2	65.3	4.44	1.99	12.3	522	179	10.0	3.4	13.4	29	14
	0.8	5.2	67.7	4.44	2.31	12.8	543	202	10.4	3.9	14.2	32	15
	0.3	5.9	56.5	5.24	0.93	12.0	508	69	8.6	1.2	9.8	19	11
	0.4	6.0	58.6	5.24	1.28	12.7	537	91	9.0	1.5	10.5	21	12
	0.5	6.1	60.7	5.24	1.63	13.4	565	113	9.3	1.9	11.1	24	13
	0.6	6.1	62.9	5.24	1.99	14.0	592	135	9.6	2.2	11.8	27	14
	0.7	6.2	65.3	5.24	2.36	14.6	617	155	10.0	2.5	12.5	30	15
	0.8	6.2	67.7	5.24	2.73	15.2	642	175	10.4	2.8	13.2	32	16
250	0.3	6.7	56.5	6.01	1.07	13.8	582	58	8.6	0.9	9.5	20	12
	0.4	6.9	58.6	6.01	1.46	14.6	616	79	9.0	1.1	10.1	23	13
	0.5	7.0	60.7	6.01	1.87	15.3	648	98	9.3	1.4	10.7	26	14
	0.6	7.0	62.9	6.01	2.28	16.0	678	117	9.6	1.7	11.3	28	15
	0.7	7.1	65.3	6.01	2.70	16.7	707	135	10.0	1.9	11.9	31	16
	0.8	7.1	67.7	6.01	3.13	17.4	736	151	10.4	2.1	12.5	34	17

<sup>a</sup>Crude protein required only if ration is perfectly balanced for RDP and RUP.

TABLE 14-13 Daily Nutrient Requirements (DM basis) of Large Breed (mature weight = 650 kg) Non-Bred Heifers

BW kg	ADG kg/d	DMI kg/d	TDN %	NE <sub>M</sub> Mcal/d	NE <sub>G</sub> Mcal/d	ME Mcal/d	RDP g/d	RUP g/d	RDP %	RUP %	CP <sup>a</sup> %	Ca g/d	P g/d
150	0.5	4.1	58.4	3.57	0.84	8.6	364	167	8.9	4.1	13.0	23	11
	0.6	4.1	60.0	3.57	1.03	9.0	379	199	9.2	4.8	14.0	26	12
	0.7	4.2	61.7	3.57	1.22	9.3	393	230	9.4	5.5	14.9	30	13
	0.8	4.2	63.4	3.57	1.41	9.6	407	261	9.7	6.2	15.9	33	15
	0.9	4.2	65.3	3.57	1.61	9.9	421	292	10.0	6.9	16.9	37	16
	1.0	4.2	67.2	3.57	1.80	10.3	434	322	10.3	7.6	17.9	40	17
	1.1	4.2	69.2	3.57	2.00	10.6	446	352	10.6	8.3	18.9	43	18
	0.5	5.1	58.4	4.44	1.05	10.7	452	148	8.9	2.9	11.9	24	12
	0.6	5.1	60.0	4.44	1.28	11.1	470	177	9.2	3.4	12.6	27	13
	0.7	5.2	61.7	4.44	1.51	11.5	488	205	9.4	4.0	13.4	30	14
	0.8	5.2	63.4	4.44	1.75	11.9	505	233	9.7	4.5	14.2	34	15
200	0.9	5.2	65.3	4.44	1.99	12.3	522	260	10.0	5.0	15.0	37	17
	1.0	5.2	67.2	4.44	2.24	12.7	538	287	10.3	5.5	15.8	40	18
	1.1	5.2	69.2	4.44	2.49	13.1	554	314	10.6	6.0	16.6	43	19
	0.5	6.0	58.4	5.24	1.24	12.6	534	131	8.9	2.2	11.1	25	13
	0.6	6.1	60.0	5.24	1.51	13.1	556	156	9.2	2.6	11.8	28	14
	0.7	6.1	61.7	5.24	1.79	13.6	577	182	9.4	3.0	12.4	31	15
250	0.8	6.2	63.4	5.24	2.07	14.1	597	207	9.7	3.4	13.1	34	16
	0.9	6.2	65.3	5.24	2.36	14.6	617	232	10.0	3.7	13.7	37	17
	1.0	6.2	67.2	5.24	2.65	15.0	636	256	10.3	4.1	14.4	40	18
	1.1	6.2	69.2	5.24	2.94	15.5	655	280	10.6	4.5	15.1	43	19
	0.5	6.9	58.4	6.01	1.42	14.5	612	114	8.9	1.7	10.6	27	14
	0.6	6.9	60.0	6.01	1.73	15.1	637	138	9.2	2.0	11.2	30	15
300	0.7	7.0	61.7	6.01	2.05	15.6	661	161	9.4	2.3	11.7	33	16
	0.8	7.1	63.4	6.01	2.38	16.2	685	183	9.7	2.6	12.3	35	17
	0.9	7.1	65.3	6.01	2.70	16.7	707	205	10.0	2.9	12.9	38	18
	1.0	7.1	67.2	6.01	3.03	17.2	729	227	10.3	3.2	13.5	41	19
	1.1	7.1	69.2	6.01	3.37	17.7	751	248	10.6	3.5	14.1	44	20
	0.5	7.7	58.4	6.75	1.59	16.2	687	99	8.9	1.3	10.2	28	15
350	0.6	7.8	60.0	6.75	1.94	16.9	715	121	9.2	1.5	10.7	31	16
	0.7	7.9	61.7	6.75	2.30	17.6	742	141	9.4	1.8	11.2	34	17
	0.8	7.9	63.4	6.75	2.67	18.2	769	162	9.7	2.0	11.7	37	18
	0.9	8.0	65.3	6.75	3.03	18.8	794	181	10.0	2.3	12.3	40	19
	1.0	8.0	67.2	6.75	3.41	19.4	819	200	10.3	2.5	12.8	42	20
	1.1	8.0	69.2	6.75	3.78	19.9	843	218	10.6	2.7	13.3	45	21
400	0.5	8.5	58.4	7.46	1.76	18.0	760	86	8.9	1.0	9.9	30	16
	0.6	8.6	60.0	7.46	2.15	18.7	791	105	9.2	1.2	10.4	33	17
	0.7	8.7	61.7	7.46	2.55	19.4	821	124	9.4	1.4	10.9	35	18
	0.8	8.8	63.4	7.46	2.95	20.1	850	142	9.7	1.6	11.3	38	19
	0.9	8.8	65.3	7.46	3.35	20.7	878	159	10.0	1.8	11.8	41	20
	1.0	8.8	67.2	7.46	3.76	21.4	905	176	10.3	2.0	12.3	44	21
1.1	8.8	69.2	7.46	4.18	22.0	931	192	10.6	2.2	12.8	46	22	

<sup>a</sup>Crude protein required only if ration is perfectly balanced for RDP and RUP.

TABLE 14-14 Daily Nutrient Requirements (DM basis) of Small Breed (mature weight = 450 kg) Bred Heifers

BW kg	ADG kg/d	DMI kg/d	TDN %	NE <sub>m</sub> Mcal/d	NE <sub>G</sub> Mcal/d	ME Mcal/d	RDP g/d	RUP g/d	RDP %	RUP %	CP <sup>a</sup> %	Ca g/d	P g/d
240 days pregnant (Conceptus weight of 39 kg and ADG of 0.4 kg/day)													
300	0.3 (0.7) <sup>b</sup>	7.7	56.5	5.42	0.96	15.7	663	291	8.6	3.8	12.4	36	19
	0.4 (0.8)	7.7	58.6	5.42	1.32	16.4	693	310	9.0	4.0	13.0	39	20
	0.5 (0.9)	7.7	60.8	5.42	1.68	17.0	721	329	9.3	4.2	13.5	41	21
	0.6 (1.0)	7.7	63.1	5.42	2.06	17.7	748	346	9.7	4.5	14.1	44	22
	0.7 (1.1)	7.7	65.5	5.42	2.44	18.3	774	364	10.0	4.7	14.7	47	23
	0.8 (1.2)	7.7	68.1	5.42	2.82	18.9	798	380	10.4	5.0	15.4	49	24
	0.9 (1.3)	7.6	70.9	5.42	3.21	19.4	822	395	10.8	5.2	16.1	52	24
	0.3 (0.7)	8.6	56.2	6.18	1.10	17.5	739	282	8.6	3.3	11.9	38	20
	0.4 (0.8)	8.7	58.3	6.18	1.50	18.3	773	299	8.9	3.4	12.4	40	21
350	0.5 (0.9)	8.7	60.5	6.18	1.92	19.0	805	315	9.3	3.6	12.9	43	22
	0.6 (1.0)	8.7	62.8	6.18	2.35	19.8	836	330	9.6	3.8	13.4	46	23
	0.7 (1.1)	8.7	65.3	6.18	2.78	20.4	865	345	10.0	4.0	14.0	48	24
	0.8 (1.2)	8.6	67.8	6.18	3.22	21.1	893	358	10.4	4.2	14.5	51	25
	0.9 (1.3)	8.5	70.6	6.18	3.66	21.8	921	371	10.8	4.3	15.1	53	25
	0.3 (0.7)	9.5	56.0	6.91	1.23	19.2	813	275	8.6	2.9	11.5	40	21
	0.4 (0.8)	9.6	58.1	6.91	1.68	20.1	851	291	8.9	3.0	11.9	42	22
	0.5 (0.9)	9.6	60.3	6.91	2.15	21.0	887	305	9.2	3.2	12.4	45	23
	0.6 (1.0)	9.6	62.6	6.91	2.62	21.8	921	319	9.6	3.3	12.9	47	24
400	0.7 (1.1)	9.6	65.0	6.91	3.11	22.5	953	331	9.9	3.5	13.4	50	25
	0.8 (1.2)	9.5	67.6	6.91	3.60	23.3	985	342	10.3	3.6	13.9	52	26
	0.9 (1.3)	9.4	70.3	6.91	4.09	24.0	1015	352	10.8	3.7	14.5	55	26
	0.3 (0.7)	10.4	55.8	7.62	1.35	20.9	884	273	8.5	2.6	11.2	41	22
	0.4 (0.8)	10.5	57.9	7.62	1.85	21.9	926	288	8.9	2.8	11.6	44	23
	0.5 (0.9)	10.5	60.1	7.62	2.37	22.8	965	301	9.2	2.9	12.1	46	24
	0.6 (1.0)	10.5	62.4	7.62	2.89	23.7	1003	313	9.5	3.0	12.5	49	25
	0.7 (1.1)	10.5	64.8	7.62	3.42	24.5	1038	324	9.9	3.1	13.0	51	26
	0.8 (1.2)	10.4	67.4	7.62	3.96	25.4	1073	333	10.3	3.2	13.5	54	27
450	0.9 (1.3)	10.3	70.1	7.62	4.51	26.1	1106	341	10.7	3.3	14.0	56	28

<sup>a</sup>Crude protein required only if ration is perfectly balanced for RDP and RUP.<sup>b</sup>Values in parentheses are ADG (lbs/d).

TABLE 14-15 Daily Nutrient Requirements (DM basis) of Large Breed (mature weight = 650 kg) Bred Heifers

BW kg	ADG kg/d	DMI kg/d	TDN %	NEm Mcal/d	NE <sub>G</sub> Mcal/d	ME Mcal/d	RDP g/d	RUP g/d	RDP %	RUP %	CP <sup>a</sup> %	Ca g/d	P g/d
240 days pregnant (Conceptus weight of 48 kg and ADG of 0.6 kg/day)													
450	0.5 (1.1) <sup>b</sup>	10.5	59.3	7.49	1.77	22.5	951	402	9.1	3.8	12.9	47	25
	0.6 (1.2)	10.5	61.1	7.49	2.16	23.2	981	418	9.3	4.0	13.3	50	25
	0.7 (1.3)	10.5	62.9	7.49	2.55	23.9	1010	433	9.6	4.1	13.7	53	26
	0.8 (1.4)	10.5	64.8	7.49	2.96	24.5	1038	448	9.9	4.3	14.2	55	27
	0.9 (1.5)	10.4	66.8	7.49	3.37	25.2	1066	462	10.2	4.4	14.7	58	28
	1.0 (1.6)	10.4	68.9	7.49	3.78	25.8	1092	475	10.5	4.6	15.1	61	29
	1.1 (1.7)	10.3	71.2	7.49	4.19	26.4	1118	488	10.9	4.8	15.6	63	30
500	0.5 (1.1)	11.3	59.0	8.17	1.93	24.2	1024	391	9.0	3.4	12.5	49	26
	0.6 (1.2)	11.4	60.8	8.17	2.36	25.0	1057	405	9.3	3.6	12.9	52	27
	0.7 (1.3)	11.4	62.6	8.17	2.79	25.7	1088	419	9.6	3.7	13.3	54	27
	0.8 (1.4)	11.3	64.5	8.17	3.23	26.4	1119	432	9.9	3.8	13.7	57	28
	0.9 (1.5)	11.3	66.5	8.17	3.67	27.2	1149	444	10.2	3.9	14.1	59	29
	1.0 (1.6)	11.2	68.6	8.17	4.13	27.8	1177	455	10.5	4.1	14.5	62	30
	1.1 (1.7)	11.1	70.8	8.17	4.58	28.5	1206	465	10.8	4.2	15.0	65	31
550	0.5 (1.1)	12.2	58.8	8.84	2.09	25.9	1094	382	9.0	3.1	12.1	51	27
	0.6 (1.2)	12.2	60.5	8.84	2.55	26.7	1130	395	9.3	3.2	12.5	53	28
	0.7 (1.3)	12.2	62.3	8.84	3.02	27.5	1164	407	9.5	3.3	12.9	56	29
	0.8 (1.4)	12.2	64.2	8.84	3.49	28.3	1197	418	9.8	3.4	13.3	58	29
	0.9 (1.5)	12.1	66.2	8.84	3.98	29.1	1229	428	10.1	3.5	13.7	61	30
	1.0 (1.6)	12.1	68.3	8.84	4.46	29.8	1260	437	10.4	3.6	14.1	64	31
	1.1 (1.7)	12.0	70.5	8.84	4.95	30.5	1291	445	10.8	3.7	14.5	66	32
600	0.5 (1.1)	13.0	58.6	9.50	2.24	27.5	1163	375	9.0	2.9	11.8	53	28
	0.6 (1.2)	13.0	60.3	9.50	2.74	28.4	1202	387	9.2	3.0	12.2	55	29
	0.7 (1.3)	13.0	62.1	9.50	3.24	29.3	1238	397	9.5	3.0	12.5	58	30
	0.8 (1.4)	13.0	64.0	9.50	3.75	30.1	1274	407	9.8	3.1	12.9	60	30
	0.9 (1.5)	13.0	66.0	9.50	4.27	30.9	1308	416	10.1	3.2	13.3	63	31
	1.0 (1.6)	12.9	68.0	9.50	4.79	31.7	1342	423	10.4	3.3	13.7	65	32
	1.1 (1.7)	12.8	70.2	9.50	5.32	32.5	1374	430	10.7	3.4	14.1	68	33
650	0.5 (1.1)	13.8	58.4	10.14	2.39	29.1	1231	371	8.9	2.7	11.6	54	29
	0.6 (1.2)	13.8	60.1	10.14	2.92	30.1	1272	382	9.2	2.8	12.0	57	30
	0.7 (1.3)	13.8	61.9	10.14	3.46	31.0	1311	392	9.5	2.8	12.3	59	31
	0.8 (1.4)	13.8	63.8	10.14	4.00	31.9	1349	400	9.8	2.9	12.7	62	31
	0.9 (1.5)	13.8	65.8	10.14	4.56	32.7	1385	408	10.1	3.0	13.0	64	32
	1.0 (1.6)	13.7	67.8	10.14	5.11	33.6	1421	414	10.4	3.0	13.4	67	33
	1.1 (1.7)	13.6	70.0	10.14	5.68	34.4	1456	418	10.7	3.1	13.8	69	34

<sup>a</sup>Crude protein required only if ration is perfectly balanced for RDP and RUP.<sup>b</sup>Values in parentheses are ADG (lbs/d).

TABLE 14-16 Nutrient Requirements of Growing Holstein Heifers Using Model to Predict Target Average Daily Gain Needed to Attain a Mature Body Weight of 680 Kg

	6 mos. (200 kg) BCS = 3.0 to calve at 24 mos age	12 mos. (300 kg) BCS = 3.0 to calve at 24 mos age	18 mos. (450 kg) BCS = 3.0 90 days gestation to calve at 24 mos age
Dry matter intake predicted by model (kg)	5.2	7.1	11.3
Dry matter intake predicted by model (lbs)	11.4	15.62	24.9
Energy			
ME (Mcal/day)	10.6	16.2	20.3
ME (Mcal/kg)	2.04	2.28	1.79
ME (Mcal/lb)	0.93	1.03	0.82
Protein			
Metabolizable protein (g/d)	415	550	635
Diet % MP	8.0	7.7	5.6
Rumen degradable protein	481	667	970
Diet % RDP	9.3	9.4	8.6
Rumen undegradable protein	176	209	88
Diet % RUP	3.4	2.9	0.8
% RDP + % RUP (crude protein) <sup>a</sup>	12.7	12.3	9.4
Fiber and carbohydrate <sup>b</sup>			
NDF, min %	30–33	30–33	30–33
ADF, min %	20–21	20–21	20–21
NFC, max %	34–38	34–38	34–38
Minerals			
Absorbable calcium (g)	11.3	15.0	13.0
Dietary Ca %	0.41	0.41	0.37
Absorbable phosphorus (g)	9.1	10.6	13
Dietary P %	0.28	0.23	0.18
Mg <sup>c</sup> %	0.11	0.11	0.08
Cl %	0.11	0.12	0.10
K %	0.47	0.48	0.46
Na %	0.08	0.08	0.07
S %	0.2	0.2	0.2
Co mg/kg	0.11	0.11	0.11
Cu mg/kg <sup>d</sup>	10	10	9
I mg/kg <sup>e</sup>	0.27	0.30	0.30
Fe mg/kg	43	31	13
Mn mg/kg	22	20	14
Se mg/kg	0.3	0.3	0.3
Zn mg/kg	32	27	18
Vitamin A (IU/ day)	16000	24000	36000
Vitamin D (IU/ day)	6000	9000	13500
Vitamin E (IU /day)	160	240	360
Vitamin A (IU/kg)	3076	3380	3185
Vitamin D (IU/kg)	1154	1268	1195
Vitamin E (IU /kg)	31	34	32

Sample Diets used in model to generate tables

## Ingredient (kg/d)

Corn silage, normal	2.90	4.08	1.51
Soybean meal, solv. 48% CP	0.30	0.41	0
Grass silage, C-3, mid-mat	1.68	2.29	9.52
Limestone	0.03	0.02	0
Vitamin premix	0.30	0.27	0.30
Diet ME (Mcal/kg)	2.24	2.29	2.08
Diet undiscounted TDN %	61	62	56
Target ADG without conceptus (kg)	0.65	0.87	0.59
Target ADG with conceptus (kg)	0.65	0.87	0.59
ME allowable ADG without conceptus of diet	0.82	0.87	0.86
ME allowable ADG with conceptus of diet	0.82	0.87	0.86
MP allowable ADG without conceptus of diet	0.76	1.09	1.30
MP allowable ADG with conceptus of diet	0.76	1.09	1.30

<sup>a</sup>Equivalent to crude protein requirement only if RDP and RUP are perfectly balanced.<sup>b</sup>These are the minimum fiber (or maximum NFC) concentrations needed to maintain rumen health (see Chapter 4). Actual concentrations may need to be higher (or lower for NFC) depending on energy requirements of the heifer.<sup>c</sup>Assumes that active transport of magnesium across the rumen wall is intact. High dietary potassium and excess non-protein nitrogen often interfere with Mg absorption. Under these conditions dietary Mg should be increased. (see Chapter 6).<sup>d</sup>High dietary Mo, sulfur, and Fe can interfere with Cu absorption increasing the requirement (see Chapter 6).<sup>e</sup>Diets high in goitrogenic substances increase the iodine requirement (see Chapter 6).