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MAKING NUTRIENT COMPOSITION TABLES RELEVANT

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Nutrient requirements, feed intake, and feed composition form the trifecta of ration balancing. Requirements are determined using published tables or computer programs. Intake is reasonably established with stable-fed animals but more difficult to estimate for horses on pasture. Feed composition is based on actual analyses or from nutrient composition tables. The best rations are based on feed analyses. Nutrient composition tables should be used only as a secondary source in the absence of analytical data. To provide the best information, tables should incorporate data from a variety of contemporary sources.

Source of Data

The *United States-Canadian Tables of Feed Composition* (NRC, 1982) was the last comprehensive set of nutrient values published by the National Research Council (NRC). The data are reported to be from "individuals in both industry and public institutions." In order to complete the table, missing values were estimated using regression equations or estimated from similar feeds. No information is given regarding the number of samples or the standard deviation for each nutrient. Individual forages can vary widely in nutrient composition. Table 1 illustrates the variation in legume hays analyzed by our lab. Reporting the standard deviation improves the usefulness of the tables. For example, if an individual forage is recognized as being better than average in quality, the crude protein plus one standard deviation and the ADF minus one standard deviation can be used to better estimate the quality of the feed.

No overt reference is made to the origins of the data in *Nutrient Requirements of Horses* (NRC, 1989), heretofore referred to as the 1989 Horse NRC. Presumably, the information comes from other NRC sources. A big improvement in this table was the inclusion of the number of observations used in the statistics along with the standard deviation. Disappointingly, many feed types are based on few observations. For example, commonly fed timothy hay listed an average of four observations per nutrient.

The challenge for the next NRC equine committee will be to construct tables using current, relevant information. Securing data based on large numbers of observations will enhance the meaningfulness of the tabular values and provide measures of variation for individual feeds.

Table 1. Composition of legume hays (DM basis) from 5/01/00 to 4/30/04.

	n	*Mean*	*sd*
CP, %	51389	21.1	2.8
ADF, %	51032	30.0	4.1
NDF,%	51055	38.6	5.5
DE, Mcal/kg		2.63	
Fat,%	23856	2.5	0.5
Ash, %	24048	10.8	1.8
Ca, %	44327	1.56	0.28
P, %	44336	0.28	0.05
Mg, %	43663	0.31	0.07
K,%	43773	2.44	0.54
Na, %	14082	0.14	0.13
Fe, ppm	14025	353	320
Zn, ppm	14012	36	
Cu, ppm	14008	9	7
Mn, ppm	14011	35	17
S, %	26023	0.28	0.17

Commercial Analyses

Commercial forage analysis began to grow in the latter part of the 1960s. Initially targeted at the dairy industry, the number of labs and nutrient analyses available continue to grow. The National Forage Testing Association (NFTA) started with 25 labs in the late 1980s and enlists over 150 labs today. Forage analysis was seen as a way to optimize feed costs by providing the nutrients required and avoiding the costs incurred with over- and underfeeding. Commercial forage analysis is now a virtual requirement for doing business with today's dairies. This is evidenced by the growth of Dairy One services. In 1975, just over 5,000 samples were analyzed, primarily from New York and New England. In 2003, analyses were performed on over 120,000 samples from all across the world.

Commercial labs typically perform a greater number of nutrient analyses per sample than would be found in research trials, where the focus tends to be on specific or few components. In 1975 Dairy One provided 20 nutrients compared to 63 values in 2003. These more complete profiles would serve to greatly enhance aggregate tabular values.

Labs also receive samples from a greater number of different sources. This enables the lab to produce a more robust database and truer indication of variation within a feed type. Table 2 compares summarized data for commonly fed grains from Dairy One compared with data from the 1989 Horse NRC. The corn data were relatively consistent across the two sources. Compare this to the oats and barley data. Calculated

Table 2. Comparison of small grains (DM basis) from Dairy One (5/01/00-4/30/04) and the NRC (NRC, 1989).

	Dairy One Oats			*NRC Oats*			*Dairy One Corn*			*NRC Corn*			*Dairy One Barley*			*NRC Barley*		
	n	*mean*	*sd*	*n*	*mean*	*sd*	*n*	*mean*	*sd*	*n*	*mean*	*sd*	*n*	*mean*	*sd*	*n*	*mean*	*sd*
CP, %	270	12.9	2.4	110	13.3	1.3	1699	9.4	1.8	527	10.4	1.4	439	12.9	2.2	304	13.2	1.9
ADF, %	206	13.2	5.3	2	15.9	1.6	1361	3.6	1.3	5	4.1	0.8	416	7.7	4.1	13	7.0	5.2
NDF, %	208	27.2	9.8	14	27.3	4.5	1376	10.0	3.1	3	10.8	2.1	427	19.6	7.1	25	19.0	3.3
DE, Mcal/kg		3.34			3.20			3.87			3.84			3.65			3.69	
Fat, %	184	7.2	2.0	108	5.2	1.	1090	4.4	1.6	89	4.1	0.6	231	2.7	1.3	208	2.0	0.5
Ash, %	155	2.7	1.3	91	3.4	0.5	789	1.5	0.5	64	1.5	0.3	181	3.1	1.2	217	2.7	0.3
Starch, %	92	44.4	10.5				737	70.4	4.4				141	53.7	9.7			
Ca, %	189	0.15	0.15	64	0.09	0.03	1147	0.05	0.16	48	0.05	0.07	336	0.10	0.12	117	0.05	0.02
P, %	189	0.42	0.08	71	0.38	0.05	1137	0.33	0.12	47	0.31	0.04	336	0.44	0.11	134	0.38	0.07
Mg, %	185	0.15	0.03	48	0.16	0.03	1129	0.13	0.13	41	0.12	0.03	335	0.15	0.04	73	0.15	0.02
K, %	185	0.58	0.20	47	0.45	0.12	1130	0.41	0.10	35	0.37	0.03	335	0.59	0.17	71	0.50	0.13
Na, %	122	0.03	0.10	15	0.06	0.03	745	0.04	0.20	26	0.03	0.01	255	0.04	0.13	19	0.03	0.02
Fe, ppm	122	108	80.2	38	73	25.2	712	63	104	29	35	12.6	255	99	131	59	83	30
Zn, ppm	122	36	28.6	40	39	10.9	712	24	18	33	22	5.5	255	32	15.2	65	19	18
Cu, ppm	122	8	4.6	27	7	1.8	712	3	3.2	33	4	1.3	255	6	2.6	45	9	4.1
Mn, ppm	122	51	21	37	40	10	712	9	15.2	31	6	1.5	255	20	10.5	60	18	3.7
S, %	97	0.14	0.04	13	0.23	0.01	756	0.1	0.02	7	0.13	0.02	203	0.13	0.03	14	0.17	0.01

coefficients of variation (cv) for NDF (36.0%, 36.2%) and starch (23.6%, 18.0%) in the Dairy One data for oats and barley, respectively, are greater than the NRC (NDF: 16.4%, 17.3%; no starch figures available). The wide variation in starch is extremely important as the management of carbohydrates in equine diets continues to receive increasing emphasis. Table users need to be aware of the diversity in nutrient composition of commodities.

The area of mineral composition values needs an infusion of fresh data. Table 3 compares the mineral values of common grasses from the 1989 Horse NRC to Dairy One. There is a large disparity in the number of observations (NRC <4, Dairy One >6000). Of particular interest is the difference in copper values. The NRC values are 2.0 to 2.9 times the Dairy One values and inconsistent with values from other NRC publications. Table 4 compares the Horse NRC values for grasses with other NRC publications.

As a result, some commercial labs have created large databases of nutrient values. Dairy One published an annual summary of analytical results until 1996 when it became cost-prohibitive. This information was of great value to the feed industry and was sorely missed. The advent of the Internet allowed us to establish a platform for storing and updating information and making it available in a readily accessible form. Nutrient composition data are available to the public on both our dairy (dairyone.com) and equine (equi-analytical.com) Web sites. Data are summarized on annual and cumulative bases and serve as valuable references for industry professionals and laymen alike. The large numbers of observations provide the industry with confidence in the published values. For example, the crude protein values for legume hay reported in Table 1 are from 51,389 observations compared to 63 observations in the 1989 Horse NRC.

Building Tables

Feed composition tables are a necessary component of the nutrient requirement series to provide users with baseline values for different feed types. To be useful, the tables should be built on large numbers of observations to accurately represent feed and forages commonly fed to today's livestock. Future NRC committees should seek out as many sources as possible to ensure the robustness of the data presented in the tables. Commercial labs perform the bulk of nutrient analyses in the U.S. and hopefully would be willing to share information for the betterment of the industry. A precedent was set when the committee writing Nutrient Requirements of Dairy Cattle (NRC, 2001) sought and extensively used commercial analyses in the development of its published tables. This greatly increased the number of observations and the value of the information therein. Table 5 compares the 1989 Horse NRC to the 2001 Dairy NRC. The large difference in the number of observations inspires greater confidence in the use of these values.

Table 3. Comparison of grass hay mineral values (DM basis) between the *Nutrient Requirements of Horses* (NRC, 1989) and Dairy One (5/01/00 - 04/30/04).

	NRC Bermuda 56d growth		*NRC Brome mid bloom*		*NRC Fescue mature*		*NRC Orchard late bloom*		*NRC Timothy full bloom*		*Dairy One Grass*		
	n	*mean*	*n*	*mean*	*n*	*mean*	*n*	*mean*	*n*	*mean*	*n*	*mean*	*sd*
Ca, %	1	0.26	1	0.29	2	0.41	1	0.26	3	0.43	14309	0.54	0.22
P, %	1	.018	1	0.28	2	0.30	1	0.30	4	0.20	14311	0.25	0.08
Mg, %	1	0.13	1	0.10	2	0.16	1	0.11	3	0.09	14246	0.21	0.08
K, %	1	1.30	1	1.99	2	1.96	1	2.67	4	1.99	14324	1.89	0.57
Na, %		x	1	0.01	1	0.02	1	0.01	3	0.07	6374	0.05	0.11
Fe, ppm		x	1	91	2	132	1	84	2	140	6359	177	220
Zn, ppm		x	1	30	2	35	1	38	1	54	6362	23	14
Cu, ppm		x	1	25	2	22	1	20	2	29	6360	10	5
Mn, ppm		x	1	40	2	97	1	167	2	93	6361	66	57
S, %		x		x		x		x	3	0.14	8291	0.18	0.07

x = no values reported

Table 4. Comparison of grass hay mineral composition (DM basis) between NRC publications (NRC, 1982, 1989, 2001).

	NRC Horse 1989*	*NRC* US-Can 1982*	*NRC** Dairy 2001*
Ca, %	0.43	0.43	0.58
P, %	0.20	0.20	0.23
Mg, %	0.09	0.14	0.20
K, %	1.99	1.64	2.01
Na, %	0.07		0.04
Fe, ppm	140	157	156
Zn ppm	54		31
Cu, ppm	29	5	9
Mn, ppm	93		72
S, %	0.14		0.21

*Values for full bloom timothy hay
**Values for all grass hays

Table 5. Comparison of grass hays (DM basis) from the dairy (NRC, 2001) and horse (NRC, 1989) nutrient requirement series.

	*Dairy NRC 2001**		*Horse NRC 1989***	
	n	*mean*	*n*	*mean*
CP, %	4702	10.6	15	8.1
ADF, %	4695	39.5	8	37.5
NDF, %	4695	64.4	8	64.2
DE, Mcal/kg		1.97		1.94
Fat, %	542	2.6	7	2.9
Ash, %	1791	7.6	8	5.2
Ca, %	4653	0.58	3	0.43
P, %	4653	0.23	4	0.20
Mg, %	4653	0.20	3	0.09
K, %	4653	2.01	4	1.99
Na, %	1321	0.04	3	0.07
Fe, ppm	1321	156	2	140
Zn, ppm	1321	31	1	54
Cu, ppm	1321	9	2	29
Mn, ppm	1321	72	2	93
S, %	1448	0.21	3	0.14

*Values for all grass hays
**Values for full bloom timothy hay

Classifying Feeds

Previous editions of NRC publications have attempted to characterize forages by species and stage of maturity. No one can argue the impact of these two factors on forage quality, but assembling data of this nature is difficult. From a commercial lab standpoint, consider the following:

1. True sample identification is often missing.
2. Stage of maturity is rarely reported.
3. More often than not, samples are mixtures rather than pure forages.
4. Ability of the person submitting the sample to accurately identify the species and stage of maturity is unknown.

All attempts are made to properly identify feeds at the lab. Dairy One uses 471 different codes to categorize feeds. No feeds are classified by stage of maturity. There are some individual forage codes, but to simplify matters for our customers, hay crop forages are divided into four broad categories: legume, mixed mostly legume (MML), mixed mostly grass (MMG), and grass forages. Customers can usually place forages correctly into one of these groups. Evidence of this can be seen in Table 6. Note the expected decline in CP and rise in ADF and NDF as samples move across the continuum from legumes to grasses.

Table 6. Comparison of major nutrients (DM basis) for broad categories of hays as classified by Dairy One (5/01/03-4/30/04).

	Legume	*MML**	*MMG**	*Grass*
CP, %	21.1	17.0	12.1	10.6
ADF, %	30.0	35.3	38.7	39.1
NDF, %	38.6	49.7	60.6	63.7

*Mixed mostly legume and mixed mostly grass hays

Cherney et al. (1993) reported similarity in nutrient composition across grass species and stage of maturity. Table 7 is a comparison of late bloom orchardgrass, full bloom timothy, and mid bloom timothy from the 1989 Horse NRC and grass data from Dairy One. Based on the lack of observations in the NRC data, it is clear that the broad grass category used by Dairy One would provide sufficient values to be used for any of these.

The 2001 Dairy NRC committee recognized this fact. Species and maturity data were eliminated from the nutrient composition tables and were replaced by broader forage categories. This enabled them to:

1. Increase the numbers of observations.
2. Report better standard deviations.
3. Provide current, robust data for industry use.

Table 7. Comparison of several grass hays (DM basis) across species and maturities (NRC, 1989) with Dairy One grass hays (5/01/03-4/30-04).

	Late bloom orchard (NRC)		*Full bloom timothy (NRC)*		*Mid bloom timothy (NRC)*		*Mean of hays (NRC)*		*Grass (Dairy One)*	
	n	*mean*	*n*	*mean*	*n*	*mean*	*n*	*mean*	*n*	*mean*
CP, %	1	8.4	15	8.1	20	9.7	36	8.7	15097	10.6
ADF, %	3	37.8	8	37.5	13	36.4	24	37.2	14815	39.1
NDF, %	3	65.0	8	64.2	13	63.7	24	64.3	15030	63.7
DE, Mcal/kg		1.94		1.94		2.02		1.97		1.98
Fat, %	1	3.4	7	2.9	11	2.6	19	3.0	8074	2.5
Ash, %	3	10.1	8	5.2	8	6.1	19	7.1	8170	7.6
Ca, %	1	0.26	3	0.43	2	0.48	6	0.39	14309	0.54
P, %	1	0.30	4	0.20	2	0.23	7	0.24	14311	0.25
Mg, %	1	0.11	3	0.09	3	0.13	7	0.11	14246	0.21
K, %	1	2.67	4	1.99	3	1.82	8	2.16	14324	1.89
Na, %	1	0.01	3	0.07	1	0.01	5	0.03	6374	0.05
Fe, ppm	1	84	2	140	3	149	6	124	6359	177
Zn, ppm	1	38	1	54	1	43	3	45	6362	23
Cu, ppm	1	20	2	29	2	16	5	22	6360	10
Mn, ppm	1	167	2	93	2	56	5	105	6361	66
S, %			3	0.14	1	0.13	4	0.14	8291	0.18

Summary

Feed composition tables are an essential component of the nutrient requirement publication series created by the NRC. It is the charge of the committees to locate and assimilate data to provide the industry with meaningful reference/baseline values. Confidence in values improves when represented by larger numbers of samples. Measures of variation must be included to reflect the variation inherent in the population. Commercial forage/feed laboratories conduct the majority of analyses in today's market. Many have large nutrient databases. Commercial labs should be sought out to see if they are willing to share this information with the committee. The previous NRC dairy committee recognized this fact and included extensive commercial data in its tables. The large number of observations and inclusion of standard deviations has improved the robustness and usefulness of the nutrient composition tables. A good goal would be to create a single Web-based nutrient composition table for all species that would be routinely updated and upgraded.

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